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Innovation as social processes

A participative study of the Statoil R & D program Subsea Increased Oil Recovery (SIOR)

Thesis for the degree of Philosophiae Doctor

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Norwegian University of Science and Technology
Faculty of Social Sciences and Technology Management
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Sammendrag

Denne avhandlingen er basert på en studie av samhandlingsprosessene i et forskningsprogram i Statoil kalt *Subsea Increased Oil Recovery*. Programmet ble gjennomført i perioden 2004 til 2007. Hensikten med programmet var å utvikle og ta i bruk ny teknologi og nye arbeidsprosesser for å oppnå økt oljeutvinning fra selskapets undervannsbrønner på norsk sokkel. Studien stiller spørsmålstegn ved om eksisterende modeller og teorier utviklet for å forklare innovasjon i tilstrekkelig grad fanger opp de flyktige, komplekse og situasjonsspesifikke aspektene ved pågående innovasjonsprosesser, og derfor gir oss et feilaktig inntrykk av at innovasjonsprosesser kan designes og styres av enkeltpersoner. Det som synes å være oversett i rådende perspektiver, er at innovasjon resulterer fra direkte og indirekte relasjoner mellom et stort antall mennesker, som enkeltvis og sammen er opptatt med å gjøre det de skal gjøre i sin jobbsituasjon. Det betyr altså at innovasjon handler om samhandling mellom mange mennesker som har ulike roller, funksjoner og intensjoner, og derfor omfatter aspekter som makt, kontroll, mening og identitet. En konsekvens av dette synet er at innovasjon verken kan betraktes som forhåndplanlagte handlinger eller som tilfeldige hendelser, men heller som et framvoksende fenomen som på samme tid blir gitt generell og situasjonsspesifikk mening i jobbhverdagen.

Det viktigste bidraget fra denne studien er tilnærmingen som er benyttet for å beskrive og forklare pågående innovasjonsprosesser. Erfaringer og tematikk knyttet til innovasjonsprosessene i Statoil ble utforsket med utgangspunkt i teorien om *komplekse responderende prosesser.* Et nøkkelargument er at for å videreutvikle forståelsen for innovasjonsprosesser, er det nødvendig å flytte fokus innen forskning på innovasjonsprosesser bort fra en søken etter faktorer som hemmer og fremmer innovasjon, og studere de selvorganiserende, framvoksende egenskapene ved menneskelig kommunikasjon med utgangspunkt i de aktivitetene som skjer i hverdagen i en organisasjon. Studien indikerer at perspektivet *komplekse responderende prosesser* kan lede til en mer grunnleggende forståelse for innovasjonens natur, fordi oppmerksomheten rettes mot utviklingen av handlingsmønstre som gradvis gjenkjennes som “innovasjon”, og mot spørsmål som hva det er som gjør at noen mennesker, eller grupper av mennesker, er mer mottakelige for nye ideer enn andre.

Abstract

In this study, collaboration processes in the Norwegian petroleum company Statoil intended to lead to the development and use of new technology and work processes supportive of increased oil recovery from subsea wells on the Norwegian Continental Shelf have been studied. The authors' experience as participant observer in the Statoil research program *Subsea Increased Oil Recovery* from 2004 to 2007 indicated that most approaches to innovation fail to capture the fluid, complex and situational properties of ongoing innovation processes, and therefore leave us with the impression that innovation can be designed and controlled. What these perspectives tend to ignore, is that innovation is the outcome of direct and indirect relations between many people attending to their responsibilities at work, implicitly involving communicative aspects such as power, control, meaning and identity. Therefore, innovation should be seen neither as designable courses of action, nor as events evolving by chance, but rather as an emerging phenomenon; paradoxically generalized and particularized in the experiences of everyday social interactions.

The main contribution of the study is the exploration of the relevance of taking a *complex responsive processes perspective* on innovation processes. Innovation is seen as everyday communicative patterning processes which at the same time uphold and change patterns of power relating and identity formation. A key argument is that in order to move our understanding of innovation processes in organizations ahead, it is necessary to turn our attention in innovation research away from the quest for factors which stimulate or suppress innovation towards exploring the self-organizing, emerging nature of communicative interaction in terms of ongoing everyday activity in organizations. The study indicates that the complex responsive processes perspective can provide a deeper understanding of innovation processes by directing attention towards how patterns of action recognized as 'innovation' evolve in everyday life in organizations, and towards questions like what it is that makes some groups of people more susceptible towards innovative ideas than others.

Acknowledgements

If somebody had told me, five years ago, that I was going to apply for admission at the PhD in Sociology at NTNU some months later, I would have thought they were talking nonsense. Still, for several reasons, that was what happened. I sincerely thank Irene and Vidar Hepsø for letting me know that some people in Statoil searched for somebody like me to study their innovation processes, for insisting that this was an opportunity I should consider, for willingly sharing their expertise throughout the study, and for being my friends. I am also indebted to my former SINTEF colleague, Sigmund Kvernes, who taught me the word ‘innovation’ in 1993, and about six years later, introduced me to complexity sciences. Without his confidence and inspiring enthusiasm, this dissertation would probably never have come to be. I am also deeply grateful to Per Morten Schiefloe for believing I could manage this study, even if I barely knew what sociology was the first time we met. He has patiently guided me into the world of organizational theory, challenged me not to run too carelessly over it, yet open-mindedly supported my desire to explore alternative ideas. Sincere thanks also to Stig Ole Johannessen for spending so much time with me discussing the ideas of the complex responsive processes perspective. Our conversations and joint paper preparations brought about new thoughts which are included as important parts of this dissertation. Thanks are also merited by my colleagues at Studio Apertura, for inspiring professional discussions, everyday consideration, and fun. It is a privilege to know you. A special thanks to Tor G. Syvertsen, who searches out the most priceless professional and non-professional contributions on the internet, tailored to my current situation, to Arne Krokan, who provided valuable response and encouragement at the finishing stage, and to Ellen Knudsen, who always cares. Thank you also to Aslak Eide Bø and Siri Loretta Griffin for taking on the most tedious of all jobs, transcribing my interviews.

This dissertation would not have been possible without quite a few other persons. Many of them are, or were, employed in StatoilHydro (Statoil). Very sincere thanks to SIOR program director Rolf Utseth for generously including me in the SIOR core team for almost four years. Through this, and in many other ways, he made it possible for me to gain close insight into the Statoil up-stream operations and development processes. Special thanks also to the members of the original SIOR core team; Per Ivar Karstad (who still pops in for an inspirational chat), Steinar Strøm and Eric Ulland, who accepted me with such receptiveness, and spent so much time explaining me about their tasks and their challenges. Moreover, I would like to thank the succeeding core team members: Bjørn André Egerdal, Svein Omdal, Alfhild Lien Eide, Halvard Kjørholt, Per Kristian Munkerud, Ola Petter Munkvold, Mark Thompson, Knut Håvard Norstad, Jan Richard Sagli, Audun Faanes, Kjell Arne Haugen, and Adelheid Rø. I highly appreciate your accommodating attitude and your willingness to share knowledge and reflections during my study. I also owe special thanks to the TAIL core team, managed by Astrid Jørgenvaag, to Tyrihans core team manager Ståle Gjersvold, and to investment manager Asle Jostein Hovda, for inviting me to several of their meetings, and for educating me about some of the many considerations they faced in their everyday Statoil life. Next, I want to thank everybody else who took their time to talk with me about their work. A big thank-you-hug to Dag Sjong for being the best and most including of friends. My reference group, Terje Overvik, Roar Andersen, Cato Wille, and Rolf Utseth also deserve sincere thanks for being there for me, for sharing experience and Statoil anecdotes, and for showing only limited interest in my first ideas. Particular thanks to Cato for his untiring engagement, interest and friendliness.

Finally, the biggest thank you goes to the pillars of my life, Olav and our great youths, Idun, Eirik Audun, and Erlend. When this study started, we were a 'fresh' family. Our first years together brought along more change and challenge for all of us than anybody could have foreseen. During all the time, the four of you precious 'children' have shown a lot of courage and consideration, and I feel so lucky to share my life with you. Thank you ever so much for being who you are. All along, Olav has continued to lend his ear to my more or less well founded reflections and explanations with incredible patience, and his shoulder has always been available to make the grey days bright again. You are the love of my life and my best friend, thank you.

- Tone Merethe, December 2008.

Abstract

This dissertation examines collaboration processes in Statoil intended to lead to the development and use of new technology and work processes supportive of increased oil recovery from subsea wells on the Norwegian Continental Shelf. My experience as participant observer in the Statoil R & D program *Subsea Increased Oil Recovery* from 2004 to 2007 indicates that traditional approaches to innovation research fail to capture the fluid, complex and situational properties of innovation processes, and leave us with the impression that innovation can be designed and controlled. What appears commonly neglected is that innovation is social processes, influenced by large numbers of individuals who follow their intentions, and who at the same time are interdependent. This involves an understanding that the actual development of such processes can not be foreseen. Moreover, it means that decisions about innovation can be seen as decisions to shift existing individual and joint experiences of communicative aspects such as power, control, meaning and identity.

In accordance with this, I have addressed theoretical and practical consequences of adopting a *complex responsive processes* perspective on innovation processes in the particular context of Statoil. The investigation was guided by my wondering *how innovation, understood as novel patterns of talk (action), evolves in the course of everyday professional life.* The argumentation goes in favour of the value and potential of moving attention in innovation process research away from the quest for factors which stimulate or suppress innovation towards exploring the basic feature of commercial life, which is seen to be communicative interaction. Innovation is seen as a phenomenon inherent in all human interaction, and should therefore be seen neither as designable courses of action, nor as events evolving by chance, but rather as an emergent phenomenon; paradoxically generalized and particularized in the experiences of everyday interactions in business. This line of thought resulted in a comprehensive review of existing innovation literature (chapter 3), an elaboration of the phenomena of innovation and change seen from a complex responsive processes perspective (chapter 8), and of the challenges of variation in innovation research (chapter 9). It also formed the basis for the four papers:

A. Johannessen, S. and Aasen, T. M. B. (2007) Exploring Innovation Processes from a Complexity Perspective. Part I: Theoretical and Methodological approach, *International Journal of Learning and Change*, Vol. 2, No. 4, pp. 420 – 433

The relevance of taking a complexity perspective on innovation processes is explored in two consecutive papers, paper A and B. In this first part the need for novel perspectives in this research field is discussed, and the relevance of the theoretical and methodological approach of the complex responsive processes perspective in meeting these needs. Some central aspects and implications of this approach are outlined. The key argument is that in order to move our understanding of innovation processes in organisations ahead, it is necessary to study the self-organising emerging nature of communicative interaction in terms of ongoing everyday activity in organisations. Based on the empirical findings, the phenomena of leadership, power and identity are found to be crucial for the explanation and understanding of innovation. Consequently, particular attention is given to the nature of these phenomena from a complexity perspective.

B. Aasen, T. M. B. and Johannessen, S. (2007) Exploring Innovation Processes from a Complexity Perspective. Part II: Experiences from the SIOR case, *International Journal of Learning and Change,* Vol. 2, No. 4, pp. 434 – 446

In this paper, an empirical example to strengthen further the relevance of the complex responsive processes perspective to innovation is presented. The example draws on experiences form the present study, which was performed with an attitude and understanding of emergent participative exploration, an approach rooted in the complex responsive processes perspective. It is demonstrated how this perspective reorients attention towards the everyday communicative action which constitutes innovation processes. The findings suggest that innovation could be understood as self-organising emergence of conversational patterns, identity formation, power relations and leadership. It is argued that seeking to explain innovation efforts in complexity terms opens up potential for the movement of thought in innovation research.

C. Aasen, T. M. B. (2008) A complexity perspective on innovation processes for subsea technology development. *International Journal of Learning and Change,* special issue on Complexity, Leadership and Change Processes, Vol 3, No. 3, pp. 294 - 307

In today's business thinking, innovation is commonly equated with progress, indicating an underlying assumption that company management have the power to choose a specific future and control the way into it. Drawing on examples from the present study, this paper raises some of the problems with this thinking. Experiences from the study indicate that most people in the organization do not consider what they do in their everyday organizational life as 'innovation', but rather as the provision, testing and use of technology. This suggests that the recognition of everyday activity as acts of innovation is an emergent phenomenon, expressed and potentially idealized in retrospection. The importance ascribed to technology as the enabler of a chosen future also makes topical the conceptualization of 'technology' in terms of innovation.

D. Aasen, T. M. B. and Johannessen, S. (2009) Innovation management as communicative processes: Experiences from the Statoil SIOR R&D program. The enclosed version is based on a paper presented at the *International Communication Association (ICA) conference* in Montreal, 2008, as part of a four paper panel 'The Use of Complexity Science in Applied Organizational Settings'. A revised version of the paper is published in *International Journal of Business Science and Applied Management*, Vol 4, No. 3, pp. 22 – 33 (title modified to 'Managing innovation as communicative processes: a case of subsea technology R&D').

In this paper some findings from the present study are interpreted from a complex responsive processes perspective. Attention is on innovation management as everyday communicative action between organizational actors. Our findings suggest that innovation processes can be seen as communicative patterning processes which at the same time uphold and change patterns of power relating and identity *formation. These processes are influenced by a number of people, having their own intentions and plans, and are not controllable by any one individual or group in the organization. Management of such processes is therefore not about 'being in control', but rather about the intentional participation in everyday conversations where the quality of relations influences peoples' ability to go on together. From this perspective top management inclination to over-focus on control and monitoring of processes of innovation could be seen as a disregard for the significance of participation as a management 'tool' in innovation processes.*

Preface

This dissertation is submitted as a partial fulfilment of the requirements for the degree Philosophiae Doctor (PhD) at the faculty of Social Sciences and Technology Management at the Norwegian University of Science and Technology (NTNU). The study was carried out between 2004 and 2008, financed by StatoilHydro. My advisors have been Professor Per Morten Schiefloe at the Department of Sociology and Political Sciences, and Stig Ole Johannessen, Adjunct Professor at Bodø Graduate School of Business. The dissertation consists of four papers and an additional introductory part where I present the background for the study, research questions, the Statoil Subsea Increased Oil Recovery R & D program, a review of existing innovation literature, some theoretical background, research approach, and main results. I also expand upon a few themes which I find inadequately dealt with in the papers, and discuss some possible implications of the study for further innovation practices and for academic investigation. The individual papers, which represent the groundwork of the dissertation, are attached in section II. Three of the papers are written in collaboration with Stig Johannessen. Our contributions to papers A and B are equivalent. Stig's contribution to paper D could be estimated to about one fifth of the total work. Paper C and chapters 1-9 of this dissertation are solely my own work, although it is important to acknowledge the valuable insights of my supervisors. The papers are:

A. Exploring Innovation Processes from a Complexity Perspective. Part I: Theoretical and Methodological approach. Johannessen, S. and Aasen, T.M.B, 2007. International Journal of Learning and Change, Vol 2, No. 4, pp. 420 – 433[1].

B. Exploring Innovation Processes from a Complexity Perspective. Part II: Experiences from the SIOR case. Aasen, T.M.B. and Johannessen, S., 2007. International Journal of Learning and Change, Vol 2, No. 4, pp. 434 – 446.

C. A complexity perspective on innovation processes for subsea technology development. Aasen, T.M.B., 2008. International Journal of Learning and Change, Special issue on Complexity, Leadership and Change Processes, Vol 3, No. 3, pp 294 - 307.

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B. Exploring Innovation Processes from a Complexity Perspective. Part II: Experiences from the SIOR case. Aasen, T.M.B. and Johannessen, S., 2007. *International Journal of Learning and Change, Vol 2, No. 4, pp. 434 – 446.*

C. A complexity perspective on innovation processes for subsea technology development. Aasen, T.M.B., 2008. *Accepted for publication in International Journal of Learning and Change, Special issue on Complexity, Leadership and Change Processes.*

D. Innovation management as communicative processes: Experiences from the Statoil SIOR R&D program. Aasen, T.M.B. and Johannessen, S., 2009. *Accepted for publication in International Journal of Business Science and Applied Management*.

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1 Introduction and overview

The general reader will have to
make up his mind whether he wants simple
answers to his questions – or useful ones,
in this as in other economic matters, you cannot have both.
Schumpeter, 1930

Innovation is often made to look like an almost magical opportunity to success. Today, there is hardly any paper about innovation which does not emphasize the vital importance of this ‘tool’ for the adaptability, competitiveness and economic growth of companies (Arad et al., 1997; Hamel and Getz, 2004; Damanpour and Wischnevsky, 2006; Koc and Ceylan, 2007). Most research results are based on for-profit companies, but innovation in public sector (Frederickson and Johnston, 1999) and in non-profit organizations (Wheatley, 2002) has also been looked into

’Innovation’ is not only a concept in fashion, but has during the last 50 years also been developed into a comprehensive field of research. The Austrian economist Joseph Schumpeter has been pointed out as the ’godfather’ of innovation research (Tidd et al., 2005). He published his first book, *The Theory of Economic Development,* as early as in 1911. In the book he discusses the limitations of contemporary economic thinking as an explanatory factor for economic developments, and the role of innovation in this connection. Schumpeter’s’ conception of innovation was broad. He pointed out the importance of technology, but also of knowledge as the basis for development of new products, production processes, the opening of new markets, adoption of new raw materials, and reorganizing of economic sectors. Schumpeter has, however, been renowned primarily for his focus on the *entrepreneur* as the prime mover of innovation, and the source to ‘creative destruction’ as innovations caused old inventories, ideas, technologies, skills, and equipment to become obsolete. The question, as Schumpeter saw it, was not how capitalism administers existing structures, but how it creates and destroys them, causing continuous progress and improved standards of living for everyone. In his later years of research, Schumpeter became more engaged in the role played by large enterprises as main 'engines' for the development of innovation and economic growth. Schumpeter's ideas have been greatly acknowledged, and are still a source of inspiration for many researchers within the field of innovation research. His ideas can also be recognized in the EU development plan for innovation, *Green paper on innovation* (1995), in which innovation is referred to as a fundamental economic process, as well as in the EU report *Future directions of innovation policy in Europe* (2002). Although Schumpeter was an economist, his work is of interest seen from an organizational perspective as well, because of his attempt to integrate sociological knowledge into his economic theories (Swedberg, 2000).

With the exception of Schumpeter's work, the phenomenon of innovation was ignored by researchers for a long time, and did not appear as a separate field of research until the 1960's (Fagerberg, 2005). In 1961 Burns and Stalker published the at the time pioneering book 'The management of innovation', in which innovation for the first time was discussed from an organizational theoretical perspective. Later on a great number of contributions from researchers within many disciplines have been published. Between mid-1960s and early 1980's innovation research was dominated by descriptive studies (Rothwell, 1994), which focused on conceptualization and theory building, and on relations between contextual factors and organizational characteristics related to innovation. In the course of the 1980s the theoretical basis was extended, and a large number of books and papers were published offering normative advice on how organizations should be designed and managed to promote innovation.

The last 10-15 years, attention towards the importance of networks and learning for innovation processes has increased (Cohen and Levinthal, 1990; Nonaka, 1991; Nootebom, 1999). Social scientists have contributed substantially to current knowledge about organizational innovation, including knowledge about possible relations between characteristics of organizations and cooperation processes, and the outcome of innovation processes (Nonaka et al., 2000; Hargadon, 2003; Caloghirou et al., 2004; Evans and Wolf 2005). In my original dissertation research project description, I outlined a study intending to support and extend this line of research. I was, however, given the opportunity to take part in innovation processes in Statoil[2] as they happened. My close involvement with the strategic R & D program Subsea Increased Oil Recovery (SIOR) opened up the possibility of describing processes for innovation in terms of everyday life. This meant moving attention to perspectives and ideas very different from those I started out with. Although I am still very interested in the phenomenon of innovation in relation to business performance, it is safe to say that the outcome of my research is not in line with the original plan. But it is not entirely surprising that is should turn out like this, either.

1.1 How it started

I started on my doctorate study in January 2004, but it all began way before that, in 1993. Others would rightly say that it started many years before that; or maybe much later, but as I am the story teller, I have decided that this is how it goes:

One way to tell the story

In 1993 a formal collaboration agreement between The Norwegian petroleum company Statoil and the Norwegian University for Technology and Science, NTNU, was signed. This was the beginning of a program called PAKT (Program for applied coordination technology). PAKT was established as an interdisciplinary research program addressing problems related to organizational challenges and development in knowledge intensive organizations, focusing in particular on the areas of distributed collaboration and safety in work processes. Several PhD- and master students were engaged as part of the program. In 1998 PAKT was renamed 'Studio Apertura', but Statoil continued to be an important customer and research partner. During the 15 years since the first agreement was signed, a joint steering committee has met 3-4 times a year to follow up the still extensive joint project activities.

In 2003 this steering committee suggested that 'innovation' should be included as a new research area in Studio Apertura. The ground given for this was the concern of some Statoil directors that, despite an impressive company history of successful field

[2] The field study was carried out from 2004 until September 2007. The references are therefore made mainly to Statoil, and not to StatoilHydro, which was formally established October 1st, 2007 after a merger with the oil and gas division of Norsk Hydro.

developments, the innovative ‘spirit’ of Statoil was fading as the company expanded and focus on profitability and efficiency increased. In the Technology Strategy 2003 – 2012 Statoil had identified six business challenges which were believed to be of great importance to maintain the company capacity to renew and grow. Two of the six areas were about increased oil recovery, respectively from platform fields (Tail end production – shortened to Tail) and from subsea fields (Subsea Increased Oil Recovery - SIOR). In agreement between the SIOR core team members and the Statoil-Apertura steering committee, a 4-year doctoral fellowship funded by Statoil was established. The subject of the study was ‘innovation processes in Statoil’. The research fellow was to be employed at Studio Apertura, and given a temporary appointment in Statoil connected to the SIOR initiative. The fellowship was announced at the time SIOR was initiated, in the second half of 2003.

I was unaware of all this at the time. I worked as a middle manager in a private consultancy firm. It was a slack period in the market, and we were all occupied trying to get sufficient project assignments to cover the wage bill. One evening I went out with a friend to chat. We had not seen each other for a long time, and had a lot of catching up to do. She told me about her doctorate study at Studio Apertura. In the course of the evening she also mentioned the research fellow position connected to ‘innovation’, and encouraged me to look into it and consider applying for the position. The deadline for application was the next day. I was really exhausted at the time, and found the opportunity to do something different tempting. I liked my job, though, and besides, this was intended to be a doctorate study in sociology, and I was trained in medical engineering and management. Even though I had been working with innovation research for some years in my previous position, I doubted that I was formally qualified for this fellowship. I did in fact put in an application, mainly from curiosity. Being fairly sure that I was neither going to accept, nor get, an offer, I withdrew my application quite early in the process.

This incident had, however, made me reflect that maybe it would be smart for me to look for a less demanding job. During the 3-4 years before this my personal life had been turbulent. I had divorced and remarried, and established a new family including his children and mine, and the children deserved more of my attention. After some days destiny intervened, in the shape of a phone call from my friends’ husband, who happened to work in Statoil, in the SIOR project. We had never met, but my friend had told him about my background, and he wanted me back on the applicant list. To make the rest of the story short - I got the fellowship.

Now, let me tell you the story once more. This version is equally true, equally inaccurate, and in many ways different. I will start my story on a particular day in 2000. As I did not know at the time that this day was going to be important, the exact date has slipped my memory.

Another way to tell the story

At the time I was working in SINTEF[3]. My responsibility was to manage a National centre for innovation in health care. This particular day, my boss came to me to tell me about a meeting he had been attending, in which he had been introduced to a new theoretical approach to organization and management. He called this 'chaos theory', and he was very enthusiastic about it. To explain to me the essence of this perspective, he used a racing boat with a coxswain as a metaphor to current management thinking, whereas – said he - chaos theory was about eliminating both the coxswain and the boat. At the time I felt very unsure if this could be a good idea, but as I highly respected my boss, I decided to put some effort in understanding what he was talking about. He gave me a working paper called 'The emergence of Organizational Futures', written by an English professor named Ralph Stacey. From what I could grasp, the paper touched on knowledge from different parts of the natural sciences, and used this to discuss aspects of organizational life. I recognized many of the words, but they were set into a context where they made no sense to me.

At roughly the same time I was given the opportunity to participate in the Executive Master of management program at the BI Norwegian School of Management. In the required course reading material there were several books about chaos and complexity, two of them written by Ralph Stacey. Now I started to be really curious about this perspective, but none of the lecturers at BI were able to explain to me the substance of the ideas. So I read, and read again, and gradually I realized that what this was about

[3] SINTEF is the largest independent research organisation in Scandinavia

was my everyday experiences working in innovation projects. Convinced that this was a useful perspective, I decided to join in as one of the founding members of the Complexity and Management Centre, Norway (CMC Norway) in 2001. I paid the required amount, and became a very passive member.

Late 2001 I started to work for a private project management company. I headed a new section working mainly with organization development and work processes. We were newcomers in a market which at the time was in an expectant phase, and economically we were in a squeeze. My attention was everywhere but on complexity theory. However, somewhat coincidental I was encouraged to meet with the manager of CMC Norway in connection with a possible joint tender. During this meeting the Chairman of the Board of CMC Norway, showed up. His name was Stig Johannessen. We had a brief talk, and I was invited to a meeting with representatives from several other private companies, to discuss the relevance of complexity theory in our work. I attended the meeting, but concluded that the gap between my every day challenges and what the people from CMC Norway were talking about was too wide to justify further cooperation.

From various reasons I decided to apply for a 4-year fellowship at NTNU Studio Apertura about 2 years later. The fellowship was funded by Statoil, and the theme was innovation processes. I was accepted for the position after job interviews both at Studio Apertura and in Statoil, and started as a research fellow in January 2004. NTNU professor and Studio Apertura general manager Per Morten Schiefloe was supervising the study, which was titled: 'Innovation capability and business performance in large companies'. The original aim of the study was to contribute to the understanding of organizational characteristics affecting company level innovation, how such characteristics relates to business performance and growth in large companies, and the skills of companies to explore and exploit such characteristics. The assumption underlying the study was that innovative capacity at the organisational level reflects specific organisational and individual qualities, analytically decomposable to a set of organisational and individual characteristics. I further assumed that innovative performance could be improved through purposeful exploitation of such characteristics.

About a year into the study, one of my colleagues in Statoil asked if I would participate in an internal seminar. The theme was organization and management in a complexity perspective, and the visiting lecturer was Stig Johannessen. After the presentation, I went to say hello to him and learn more about his research. At the time I was looking for an alternative theoretical approach to analyze my empirical data, as experiencing innovation from 'inside' the very including context in Statoil had turned out to be a lot more confusing than I had predicted. I had already considered the possibility of exploring complexity theory as a way to make sense of my experiences and observations. Stig and I had several conversations about this, and I gradually became convinced that this was an exiting, but also challenging, way to go.

1.2 Research situation

Why do I tell these stories? One reason, of course, is to provide you with information about the origin of the present study. Another reason, which from my point of view is at least as important, is that they display a point which turned out to become influential of my thinking, and, in consequence, of the outcome of my work. The point is related to the particular, subjective and interdependent aspects of human experience, and the recognition that a factual situation (like time and place of events, who were there, what was discussed) is inseparably connected to some kind of evaluation (Stacey, 2007), which, over time and in the light of subsequent experience, may alter. Before I go into details on that, I will tell you a little more about the research situation I was invited into in Statoil.

Consistent with ethnographic research methods (e.g. Wadel, 1991; Becker, 1998; Magolda, 2000; Randall et al., 2007) I entered a role as associated member of the SIOR core team, which at the initiation of the program comprised four persons. I was granted an employee number and ID-card; given access to internal databases, e-mail system and intranet; and the opportunity to work on-site. For 3 ½ years I participated regularly in the fortnightly core team meetings, as well as in a range of other events. This enabled me to become closely involved with the flow of conversations related to SIOR. It was a comprehensive R & D program, which consisted of about 25 different technology development projects. More than a hundred people from Statoil as well as from supplying companies were engaged in the program activities. In addition, a large number of (internal) customers and managers in key positions were involved, in different roles. Among the challenges I faced trying to learn about Statoil innovation processes was hence the selection of arenas for participation. Everybody I met seemed to be involved in a multitude of meetings, conversations and communications with people in the company as well as in many other organizations, and it was impossible to predict which events, meetings or individuals would be most valuable for my research. My judgement of where to participate and whom to meet evolved and altered with time, and was influenced by the activities and conversations I became engaged in. Given the large number of events, I was able to experience only a fraction of the activities going on. I tried to fill in with stories told to me in both formal and informal conversations.

From my standpoint, partly taking part in SIOR activities, partly being an outsider, life in Statoil appeared as the intertwined actions of a large number of people, some being informed of each other, others not, yet all bound together in what Elias (1991) refers to as 'complex patterns of interdependencies'. Accordingly, experiencing innovative capacity from the everyday interactions in Statoil proved to be a bewildering activity. My idea was that to understand the innovation processes in SIOR I had to try not to take the role as evaluator of group processes in every meeting I attended. I rather attempted to look at the SIOR challenges 'through the eyes' of the people I talked to, in particular the SIOR core team members, to try to understand why they did what they did. In consequence I kept asking the SIOR core team members about their discussions and decisions, to check out if my understanding was in line with theirs. I noticed that while they were in the middle of a situation, their justification of events and actions tended to differ from the accounts they offered when I asked them to describe the situation in retrospect. In the latter case causal connections between decisions and outcomes were more often elucidated, as exemplified in my own story of 'how it all began'. Moreover, the accounts tended to become more generalized, yet also more complex as more details about the coincidental actions of others influencing the final outcome were known to them. It is reasonable to believe that they, like me, left out quite a few details from their stories, intentionally or unconsciously, and potentially also adapted it to fit an 'innovation context'.

1.3 Redefinition of purpose

I gradually recognized that my original research design, involving the search for generalized categories and connections, would limit rather than extend my understanding of innovation processes. Incidentally, the approach of isolating phenomena disembodied from space and time from organisational processes, and to ascribe to them an objective, universal validity, is increasingly questioned (Elias, 1978; Stacey et al., 2000; Tidd, 2001; Tsoukas and Hatch, 2001; Tsoukas and Chia, 2002; Weick, 2003; Dopson, 2005). Elias (2000:xii) substantiates this point of view in the following way:

> *It may perhaps seem at first sight an unnecessary complication to investigate the genesis of each historical formation. But since every historical phenomenon, human attitudes as much as social institutions, did actually once 'develop', how can modes of thought prove either simple or adequate in explaining these phenomena if, by a kind of artificial abstraction, they isolate the phenomena from their natural, historical flow, deprive them of their character as movement and process, and try to understand them as static formations without regard to the way in which they have come into being and change? It is not theoretical prejudice but experience itself which urges us to seek intellectual ways and means of steering a course between the Scylla of this 'staticism', which tends to express all historical movement as something motionless and without evolution, and the Charybdis of the 'historical relativism' which sees in history only constant transformation, without penetrating to the order underlying this transformation and to the laws governing the formation of historical structures.*

My search for approaches enabling me to find and explain the phenomenon of innovation in its '*natural, historical flow'* (Elias, 2000:xii) based on my SIOR experiences, led me to the theory of complex responsive processes (Stacey et al., 2000; 2007, Stacey, 2001; Fonseca, 2002; Griffin, 2002; Shaw, 2002; Johannessen and Stacey, 2005), as indicated in the second story. I will go into more detail about the complexity research in Chapter 5 and 6. In accordance with this change of perspective, I redefined the purpose of my study to be the *exploration of innovation processes in the SIOR program as complex responsive processes, to develop a possible new way to think about innovation which reflects better the everyday experiences of participating in and managing such processes.*

1.4 Overview of chapters

Chapter One: Introduction and overview

Chapter Two: Statoil and subsea increased recovery (SIOR)
In this chapter background information about the Statoil organization is provided, as it was during my SIOR study. I also go into detail about the SIOR program, its origin, objectives, and technological development areas, as well as important events and outcome.

Chapter Three: Innovation in organizations – current perspectives
In this chapter an overview of prevalent research perspectives on organizational innovation processes and innovation management are presented. First, an overview over definitions of innovation which have been proposed over the years is provided. Then, existing innovation studies are broadly classified. Next, focus is set particularly on research on innovation in organizations, and important research results and research approaches are described. Finally, a brief review is made of what we know and what we still want to know about innovation.

Chapter Four: Attempting to make sense of my experiences
This chapter deal with my shift of attention from a systems perspective to a radical process approach, which after about 1 ½ years of work implied my rejection of the original research questions. In this chapter I present and comment on the new research questions which emerged during the SIOR study, and guided the themes of the four papers constituting the core of this dissertation.

Chapter Five: Complexity science

In this chapter, attention is on the theoretical foundations known as the complexity sciences. The complexity sciences cover a number of strands and ways of thinking. In different ways they all show how particular kinds of dynamics arise when interaction has particular characteristics of diversity and connectivity, which both enable and constrain interaction between identities. In this chapter I account for the thinking on which these strands are founded. The chapter also includes a brief review of recent research on organizations, innovation and management based on the complexity sciences.

Chapter Six: Exploring organizations as complex responsive processes

The chapter is introduced by a brief account of process thinking in modern organization research. The rest of the chapter is devoted entirely to the complex responsive processes perspective, which forms the theoretical basis for the present study.

Chapter Seven: Research approach

This chapter presents the methodological orientation of this research, which was performed according to the ideas of the *emergent participative exploration* approach (Christensen, 2005). The account of the research processes includes descriptions of the processes of collecting and representing data, reflections on the role as participant observer, and on the themes of subjectivity, ideology, ethics, validity and generalizability.

Chapter Eight: From local interaction to widespread innovation

This chapter presents the key contributions of the present study, structured according to research questions. The chapter includes a reflection about the concepts of innovation and change, as they can be derived from a complex responsive processes perspective.

Chapter Nine: Significance and implications of research

In this final chapter, the contributions of the present research are discussed in light of prevailing ideas about innovation processes and innovation management. The problem of variance in innovation research is focused in particular, and the concept of context discussed. The chapter is concluded with some suggestions of implications of the present study for innovation practices, and for future research.

2 Statoil and subsea increased oil recovery (SIOR)

In spite of more than 30 years of production, only approximately 35 percent of the expected total oil and gas resources on the Norwegian continental shelf (NCS) have been produced. There is thus potential for further value creation (Facts 2007). In accordance with this, the ambition of the Statoil Research & Development (R & D) program called Subsea Increased Oil Recovery, or SIOR, was to increase the average recovery factor of oil from the subsea fields at the NCS from 43 % in 2003 to 55 % within the end of 2008. In the autumn of 2002, when the ambition was first suggested, this was seen as an unattainable and even unrealistic target by most managers and specialists in the company. Nevertheless, the ambition was given full support by the top management. What was it, then, which made Statoil employees so preoccupied with these percentages? To give you an idea of why this target was seen to be so important, and so difficult, let me indicate some figures. First, I will give a hint of the problem. Presently more than 50 % of the Statoil oil production on the NCS comes from subsea fields. The production rate of subsea fields is slower than on platform fields, and the average recovery rate is about 15 % lower. The costs of wells and necessary interventions on the other hand are higher for subsea fields, with a factor of about 10, meaning that there is a need to reduce the costs of development and use of subsea technology and operations substantially. As an example, the most important way to increase the recovery factor generally is to drill more wells, but the initial work of the SIOR core team identified the need for the cost of each subsea well to be reduced from 200 million NOK to 60 million NOK, which was a substantial challenge. A lot of the technology considered of interest as part of the SIOR program was already developed for platform fields, but had to be made lighter, smaller and cheaper, which was not seen as purely routine, either. In addition, operating subsea fields means that intervention largely has to happen through the use of rigs, and/or via remote control, adding costs, uncertainty, and risk.

Second, let me give you an indication of the profit potential of the SIOR ambition. An increase of *1 %* oil recovery, calculated over the lifetime of the NCS subsea fields, is roughly equivalent to 20 million Sm3 (standard cubic meters) oil, or 120 million barrels.

To compare with, the total daily production from all the Statoil fields on the NCS is approximately 1 million barrels. During the SIOR program period the price of oil increased substantially. For the sake of simplicity, I am nevertheless assuming an oil price of 50 US$ a barrel. This would mean that the gross value of an average of *1 %* increased oil recovery on the NCS subsea fields would come to *6 billion US$*. As the SIOR target was not an average increase of 1 %, but 12 %, the extra gross profit would be about *72 billion US$.* Today the oil price is well above 100 US$, and so, even with the present decrease of the dollar value, my calculations should be seen as modest. The profit potential of SIOR therefore was, and is, considerable.

Before I go into further detail about the SIOR program, I will give a brief summary of the petroleum history. I will also provide some background on the Norwegian petroleum sector and of the Statoil organization, which I believe will help to understand better the significance and challenges of the SIOR initiative.

2.1 The petroleum history in brief

Petroleum, or *crude oil,* is an oily, flammable liquid that occurs naturally in deposits, most often found beneath the surface of the earth. Over millions of years, plant and animal remains fall to the floor of shallow seas. As the seas recede, the plant material is covered by sediment layers, such as silt, sand, clay, and other plant material. Underneath layers of rock and debris, under an absence of oxygen, the organic material partially decomposes into petroleum that eventually seeps into the spaces between rock layers. As the continental crusts move, the rock is bent or warped into folds or it breaks along fault lines, allowing the petroleum to collect in pools. Crude oil seeps from natural springs in many localities, and has been known and used since ancient times. It has been mentioned by historians for more than 4000 years, although not as fuel, but among other things as the natural source to fire worship. It was also used for building mortar, for roads, for lighting (in a limited way), but chiefly for liniment and other medical purposes. Incidentally, the earliest known oil wells were drilled in China around year 350 AC.

In 1849 the Canadian geologist Abraham Gesner, who has later on been referred to as the 'father of the petroleum industry', distilled a new lamp fuel from petroleum, which he called kerosene. This achievement has been seen as the beginning of the modern petroleum history, and oil soon became known as *black gold.* American companies soon started to look for more effective ways of recovering oil, and the answer came with the development of drilling for crude oil. The very first land oil well was drilled in Pennsylvania by Edwin Drake in 1859 (en.wikipedia.org). The area quickly boomed and the modern oil industry was born, leading to i.a. the foundation of the petroleum companies *The Texas Fuel Co* and *British Petroleu*m in 1901, and *Dutch Shell* in 1907. Another of the international petroleum companies, *Chevron*, has roots all the way back to 1879, while *Exxon Mobil* originates from two companies, both established at the end of the 1800's.

Petroleum entered the energy market in the late 1800's as a kind of disruptive technology (Christensen, 1997), and soon outsold coal. As the demand for petroleum continued to grow exploration companies began to look below the sea bed. The first oil well structures to be built in open waters were in the Gulf of Mexico, around 1900. They were in water depths of up to 100 m, and the structures that were built were the fore-runners for the massive platforms that now stand in very deep water and in many locations around the world, including the North Sea. In Europe the first land oil wells were drilled in the 1920s, but it was not until the 1960s that exploration in the North Sea got started, without success in the early years. Oil was not discovered until 1969, in the Ekofisk field, but since then new fields have continuously been found. The subsequent development on the NCS is one of the greatest investment projects in the world.

Today, oil and gas are the world leading energy sources. The modern history of the petroleum industry has been closely connected with the economic and political developments in the 20th century. Prices of crude oil and gas are closely correlated with the state of the world economy, decisions of the OPEC cartel, war, terrorism and other political events. Evaluations of commerciality of oil discoveries and willingness to invest in R & D are largely based on anticipated prices of crude oil (income) and costs connected with field development and operations (expenditure). The total volume produced by the individual oil company is primarily affected by their capacity of finding oil, and the volume they are able to recover, referred to as the *recovery factor*, from each field. As each field is estimated to yield a certain volume of oil, profitability depends on costs related to exploration and development. This means that the most important driving forces for technology development are exploration success, cost reduction and production efficiency, in that order (Lægreid, 2001).

2.2 The Norwegian petroleum industry

Since the discovery of the Ekofisk field, the Norwegian petroleum industry has been developed and grown to be the largest industry in the country. The petroleum activities have contributed significantly to economic growth in Norway, and to the financing of the Norwegian welfare state. In 2006, the petroleum sector accounted for 25 percent of the national value creation (Facts 2007). Furthermore, crude oil, natural gas and pipeline services accounted for 51 percent of the value of Norway's exports. Since the petroleum industry started its activities on the NCS, enormous sums have been invested in exploration, field development, transport infrastructure, and land facilities; amounting to approximately NOK 2000 billion in current terms at the end of 2006.

The development of a Norwegian petroleum industry was not given. As early as 1962 the American oil company Phillips Petroleum approached the Norwegian authorities and asked to have the exclusive rights to exploration and recovery of oil and gas on the NCS. This was declined by the authorities, who did not want any company to get sole rights to what they regarded as Norwegian natural resources. The application resulted, however, in the initiation of seismic surveys and wildcat drilling, and the discovery of Ekofisk. Based on this, oil production was established as a business area in Hydro, an industrial company founded in 1905 based on the production of fertilizer, and being now a world leading supplier of aluminium.

In the beginning, the alliances between the Norwegian State and foreign petroleum companies were characterized by joint interests in exploiting the petroleum resources on the NCS. For Norway, this enabled the flying start of a national petroleum activity, supported by a substantial transfer of knowledge and capital primarily from the United States, as during the first years the Norwegian industry could offer little to the petroleum activity (Sejersted, 1999). The first oil discoveries contributed however to a change in the political thinking in Norway, towards the dedicated engagement to make the most of the petroleum activity for value creation in and for the Norwegian society. This led to the decision to establish a petroleum directory and a wholly government owned petroleum company. Hence, in 1972 the Norwegian State Oil company – Statoil – was formed with 6 employees, and with the given task to administer the interests of the Norwegian State on the NCS. In the beginning, the identity of Statoil was somewhat diffuse. It was partly seen as an operative oil company, partly as a political instrument. Two years after the establishment, the Statfjord-field was discovered in the North Sea, and five years after that, in 1979, production commenced, operated by Mobil, and owned 44 % by Statoil. In 1981 was Statoil the first Norwegian company to be given operator responsibility for a field, at Gullfaks in the North Sea. Production on Gullfaks started in 1985.

The history of Statoil, now StatoilHydro, is a history of growth and of substantial political, economical and technological changes. Even if over the years there has been a tremendous development in the petroleum business, Statoil members did not seem to see this as dramatic, but referred to the changes as 'steps following as natural consequences of the preceding'. Roughly, four main epochs can be identified:

The 1970's were the years of establishment, characterized by competence building, national positioning and large challenges related to the development of the Statfjord field, which is still one of the largest offshore petroleum fields. It was put on stream in 1979 and operated by Mobil until 1987, when Statoil took over the exploration rights.

During **the 1980's** the company grew to be a large actor in the European gas market. Among other things Statoil representatives presided at the discussions about sale of gas from the Troll field. The company entered into extensive contracts, and developed and operated gas transport systems and terminals. It also gained foothold in Denmark and Sweden through the acquisition of all the service stations, refineries and petrochemical industry at the time owned by Esso. The internationalization continued during **the 1990's** – which were also characterized by technological innovation leading to floating production plants and the development of subsea fields. Statoil grew rapidly, expanded in product markets, and pursued international exploration and production in alliance with British Petroleum. Incidentally this initiative was not a success, and the alliance was winded up.

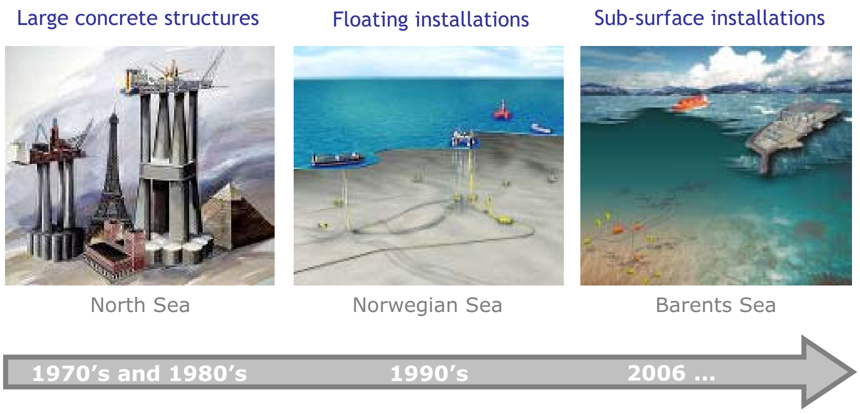

Figure 2-1 Technology development on the Norwegian Continental Shelf (Photo: Statoil)

In **2001** Statoil was partly privatized, and the shares quoted on the stock markets in Oslo and New York. The company is still majority owned by the Norwegian State, and has obtained a dominant position as operator on the NCS. Today, the company is subjected to the same conditions as the other petroleum companies present on the NCS. It has been developed into an integrated oil- and gas company with considerable international activity. **October 1st, 2007**, Statoil changed its name to StatoilHydro after a merger with the Oil- and gas division of another Norwegian company, Hydro. At the time of the merger, Statoil was operator for 39 oil and gas fields on the NCS, and Hydro for 13. StatoilHydro is presently Scandinavia's largest industrial company. Per January 2008, StatoilHydro was represented in 40 different countries and had 29,500 employees, of which about 40 % worked outside Norway. According to the StatoilHydro *Annual report 2007*, the entitlement production of the company was 1,724 million barrels of oil equivalents per day in 2007; 18 % of which was produced in fields outside the NCS. Presently, StatoilHydro is among the world's biggest sellers of crude oil, and the second biggest supplier to the European gas market. In addition, the company has substantial activity in the fields of processing and refining, and operate service stations in Scandinavia, Poland, the Baltic countries and Russia. The company core expertise is pointed out to be *deepwater projects, heavy oil, harsh environments* and the *handling of gas* *value chains*. According to the StatoilHydro web May 2008 (www.statoilhydro.com) their business strategy addresses four principal challenges, which are *The Norwegian continental shelf; international growth; the gas position;* and *the profitability of down-stream operations* (which are refining and distribution).

At the same time as Statoil and Hydro developed their petroleum activities, a Norwegian petroleum supplier industry was formed and developed into one of the most innovative and internationally competitive industries in Norway. Today, supplier companies are localized in all of the 19 counties in Norway, and extended local and regional effects can be seen even in parts of the country which are not usually associated with the petroleum industry. More recently, several small national petroleum companies have been established, entering into competition with StatoilHydro and the other international petroleum companies about exploration rights, commonly specializing on the development and operation of smaller, or mature, oil fields.

2.3 Characteristics about Statoil

A core point in petroleum business is that value creation is not based on technology ownership, but on the ownership of *production licenses*. Accordingly, when StatoilHydro has pointed out technology as a principal key to commercial success (www.statoilhydro.com) on their web site, the primary goal is not the technology itself, but *the enabling of oil discovery, field development,* and *safe and efficient petroleum production*. With this in mind, I will gradually begin to develop my story about the SIOR program. Before I go into the details about the program, I will give a description of some characteristics of the Statoil organization, based on evaluations provided in interviews and conversations with Statoil members involved in SIOR. I will also provide what I see to be the essence of the discussions I have been part of concerning why Statoil benchmark as being presently the most innovative petroleum company (as measured by the adoption of new technology in field development projects).

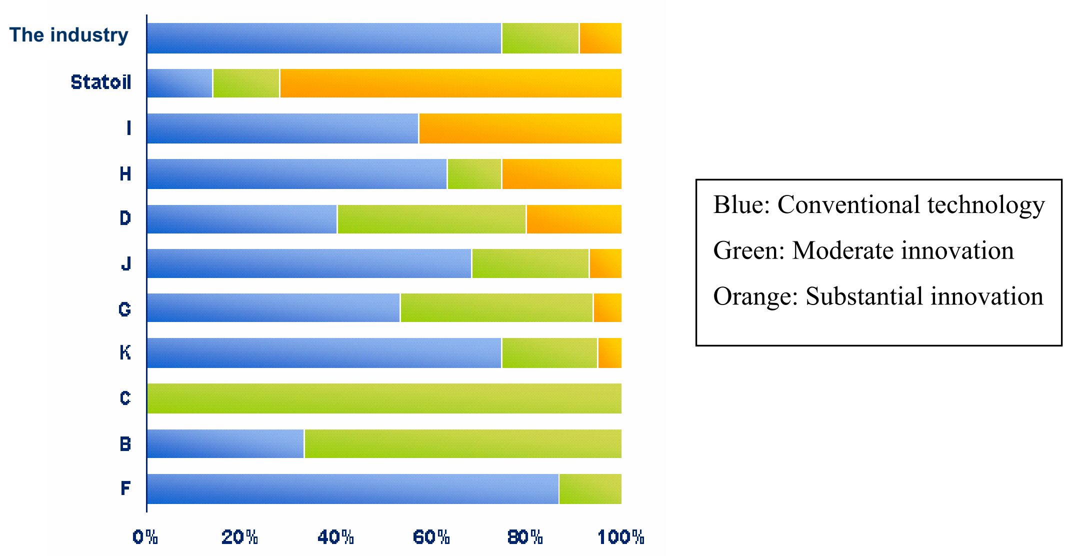

Figure 2-2 Implementation of new technology in development projects in various petroleum companies (depersonalized data)(source: PA benchmarking study 2004).

In this section I draw on some of my notes and experiences which have also been discussed in three short reports prepared in 2006. The reports are:

1. *Organisatoriske forutsetninger for innovasjon i Statoil* [Organizational qualifications for innovation in Statoil]. Notat 2007:1
2. *Innovasjonsprosesser i Statoil* [Innovation processes in Statoil]. Notat 2007:2
3. *SIOR i Statoil. Verktøy for innovasjon og verdiskaping* [SIOR in Statoil. Tool for innovation and value creation]. Notat 2007:3

Even if I had decided to use the complex responsive processes perspective at the time these reports were written, they were based on a more traditional approach of reading through interviews and notes, and identifying recurring themes, such as *organizational characteristics*, *what makes Statoil innovative*, *where does innovation happen, innovation adoption, forces in innovation processes, encouraging innovative attitude,* and *how does SIOR 'work'*. The reports were structured according to these themes, and results discussed in the light of current innovation literature. The reports were distributed to managers in the Research Centre, to the core team members of the programs SIOR and Tail, and to my reference group. The reports are considered confidential reports, and will not be made public without prior consent from StatoilHydro. Some of the more generalized characteristics are, however, included in this section.

When Statoil members talked about their organization, some keywords were more salient than others. One of them was *participation*. Social democratic principles were prevalent, implying that a large number of people were involved in most processes. One of the comments I got from a Statoil member involved in strategy work, was that he got 'shot everyday day' because he had forgot to involve somebody in some process. A common assertion was also that in Statoil, a decision was not the end of a discussion; it was just the opening line. This leads to another two keywords: *consensus orientation*, which reflects a tradition that many people were involved in decision taking, and *heavy*, used to emphasize that the maturation of new ideas within the context of participation and consensus was time-consuming. *Skilled* was yet another characteristic, appearing in stories about competent and courageous professionals enabling the development and recovery of oil resources under extreme conditions, and about proficient leaders, capable of balancing development needs and risk considerations. Another two adjectives were frequently used, and seems to me to be of relevance to describe Statoil. One was *busy*, confirming my impression that everybody I met seemed to have very busy days. It was quite common that they were double and triple booked, and the e-mail system was among other terms referred to as a 'tyrant'. The last word was *fragmented*, based on the observation that over the years, managers of the different operating units had been given a lot of freedom to develop their local organizations according to own desires and needs. Statoil operated fields have been developed in different epochs, in areas giving rise to very different challenges, and under differing technological conditions. The result was that the Statoil upstream activities were composed of several parallel, dissimilar, and more or less independent operational organizations, such as Statfjord, Gullfaks, and Heidrun, which in addition were located on geographically spread premises.

The overall Statoil organization was complex, involving hierarchy, matrixes, processes, projects and value chains. An implication of this was that there are a large number of people who have some kind of managerial responsibility, as line managers, administrative managers, specialist mangers, and project managers. It was a widespread opinion that this affected communication in the company in ways which were not always fortunate. '*If only Statoil knew what Statoil knows*' was a repeated expression, which apparently originated from somebody in the Norwegian Petroleum Directorate. Incidentally, it added to the complexity that individuals in managerial and specialist roles changed their internal position fairly often. Although most managers 'high up' in the hierarchy meant that it was feasible to 'understand' Statoil, others admitted that they struggled to get a general view of all the actors and activities. Great differences were experienced between operational units, but also from 'top to bottom', between operations and research, and between onshore and offshore.

A comprehensive set of routines and steering documents were developed to support and ensure the quality of company operations, and to facilitate communication of relevant information across the company. Many of those I talked to complained, however, that this entailed too much administration. It was a frequent comment that it was impossible to keep updated on procedures, read all the e-mails, follow up on project administrative applications, do procurements by the book, and meet the deadlines without compromising with other tasks, like talking with your colleagues in a project. In contrast to this, some of the managers close to the top maintained that this stress was important, because it forced people to prioritize the tasks essential to realize main targets, and to engage the 'best'. Despite the many routines, as well as a number of professional networks, many referred to the flow of experiences in Statoil as limited. In addition to ascribing this to an administrative overflow, and also to a general lack of curiosity, it was substantiated by the freedom most Statoil members were given to focus on short or long term projects at their own request, to cooperate with whom they wanted, and to choose which networks to participate in.

My impression was that Statoil members showed an increasing interest in exploring new approaches to working in multidisciplinary teams. Supported in particular by the ideas within the area of *Integrated Operation* more and more groups tried to work concurrently, in the same room, or virtually in the same room (supported by advanced collaboration technology), to avoid the more traditional 'relay races'. A lot of the managers I spoke to referred to collaboration as being presently a cult word in the company, but the sound of it did not seem to be negative. More meant that technology supported collaboration was a useful way to increase the exchange of knowledge among people holding diverse specializations and roles, and that this was requisite to ensure safer operations, quicker and better decisions, and also innovation. Among the managers showing most interest in discussing collaboration, there was a view that Statoil multidisciplinary teams still were characterized by inclination among members to ‘territory thinking’, also referred to as ‘protection of professional integrity’. The groups that worked best were characterized by distinct leadership, involving clear expectations about performance, and managers’ attentive pursuing of objectives and tasks.

2.3.1 Why is Statoil so good at innovation?

> *Statoil is in fact quite innovative, the petroleum industry is conservative, you could say that. ... This thing with innovation – it is not always us that get the idea, but we take the risk to use it, and put our money in it, and that is an important part of being innovative, in my view. Another thing which characterizes Statoil is that we are not best at everything, but we get best really fast when we are exposed to a challenge. We are not best at deep water, but that is because we haven’t had any operatorship on deep water. As soon as we get it, I see no reason that we shouldn’t become the best.*
>
> Line manager, Exploration & Production Norway

The Statoil history is characterized by innovative milestones; major field developments which have been worked out successfully, leading to the creation of a robust commercial basis and the development of self-confidence towards future challenges. Technology has been continuously improved and changed, and challenges which are unsolvable today, are seen as future opportunities. The gas field Snøhvit, which is the first major development on the Norwegian continental shelf with no surface installations, is the latest ground-breaking project. In the pipeline are the subsea fields Tordis and Tyrihans, which do both include ‘first-in-the-world’ technologies developed in collaboration with the SIOR program. Before Snøhvit, the high-temperature, high-pressure Kristin field led to substantial technological innovation, and before that, the Åsgard field. The conceptual solution for Åsgard was completely new, and seen as a premise for profitable development of the field.

To me, the culture in the local organizations I became acquainted with, appeared to be heavily influenced by the idea that *'if you can send a man to the moon, and cross the Norwegian Sea with Statpipe, you can do almost anything'*. This was also reflected in a speech made by Chief Executive officer Helge Lund at the Technology Summit in 2006, where he commented the acquisition of several fields in the Gulf of Mexico like this: '*We have invested heavily in your competence; we trust your competence will make us able to deliver on the very complex fields we have invested in recently*'.

When I asked Statoil members why the company had shown so much will to innovate through the adoption of new technology, I was told that it was because:

…. they had to

While the large petroleum companies have had comprehensive portfolios, and been able to prioritize projects involving as little risk as possible, Statoil's situation has been quite different. Being assigned a main responsibility for the development of the petroleum resources on the NCS, the movement has been towards the challenge which at any time has been seen as most feasible, leading to what the Statoil members refer to as a step-to-step development. To uphold profitability within the limited set of business opportunities on the NCS, it was necessary to meet increasingly bigger challenges:

> *If you ask why the company has become what it is, it is simply that we started where we did – and then we moved to deeper waters, harsher climates, environmental requirements have been more stringent…We have had very large capital investments per barrel of oil, which means that we have high costs per unit compared to for example Saudi Arabia, which has a hole and a big reservoir, while we have to drain oil from within the stone. So, until now, we have had the toughest jobs, and we have been able to pull ourselves up by that.*
>
> Line manager, Exploration & Production Norway

Earlier, innovation in Statoil has mainly happened in connection with field developments. During the later years managers of on-stream fields have become more active in demanding and adopting new technology and new work processes. An important reason for this is that fields are maturing, and gradually face a threat of being closed down unless profitable production can be maintained through organizational and technological changes. Despite this, some managers very frankly admitted that they would not prioritize the piloting and use of new technology if the top management were not demanding it. Others emphasized that development was caused by an 'inner drive' in the company, a genuine desire to be in front and produce as much as possible from new and existing reservoirs, which implied a need to be courageous and innovative.

… they have what it takes

'Knowledge, boldness and leadership' is another general answer to my question about what has made Statoil successful, commonly accompanied by '*There are a lot of capable people in Statoil'*. It is pointed out that the majority of the employees are well educated, and very many are good at recognizing opportunities and possibilities. While members of the Research Centre largely claim that the professional skills of Statoil employees are better than in most other companies, more members of the operational units emphasize that the competence of other companies should not be underestimated. An important difference between Statoil and most other petroleum companies is, however, seen to be that Statoil members have been given more room to 'play' with technology, suggested to be a main reason that they have become a leading technology user.

Leadership is seen as an important factor for the development of a culture where experimentation and risk, although obviously within given limits, are seen as acceptable parts of the game. Other companies, for example Exxon Mobil, are referred to as being much more restrictive in connection with technology adoption, without their commercial results being weaker.

2.3.2 Ability and will to future innovation

As indicated, one of the reasons some people in Statoil decided to take the initiative to have a PhD candidate in the SIOR program, was a certain concern that previous success combined with a tendency among managers to be less ready to take risk, would result in a general idea that innovation was less important than before; i.e. that the organization was becoming '*full of success'*. I kept asking everybody I talked to about this, and was met with nothing but objections to the assertion that the will to renew and innovate was decreasing. The main view was that corporate challenges were queuing up, implying a need for innovation greater than ever. Pride and self-confidence based on former achievements were seen as additional driving forces. This view was, however, differentiated by some who pointed out that the urge for innovation was not equally strong in every employee. Another factor discussed as a potential constraint, but at the same time also as an innovation driver, was the oil price. As an example, it was decided to maximise oil recovery on the Tyrihans field in spite of calculations showing marginal profitability. In retrospect, this showed to be a decision of strategic importance, as increasing oil prices presently indicate an extra profit potential in the order of a two-digit billion amount.

The gradually more elaborative and lengthy decision processes in Statoil have also been pointed out as a threat to innovation, as has the inclination to demand more and more control in development projects, whether field developments or technology developments. On the other hand, it is reason to believe that the need to develop new business opportunities will be a persistent counterweight to stagnation.

2.4 The Subsea increased oil recovery case - SIOR

At the end of 2002, Terje Overvik, who was at the time Executive vice president for the Technology division (TEK), and Ingve Theodorsen, who was head of the Research Centre (which was the largest part of TEK), launched as an ambition that the oil recovery factor from Statoil operated subsea fields on the NCS should be increased from the then average of 43 % to an average of 55 % within the end of 2008. The then Executive vice president for the business area Exploration & Production Norway (UPN), Henrik Carlsen, was also an important motive power behind this idea. The specific number, 55 %, came to be as the result of prior discussions about the potential for increased oil recovery, involving several key persons in the company.

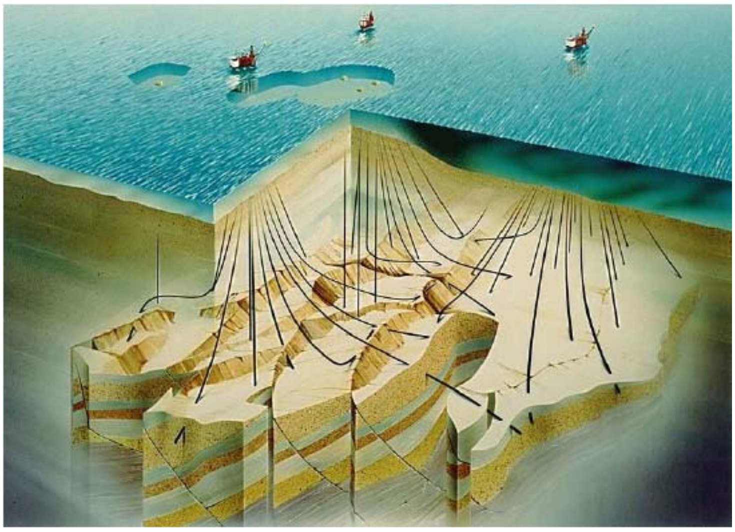

Figure 2-3 Subsea and top side wells (Photo: Statoil)

Before I go on, let me explain a little more about the significance of the 55 % ambition. The percentage indicates the average quantity of oil assessed as recoverable, compared to the estimated total volume of oil in the NCS fields. Now, the discussions among Statoil specialists had led to the suggestion that a recovery factor of up to 50-52 % was possible, although difficult. According to Terje and Ingve, they 'just added a few percentages' rather spontaneously at the presentation when the 55 % ambition was launched. This, however, led to widespread headshaking in the company. Later on, Ingve told me that at the time, the realism of the ambition, as well as the rationality of Terje and himself, was indeed questioned by a majority of managers and specialists in the company. From what I could understand, there were two main reasons for this. One was related to the very possibility of recovering oil at all. To recover oil, it was explained to me, is not like putting a straw into a pond and soak up the liquid. It is more like dipping a lump of sugar into a cup of coffee, and then trying to suck all the coffee out again, without any sugar going with it. Some of the coffee would be enclosed within the pores and structures of the lump, implying that the recovery of the coffee would get increasingly demanding. Even with the adoption of sophisticated techniques, a complete recovery of coffee would not be possible. Translated into oil recovery, this means that a 100 % recovery factor is unattainable, and that operations get more and more demanding, and hence expensive. The late production phase, which is often referred to as 'tail' production, involves the gradual production not only of petroleum, but also of more and more sea water, sand and other substances which go with the stream of oil and gas, and need to be separated and handled, thus further pushing the costs.

The other reason that many of the Statoil members doubted the 55 % ambition was that increased oil recovery implied the drilling of more wells. At the time, drilling of subsea wells was substantially more expensive than drilling from a platform. As indicated introductorily, the opinion among Statoil specialists was therefore that the price of wells had to be reduced to less than 1/3 of the price at the time, that is from more than 200 million NOK per well, to 60 million NOK. In addition, the price of well intervention technology had to decrease, and the availability of such technology had to be improved.

Given these challenges, why should the Statoil managers still be so preoccupied with increasing the recovery factor? In the introduction to this chapter, I indicated two reasons. One was that only a fraction of the estimated NCS petroleum volumes are produced as yet, the other was the profit potential of the added volumes. The Statoil activity on the NCS has been dominated by a few large fields, such as Statfjord, Gullfaks, Snorre and Troll. Many of these fields are now maturing, meaning increasing operational costs and declining production. Nevertheless, the existing NCS fields are still seen to constitute a potential that can generate significant value for the petroleum companies for many years, if exploited prudently. Accordingly, in 2003, the Statoil Corporate Executive Committee decided that the current NCS production volumes were to be maintained beyond 2010. Challenges related to the maturation of older fields, and also to the more modest size of newer fields did, however, obviously call for the development of a broad range of new, cost-efficient, 'safe' and 'green' technologies, as well as for new approaches to technology exploitation. For these reasons, and possibly also for others unexplained to me, the top management gave the 55% ambition its full support, although a majority of the specialists and quite a few of the middle managers expressed doubt about the idea.

I should comment on another challenge, which was mentioned above. This was related to the fact that new field discoveries were gradually smaller. In the past, fields, and thus the size of the field development projects, had been larger. Development times were long, and there had been ample time and money to develop innovative technology within the frames of one project. According to people who had worked for many years with the company, there had also been a sense of urgency related to the need to develop new knowledge and new technologies that now seemed to be fading. To be able to pursue future developments with the same engagement as before, the top management suggested that increased long term planning and cooperation across assets was needed, as well as the initiation of corporate improvement activities with demanding ambitions, and a systematic approach to development and use of new technology.

2.4.1 Expectations of the SIOR program

The SIOR ambition reflected a generalized expectation about innovation and value creation. To assign to an R & D program the responsibility for increased oil recovery (IOR) was a new way to pursue innovation in Statoil. It is important to understand, however, that being on the 'offerer-side', SIOR members' freedom of action was limited to *substantiate* value creation by making available technological solutions anticipated to support the recovery of extra volumes oil. Consequently, the actual realization of the 55 % ambition was contingent on the close cooperation between members of SIOR and people in the operational units. The perception of the challenge among most SIOR participants was mixed, as this comment made by one of the SIOR members illustrate:

> *One has to be aware that SIOR is exceptional; it is exceptional the way they did it. First, the intention and objective of SIOR is very special, because we are going to increase the recovery factor of subsea fields to 55 %. Basically, this is an absurd objective for a research project. We do not operate fields, we do not increase production – the operating units do that. And if the objective should be obtained, the operating units will say that they did the job, SIOR will never be given credit for increased oil recovery.*

What then, was the actual expectation on SIOR? Another piece of information about the Norwegian authorities' petroleum management system is needed to explain that. On the NCS the resources are classified according to profitability and maturity by means of a categorization system spanning from class 9, signifying that resources are unmapped or in leads, to class 0, representing produced petroleum which is sold and delivered. The actual expectation on SIOR was that technology made available by the program should contribute to the transfer of petroleum from resource class 7: *Resources that have not been evaluated*, to class 5A: *Discovered, recoverable petroleum resources whose recovery is likely, but not clarified*. The move of petroleum volumes from resource class 7 to 5A could be seen as representing a paper profit, and did not imply the imminent production of resources. It could, however, be seen as a first step towards commitment to the adoption of SIOR technology, as it involved a disclosure of the revised numbers to the Norwegian Petroleum Directorate, and thus an increased expectation about future production volumes from Norwegian authorities. To reach the point where volumes were formally moved to resource class 5A, involved the active engagement of the SIOR core team members to inform and convince the managers of the various business assets (i.e. fields) about technological options. As geological and geophysical characteristics may differ substantially from field to field, the IOR potential of new technology elements had to be evaluated for each field. During the first year of SIOR, the four CT members managed to talk most of the operating field directors into making forecasts about increased future recoveries, related to coming SIOR technologies. Still, this first 'sales tour' was not without problems, as indicated by the SIOR program director:

> *The job internally was huge. We had to convince the researchers and the specialists, and then we went around to the field organizations with our volumes and our technologies, and if we hadn't had the extensive support from the top management, I think we would have been thrown out of many of those meetings. […] In the beginning people shook their head when we told them that they were to produce 200 million cubic meters of oil more than planned. They meant, of course, that they were already doing a very good job maturing volumes and working with increased oil recovery.*

2.4.2 Subsea increased oil recovery in Statoil

My study of innovation processes in Statoil began in January 2004. At the time Inge K. Hansen acted as head of the company. The former CEO, Olav Fjell, had been forced to leave his position some month earlier due to accusations of corruption against the company. In September 2004 the present CEO and president, Helge Lund, took up the position. He decided to reorganize the company, involving the change of position for many of the people in managing positions. Of particular interest for my study was that Terje Overvik, former Executive vice president of the Technology division, gained the position of Executive vice president of the business area *Exploration & Production Norway* (UPN). Terje Overvik had been instrumental in the establishment of my study, and also contributed throughout the study as a conversation partner and a 'door-opener' to other people in key positions in the company. The former Technology division was turned into a business area on a level with the operational units, and the field development activities was integrated as part of this area, which was renamed to *Technology & Projects* (T&P). This business area was headed by Margareth Øvrum. The formal organization chart, valid until the merger in 2007, is shown in figure 2-4.

The business areas relevant for my SIOR study were, in addition to *Exploration & Production Norway (UPN)* and *Technology & Projects (T&P),* the area called *International Exploration & Production (INT).* The other two, *Natural Gas* and *Manufacturing & Marketing*, were responsible for transporting, processing and marketing Statoil's own gas from the NCS to European destinations, and for the group's combined operations in transportation of oil, processing, sale of crude oil and refined products and retail activities in 12 countries, respectively.

Exploration & Production Norway (UPN) is responsible for Statoil's operations on the NCS. During the SIOR program period, the fields operated by UPN accounted for about 60 per cent of Norwegian oil and gas production, and the business area was the main customer for technology for increased oil recovery from subsea fields. The ambition of UPN was to maintain the daily production of one million barrels of oil equivalent from the NCS after 2010. Improved recovery from existing fields, production from new fields and good results within health, safety and the environment (HSE) were seen as important preconditions to succeed. UPN included three business clusters: *Operations, Exploration Norway* and *Operations Support*. The *Operations* area was divided into three subareas: *Tampen (TO), Troll / Sleipner (T-S)* and *Halten Nordland (HNO)*. At the time the SIOR program was initiated, the Operations area managed 24 on-stream oil and gas fields, which comprised 20 platforms or production ships with crew, four unstaffed installations and 23 subsea facilities. The various fields – or *business assets* - had been developed at different periods of time, and the local management had been given the opportunity to form the field organizations largely according to own ideas. The result was that the business assets appeared as very different groupings, the oldest – Statfjord - being mentioned as the most 'conservative'. Incidentally, it seemed to me that this was not unambiguously the case, as the Statfjord organization was subjected to substantial restructuring and cuts of workforce, to increase profitability and prolong field lifetime.

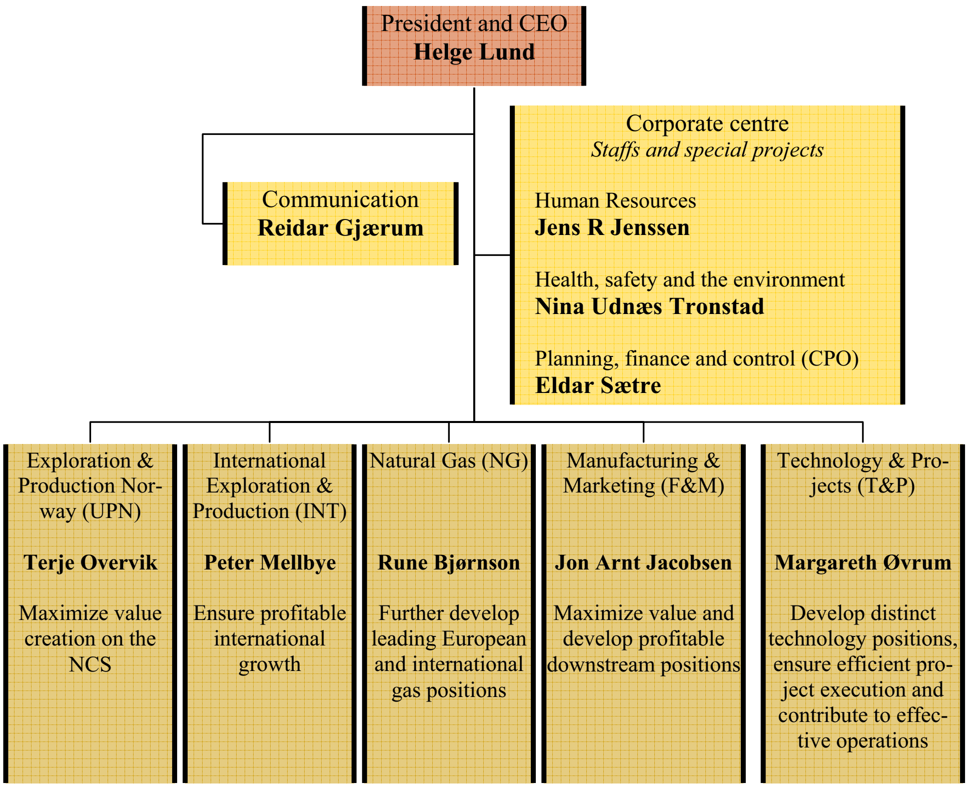

Figure 2-4 The Statoil organization from October 2004 to September 2007

The Business Area *International Exploration & Production* (INT) is responsible for Statoil's exploration, development and production of oil and gas outside the NCS. Its objective is to ensure production growth through the improved recovery from producing fields outside the NCS and through the development of new fields. In addition an annual long-term growth of 2-4 % from 2007-10 had been presupposed through effective business development and exploration in potentially resource-rich regions. An important element in the international strategy was the exploitation of expertise and technology from activities off Norway. The business area stood for only just 10 % of Statoil's oil and gas production in 2004, but output shows strong growth, and was nearly doubled at the end of 2007. Originally, INT was not pointed out as customer organization for the SIOR program, but key persons engaged in INT activities saw SIOR technology to be of strategic value to obtain engagements with new fields internationally, and so representatives for the business area was included as part of the SIOR steering committee. Presently, INT is responsible for exploration and business development activities in the US Gulf of Mexico, Canada, Ireland, Great Britain, Angola, Algeria, Azerbaijan, Mozambique, Nigeria, Morocco, Libya, Egypt, Russia, Iran, Indonesia, China, Brazil, Cuba, and Venezuela.

The Business Area *Technology & Projects* (T&P) was responsible for Statoil's strategic procurements, technology expertise (specialists and researchers), R & D activities, planning and execution of large development projects, and for contributing to safe and efficient operations. It was also in charge of commercialising technology and of industrial rights (IPR). The Research Centre in Trondheim was part of T & P, and was given a special responsibility for technological innovation intended to contribute to the finding of more oil and gas, and to the recovery of more of the resources in producing fields. From 2003 / 2004 until October 2007 the SIOR program was one of six R & D target areas in the Research Centre. The major field developments on the NCS, which were organized as part of T&P, incidentally also were potential SIOR customers; the most important being the Tordis and Tyrihans subsea fields.

During the SIOR program period, T&P was formally organized as shown below:

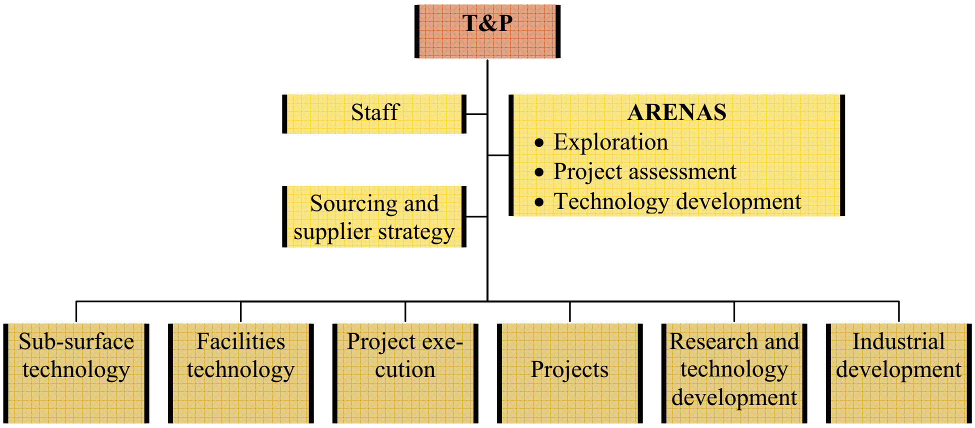

Figure 2-5 T&P organization 2004 - 2007

One of the boxes in the above figure deserves particular attention; and that is *Arenas*. The three Arenas, called *Exploration; Project assessment;* and *Technology development,* were established in May 1999 by the Statoil management. They were composed of an Arena manager and representatives for T&P specialists and UPN business assets. The reason for the establishment of these groups was an experience during the preceding 5-10 years that improved performance precisely within these three areas was needed. In practice, this was seen as a need for better coordination and prioritizing across the company of ongoing and new activities within each area. An annual review of the complete project portfolio within each Arena was therefore seen as requisite. The Arena processes were mentioned as elaborate decision processes, involving a large number of people.

The SIOR program was decided in the *Technology development* Arena, often referred to as the TEK Arena. TEK Arena was, and still is, a group of people representing the business areas UPN, INT, and specialists organized in the Technology division. The purpose of the TEK Arena group is to prioritize between technology developments projects in Statoil, and grant money for their accomplishment. The annual investment in Statoil in R & D was in the order of 1 billion NOK (increased to 1.8 billion after the merger), channelled through the TEK Arena process. From 2004 – 2007 SIOR was granted just above 20 % of this amount. Incidentally the TEK Arena also has the main responsibility for the preparation and following up of the Statoil Technology strategy.

The processes of the TEK Arena were reviewed and attempted simplified during the first half of 2005. An outline of the process is shown below:

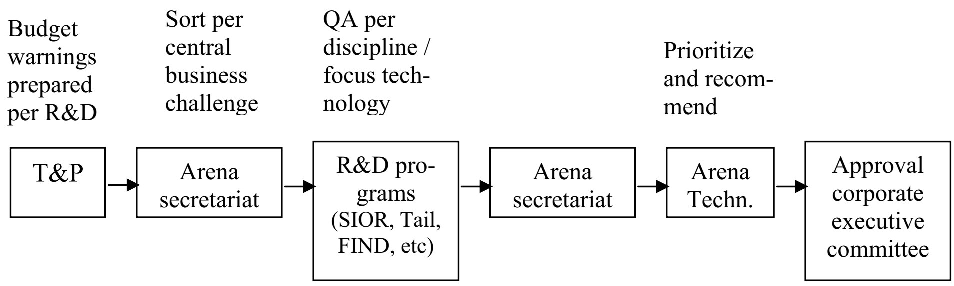

Figure 2-6 Technology Arena process 2005

The restructuring resulted in a smaller group, apparently without leading to less preparation work on the part of the members of the program and projects evaluated by the Arena. The reorganization of TEK Arena was nevertheless considered necessary for several reasons, of which the most important were the change towards a more 'business driven technology development' portfolio and the introduction of *Lead Asset* thinking for technology testing. In connection with the TEK Arena restructuring, a proposal for principles and work processes on which future decisions for technology development should be based was prepared, and the principal roles and responsibilities related to the continual process of business driven technology development were described. The proposal is shown below:

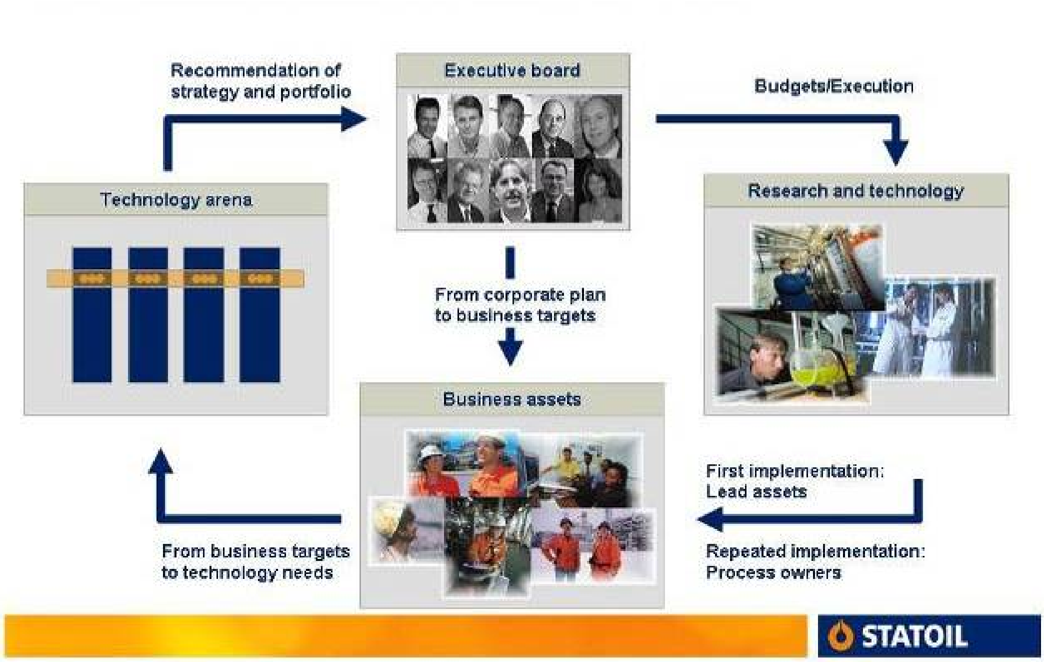

Figure 2-7 A systematic approach to R & D in Statoil

A clarification of the concept of 'business driven technology development' may be required. Given the challenges that appeared to be facing Statoil, it was seen as vital that technology development was not limited to the activities in the Research Centre alone, but that it covered promotion of all new technologies within Statoil's business. The increasing importance of collaboration and cooperation with people engaged in other companies to develop petroleum technology and services was emphasized, and so was the need for the integration of Statoil internal technology with that developed by others. It was particularly emphasized that the new principles of technology procurement were based on what was referred to as '3rd Generation R&D' (Roussel et al., 1991). These were principles built on experiences from successful companies around the world, and their application related to business driven technology development.

2.4.3 Networks and roles in Statoil

The legitimate Statoil power structures consist of a hierarchical line management as well as transverse groups of experts within technical, quality related and strategic issues, resource management and trade union representatives. SIOR and other strategic technology development areas within the Research Centre and in other parts of the company were organized as projects with project directors reporting to the line management. This rather complicated organization meant that there were a large number of people in managerial positions, or holding the role as experts, feeling entitled to give their opinion on the various issues which were brought up in the company. This clearly influenced on SIOR as well. A few comments should therefore be made about some of the transverse networks and roles particularly affecting the program.

Process networks / process owners

The process networks are decided by the Corporate Executive Committee. They are organised collaborations for the introduction and use of corporate work processes. These networks are further intended to be meeting places where people can talk about matters which the top management see as necessary to coordinate across the business areas. For special fields that are not covered by process networks, the management of the business area units are given the responsibility of ensuring that best practices are identified and documented in governing and advisory documents.

The various process networks in Statoil are headed by *Process owners*. The main tasks of the Process owner are to identify, document, develop, perform quality assurance and pass on best practices for the corporate work processes. Among other things this also involves the establishment of performance indicators to evaluate internal processes, and the facilitation of interaction and collaboration within and between process networks. Each Process owner is expected to appoint a *Process owner representative* whose responsibility is to coordinate, take care of and organise the ongoing improvement work. This applies in particular to the integration with the other joint work processes in the group, establishment of best practise, choice of system solutions, and follow-up of suppliers of systems and tools. From what I was told by SIOR members, the Process owners viewed their role very differently, leading to a situation where some of them were very supportive of technology and work process development, while others referred to best practice routines in a way that was seen to contribute to the conservation of the existing state of things.

Chief researchers / chief engineers

In Statoil, the *discipline ladder* ('fagstigen') is used as a joint designation for the specialists engaged in the development and construction of top side and subsurface fields, and of operational support. These were divided in groups according to traditional petroleum disciplines, which typically are Drilling & Well, Geology, Geophysics, Reservoir Management and Processing. Each specialist discipline is headed by a *Chief engineer*. In the same way, the Statoil researchers are organized into fields of research mirroring the different petroleum disciplines. Each research field is headed by a *Chief researcher*. Their responsibilities are to ensure the quality of the formulations of the technology strategy, to plan and implement the research portfolio, and to identify the necessary research competence within their disciplines.

Like the Process owners, the Chief engineers and the Chief researchers are important actors in technology development processes, and their opinions on new ideas are attached great significance. Similarly to the varying views on the Process owners, there were also varying opinions about the role of Chief engineers and Chief researchers in encouraging innovation in the company. The Chief engineers and Chief researchers I talked to did however show great interest in innovation, at least as a subject of conversation.

Resource owners

Statoil T&P employees are organized in groups headed by *Resource owners*. The Resource owners are responsible for the administration of the persons in his or her group, including appraisal interviews, plans for continuing education and career development, and the allocation of personnel to the various development activities and projects. This means that most of the employees have two superiors; the Resource owner and the manager of the development project (or program) they work in. The project manager is in charge of the projects planning and execution processes, but can not order anybody to work in a project. From my point of view, this made the Resource owner role a powerful role in the Statoil development processes, although this was never clearly expressed in the conversations I took part in. The reason for my view is the Resource owners' opportunity to allocate people to the different projects, and to reallocate them. As most of the projects expressed a constant need for labour, the task to ensure the resource owners' knowledge of, and sympathy for, the various activities appeared to be an essential part of the project (program) manager responsibility.

Trade union representatives

In Norway, the Trade unions in the petroleum industry have gained a very strong position. All changes affecting the situation of employees, particularly those working off-shore, thus have to be discussed with trade union representatives, and agreements negotiated. This also affected the SIOR program, most noticeably within the activities connected to Integrated Operations (see section 2.5 *SIOR technologies*). These were efforts to gradually control more of the operations from onshore premises, and thus, little by little to reduce off-shore manning. This entailed questions about safety, and about pay, which obviously where within the areas of trade union representatives' responsibility.

2.4.4 SIOR and the Technology strategy 2003 - 2012

In the months following the launch of the 55 % SIOR ambition, a technology strategy for the period from 2003 to 2012 was developed. The intention of the strategy was to lay down guidelines for the prioritizing of technology areas assumed to support the corporate business ambitions. In the *Technology strategy 2003 - 2012* two overall challenges were pointed out: To *deliver current aspirations,* meaning the maintenance of regular production, and to *create options for the future,* meaning technology development to support the discovery of new reserves, to make profitable the production of tail volumes of oil, and also the production of oil located in difficult formations or in remote and harsh areas. The most important areas on which this commitment was intended to concentrate was exploration operations and reservoir management, subsea field development, environmental protection, development of the gas value chain, cost efficiency and safe operations.

The challenging target set for production growth was based on maintaining NCS production at 1 MMBOED (1 million Barrels of Oil Equivalents per Day) and increasing international production to more than 300.000 BOED by 2007. To meet these targets, five specific business challenges were pointed out, and five prioritized R & D areas, called 'mountain peaks', were identified to address these challenges. Two of these five areas were about increased oil recovery, from top side fields (*Tail end production*, or *TAIL*), and from subsea fields (*Subsea increased oil recovery*, or *SIOR*), respectively. The other three mountain peaks were *Develop assets*, *Find hydrocarbons* (FIND) and *New business options*. In the second half of 2004 a sixth peak was added; *Oil and gas processing*. The peaks represented project organizations. As can be seen from figure below, six cross-program areas were also included. In practice, these areas reflected the established line organization.

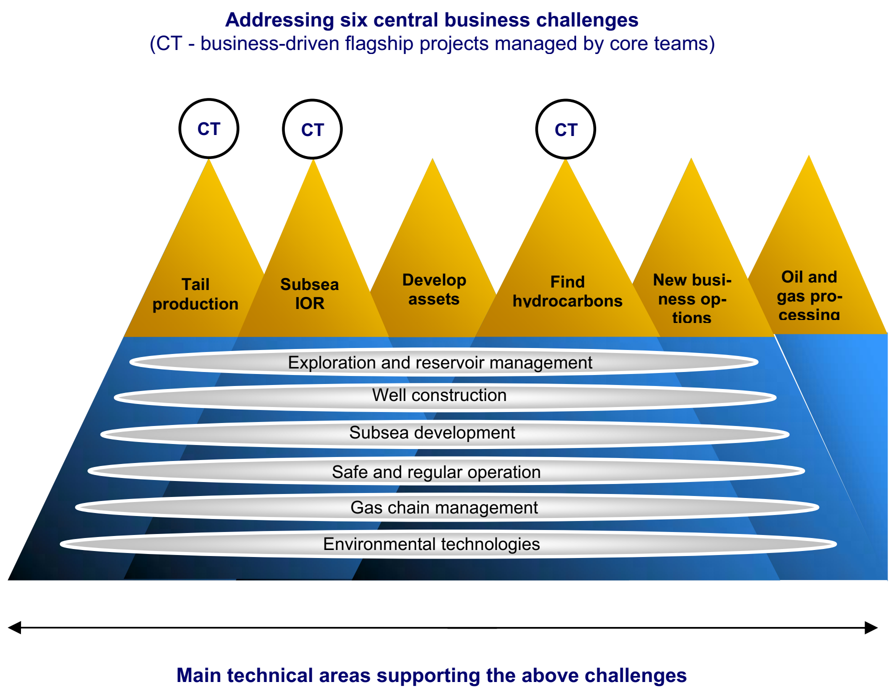

Figure 2-8 Six central Statoil business challenges supported by R & D priority areas

SIOR, TAIL and FIND were organized as programs, including a lot of sub-activities, managed by a multidisciplinary core team, and given very clear, overall ambitions. Each program should interact closely with the business area called Exploration & Production Norway (UPN) to identify needs in the various business assets; seen to be business *opportunities*, and also to identify pilot customers for the new solutions. The other three mountain peaks: *Develop Assets, New business options* and *Oil and Gas Processing* were also umbrella initiatives, embracing several smaller projects, but without the clear, unifying objective.

Seen from my perspective, one of the most interesting statements in the Technology strategy was that:

> *Statoil's internal R & D work should mainly focus on **application of technology** (my italics), while we should seek cooperation with institutions to solve our technology challenges fundamentally. When it comes to long-term technology challenges in cost demanding technology, i.e. development of new well technology, new process concepts etc., we should seek cooperation with suppliers or / and partners being complementary to Statoil.*

In practice, this meant that managements' attention was turned to short-term technology *deliverances* from the internal Statoil R & D programs, more than to the encouragement of what could be seen as efforts to ensure long-term value creation, i.e. invention. In addition, the idea was that Statoil should become a more efficient R & D investor 'to get more from what we already have and to be a *fast track learner*'. At the time, in 2003, there was a 70/30 split between internal and external R & D investments. The ambition was to reach a balance of 50/50, and to 'deliver similar high quality R & D results, in accordance with business needs, at lower cost'. The collaboration with supplying companies was already extensive. Only in the SIOR program, there were about 70 agreements on cooperation with external companies at the time the program was initiated. The intensified demand on external collaboration, however, resulted in the development of an acquisition process called *Acquisition SIOR and TAIL Integrated operations* (ASTI). The process is partially described in the second paper of this dissertation. The ASTI process, which lasted for almost two years, involved a completely new way of organizing collaboration between researchers in Statoil and specialists in other companies to develop innovative technologies in six specific technology areas. Three things characterized the ASTI process: 1) The people responsible for the ASTI process in Statoil requested that larger and smaller suppliers entered into binding cooperation, and prepared their offer to the ASTI pre-tender inquiry as groups, 2) The collaboration implied that coadjutant suppliers co-invested in the development work, 3) Statoil placed itself at the disposal to test new technological solutions developed in the joint ventures established as the result of the ASTI process.

2.4.5 The SIOR organization

SIOR and the other mountain peaks were organized within the Statoil division Technology, which became *Technology & Projects*, T&P, in October 2004, in the department for *Research and technology development*. The department is mainly situated at the Research Centre in Trondheim, but several of the program members were located at the main office at Forus in Stavanger.

The SIOR core team was established early in the second half of 2003. The composition of the team was not random. It was made up by four persons who were all experienced professionals, representing different disciplines within petroleum engineering. All of them had worked in Statoil for many years, and benefited from a broad network and a considerable standing in the company. Furthermore, all of them had had various roles in the Statoil business assets on the NCS. This was important, because as indicated, at the time many Statoil employees questioned the realism of the SIOR ambition. The team members where: Rolf Utseth (program director), Eric Ulland (representing the *Subsea* area), Steinar Strøm (representing *Drilling & Well*) and Per Ivar Karstad (representing *Reservoir management*). In a meeting with the UPN business area Tampen, Rolf Utseth commented the SIOR ambition as follows:

> *One might ask if it was wise to formulate goals that were felt by many to be almost unrealistic. I think it made sense, making the organization really stretch. Hence the SIOR team, based on meetings with all assets and on their own experience, allocated the 55 % to the various assets and defined corresponding technology elements. When we came back a second time to the assets presenting the result of our findings, the reactions were as expected – this is not possible. But when we asked what the assets needed from TEK (Technology division) in order for them to*

achieve the 'impossible', the discussions became very interesting and constructive. The result of the process between UPN assets and TEK is that this spring (2006) the assets have been confident enough to increase their IOR targets substantially.

Formally, the responsibility of the SIOR core team members and activity managers was described to involve the identification of technologies which would result in increased oil recovery from subsea fields, including the tasks of:

- Identification of SIOR technology elements, including the potential gain volumes of each technology element as contribution to the realization of the overall ambition
- Identification of technology gaps, risk factors and actions to reduce disadvantages of technology implementation for the business assets (the licences)
- Development and implementation of programs for technology qualification

The scope of their work was existing Statoil operated subsea wells, ongoing Statoil field development and fields due to be under construction before 2008, as well as the transfer of technology to partner operated NCS fields and Statoil international assets. The program was organized with a steering committee and a reference group. Representatives from the business areas UPN and INT, as well as from the specialist environments, were designated to both groups.

As mentioned the SIOR and TAIL programs both were intended to lead to increased oil recovery, the ambition of TAIL being the increase to an average of 65 % recovery of oil from platform fields. From this reason, the steering committee was common to both programs. The responsibilities of the *SIOR reference group* was principally to assist the SIOR core team in the annual process of budgeting and preparing work programs, to facilitate the implementation and visualization of cross-asset business challenges, and to perform quality assessment of the R & D portfolio, including project status, alignment to business challenges, identification of deliverables, technology qualification and implementation, and plans for next year. *The SIOR (and TAIL) steering committee*, on the other hand, were expected to contribute to the approval of next year's budget and work program, give recommendation to TEK Arena, develop incentives for technology implementation in the business assets, and provide financing for technology qualification of cross-asset challenges. In addition to this, UPN representatives in both the steering committee and the reference group were expected to follow up on calculations of SIOR volume potential in the different licences, and make sure that the volumes were actually included in the annual asset increased oil recovery targets. Their responsibilities also included supervising that personnel were allocated towards SIOR potentials, as well as the promotion of new SIOR solutions towards the license partnership, and the initiation of implementation of SIOR technology elements.

2.4.6 SIOR - three phases

Seen in retrospect, the SIOR program could be divided into three phases. The first lasted from August to December 2003, the second from January 2004 to December 2005, and the third and last phase from January 2006 to October 2007. After the merger with the Oil and gas division of Hydro October 1, 2007, the SIOR program was concluded, but most of the activities were continued within a new, comprehensive program called *Increased oil recovery (IOR)*. This program is headed by the former director of the Tail program, and two of the members of the SIOR core team went into the new IOR core team.

Back in 2003, at the start-up of the SIOR program, the four core team members, Rolf, Steinar, Per Ivar and Eric, immediately started to 'chisel out' the main focus areas and objectives for the program. Their view was that in order to succeed, it would be imperative to put the principal 55 % ambition in concrete terms, to persuade business asset managers, licence partners and other key persons in the operating units of the feasibility of the 55% ambition, and the significance of the SIOR technologies. As one of their first activities, they therefore visited all the Statoil operated business assets, 24 at the time, to discuss technology elements, or 'enablers', requisite to realize the goal of the average 55 % recovery factor by 2008. The attention in these meetings was primarily on petroleum cubic metre accounts, representing the added value of successful development efforts. Technology elements believed to support the development towards profitable recovery of increased subsea volumes of oil and gas were identified and ranged according to the expected contribution to the overall 55 % ambition. Worth noticing is that a lot of the technology elements that gradually were referred to as 'SIOR technologies' were ongoing R & D activities, or almost finished technologies which had been 'put on the shelf'. Furthermore, many of the technologies were in use on topside fields. The challenge was that the application of this technology on subsea fields was extremely expensive. Reducing costs through the development of alternative technologies, or through the cheaper production of existing technologies, was thus seen to be imperative.

Through the business asset meetings, and also a series of other meetings including several with technology suppliers, collaborating partners, and professionals in Statoil, three focus areas where identified to be the most important for the SIOR program to prioritize. These were:

- *Accelerated production*
- *Low cost drainage points* and *interventions*
- *Target remaining oil and integrated operations*

A more detailed explanation of the three focus areas is given in section 2.4 *SIOR technologies*. In short, responsibility for the areas was divided between Eric, Steinar and Per Ivar. For each focus area, two main goals were framed, and within the six goals, 25 'enabling' technology elements were identified. Development projects were organized (or continued) for each of the technology elements. Below, an outline of the SIOR organization, goals and targets, as it was presented in the management team of the Technology division in December 2003, is shown:

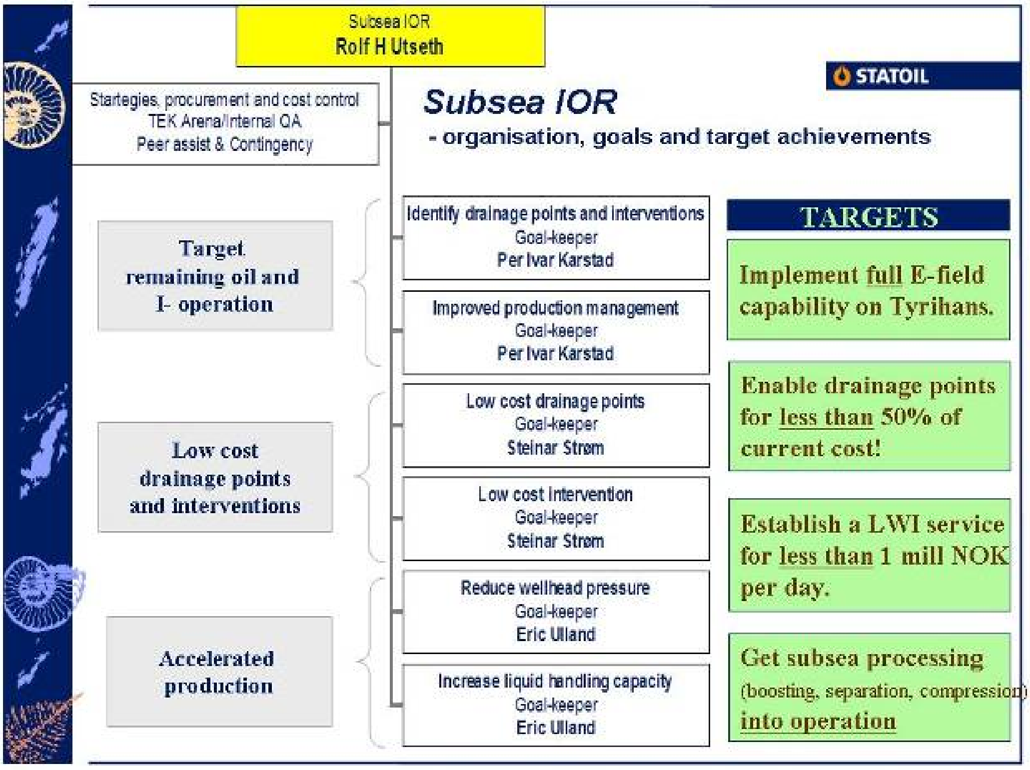

Figure 2-9 SIOR – goals and target achievements

As indicated, in this 'first phase' of the SIOR program period, the four core team members saw as their main challenge to 'translate' the rather abstract ambition of 55 % SIOR into cubic metres of extra oil, and to prove relations between technology elements and increased volumes of recovered oil. Their (conservative) estimate was that the 12 % increase in oil recovery by 2008, from 43 % to 55 %, corresponded to the added volume of 200 million Sm3 oil from the NCS (as compared to the RNB 2003 base line). To be able to make these estimates, it was necessary to work out a new way to calculate oil reserves, based on assumptions of IOR effects of future technologies. The intention was to boost the expectation abut increased recovery rates in the company, and with Norwegian authorities. These calculations, which were worked out mainly by Per Ivar, are now developed into a standardized approach to substantiate oil volume reserves, a result which in itself is a kind of innovation brought about due to the SIOR program. The figure below shows an example of how the estimates were presented to the business area Tampen:

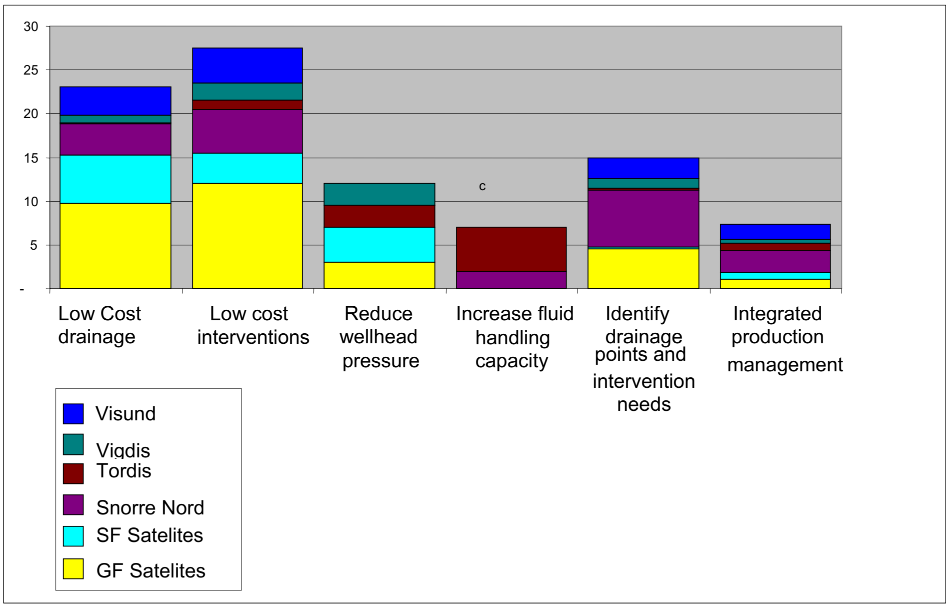

Figure 2-10 Calculation of increased oil recovery (%) due to SIOR technologies

The diagram indicate the assumed effects of the six SIOR technology target areas on oil recovery in the Tampen assets Visund, Vigdis, Tordis, Snorre North, Statfjord satellites and Gullfaks satellites. As each field have its own unique geological and geophysical characteristics, and its unique challenges related to the exploration of oil, well drilling, oil and gas production, the assumed advantage gained through the implementation of the different technologies differed accordingly.

The second phase of SIOR started in January 2004. This was also when I started my SIOR study. At this point in time, Rolf, Steinar, Per Ivar and Eric had selected a SIOR project portfolio, and the activities were financed and manned. The core team members told me that they followed up along two strategic lines. First, they tried to do what they referred to as ‘massage and control’ the scope and schedules of the various sub-projects included in the SIOR program, to make them fit the SIOR objectives to the largest possible extent. Secondly, they met with the internal customers; that is individuals and groups of people responsible for the various Statoil business assets on the NCS, to discuss the possibilities related to the development and use of SIOR technology elements. Incidentally, I gradually started to think about many of these meetings as ‘persuasion meetings’, as a lot of people, including the researchers assigned to the SIOR program, seemed quite reluctant about the SIOR idea. Because of the scepticism shown towards the SIOR ambition, the first year and a half the attention of the four core team members was mainly directed towards their (internal) customers, i.e. the operating units and the field development projects. For many of those actually developing the new technology in the *Research & technology development* department, including the SIOR activity managers, this was perceived as lack of interest in their work. From the many meetings, interviews and coffee break conversations I became part of, it became clear that many felt that information was neither demanded from nor offered by the core team members, and that being assigned to SIOR did not involve any perceptible change in their everyday working routines. In the beginning, this partly seemed to be true. This was also largely the reason for the change in the SIOR program structure, leading to what I have called the ‘third phase’ of SIOR.

This third phase started in January 2006. At this point in time, about midway in the SIOR program period, the program was highly profiled, and the examination by SIOR members of possibilities of increased oil recovery was demanded by many of the senior production managers. The problem however was that, although a certain success was achieved, this was largely based on business asset adoption of close-to finished technologies which, according to the SIOR director, was ‘taken off the shelf and dusted of’ by the SIOR members. From the discussions in the SIOR core team meetings, it was clear that the core team members saw as their most important task from then on to ensure that adapted, testable technology was delivered on expectations. More over, fresh research results were demanded by the Research Centre management. It is important to mention that SIOR was but one of very many development programs and projects in Statoil. Therefore, the core team members were dependent on the continued positive attention from quite a few people in managerial positions in the company, from two important reasons in particular. One was that the Statoil researchers and experts were given a considerable degree of freedom to select the projects they wanted to participate in. As, simply put, the situation in Statoil was that they had more money for technology development than projects; financing was not considered to be a problem. The shortage of professionals, however, was, and so there was an ongoing competition for resources among the projects. Although SIOR was highly profiled, and gradually appreciated, in the business assets, the professionals, i.e. the specialists and the researchers, did not show corresponding interest in the program activities. The second challenge was that most of the development projects made enquiries about technology testing to the NCS business assets. For SIOR, this meant that they had to struggle for the continued attention of both professionals and of those responsible for the operating field activities. This situation led to an engaged discussion among the four members of the core team in the second half of 2005, about the need to invite the SIOR activity managers in as part of the core team to strengthen their feeling of identity and loyalty towards the SIOR ambition. The doubt that this would make the core team too large was gradually put aside to the benefit of the argument that a closer follow-up of the various research activities was needed, and in the end the original SIOR core team members agreed to extend the team. Consequently, from 2006 the SIOR core team consisted of 11 persons, including a program administrator. Of the original core team, only two persons, Rolf and Steinar, remained. The following figure shows the SIOR organization as it was at the conclusion of SIOR October 2007.

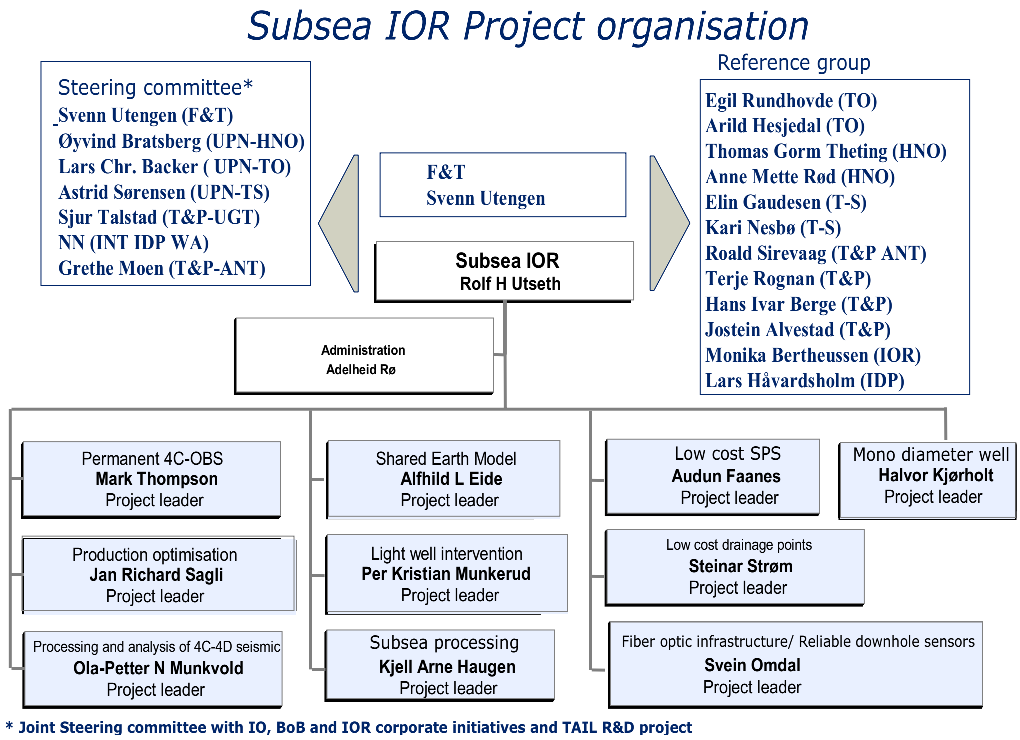

Figure 2-11 The SIOR project organization September, 2007

2.5 SIOR technologies

The major part of the SIOR portfolio was projects already ongoing in the Research Centre, re-focused to meet the demands on volume gains. Table 2-1 shows the six SIOR goals and the accompanying technology elements, as they were described in January 2004. I will comment on the most important of these projects below.

Table 2-1 SIOR goals and technology elements

1. Identify drainage points and intervention needs	i. 4-D (4 dimensions) / 4-C (4 components, which are shear wave xyz + pressure wave) prediction of fluid and pressure distribution ii. Fast updates of static models iii. Seismic derived saturation maps of history matching iv. Permanent 4-C, OBS (Ocean Bottom Seismic) for e-field (fibre optics)
2. Improve production management	v. Data integration platform vi. Integrated fibre optics system vii. Improved data integration, methods and software viii. Software for 'right- time' reservoir management ix. Improved work processes
3. Secure low cost drainage points	x. TTRD (Through Tubing Rotary Drilling) xi. E-drilling xii. New drilling concepts / monodiameter drilling xiii. Low cost flow lines xiv. Flexible subsea systems
4. Secure low cost intervention	xv. LWI (Light Well Intervention) – wire line xvi. LWI – coiled tubing xvii. Reliable down hole sensors xviii. Reliable DIACS system (Down hole Instrumentation And Control System)
5. Reduce wellhead pressures	xix. Gas lift xx. ESP (Electric Submersible Pumps) xxi. Multi phase pumps xxii. Flow improvers
6. Increase liquid handling capacity	xxiii. Subsea separation xxiv. Subsea injection of produced water xxv. Subsea injection of sea water

I. Identification of drainage points and intervention needs

Time-lapse or *4-D seismic* involves comparing the results of 3D seismic surveys repeated at considerable time intervals (e.g. before a field starts producing versus various post-production stages); i.e. time is the fourth dimension. This application was in continuous use in Statoil at the conclusion of SIOR. One of the important SIOR projects was the processing and analysis of 4-D data, and also data from the alternative seismologic registration approach, called *4-C* (which is built on three dimensional pressure waves and shear waves).

A particular application of the 4-C seismic, called *Permanent 4C-OBS* (ocean bottom seismic), was being tested in the Trondheim Fjord during 2007, and the result were very promising. The first system is intended installed at the Snorre field in 2008. Acquisition, processing and utilisation of 4C-OBS are still experimental, with new technologies emerging across the value chain. Statoil is the dominant user of this technology in the world, and has used the technology to improve reservoir imaging of complex structures and under gas clouds, contributing to value addition for several assets.

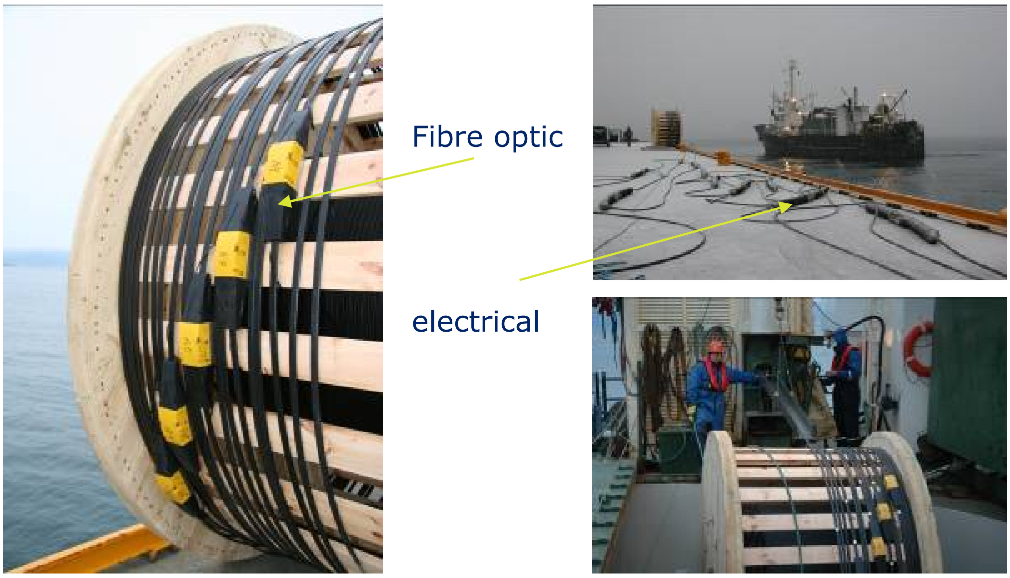

Figure 2-12 Fjord Test, 4C-OBS fibre optic seismic, installation (Photo: Statoil)

The *Integrated fibre optic subsea system* (IFOSS) will be partly implemented on Tyrihans and Åsgard. This is seen as the future subsea infrastructure setting a new direction by changing today's established subsea infrastructure for high bandwidth data transfer and control over long distances (~ 500-600 km). This will enable technologies like *Fibre Optical Ocean Bottom Seismic* and environmental monitoring technology.

II. Improved production management

An important concept development was *Integrated Operations* (IO), also referred to as *e-field*, or *smart field.* IO is about employing real time data and new technology to remove barriers between disciplines, expert groups, and people offshore, onshore, and employed in different companies, independent of time and space. The technology also makes remote operations possible, and thus forms the basis for new and more integrated ways of working. This is believed to reduce risk, ensure better decisions, and thus lead to improved value creation. The technology is already in use to support offshore operations from *onshore support centres* (OSC). In the longer term, this way of working is also believed to enable the unmanned operations of entire subsurface fields. An important part of this concept is the development of new work processes involving interdisciplinary teams. Another part is the development of shared earth models.

One of the most discussed projects in SIOR, to my judgement, was *Shared Earth Model (SEM)*. The reason for this seemed to be that there was more research to complete in this project than in any of the other activities, and that the actual effects on oil recovery therefore were correspondingly difficult to determine.

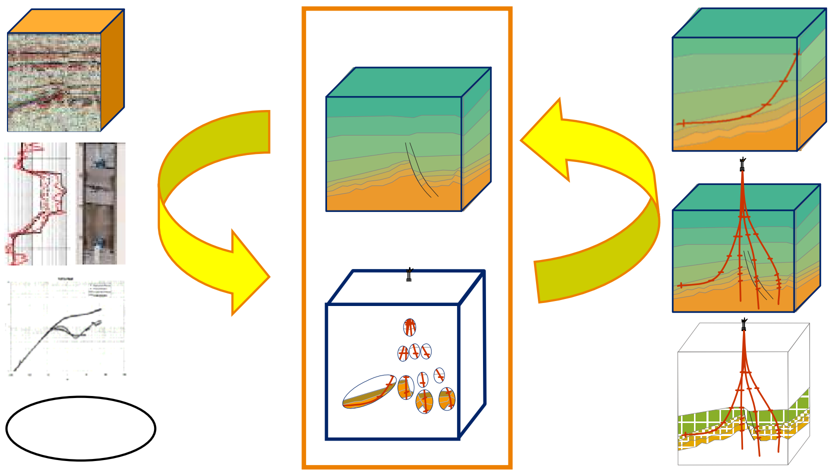

Figure 2-13 Shared Earth Model (Graphics: Statoil)

The SEM project originated from two projects, a *data integration* project and a project working with *well positioning*. These were developed into a joint project focusing on more rapid reservoir models updates. To obtain accurate geological/ petro-physical reservoir models and reliable simulations of reservoir performance are the basis for optimum field development. The concept of shared earth modelling had thus been used in the petroleum segment for at least ten years when SIOR was started, but as disciplines traditionally have worked apart, with different data tools, the SIOR project was innovative in that it tried to integrate and optimize information from several of these sources into one model. In relation to the development of SEM, a range of new products for achieving real-time, optimised and quality-controlled positioning of production wells were developed and industrialised.

Other technologies within the field of improved production management was *Optical down hole sensors* (DHS), which will be critical for down hole instrumentation in High Pressure High Temperature fields, and *Production and process optimisation*, which was looked upon as an important technology contributing to increased revenue, higher regularity and prolonged production.

III. Secure low cost drainage points

The concept called *TTRD*, or *Through Tubing Rotary Drilling*, was largely developed as part of SIOR. It had been extremely demanding to accomplish the technological solutions, and there had been problems related to cost estimates, tools and IPR (intellectual property rights). As the SIOR program period ebbed away, this concept had, according to Rolf, finally been 'taken into the warmth' by the business assets, and it was in fact referred to as one of the most successful SIOR activities. The technology permits offshoot wells (sidetracks) to be drilled sideways from a parent well by cutting through the production liner and sometimes through production casing. The estimated saving per subsea drilling operation has been estimated to around 6-10 million US$.

Figure 2-14 Through Tubing Drilling *(Photo: Statoil)*

The business assets were regarding TTRD subsea as one of the most important technologies to be able to realise allocated IOR volumes. By the end of SIOR Statoil had performed one subsea TTRD well on Norne, but plans showed a significant number of TTRD operations in the years to come.

IV. Secure low cost intervention

The project for *Light Well Intervention (LWI)*, which was commercialized across the licences during the SIOR program period, was one of the activities seen as new in SIOR, although work had been going on in Statoil for about 10 years to have the LWI concept adapted and accepted. According to Steinar, who headed this activity, this had been a slow process, but when people in the business assets finally got interested, it was like ‘a plug which had been stuck, but suddenly shot out of the bottle’. LWI is seen to be of particular importance as Statoil moved towards deep water.

A part of this concept was the riserless Light Well Intervention system, which is an alternative for gaining quick and easy access to subsea wells for maintenance and technical purposes. These activities also included the development of so-called ‘smart wells’. These are wells completed with valves or chokes down hole in the reservoir and with equipment that can be operated from the surface. SIOR activities included the development of fibre optic infrastructure with a substantially increased capacity for data transmission, and reliable sensors for placing in the wells, to reduce or eliminate the need for well intervention.

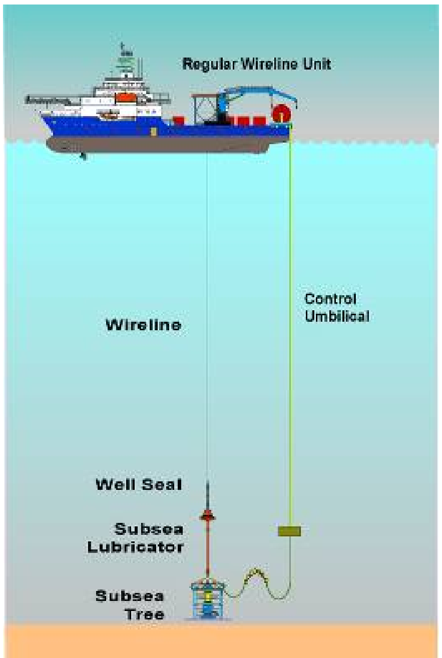

Figure 2-15 Light Well Intervention (Photo: Statoil)

Another activity was *Wet gas compression*. This project had been established to prepare for subsea gas compression on the Åsgard field in the Norwegian Sea from 2013.

V. Reduce wellhead pressures

A concept which in its entirety was developed as part of SIOR was *Subsea MMX*. The concept combines several approaches to marine operations with the objective of obtaining a 50% reduction of total costs of subsea wells within 2010. It includes monodiameter drilling, which is believed to give increased flexibility in future well constructions light drilling rigs, light well intervention (LWI) related to drilling, compact and flexible subsea systems adapted to slender fittings, and low cost flow lines. In September 2007 the concept was not completed, but the interest for it among people employed in the business assets seemed to be substantial.

VI. Increase liquid handling capacity

The first success story of the SIOR program was the decision to implement a full-scale separation facility on the Tordis field. This was estimated to increase oil recovery from the field to the magic 55 %, adding 35 million barrels of oil reserves. The system was installed in 2007 as the world's first commercially operated subsea processing system.

Another important achievement was the approval of *Raw sea water injection* by subsea pumping approved for Tyrihans development, increasing recovery by 3 Mm3 (million cubic meters), or 18 million barrels.

In the next section, *Statoil and SIOR 2004 – 2007, year by year*, important events related to the most important of these development projects are commented.

2.6 Statoil and SIOR 2004 – 2007. Year by year.

There is no way to make justice to the comprehensive activities of the SIOR core team and the rest of the SIOR members and collaborating supplier representatives within the frame of this chapter. This means that, if former SIOR members read this, some of them will probably miss the reference to their activities, and most would talk about what they did in SIOR in other ways than I have chosen to do it. The events I bring up in this section are however events emphasized partly in the Statoil Annual report, but more importantly, by the SIOR core team members in their fortnightly meetings. In the second half of 2004 I was allowed a separate item on the SIOR core team meeting agenda. The item was called 'event log'. In practice, what I did was to note everything the SIOR CT members said during the meeting that I perceived to be of importance for the project activities. At the end of the meeting, I summed up my notes, and everybody commented and supplied items for the log in turn. This exercise went on for more than three years, and in this way I learned about important problems and achievements, and about planned events attributed particular importance. In the following sections, I will give an account of the SIOR program period, based on the event log, other notes, and a somewhat unreliable memory.

2.6.1 2004

In 2004 the net income of Statoil was 24.9 billion NOK after tax (which equals *4.6 billion US$* at a dollar price of 7.5 NOK). At the time this was the best-ever result in Statoil's history and 51 per cent up on 2003. This implied increased return for the owners, and earnings per share came to NOK 11.50 as against NOK 7.64 in 2003. There was a 29 % increase in international oil and gas output (which nevertheless was not more than about 8 % of the total production), and the production in the year was replaced by additions of new reserves. Furthermore, eight of twelve exploration and appraisal wells resulted in finds. In 2004 a new CEO, Helge Lund, was appointed. When he started, in October 2004, he immediately carried out a reorganization implying that quite a few Statoil managers, also in the Corporate Executive Committee, changed their positions. The Statoil division for Technology (TEK) was defined as a business area on a level with UPN and INT, and was renamed to Technology & Projects (T&P), as mentioned in section 4.3.2. A new corporate control model was introduced, and the focus on ethical guidelines and corporate values was strengthened. Particular demands were made on the business areas T&P and UPN to develop similar *Key performance Indicators* (KPI) to encourage the joint effort to develop and implement technology for increased oil recovery (IOR).

For the SIOR core team members, most of the year was spent meeting with people in the business assets, and also to adapt the SIOR project portfolio to support the 55 % ambition. A particular effort was made to ensure the implementation of *subsea separation* on the Tordis field, and to establish contact with the Tyrihans subsea field development project, to try to get altogether six SIOR technology elements included as part of the Tyrihans *Plan for development and operations* (PDO). Another important initiative was the development of a strategy for *Integrated operations (IO).* At the time SIOR was initiated, activities in the field of IO (of which the actual content was yet somewhat diffuse) were spread out in the Statoil organization as projects and initiatives, many of them without connection to the others. Per Ivar, who was responsible for the IO activities in the Research Centre, was convinced that Statoil had to concentrate on a joint development effort. Furthermore, the availability of commercial products was considered a prerequisite for the success of the implementation of this kind of technology. Thus collaboration, both in Statoil and with suppliers, was seen as imperative. Towards the end of 2004, a steering committee for the IO activities was established. During the second part of 2004 a comprehensive acquisition process, intended to lead to the increased cooperation between Statoil researchers in the SIOR and Tail programs and experts from other companies for technology development within the area called IO, was outlined. The process was called ASTI (Acquisition SIOR and Tail Integrated operations), and implied the pre-tender inquiry, offer evaluations and contract negotiations on six comprehensive development areas defined to be part of the IO activities; five which were organized in SIOR, and one in Tail. A part of the idea behind ASTI was that the partnerships established should also co-finance the development work.

In November, a first joint meeting between the core teams of the SIOR and Tail program was held; the theme was interfaces and coordination between the two programs, which were both about IOR. At the same time, a joint steering committee for SIOR and Tail was established, and the first specification of the future SIOR organization, with names of the participants, was presented. The core team had struggled to find persons willing to take the role as activity managers for two important projects, *Wet gas compression* and *Monodiameter drilling*. This fell into place at the end of the year.

As part of the change process put into effect by the new CEO, a number of so-called *corporate initiatives* were introduced. These were development areas picked out as being of particular importance to Statoil. They were assigned corporate coordinators, and received special attention from the top management. Two areas of great relevance to SIOR were among these corporate initiatives, which were *Integrated operations – IO,* and *Increased oil recovery - IOR*. This contributed to make SIOR more than an important technology development initiative - the project was referred to as a requisite tool to reach the ambitions outlined in the corporate initiatives. This also meant, however, that SIOR had to coordinate their activities with an increasing number of other development project managers.

2.6.2 2005

In 2005 Statoil again had a best-ever economic result, of 30.7 billion NOK. On the NCS twelve new development projects were ongoing, nine finds were made, and 16 new licences assigned. There was a record production, and the focus on increased oil recovery started to show results in the shape of estimates of prolonged field life times, and consequently, in the increasing value of mature fields. In addition, there was a 60 % increase in the international oil- and gas production, largely due to extensive acquisition of fields and exploration licences in the Gulf of Mexico, where the first field developments were also initiated. On the negative side was the delayed start of deliveries and increased costs on the Snøhvit project.

In January, five new corporate values were introduced, of which one was *imaginative* (or 'innovative' if directly translated from Norwegian). The other four were *hands-on, professional, truthful* and *considerate.* Two months later, a new concept, called 'distinctive technologies', was introduced by the Statoil CEO. The exact meaning of the concept seemed to be unclear to many of the SIOR members for quite some time, and was discussed on several occasions. In August a so-called 'unbundling process', in which Rolf was one of the participants, was initiated by the top management to identify which should be the Statoil distinctive technology areas. As result of this process, five areas were pointed out: *Subsea field technology; Reservoir management; Gas chain management; Environmental technology;* and *Exploration technology*. Within these five areas, 18 classes of technology where Statoil was to be 'distinct' were identified. From what I could understand, this 'distinctness' was something others should be able to notice, without Statoil promoting it. The ultimate target, as formulated by my SIOR colleagues, was 'licences to operate'. The following criteria were emphasized as important to reach the target of distinctive technologies: Statoil had to be operator; the technologies had to be cost effective and suitable; implementation had to be successful; innovative collaborations and procurement strategies were needed; technologies had to be integrated; top talents were needed; and success stories had to be communicated throughout the company.

The attention on technological innovation was, as can be seen from this, high, and I was told that as many as one hundred different measures were pursued to improve oil recovery from the NCS. Gradually the UPN business areas Tampen and Halten Nordland established a closer contact with SIOR members, to discuss joint IOR activities. The third UPN business area at the time, Troll-Sleipner, was originally not asked to be involved in SIOR activities, but demanded to get a representative both in the Reference group and in the Steering committee.

Important for SIOR was that the technology for *subsea separation* on the Tordis field was approved in Statoil, and the Tordis PDO (Plan for Development and Operations) submitted to the authorities. This was in October. The technology was assumed to increase the recovery factor from 49 % to 55 %. Tordis thus became the world's first field with subsea processing, and was seen to represent a substantial contribution to the increased recovery of oil in smaller fields, in deep waters, and in fields located at a longer distance from fixed installations. Incidentally the technology was also sold to Angola fields. A large part of the credit for this achievement went to the SIOR core team; and Eric in particular. Another achievement made in the collaboration between the core teams of SIOR and Tyrihans, was the decision to make Tyrihans the first field with untreated seawater injected directly into its reservoir from seabed installations. The collaboration with Tyrihans was however not without problems. When the Tyrihans core team submitted the PDO to the authorities in June 2005, only two of the six technologies the SIOR core team had evaluated as important to the Tyrihans concept, was included.

Other SIOR activities also got a lot of attention this year, both positive and negative. One of the most demanding projects was the TTRD (Through Tubing Rotary Drilling) activity. From the beginning of the year constraints on rig capacity was critical. It also became clear that disagreement had arisen between the SIOR program and the collaborating supplier regarding IPR, and this situation had evolved into a demanding process. At the same time, work progressed slowly. In August, one TTRD drainage point had been obtained at Norne, and the results were referred to as promising.

The LWI (Light Well Intervention) project had escalated, and interest increased in the business assets. As an example, the Tampen business area had undertaken to 160 days of LWI operations. The lack of activity manager for the LWI activities was however seen as a problem in the beginning of the year, as it was for another program, the *wet gas compression*. In August there was a breakthrough in the LWI project, as a new vessel was got hold of, and commitment to test the technology obtained across licences. The SIOR objective of LWI to a cost of 1 million NOK a day was seen to be within reach, although the collaborating supplier expressed concern about own manning situation.

In March, an extra allocation of 50 million NOK was given to SIOR to support the *wet gas compression* activity. A very experienced activity manager was finally identified, and potential collaborators for the activity were discussed. Both Shell and Hydro were mentioned as potential partners in the program.

The ASTI process occupied a lot of the time for SIOR members. In February a first meeting with potential collaborating suppliers was brought about. About 90 representatives from suppliers participated. A series of meetings with the different suppliers followed. One of the intentions from Statoil was to encourage the collaboration between larger and smaller suppliers to be able to deliver 'complete' packages of development capacity, and this led to the gradual formation of new collaborative constellations among suppliers. The call for tenders was announced in June, with the deadline set to early September. All summer I could observe SIOR members dragging around with large heaps of loose-leaf binders, but the actual discussions about the offers were held within a circle of only a limited number of people. The first part of the evaluation process was completed in November, and after an ASTI steering committee meeting, negotiation meetings with ASTI bidders were initiated. To the relief of the SIOR core team, responses from supplier representatives indicated that the SIOR program had obtained a good standing among the suppliers related to the ASTI process, but also to the other SIOR activities.

An interest group of importance to the IO activity was the trade union representatives. They worried about the IO activities, which in the future could imply unmanned offshore petroleum activity, but also a transitional stage were operations were controlled offshore and onshore at the same time. The concern of the trade union representatives was both for the safety of those working offshore, and for the level of wages as people were moved onshore. One of the reasons for the latter concern was that in Norway, trade unions have obtained a strong position, and negotiated salary conditions for offshore workers which are seen as extremely good. The development of IO technology was thus seen as a threat towards the further development of this benefit. In September a meeting was arranged between trade union representatives and SIOR and Tail IO activity representatives to discuss these matters. Concerns were brought up, and as far as I could see, discussions about this continued throughout the program period.

In April, Eric decided to go to another position in Statoil, and was replaced in the core team by Bjørn-André Egerdahl, who came from a position in the Tordis IOR project team. Headed by Bjørn-André, a new technology concept was formed by the SIOR members, called *Subsea MMX*. The concept was presented to the Research Centre management in November, and met with great interest.

Throughout most of the year, as every year, a quite comprehensive project planning and execution process took place. An annual 'wheel' was established for the steps in the process of planning the coming year. For SIOR and the other R & D mountain peaks, the process started in October / November the year before, with the first preparation of Project Execution Plans (PEP). In the course of the spring, the plans was discussed and aligned with the development plans of the business assets, and adjusted according to responses from quality assessment and TEK Arena processes, as well as from reference groups and steering committees.

Another time-consuming process in 2005 was the change from Lotus Notes to Windows / Team sites as the formal Statoil IT-based document administration system. All the core team members had to do an extensive job converting documents and other files into the new system, and categorizing them according to the new retrieval criteria. At the end of the year, the SIOR core team members carried out series of meetings with pilot customers in the business assets to ensure their continued interest in the program. The meetings were described as important, positive and resource-demanding. A concern had however evolved in the core team that all these meetings with business assets and suppliers, together with the increasingly comprehensive project administrative routines, had made them to a large extent neglect the SIOR activity managers and the researchers 'actually doing the work' (as Rolf worded it). Rolf, Steinar, Per Ivar and Bjørn-André therefore gradually agreed that the activity managers should be included in the core team, although they also worried that this would make the team too large, and more inefficient. When Per Ivar announced that he had decided to quit the core team to do a PhD, a final agreement that the core team should be extended was obtained.

2.6.3 2006

In 2006 the Statoil oil production declined with 34.000 barrels per day. The explanation given for this was the lower production from mature fields, and the temporary reduction in production from other fields. At the same time the exploration activity increased substantially, and 37 exploration and appraisal wells were completed, compared to 20 the preceding year. Nine new projects were put on-stream. The increase in exploration activity and preparation for new production was seen as an indication that the attention to business development was increasing. Furthermore, there was a strengthened focus on the need to develop technology to deal with the climate challenges. In 2006 INT stood for 16 % of Statoil's total oil and gas production, and output continued to show growth. 2006 was also the year when the word 'simplicity' was introduced in Statoil. It was launched in April by CEO Helge Lund, who presented his ideas of how to simplify Statoil systems and regulations drawn out on a napkin.

Figure 2-16 Rolf Utseth and Adelheid Rø in a SIOR core team meeting (Photo: TMBAasen)

December 18, 2006, the forthcoming merger between Statoil and the Oil and gas division of Hydro was announced. From what I could see, this led to the almost immediate refocusing of attention of a majority of the people I met in T&P and in UPN, towards the new situation. Statoil employees in the land-based part of the organization all had to reapply for their jobs, along with their about 5000 new colleagues coming from Hydro. The organization was restructured once more, and a massive exchange of people in the various positions, especially management positions, took place. Helge Lund continued as president and CEO of the new company, which from October 1, 2007 was called StatoilHydro.

Figure 2-17 Mark and Ola Petter, and Jan Rickard *(Photo: TMBAasen)*

The local restructuring of the SIOR program from January 2006 implied that only two persons from the original core team, Rolf Utseth and Steinar Strøm, remained. In addition to them, Bjørn-Andre Egerdahl, Alfhild Lien, Halvor Kjørholt, Jan Richard Sagli, Knut Håvard Nordstad, Mark Thompson, Ola-Petter Munkvoll, Per Kristian Munkerud and Svein Omdal entered into the team. The administration of the program was supervised by Adelheid Rø.

The core team and other members of the SIOR program had succeeded in making the program known in the company. In the beginning of 2006 it was presented for the management teams of T&P and UPN, and was met with a lot of interest. The business area Halten Nordland had started to work out a strategy concerning increased oil recovery (IOR) which was supportive of the work done by the SIOR and TAIL programs, and some of the business assets also had initiated own IOR projects. In March Steinar completed a new series of meetings with the business assets to discuss further IOR measures. All in all, there was no lack of tasks for the SIOR members.

Figure 2-18 Halvard, Steinar, Audun, Svein og Rolf (Photo: TMBAasen)

A problem related to the collaboration about the *wet gas compressor* intended implemented at the Åsgard field gave rise to concern in the new core team. Extra effort was put down in the project, and in March the project passed the first peer. This was seen by the SIOR core team as an important recognition of the technology. After that, this activity seemed to slacken some, and towards the end of the year the activity manager left for another assignment. It showed difficult to get his successor.

One of the dilemmas faced by the SIOR core team, was a demand for making visible the long-term potential in SIOR activities, advanced by the chief researchers responsible for the annual quality assessments of the 'mountain peaks', and the simultaneous demand for immediate deliverances. The activity seen as really long-term was Shared Earth Model (SEM), which was about advanced reservoir modelling. Throughout the SIOR program period there had been discussions whether this activity should be part of SIOR, or not, and my impression was that Rolf in fact had held a particularly protecting hand over this project. From this reason it was a real feather in the cap of the SEM activity manager, Alfhild, when the project was informed in February that it had been granted a session in the annual *Statoil R&D Summit* in October. The session incidentally gathered 24 participants from Europe, the US and Canada.

SEM was also included as one of the six work packages of ASTI. The uncertainty about the feasibility and the profit potential of the activity affected the ASTI negotiation, and in February it also became clear that an agreement could not be obtained with external supplier about this area, because the path towards commercialization was seen to be too long. In the period from March to May the rest of the ASTI negotiations were completed. Four ‘packages’ were concluded with contracting, and two were not.

In February, Bjørn-André informed that an agreement to cooperate with Hydro about Subsea MMX was under preparation. Because of the Shtokman field activity at the time, it gradually showed that collaboration with Hydro, who was at the time competing with Statoil to get a footing in the Shtokman development, was difficult. In May collaboration between Statoil and an external supplier related to the Subsea MMX was decided, and the contract signed in October with Statoil as the only customer. Another milestone for the project was reached in November, when the business area Halten Nordland included the MMX concept in their strategic technology development plan.

In February an internal agreement related to LWI was completed. According to Rolf, this agreement was received with ’rounds of applause from the licences’. In March an expandable liner was installed in the Kristin field for the very first time, an important milestone for this technology. The *4-D Ocean Bottom Seismic* technology also got more profiled in 2006. The activity was record high, and was met with substantial interest among representatives from the business assets. Comprehensive testing was carried out, and ten seismic 4-D registrations from 16 fields were planned for the year.

From my viewpoint, there were three other developments which also characterized this year. First, an increasing demand for presentations and reports from many parts of the company occupied a lot of time for the SIOR core team members. In addition the SIOR members themselves participated in more and more conferences and meetings, to present the SIOR program work and results. As an example Statoil and SIOR got the ‘best paper award’ in the Deepwater Intervention Forum in Galveston in September. Secondly, a demand for a delivery rate of at least 80 % of planned deliveries resulted in a adjustment of focus of the SIOR core team towards obtainable short-term objectives. The third development turned out to be a problem for the SIOR program, and was related to the localization of many of the SIOR members at the Research Centre in Trondheim. Several of the SIOR members were co-localised in an open-plan office, which had been rebuilt because the SIOR core team members wanted to encourage the closer cooperation between people working in the different SIOR activities. Many of the members of SIOR did however not feel comfortable with this way of working. Because of this, some left SIOR to work in other R & D programs, and the SIOR core team were concerned that the premises affected negatively the possibility for SIOR to get the necessary resources. The end of these discussions, which lasted for many months, was that the premises had to be rebuilt once more, and walls were partly reintroduced.

2.6.4 2007

The main event in Statoil 2007 was the merger between the company and Hydro's Oil and gas activities. This was referred to in the Annual report 2007 as 'a forceful response to increasing industry complexity and international competition'. The merged StatoilHydro became the operator of 30 oil and gas fields, and was promoted to have an expanded technology base and stronger capabilities to execute larger and more demanding projects. The activity level in 2007 was described to be historic high, and included the completion of the Ormen Lange project and the first tanker to leave the plant on Melkøya with a cargo of liquefied natural gas (LNG) from the Snøhvit field. In addition, eight projects on the NCS and five international projects became operational in 2007. Access was gained to new growth opportunities, among other things through the acquisition of North American Oil Sands Corporation, thus establishing a position in Canadian oil sands, and the partnership in the development of the Shtokman offshore field. The entitlement production of oil and gas increased by 3 %, 15 new projects commenced production, an extensive exploration programme was executed, and the company gained access to new high quality projects and exploration acreage. The high oil prices contributed to a solid annual result, but from what I could evaluate, it also to some extent camouflaged the situation of falling production on the NCS.

The period from January until the realization of the merger October 1st was a little strange. Rolf was given a special assignment related to the process of preparing the integration between the two companies, and was almost never present in the core team meetings. As everybody had to reapply for their jobs, many naturally were preoccupied with the possibility of continuing in their present job, others wanted to seize the opportunity to change to another area. From what I was told, this was the situation in all groups, including line management groups. Most of the processes initiated before the announcement of the merger seemed more or less to stop, largely because many of the managers were assigned to work groups preparing the integration process. In the course of the spring, more and more of the managers appointed to top positions in the 'new' company were informed about their future responsibilities, and this seemed to contribute further to the idle running of many processes. At the same time, the SIOR core team and everybody else were instructed to go on as if nothing had changed until September 30, when 'annual settlements' were to be made. This resulted in the strange situation that the planning processes were performed almost as usual, although everybody seemed very aware that the work had to be done all over again when the new organization came into force. Still, Rolf was clear that it was important to give as good inputs as possible to the new organization, as it gradually became known that most of the SIOR activities were to be included in some form in a new program called IOR – *Increased Oil Recovery*.

The structure of the new organization was frequently demanded by the SIOR members, and there seemed to be a general lack of information about the forthcoming merger which provided a breeding ground for assumptions and uncertainty. Another source to concern among the SIOR core team members was the difficult resource situation. In connection with the merger, all Statoil employees of 58 years or more were offered a generous severance pay, which by many I spoke to was seen as a clear request for them to leave the company. Examples of comments from the SIOR core team about the resource situation in relation to this was:

- *The worst thing is the professional development; there will be no continuity and large holes.*
- *We have nobody above 58 in our team, but X and Y teams have, and they need people from our group to replace those they loose.*
- *We are not able to reach the deliverance targets when the resources disappear.*
- *We have asked him to work for us, but he doesn't want to.*

In spite of all this, the SIOR activities progressed. The IPR conflict related to the TTRD activity finally reached a settlement in January, after more than two years. At the time, Statoil had invested a three digit million amount into the development activities. The 4-D OBS technology was decided implemented on the Snorre field, and much to the surprise of the SIOR core team, the Tyrihans field development team also showed interest in the technology, although it had originally been turned down in the PDO process.

The level of development activity was high in the company in general, and all specialist resources, including the researchers, seemed to be drawn to the field development projects, thus enhancing the problem in the SIOR program of getting sufficiently manned. Another problem was the demand that collaborations with the business assets about technology development and testing had to be regulated by contract. Although agreements between SIOR and various assets had appeared to be in order, about 10 % of the contracts were still unsigned by the asset contact persons. This was explained by the SIOR core team partly by the fact that many people were about to change their positions, making it unclear who should sign the contracts. Some of the SIOR core team members also commented that signing the contracts involved a commitment on the part of the business assets which they seemed reluctant to take on; thus far they had largely been receiving support from the SIOR members. Independent of reason, the core team seemed to agree that there was a need for Rolf to work behind the scene, to land the agreements. Rolf, however, also warned the core team members that some of the SIOR researchers tended to be too preoccupied with technical details in customer meetings, and that what should be discussed to make sure that interest was aroused, was utility value, availability and potential of the specific technologies.

After the merger, my contact with SIOR core team members has been more sporadic. Rolf is heading the planning of the first Statoil technology centre outside Norway, the *Heavy Oil Technology Centre*, which will be situated in Alberta in Canada. Steinar and Jan Rickard are members of the core team of the IOR program continuing most of the SIOR activities. Several of the others from the SIOR core team continue to work with SIOR technologies, and some have chosen to do something different. But what about results, - or innovation?

2.7 Results and experiences based on the SIOR program

Towards the end of April 2008, the average recovery factor from subsea wells (calculated over resource classes 0 – 5) had increased to approximately 46 %, which meant that substantial effort was still needed to reach the target of 55 %. Some of the technologies made available by SIOR, like LWI, had however also contributed to uphold the base volume production, which seemed to be a growing challenge for several business assets.

August 31, 2007 I had the last formal conversation with SIOR program director Rolf Utseth about specific results of SIOR and the experiences gained throughout the program. As emphasized by Rolf, the most important outcome of the SIOR program, and also of the Tail program, was the setting that was created; which was the very clear focus in the company, especially in the top management, on the importance of increased oil recovery. This had resulted in an expectation about mutually binding cooperation between the business units for technology development (T&P) and operations (UPN and INT) which was new in the company. While the department for Research & Technology development (the Research Centre) had formerly played a marginal (although in some areas very important) role in the total technology development processes in Statoil, the department members, supported by T&P managers, were now largely given the responsibility for the coordination of corporate R & D activities, including transfer of technology to UPN and INT business assets. Some challenges had been identified by the SIOR core team as particularly demanding in connection with this change. Firstly, implementation of new technology was demanded from the top management, but the speed of implementation was affected by many factors which seemed to be beyond the control of SIOR members, like technological set-backs, situational changes of priority-settings in business assets, and limited rig capacity. Secondly, an important challenge was related to internal and supplier resource capacity; and also the internal dedication to R & D, which both varied. Yet another challenge was to obtain alignment between corporate and supplier objectives, including considerations about IPR. The impact of such challenges appeared to be hard to foresee, yet it looked as if the top managements' expectation about delivering on promise in the R & D programs was intensifying throughout the program period.

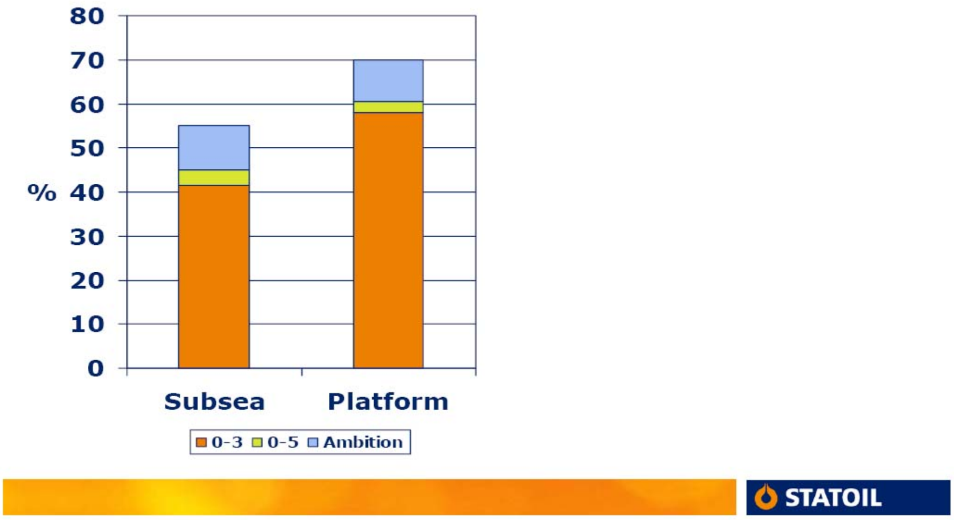

Figure 2-19 Recovery factors on the NCS October 2006 (Subsea and platform fields)

An important achievement of the SIOR members, and the core team in particular, was that they succeeded in making SIOR a brand name that people remembered, both in Statoil and in other companies. According to Rolf, one reason for this was the decision to limit the number of overall targets to a handful, which made it easier for people to remember what the program was all about. Another reason was the deliberate nurturing by the SIOR core team members of the relationship with those responsible for Statoil information services. The core team members saw to it that they were invited to relevant exhibitions, and 'educated' them within the field of subsea technology.

Rolf characterized working towards the 55 % SIOR ambition as 'the belief in the impossible'. He particularly emphasized the importance of the work made by the core team in the start-up phase of the program to flesh out possible approaches to fulfil the ambition. The SIOR approach to calculation of added volume per licence and technology element had been accepted as a corporate approach in October 2005, and CEO Helge Lund also had asked to have the procedure added as part of the business asset KPIs. This was judged by the SIOR core team members as an important recognition of their work.

At the conclusion of the SIOR program, this was the status of the most important activities:

- The world's first *subsea through-tubing rotary drilling* (TTRD) operation had been performed from a mobile unit on the Norne field in the Norwegian Sea
- Tordis in the North Sea was about to be the world's first commercial field with *subsea processing*
- *Subsea injection of raw (untreated) seawater* had been included in the plan for development and operation (PDO) of the Tyrihans field in the Norwegian Sea.
- *Light Well Intervention* (LWI) had been adopted by several business assets.
- *4-D seismology* was in continuous use
- *4-C OBS* was being tested, and plans were under preparation for implementation on the Snorre field.
- The technology *PosLog*, which was about real-time decision-making during drilling, was under testing.
- *Shared Earth Model* (SEM) was partly in use, and a sub-program called *$ target* had been implemented in the company.
- The process of adapting *wet gas compression* to the Åsgard field was still ongoing; the role of SIOR had been that of driving force and enhancer.
- A strategy of *Integrated Operations* (IO) had been established, and elements of the concept partly implemented, among other places on Snorre, Tyrihans, Åsgard, and Heidrun; to obtain what was referred to as 'everyday rationalizing'.
- In addition to efficiency improvements obtained through IO measures, *improved production* was also approached through an optimization tool adapted for the Gullfaks field, and improved work processes for production optimization in the Halten Nordland business area.
- The principles of the ASTI process formed the basis for a corporate standard approach to the acquisition of development co-operations.

A gratifying development which was partly caused by the efforts of SIOR, and also of Tail, was the improved ranking of Statoil within the field of *Integrated operations* from 2004 to 2007. A study made by Petoro (which is the company serving as the licensee for the state's direct financial interest (SDFI) in Norwegian petroleum operations) in 2007, ranged Statoil as number 2 of the oil companies within the field of Integrated Operations on the NCS, after Conoco Philips. In 2004, Statoil had been ranged number 5. Furthermore, Statoil was mentioned to be better than Conoco Philips internationally.

As can be seen, the SIOR program resulted in the completion and implementation of several technology elements, and the development of even more, which will gradually be in pipeline for testing. The processes of developing the technology elements were not without problems, and neither were the processes to get technology approved, tested and adopted. The intention of my study has been to identify ways to explain the processes which happened in, and because of, the SIOR program, and which I refer to as *innovation processes*. I will begin to make an overview over the research already existing within the field of innovation in organizations (chapter 3), and then I will discuss some of the problems I faced trying to apply this thinking to explain the SIOR processes.

2.8 Summary

The intention of this rather comprehensive chapter is to give a detailed account for the SIOR program, as a backdrop for the subsequent discussions about my experiences in SIOR, and the consequences they had for the development and results of this dissertation. The SIOR program was about the development of approximately 25 very complex technology elements, which in various ways were believed to support the SIOR ambition. Although comprehensive, my account of SIOR is far from complete, and does not do justice to the many events and efforts.

Seen from my view, there seemed to be some similarities between the SIOR program and the development of the Statoil organization. They both started with a handful of skilled people who decided to go for a very ambitious target. In the beginning, the effort to realize the target appeared to be a somewhat confusing mix of intention and chance, which nevertheless resulted in a gradual transformation of the widespread resistance towards the new ideas, into recognition. Controversial themes related to the SIOR program were the ambition of increasing oil recovery from subsea fields to an average of 55 %, involving a substantial profit potential, and the approach, which involved collaboration between members of the Research Centre, operational units and external suppliers in a way perceived as new in the company. The pronounced support from the top management was of great importance to enable establishment of the necessary collaborations. At the same time, the top management gradually intensified their demand for predictability of SIOR deliveries, apparently forcing the SIOR members to focus more on results than on fresh opportunities.

The story about the SIOR program is the story about technological achievements. More importantly, it is a story about the tremendous effort on the part of a small number of people to convince a rather large number of colleagues that the SIOR intention was of value in the particular situations they were in, at the same time paving the way for a new way of innovating in Statoil.

To add a little more depth to the picture I draw of the SIOR program, the chapter is opened by a brief introduction to Norwegian petroleum history, - because I really like history -, but also because I think that history involve events and decisions being of major influence on future development, although not always leading to the situations foreseen. The Norwegian petroleum policy has for instance shown to result in viable petroleum activity on the NCS, including a very competent supplier industry, and to social prosperity unimaginable only a few decades ago. Statoil has evolved into a multifaceted company characterized by principles of involvement and consensus, elaborate decision processes, and skilful employees. It has become one of the most innovative companies in the world out of necessity, of skill, and because a lot of leading politicians and managers have been ready to take the required risk. Incidentally, the background for this study was a question posed by some Statoil members, whether the will to innovation is fading.

3 Innovation research – current perspectives

Davila et al. (2006:10) claim that if it was to be made a list of all the advices written about innovation, it would stretch from the earth to the moon, and back again. The justness of this statement is of course somewhat difficult to verify, but what is certain is that today innovation is a global theme and a hot topic among researchers, managers, consultants, and politicians. Current research on innovation takes many disciplines as starting point, and a broad range of ideas about what innovation is and how it is best managed co-exist. The breadth of ideas within the field is illustrated among other things by the many definitions of 'innovation' suggested in the literature. In this chapter I take a closer look at some of these definitions, followed by a review of important dimensions and perspectives within research on innovation in organizations, including innovation management, and of commonly applied approaches to knowledge creation about innovation. Focus is in particular on research on innovation in established organizations.

The fundamental question for many of the studies on innovation is why some companies or teams are more innovative than others. A company's potential for producing innovative, commercially valuable results is referred to as its capacity to innovate; that is to convert scientific breakthroughs and technological achievements into industrial and commercial successes (Miles et al., 2000; Neely et al., 2001). A large number of studies have been accomplished searching for the most important organizational characteristics affecting such innovative capacity. Though the results differ, many studies point out characteristics like organizational culture, internal processes, relational skills, structural conditions, and external environment influence to be of importance in relation to innovation capability (Arad et al, 1997; Ravichandran, 2000). As have been pointed out by Christensen (1997), Tushman and O'Reilly III (2002) and Christensen and Raynor (2003), large companies face a particular challenge in managing existing products and processes, while creating - or adopting - new ones at the same time. Some authors, like Neely et al. (2001) and Durand (2004), emphasize that it is not sufficient to introduce an innovation to obtain better business performance, the innovation has to produce effective outcome, like lower costs, increased profit or enhancement to existing products or processes. To derive competitive advantage from innovation has been described as '*a highly intricate process involving technical complexities, functional interdependencies evolving solutions, high levels of uncertainty, and highly complex forms of work integration*' (Thamhain, 2003:297). This may explain why, despite extensive research efforts, relations between innovation and value creation is predominantly subject to theoretical debate (Neely et al., 2001).

3.1 Definitions of innovation

The concept of innovation is used to denote both the activity of 'innovating' and the outcome of the activity in the form of novel solutions (invention), like new products or new processes for production, distribution or collaboration. Many of the definitions of innovation focus on the result of innovation efforts; that is *what* is new and *how new* it is. Other definitions are framed to indicate that the actions taken to obtain innovative results are seen as part of an overall *innovation process*. Still others focus on the effects, or *impact* of the adoption and diffusion of innovative results in organizations or societies.

Schumpeter (1942) claimed that the purpose of innovation is strategic advantage, obtained by doing things in new ways in economic life. This thinking can be recognized in a large part of innovation research, like in the definitions proposed by Bundy (2002:37), who states that innovation is '*a major function of technology, and it begins with invention and concludes with commercialization'*, and Wijnberg (2004:1416), who emphasizes that '*innovation is something new which is presented in such a way that its value will be determined'*. Wijnberg's point is that the value of innovation is determined by the market. Akrich et al. (2002a) suggest that innovation does not only involve positive market evaluation, but also that is it only the first adopter who performs innovation, and that those who follow are imitators. Innovation is therefore defined as '*the first successful commercial transaction, or more generally, the first positive sanction from the user*' (Akrich et al., 2002a:188).

Several authors focus on impact of innovation without emphasizing the c*ommercial* aspects. Tidd et al. (2005:66) regard innovation as '*a process of turning opportunity into new ideas and of putting these into widely used practice*'. Drucker (1997:84) is of the opinion that innovation is '*change that creates new dimensions of* *performance'*, while Poole and Van de Ven (2004:xi) more poetically state that '*innovation is an important partner to change. It is the wellspring of social and economic progress, and both a product and a facilitator of the free exchange of ideas that is the lifeblood of progress*'. Somewhat in the same spirit Nonaka (1991:25) claims that '*the essence of innovation is to recreate the world according to a vision or an ideal*'. Incidentally, by this he touches upon a human characteristic essential for innovation, which is the ability of individuals to imagine themselves in future situations and to try to move towards this future by means of innovation. The understanding of innovation as something having a consequence for somebody or something is important to separate between innovation and *invention*. According to Van de Ven et al.(1999:9) invention can be defined as '*the creation of a new idea'*, while innovation is '*more encompassing and includes the process of developing and implementing a new idea*'. Durand (2004:48) quite simply sees innovation as '*an idea put to work*'.

In an economic perspective innovation is seen as a driver of economy. Social scientists and technologists are more interested in the *processes* of innovation, and seek to model and characterize these processes. Burns and Stalker's (1961) view of innovation as a sequence of activities starting with invention and proceeding through development to commercialization can still be recognised in many models. Research on innovation has had a particular focus in technology, and Christensen and Bower (2004:246) explicitly claim that innovation involves technological change. They do, however, define technology rather broadly as '*the processes by which an organization transforms labor, capital, materials, and information into products and services*'. In line with the prevailing ideas of knowledge and inter-organizational cooperation as prerequisite aspects of innovation, Luecke and Katz (2003:2) suggest a more open definition of innovation as '*the embodiment, combination, or synthesis of knowledge in original, relevant, valued new products, processes or services'.*

Damanpour (1996:694) is particularly engaged with the idea of organizational innovation, understood as '*the adoption of an idea or behaviour new to the adopting organization*'. Rogers (1995:12) supports this view, and emphasizes that innovation is not only about genuinely 'new-for-the-world-products', but is something *perceived as new* for an individual or '*other unit of adoption'*. A somewhat different approach can be found with Mezias and Glynn (1993:78), who understand innovation as '*non-routine,* *significant, and discontinuous organizational change that embodies a new idea that is not consistent with the current concept of the organization's business*'.

3.2 Important concepts in innovation research

Ravichandran (2000) has suggested that studies of innovation should be classified according to seven categories: *Innovation adoption; innovation characteristics; characteristics of innovative organizations; relationships between organizational factors and innovation;* and *sources to, processes for* and *typologies of innovation*. As this classification suggests, the various contributions to knowledge on innovation usually focus on specific aspects. The implication for innovation research is that results appear as fragmented and difficult to compare. In this section a simplified way to classify research on innovation is suggested. The intention is not so much the comparison of research contributions as the elucidation of their diversity. The classification is however based on the idea that the better part of the research fall within four main 'themes'. The themes can be recognized from the preceding section: What is new (*result)*, how new (*degree of novelty*), innovation *process* description, and innovation process *impact*. The fourth dimension, *impact*, has to be seen in relation to the *level* research is focused on (individual, organization, society). The four themes will be described in more detail in the subsequent sections.

3.2.1 Result

Authors commonly distinguish between different types of innovative results. For a long period of time innovation was mainly associated with the development of new *products*, usually technology, and new *production processes* (Schmookler, 1966). Gradually, a distinction was also introduced between *technological* and *administrative* innovation (Daft, 1982). The latter distinction reflects a more general differentiation between technology and social structures, and as such it points out the economic significance not only of technology, but also of the organizational and managerial processes connected to innovation. More recently, Schumpeter's (1934) broad definition of innovation has been adopted by researchers like Abernathy and Clark (1985), Van de Ven et al. (1999) and Tidd et al. (2005). The last 10-15 years the interpretation of innovation has been further extended to include renewal in various areas. As an example, Moore (2005) has suggested 16 categories of innovation, which he relates to a product's life cycle. Among these categories are *application innovation, marketing innovation, enhancement innovation, value engineering innovation* and *renewal innovation*. His message is that innovation is not only about creating new products, but also about increasing the value of the existing ones in various ways, for example through influencing customer perception of the value and range of use of a product, through development of new markets, or through improvements of cost efficiency. In line with Moore, Wijnberg (2004) has introduced the concept *stylistic innovation*, which refers to changes in products which have no measurable technological effect, but which increases the market value of the product. In IBMs *Global CEO study* (2006) *business model innovation* is emphasized as the type of innovation which seems to have the strongest correlation with operating profit margin. Examples of this kind of innovation are changes in organization structure, strategic partnerships, alternative models for services and operation, as well as various forms of investment in or discontinuation of activities. Hammer (2004) emphasizes *operational innovation* as the main instrument to company growth. This type of innovation is believed to lead to increased efficiency and effect of core processes and functions. Yet another typology is suggested by Tidd et al. (2005), who place four types of innovation within their 'innovation space': *Product, process, position* and *paradigm*. While the two first are known, the two latter may need some explanation. *Position innovation* is about the context in which an innovation is introduced, while *paradigm innovation* concerns '*changes in the underlying mental models which frame what the organization does*' (Tidd et al. 2005:10).

3.2.2 Degree of novelty

Within innovation research, another way to classify innovation is according to the *degree of novelty* of innovation (Johannessen et al., 2001). Research themes are connected to the challenges and impact of innovation, whether it is incrementally new, or 'new to the world'. *Incremental* innovation involves the improvement of existing solutions, while *radical* innovation represents a substantial change or something completely new. Tidd et al. (2005) add two categories. One is *modular* innovation, which is novel technology, as for example digital phones, offering functionality similar to the technology it replaces, in this case analogue phones. The other category is *architectural* innovation, which is about combining known technology elements in new ways. An example of this is the development of the table fan as an alternative to ceiling fan (Henderson and Clark 1990).

As indicated has another distinction been made between innovations which are 'new to the world', and those which are new for the adopting individual or unit (Freeman and Soete, 2000). Wijnberg (2004) draws attention to the point that the *impact* of innovation adoption can be perceived as radical for one organization, and incremental for another. The characteristics of the adopting organization or group may thus be as important for the impact of innovation as is the characteristics of the new solution per se. According to Christensen (1997), both incremental and radical innovations lie on a common progress line, because they are products offering to the customer the experience of improved functionality. The result of these *sustaining* technologies is a strengthening of existing markets. As distinct from this, *disruptive* (Christensen 1997), or *discontinuous* (Tidd et al. 2005), innovation is claimed to have a completely different impact. These are products which, when introduced in the market, usually are perceived to have a poorer functionality than the existing alternatives. An example of this is the first digital cameras, as compared to the film cameras of the time. The market for disruptive innovation is seen as limited in the introductory phase, and may even have to be developed from scratch. Typical when disruptive solutions are launched, is that suppliers of products which gradually become outdistanced do not initially perceive the competition, because of the dissimilarity and insufficiency of the novel solutions compared to existing ones. Incidentally the same idea can be found in Schumpeter's (1934) notion of *destructive creativity*, which is about innovation based on knowledge and business philosophy which is completely different, and which disrupt the fundament for existing solutions. Every supplier should therefore be prepared for the possible situation that the rules of the game change, and that their competence is no longer relevant.

The predominant ideas about disruptive innovation are developed by Christensen (Christensen, 1997; Christensen and Raynor, 2003; Christensen et al., 2004), and are based on studies of new technology development. There are however differing opinions of how this concept should be understood, discussed for instance by Utterback and Acee

(2005) and by Markides (2006). The point these authors underline, is that ideas related to the functionality of early phase disruptive innovation need to be reconsidered in the case of process- or organization innovation, like for example the introduction of Internet banking. Furthermore, the implication of disruptive innovation is not only the shift in competitive conditions. The maybe most significant impact is that markets are developed and extended, and supplied with new types of functionality (Utterback and Acee, 2005).

3.2.3 Innovation process

Innovation process is used to denote processes having somewhat differing purposes. Some see innovation as creative processes (Amabile, 1988; 1997; Bundy, 2002; Florida and Goodnight, 2005), others as a more ordinary organizational function (Crawford, 1991), still others as technology development processes (Christensen, 1997; Kash and Rycroft, 2002; Tidd et al., 2005), strategic processer (Teece et al., 1997; Markides, 1998), market oriented processes (von Hippel, 1988; 2005) or evolutionary processes (Moore, 2005). Many researchers claim that development of today's complex technologies and processes requires the combination of knowledge from various fields of specialization and experience (Leonard and Sensiper, 1998; Kash and Rycroft, 2002). Invention and innovation is thus increasingly understood as a result of the exchange of knowledge between different actors within an organization, and in different organizations. From this perspective innovation is seen as knowledge- and network processes (Powell, 1998; Hargadon, 2003; Caloghirou et al., 2004), but also as processes of a more political nature (Frost and Egri, 1991; Durand, 2004). The dominant view of innovation is still that it is a development process initiated on the basis of a new idea and terminated by the introduction in a market of a material or immaterial invention (Goffin and Mitchell, 2005; Kelley and Littman, 2005; Tidd et al., 2005). Some focus more on the impact of market introduction of novel products (Nystrom et al., 2002; Gourville, 2006), and the diffusion of innovation (Rogers, 1995; Carter Jr et al., 2001). Incidentally, one of the ongoing discussions in the innovation literature concerns the question whether innovation development and adoption are parts of the same process, or if they should be seen as two different kinds of processes (Damanpour and Wischnevsky, 2006). As an example, Ravichandran (2000) claims that innovation is

’creation’, which is about novelty and uncertainty, while adoption and diffusion are ’absorptions’ and are about recognition and predictability.

The models of innovation processes have changed concurrently with changes in society or in the context of the innovation, as described by Rothwell (1994), and also by Jevnaker (2003). Increased competition, changing competitive conditions, globalization, pressure on efficiency and labour supply, as well as access to new knowledge and new technologies are factors believed to influence processes for innovation, as well as our view on how innovation processes should be carried out (Cantwell 2005). The first innovation process models, introduced in the 1950’s, were linear models emphasizing research as the principal source to innovation (‘technology push’). Gradually attention was moved towards the customer as an important source to innovation (’market pull’), but the causality between idea and result was still seen as rational and linear. A growing acknowledgement of innovation as composed not only of technical and economic processes, but also of social processes across formalized organizational borders has resulted in an increasingly stronger focus on relations between participants (Evans and Wolf, 2005; Gloor, 2006; Huston and Sakkab, 2006), and on processes for organizational learning (Nonaka, 1991; Garvin, 1998; Nootebom, 1999; Tsai, 2001). Modern studies on innovation processes increasingly adopt non-linear, dynamic models (Cheng and Van de Ven, 1996; Van de Ven et al., 1999). In what is known as the *Minnesota studies* (Van de Ven et al., 2000) the explanations move away from the traditional rational and linear perspectives. Through computer simulations Van de Ven and his colleagues demonstrated that interactions for innovation have non-linear characteristics, with the potential of leading to both continuity and transformation at the same time, i.e. the emergence of novelty, creativity and innovation in interaction. These results have been of significance for the development of the more recent *interactive* innovation models, built on system dynamic thinking (Forrester, 1958) and on ideas about system integration and collaboration in networks (Johannessen et al., 1999; Van de Ven et al., 1999; Stacey, 2001). Lundvall and Johnson (1994) point out that the more recent models also are characterized by the ideas of the *knowledge economy*. While traditional economy deal with any products as if it can be defined by its physical qualities alone, and subjected to unshared use (i.e. ’If I own it, nobody else can have it’), the foundation for the knowledge economy is that knowledge can be indefinitely diffused without loss in value, including utility value. This means that continued competitive advances can not be obtained through the ownership of knowledge, but by beating your competitors in the race of creating and exploiting new knowledge. Accordingly, learning and innovation are seen as key phenomena in the knowledge economy. A further implication is that innovation no longer can be seen as processes only taking place within the boundaries of a single company, but often happens in cooperation between many people within and outside the company which exploit commercially the results of the innovation efforts (Tether, 2002; Caloghirou et al., 2004). The concept *open innovation* is increasingly applied about the situation where knowledge and experience is exchanged across organizational boundaries (Chesbrough et al., 2006), involving a particular focus on *collaborative structures* and on the subject of *intellectual property rights*. Another important idea in innovation research is that innovation is developed within an *innovation system* (Werker, 2001; Carlsson et al., 2002; Schmoch et al., 2006), embracing a complex set of relations between actors in various companies, universities and public research institutes. Innovation systems are analyzed as national systems, delimited by territorial boundaries, but also as regional systems within a geographical area, or as a system belonging to a specific industrial sector. Cooperation between companies, R&D institutes and the public sector on a regional level is usually referred to as 'triple helix' (Etzkowitz and Leydesdorff, 1997).

Studies of innovation focus into two major models; normative and descriptive. Normative models are prescriptive in nature, and usually provide guidelines for the design and development of organizations to increase innovative capacity (Kanter, 1983; 1988; Quinn, 1985; Drucker, 2002). The descriptive models, on the other hand, summarize the characteristics observed about innovative organizations and about processes for innovation, and relationships between such characteristics (von Hippel, 1988; Dougherty and Hardy, 1996; Van de Ven et al., 2000; Neely et al., 2001). Most descriptive, or empirical, models of innovation, including non-linear models, identify the following phases: *Idea phase, development phase* and *implementation phase*. In addition, recent models usually include an *experience phase* to emphasize the importance that learning is made explicit and exploited as basis for improvement work and further innovation. Many models start with an idea which seems to just be there. Certainly, creativity researchers are engaged with how ideas arise (Amabile, 1997; Choi and Thompson, 2005), but show little interest in how new ideas are brought into the organization and further evolved into inventions and innovation. Some authors; like von Hippel (1988; 2005) and Prahalad and Ramaswamy (2000), study sources to innovation, that is who are advancing new ideas. To move an idea into development phase *opportunity recognition* and *idea implementation* are required (O'Connor and Rice, 2001). These concepts are about the activities needed to ensure that new ideas are perceived and accepted in a company in such a way that the necessary resources are allocated and formal development activity initiated (Axtell et al., 2000). Van de Ven et al. (1999) claim that ideas will be articulated and evaluated only after some kind of shock (1999). They suggest that ahead of this, ideas evolve, often unconsciously, in a 'gestation phase' which may extend over many years.

3.2.4 Impact of innovation

Traditionally research on innovation has focused on different levels, spanning from 'micro' to 'macro'. Research on each level has been dominated by experts from specific disciplines, showing interest for different aspects of innovation. What is common, is that the knowledge which is developed is related to consequences for something or somebody, be it an organization, an industrial segment, a region, society or the innovation process itself. Table 3-1 shows a brief overview of research levels and types of consequences.

Some authors also look into the actual innovation (result). They focus on the characteristics of novel solutions, in particular characteristics affecting individual and organizational decision about adoption (Wilson et al., 1999; Frambach and Schillewart, 2002). Characteristics of the individual adopter or adopting organization, and the role of opinion leaders related to diffusion of innovative results have also been subjected to examination in several studies (Rogers, 1995; Nystrom et al., 2002; Gourville, 2006).

Independent of whether a company is going to offer a new solution to a market or employ it to good purpose in own business, authors seems to agree that innovation lead to improvement and progress. The definition of innovation as the combination of creativity and risk taking, suggested by Byrd and Brown (2003:7), however implies that innovation efforts are not always rewarded by success. This viewpoint is supported by Andrew and Sirkin (2003:76), who state that '*most new products don't generate* *substantial financial return despite companies' almost slavish worship of innovation'*. Some authors also observe that challenges are related not only to the problem that a major part of the innovative solutions never become commercial successes, but also to the fact that only a few of the innovative ideas are realized into inventions (Freeman and Soete, 2000; Thamhain, 2003; Wijnberg, 2004).

Table 3-1 Research levels and impact of innovation

Level	**Predominant discipline**	**Typical areas of research**	**Impact**
Individual	Psychology	Variables supporting individual creativity and motivation and environmental influence of such variables (Amabile, 1997; Choi and Thompson, 2005)	Significance for the development of innovative ideas
Group	Psychology Sociology	Characteristics related to creativity and cooperation in groups, group climate and communication, and management of innovative groups (Kratzer et al,. 2004; Ramamoorthy et al. 2005)	The ability of groups to produce innovative results
Organization	Micro economy Organization sociology Technology	Characteristics of innovative organizations, organization design, cognition and learning, and organizational change and adaptation (Lam, 2005). See also table 3-2.	Development of innovation. Value creation and economic growth. Organizational changes
Industry	Macro economics Technology	Diffusion of innovation (Rogers 1995) Effects of disruptive innovation (Utterback, 1994; Christensen, 1997)	Influence of innovation on the conditions for different business sectors. Impact on competing businesses.
Region and society	Macro economics Political science Geography	Diffusion of innovation (Rogers, 1995) Innovation policies (Freeman and Soete, 2000; Lundvall and Borrás, 2005; Pianta, 2005; Verspagen, 2005) Characteristics about innovative regions (Florida, 2002)	Economic development, regional and social development

Several contributors discuss the frequently surprising setbacks established organizations experience when they are facing technological change (Utterback, 1994; Christensen, 1997). Christensen (1997) bases his explanation of the phenomenon on a concept called *value network* (see also Stabell and Fjellstad, 1998). Christensen defines a value network as the context an organization identifies with. Every industry has its unique value network, with a characteristic cost structure which is being formed in particular by the competitive conditions and by customer requirements. According to Christensen the cost structure forcefully influences the types of innovation considered by a company to be profitable. When confronted with radical or disruptive innovation the members of an organization may not immediately recognize the newcomer as a threat, as previously discussed, and consequently will not evaluate the investments needed to remain competitive. Christensen et al. (2004) are strong spokespersons for the view that organizations should aim at developing disruptive innovations. The obvious risk element of this strategy has made other authors warn against the belief that disruptive innovation is the only way to survive (Getz and Robinson, 2003). As an example, Ettlie (2006) claims that over time improvements obtained as the consequence of cumulative effects of incremental innovation will be of substantially greater significance than the contribution of radical innovation. He does however also point out that organizations need to be aware that they are not independent entities and that even if their own strategy is that of incremental innovation, disruptive solutions may be introduced in the market by somebody else. The question nobody seems to pose in relation to this is whether it is actually possible to steer company processes for innovation towards a predetermined result, be it incremental or disruptive innovation.

3.3 Innovation in organisations

In the preceding sections I have given an account for the status for mainstream innovation research, with a bias towards innovation in established organizations. As already indicated, today's knowledge of innovation, including organizational innovation processes, is diverse and ambiguous; largely due to the different emphasis placed on various aspects of innovation by different authors. This diversification can be framed as differences in both theoretical and methodological approaches. In this section, I take a brief look into different strands of research on innovation in organizations, and suggest an alternative way to classify this research taking into account typical approaches to innovation within respectively economy, organization sociology and technology

Research on innovation in organizations focuses on two main themes. One of these themes has already been mentioned. It is about organizational characteristics and processes leading to value creating innovation; also referred to as organizational capacity to innovate. The other theme is *organizational innovation,* which is discussed as a phenomenon separate from, but intertwined with, technological or process innovation (Lam, 2005). The concept of organizational innovation has to do with how organizations deal with change caused by the creation and adoption of an idea or behaviour new to the organization (Damanpour, 1996). Lam (2005) classifies this literature into three streams. The first is *organizational design theory*, which is about relations between organization structure and the ability of the organization to innovate (Burns and Stalker, 1961; Mintzberg, 1979; Christensen, 1997; Tushman and O'Reilly, 2002, Prajogo et al., 2006). This stream has been very influential, and the ideas are deeply embedded in the literature about technological innovation. The second stream embraces theories about *organizational cognition* and *learning*. Typical subjects are how organizations develop new ideas for problem solving, learning and knowledge creation (Argyris, 1978; Nonaka, 1991; Garvin, 1998) and organization ability to create new knowledge and convert it into innovation (Sveiby, 1997; Patterson, 1998; Tsai, 2001). The third stream focuses on *organizational change and adaptation*, and the processes underlying the creation of new organizational forms. From this perspective innovation is seen as the capacity to respond to technological and environmental changes, and to influence on and shape emerging innovations (Nooteboom, 1999; Georgsdottir and Getz, 2004; Poole and Van de Ven, 2004). Lam (2005:139) states that in spite of the extensive research '*the bulk of the existing research on the relationships between organization and innovation continue to focus on how technology and market forces shape organizational outcomes, and treat organizations primarily as a vehicle or facilitator of innovation, rather than as innovation itself*'. Her suggestion is that organizations should be seen as 'interpretations' and 'learning systems', and organizational innovation as a necessary precondition for technological innovation. This would involve the need for placing more emphasis among other things on '*organizational forces like learning, values, interests and power in shaping organizational evolution and technological change*' (Lam, 2005:140).

In my view, a remaining problem in the field of innovation in organizations is to elucidate how typical approaches to innovation in organizations within specific disciplines influence on the research results. Based on Gopalakrishnan and Damanpour (1997) I therefore suggest an alternative way to classify contemporary research on innovation in organizations. The classification takes into account typical research foci within economy, technology and organization sociology, respectively, and the influence on these in relation to the four themes previously discussed: *result; degree of novelty; process;* and *impact*, see Table 3-2. The table does not include research on the individual level, which is generally the field of interest of psychologists and behavioural scientists. The better part of these studies focus on individual characteristics related to creativity and idea development, and neglect the 'value creating' aspect of innovation. In my view, to move our understanding about organizational innovation processes, knowledge from all the disciplines need to be combined to capture better the complexity and diversity of such processes. Before elaborating further on this, I will take a closer look at research approaches commonly applied to produce knowledge about innovation, and briefly discuss methodical implications for research results.

Table 3-2 Innovation in organizations. Research focus and outcome within different disciplines (Based on Gopalakrishnan and Damanpour, 1997)

Theoretical perspective	Research focus	Result	Degree of novelty	Process	Impact
Economy	Allocation of resources to innovation (in competition with other activities), and the effects on productivity and performance (Nelson and Winter, 1982)	Product Process	Radical or disruptive technological innovation	Idea phase and early development phase	Implications of the introduction of new solutions into relevant markets and industries, including the effect on competitors' competence (Abernathy and Clark, 1985; Utterback, 1994; Christensen, 1997). *Level:* Industry, organization. The organization is treated like a 'black box'.
Technology	1) The industrial context of innovations, and the mutual influence between context and innovation (Suarez and Utterback, 1995; Patterson, 1998; Fiegenbaum and Thomas, 2004). 2) Factors affecting development and adoption of technologic innovation, particularly in research and production units (Kash and Rycroft, 2002; Thamhain, 2003; Acha and Cusmano, 2005).	Product Process	Incremental radical and disruptive	Development Adoption	Innovation is seen as more or less significant steps in technology development (Henderson and Clark, 1990; Wijnberg, 2004). *Level:* Organization, industry
Organization sociology	1) Characteristics explaining the differences between organizations related to adoption of innovation (Frambach and Schillewart, 2002; Nystrom et al., 2002). 2) The adoption process, which is seen as a series of complex and partially unpredictable events involving a number of persons, activities, decisions and systems in a specific organizational context (Van de Ven et al., 2000; Poole and Van de Ven, 2004).	Innovation is broadly conceptualized, and all types of innovation are studied		Adoption	Organizational activities and results, like learning. Relations between organizational characteristics and capacity to develop and adopt innovation. Relations between technology and social processes. *Level:* Organization. Economy is usually neglected as an important motive power for innovation.

3.4 The creation of knowledge about innovation

The better part of the literature on innovation is published by North-American authors. A dominant view among these researchers appears to be that scholars can '*discover and accurately represent the objectively "true" nature of the empirical world*' (Martin, 2005:396). Accordingly, these studies are predominantly theoretical contributions and quantitative studies on what could be seen as a 'multi-organizational' level, including data from a large number of organizations. A third approach is qualitative case studies, in particular ethnographic studies, which are however still unusual within the field of innovation research (Akrich et al., 2002a; 2002b; Shotter, 2006). In this section typical characteristics of these approaches, and some of the possibilities and problems related to each of them, will be briefly discussed. Incidentally, common to most articles on innovation is that the authors rarely make explicit the theoretical and ideological foundation on which their analyses are resting, and that accounts of research approach and method are short and not very informative.

3.4.1 Theoretical contributions

Theoretical contributions, including *literature reviews,* are generally based on analyses of existing theories and results, intended to bring about new insight and new theories, hypotheses or models (e.g. Arad et al., 1997; Miles et al., 2000; Ravichandran, 2000, Lam, 2005). Authors of literature reviews usually include a lot of references, grouped according to some kind of thematic classification suggested as basis for new theoretical insight. Others offer more independent theoretical contributions, and make few references to previous works.

The approach of grouping existing data and theories in new ways, often supplemented with new ideas, could be seen as a kind of 'knowledge innovation', which may form the basis for new ideas and for further empirical research. A more general objection against theoretical contributions is, however, that it may be problematic to convert ideas into organizational practice. Furthermore, like in other areas of research, the development of knowledge on innovation is influenced to a great extent by people who have not themselves participated in the kinds of processes they study. There are, however, exceptions to every rule, and some authors do indeed base their contributions on own experience, often as managers. 'Own experience' should therefore be included as an important source to data. Incidentally, my impression is that theoretical contributions increasingly focus on processes and relations on an organizational level, and these authors often conclude that empirical studies are needed to verify theories.

3.4.2 Quantitative studies

Quantitative approaches are the most common within innovation research. They are usually based on specific procedures, and aim at determining important tendencies related to innovation in companies or in industrial segments based on 'how much' and 'how many'-types of questions, and the causes of such tendencies (Wadel, 1991). Typical procedures include the demonstration of correlation between dependent and independent variables. Data are generally collected from large databases, like Fortune 1000, or through questionnaires. Interviews are more rarely used as data source, although exceptions can be found (Dougherty and Hardy, 1996; Shaw, 1998; O'Connor and Rice, 2001). Data collection is often combined with some kind of case study approach. Some authors, like Arad et al. (1997), Neely et al. (2001), and Nystrom et al. (2002), also combine the development of theoretical models and categories with the collection and statistical calculations of large sets of data to test correlations, as well as the validity and reliability of own contributions. A somewhat different variant of this approach is the *sector monographs*. These are comprehensive analyses of historical data from a large number of companies, analyzed to discover how industries get influenced by changing conditions, like disruptive innovation (e.g. Utterback, 1994; Christensen, 1997). This insight is further applied as basis for theory and prescriptions of how companies should act to deal with, or create, such change.

The main value of quantitative approaches is that examination of frequency and diffusion of phenomena within and between groups is made possible (Yin, 2003), that relations between phenomena can be explored, and that hypotheses, theories and new models may be substantiated or invalidated. To accomplish this, data are generally analyzed by means of statistical methods, like correlation analysis, effect analysis and various regression models. Accordingly, the challenge of quantitative approaches is the need to standardize variables to be able to compare them. Quantifiable phenomena must be identified and assigned unambiguous labels (Huberman and Miles, 2002), involving the risk of losing valuable nuances (Allen, 1994). Characteristic of quantitative approaches is therefore that populations are selected according to fixed criteria, based on a specific theoretical perspective. The research scheme is stringent as to point of departure (theory/hypothesis/model), method, and view of what is acceptable as 'data'. The outcome of quantitative studies is generally presented on a normative form. Such approaches therefore appear to be suitable to develop new insight on an accumulated 'macro' level, like for example how industries develop and are influenced by innovation and change, because they render possible the analysis of large sets of data. In my opinion, such approaches are, however, largely inadequate to capture the complex details of innovation processes in organizations. Based on quantitative approaches, 'organization development' seems to be about managers inserting into an organization the wanting, necessary characteristics (Byrd and Brown, 2003), 'strategy' about rational choices between given alternatives (Gjeldsvik, 2004), and 'innovation capability' about the success of managers in creating a suitable organization and select the right strategy.

3.4.3 Qualitative studies

Qualitatively oriented research is also referred to as ethnographic research, or field work (Wadel, 1991). Typical for these approaches is that authors address the actual events of various processes or projects over time, leading as an example to the view that innovation processes and strategy development are co-evolutionary, non-linear processes (Van de Ven et al., 2000). Focus usually is on interaction, relations and processes (Wadel, 1991; Yin, 2003). Such studies are regarded as well suited to bring about empirical evidence, especially in areas where little prior knowledge exist, and may bring insight into specific concepts or processes based on 'how' and 'why' questions (Meyer, 2001; Yin, 2003). Qualitative studies are usually developed as case studies, or delimited by a phenomenon, a perspective or a theory. Data are commonly collected by observation or by means of semi-structured interviews.

Qualitative research is often based on one or a few cases. According to Martin (2005) the use of this kind of empirical evidence as basis for generalizations is regarded as problematic, in particular by the quantitative research communities. Eisenhardt (1989) suggests that this critique is related to the general lack of guidelines for the execution of qualitative case studies. Literature on qualitative methodology discuss several other challenges and possibilities connected to qualitative approaches, like for example data collection through participant observation (Cohen, 2000; Hong and Duff, 2002; Labaree, 2002; Murray, 2003), interview techniques (McCormack, 2000; Rapley, 2001), writing of field notes (Wadel, 1991, Wolfinger, 2002, Yin, 2003), use of case studies (Meyer, 2001; Yin, 2003) and various approaches to interpret and analyse data (Coffey and Atkinson, 1996; Becker, 1998; Huberman and Miles, 2002; Ryan and Bernard, 2003). Multiple cases are assumed to increase the possibility of categorization and comparison, but the isolation and categorization of variables can be demanding (Coffey and Atkinson, 1996; Huberman and Miles, 2002).

Akrich et al. (2002a:191) point out that it is long between the qualitative case studies which avoid '*falling into the trap of explaining in retrospect'*. An exception is the previously mentioned *Minnesota studies* (Van de Ven et al., 2000), which are considered to be pioneering within the field of qualitative innovation research. These were the first case studies providing empirical support to the claim that innovation processes are not composed of sequential events, but that '*a much more complicated multiple progression process of divergence and parallel and convergent streams of activities occurs in the development of innovations*' (Van de Ven et al., 2000:133). Van de Ven and colleagues collected large amounts of longitudinal data from various companies through observation, interviews, questionnaires, document studies, as well as in informal conversation – a source to data which is not mentioned in other studies. They found, however, that while their qualitative data generated many important insights in the innovation process, they were often limited to anecdotes and left them without the wanted capability to make empirical generalizations and inferences (Van de Ven et al., 2000). To handle this challenge, the researchers adopted a grounded theory strategy (Glaser and Strauss, 1967) to develop a basic methodology to build *innovation process theories*. The handling and visualization of relations – or simultaneities – of structure and action was particularly emphasized (Poole et al., 2000).

There are few qualitative studies within innovation research, although exceptions can be found (Dougherty and Hardy, 1996; Shaw, 1998; O'Connor and Rice, 2001; Kodama, 2003; Thamhain, 2003; Verona and Ravasi, 2003). One reason for this may have to do with the complexity of exploring relations between many concurrent organizational processes. Another reason may be that for many years innovation was largely explored based on economic perspectives, in which there are no tradition for qualitative approaches. Moreover, a purely practical explanation for the absence of this kind of studies is probably that commercial enterprises generally are restrictive about admitting researchers into their inner, everyday life (Wadel, 1991; Magolda, 2000). In Norway, our tradition for openness and transparency, even in business organizations, and for collaboration between social research and industry, opens up the possibility of carrying out qualitative studies of organizational processes, like innovation, inaccessible to most researchers who are not at the same time practitioners.

3.5 Innovation from a managerial perspective

The comprehensive interest in understanding the 'innovation journey' (Van de Ven et al., 1999) has been accompanied by a concurrent interest in identifying the managerial moves necessary to ensure the safe arrival at a predetermined destination (Nemeth, 1997; Kash and Rycroft, 2003; Snyder and Duarte, 2003; Välingankas, 2003; Fiegenbaum and Thomas, 2004; Goffin and Mitchell, 2005; Tidd et al., 2005; Trott, 2005; Davila et al., 2006; Hamel, 2006). Like in the other areas of innovation research, the results are ambiguous, but the apparent challenge of innovation management is to create an environment of perpetual innovation, where everyone is committed to excellence, resulting in growth and sustained competitive advantage. The observation that most innovative ideas are never realized into commercial ideas makes it understandable that some also refer to the management of innovation as inherently difficult and risky (Tidd 2001). Management is however found to be the only factor which is consistently and significantly positive correlated with the successful outcome of innovation effort across organizations and stages of innovation (Manz et al., 2000).

An inherent part of the challenge of innovation management is to handle simultaneous demands for cost effectiveness and innovation (Løwendal and Revang, 2004). The complexity of this challenge is emphasized by Tidd (2001), who have made a comprehensive review of current research on innovation and relevant studies within organizational behaviour and strategic management. He points out the 'random unpredictability' of innovation and the diversity of research approaches as the main reasons that knowledge about innovation management still appear as incoherent and difficult to translate into clear prescriptions. This study indicates that the relation between innovation effort and outcome is much weaker on an organizational level than on an industry level (Tidd 2001). The defining feature of processes for innovation is pointed out to be complexity and uncertainty, but management controllability of these processes is nevertheless assumed, justified by the observation that many companies survive and renew over time (Tidd, 2001; Tidd et al., 2005). According to Tidd et al. (2005) and Davila et al. (2006) innovation is a management process on the level with other business functions, because it involves choices about disposition and coordination of resources, and the need to create conditions under which successful innovation is likely by means of '*specific tools, rules and discipline*' (Davila et al., 2006:xvii). Van de Ven et al. (1999) point out that managers on many hierarchical levels are involved in the management of innovation, and that innovation processes require a set of interdependent management roles. Furthermore, they emphasize that in spite of a widespread view that managers have a uniform, common perspective; managing innovation involves diversity and conflict, thus indicating a need for the rethinking of '*traditional notions of managerial control*' (Van de Ven et al., 1999:66).

Seen from a management perspective, the literature on innovation can be broadly classified into three strands, focusing on *organization, competition* and *value realization* respectively, see table 3-3. The table displays typical research themes within each strand.

Table 3-3 Management of innovation. Three strands of research.

Organization	**Competition**	**Value realization**
• Process models	• Relations (alliances)	• Product characteristics
• Organization structures	• Resource utilization (prioritizing)	• User characteristics
• Organizational characteristics	• Positioning (marked)	• Adoption processes
• Knowledge and learning	• Priority areas (innovation types)	• Diffusion processes
• Change and adaptation		• Consequence analyses

The main objective of organization focused innovation research is to generate knowledge about organizational characteristics supportive of innovation which managers can implement into their organization to increase general innovative capacity. The range of distribution of results can be exemplified by two reviews, prepared by Arad et al. (1997) and by Ravichandran (2000). Arad et al. (1997) have developed a system to classify organizational characteristics. According to the authors this will contribute to the identification of organizational profiles which can be anticipated to promote or inhibit innovation. The system is composed of five main classes: *Organizational structure, management, human resources management, objectives,* and *organizational values*. Ravichandran (2000:251) has identified another set of characteristics which he claims are *'necessary constituents and key ingredients'* of an innovative organization. These are sensitivity, learning, problem-solving, experimenting, communication, risk-readiness, absorption, slack, and what he refers to as cosmopolitanism. Ravichandran is of the opinion that these variables should form the basis for the development of a new theoretical approach to organizational innovation capacity. He substantiates this with the observation that *'…not all innovative organizations create innovations and not all organizations creating innovations are innovative'* (Ravichandran, 2000:252).

Authors focusing on *competition* show interest in decisions seen to be of strategic importance, cooperation and alliances, selection of markets and market strategies, and areas for innovation. This research is largely based on resource based theory (Grant, 1991), a perspective which has gradually gained a dominant role within research on strategy and innovation (Johannessen et al., 1999). The more traditional approach to the development of competitive advantage builds on neoclassic microeconomic thinking, where focus is on cost effectiveness. From a resource based perspective attention should be on how to make the most of available resources and knowledge to obtain innovation, referred to as *innovative capability*. Teece and Pisano (1994) apply what they refer to as a *dynamic resource based perspective*, and have identified *dynamic capability*, defined as '*the firm's ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments*' as the most important source to sustained competitive advantage (Teece et al., 1997:516). Seen from this perspective managers can choose a strategic approach to innovation dependent on available resources and of the competitive context. In contrast to this Christensen (1997) claims that a company's freedom to act is limited to satisfy the needs of the units outside the company (primarily customers and investors) which keep it with the resources it needs to survive. He calls this the *resource dependency theory*.

The third strand, which I have called *value realization*, includes research focusing on factors having impact on the outcome of innovation processes. In this context an organization can be seen as an actor which creates and takes ownership of value (Wijnberg, 2004). The realization of value as the outcome of innovation processes is seen to be related to the ability of the organization to convert new knowledge, scientific breakthroughs and technological advances into economic success (Thamhain, 2003). This view has brought about a vast interest for theories of organizational learning (Nonaka and Takeuchi, 1995), collective knowledge (Glynn, 1996), knowledge management (Quinn et al., 1998), communities of practice (Wenger, 1999), and indeed, innovation management (Tidd et al., 2005; Trott, 2005; Davila et al., 2006). Furthermore, the recognition that organizations cannot 'own' the knowledge needed in every situation has led to an emerging view that learning, problem solving and innovation involves the close cooperation between people in many organizations, often referred to as a networks (Powell, 1998) or social capital (Becker, 1975; Bourdieu, 1986). The effect of collaborative processes on innovation and business performance is discussed by several researchers (Cohen and Levinthal, 1990; Durand, 2004; Tsai, 2001).

3.6 Problems with established theories of innovation

Research has shown that innovation is decisive for the long-term economic growth of companies and societies. It is therefore also seen to be a powerful explanatory factor of the differences in performance between companies, regions and countries. Furthermore it has been demonstrated that innovation tends to boom in certain industries or clusters of companies, which consequently will experience more rapid growth than other sectors during certain periods of time. Authors also seem to agree that companies do not innovate in isolation, but in extensive interaction with other companies and organizations. In spite of the comprehensive interest among both researchers and managers in identifying conditions which support such value creating innovation processes, present understanding of how knowledge is created and transformed into company competitive advantage is still ambiguous. The main reason for this seems to be that available research on innovation in organizations is based on a multitude of approaches, both theoretical and methodical. Another problem is that models and prescriptions usually are based on specific conceptions, like the idea that some innovations are 'knowledge destructive', that managers can control organizational movement towards a sustained state of superior innovation performance, or that the nature of the 'empirical world' is definitive and classifiable (Cantwell, 2005). These ideas are however hardly ever made explicit and subjected to discussion.

As stated by Fonseca (2002) the primary concern of writers about innovation in organizations is with how organizations should innovate, rather than with how they actually do so. Independent of recommended approach, it appears that the expected result of new knowledge in the field is increased control over innovation processes. As a researcher one is expected to contribute to the creation of 'order in the chaos' through the provision of definite, unambiguous guidelines to the organizing and managing of successful innovation (Cheng and Van de Ven, 1996). In spite of increasing evidence that innovation are non-linear processes characterized by complexity and uncertainty (Van de Ven et al., 1999; Tidd, 2001), the dominating message in innovation research continues to be that distinct steps and characteristics can be identified, and particular measures can be implemented in organizations in order to increase innovative capacity. This indicates that organizations are in fact assumed to evolve as cybernetic systems. There is a striking absence of studies focusing on the specific day-to-day activities in an organization; which individuals who relate to whom; what they say to each other; and how they respond to each other and to the various incidents in their everyday organizational life (Chanal, 2004).

Contemporary theories of innovation are largely based on systems thinking. Innovation processes are seen as consecutive acts of creation and adoption of novelty, intended to lead to value creation both for the creating and the adopting organizations. In paper A, *Exploring innovation processes from a complexity perspective - part I,* some of the shortcomings of systems thinking in innovation research are discussed. In brief, problems are related among other things to the ideas of rationalist individual choice and management controllability of organizational change, including innovation. To be true, assumptions of linearity and explanations based on cybernetic systems theory are gradually being abandoned in favour of interactive models based on systems dynamics as an alternative way of analysing innovation processes (Van de Ven et al., 2000; Hargadon, 2003; Caloghirou et al., 2004). The problem remains that without external influence even dynamic systems will cease to evolve, and approach a state of equilibrium. Implicitly, it is necessary to design radical change (novelty) outside the system and then install it. Furthermore, as Stacey (2007) points out, system dynamics attributes importance to behavioural patterns, but the emergence of such patterns is often unexpected, and may just as well counteract change as contribute to it.

Although the prevailing view is that innovation processes take place within and in cooperation between organizations, research on innovation and on organizations are by and large separate fields (Lam, 2005). While research on innovation in organizations is dominated by the search for general organizational characteristics supportive of sustained innovative capacity, organizational discourse has been dominated by questions of stability, and even change and innovation are discussed as intermediate stages between two stable states. The organization is viewed as a system consisting of a set of activities conducted in order to obtain specific goals (Johnson, 2005). Organizations and organizational processes are commonly described in reified terms, as things or organisms. The choice of words supports a view that organizations have the ability to learn and act as a unity, and also that they have an 'inside' and an 'outside'. Up to now, the accounts of the requirements for innovation to take place are given from the perspective of the observer who 'from the outside' identifies and labels the dynamics within and between groups that make up an organization, as well as within and between groups including representatives of different organizational belonging. This is essentially also the position prescribed for leaders, who are advised to objectively diagnose the organization, and then implement or manipulate the required characteristics in such a way that the organization will regulate towards a preset goal (see e.g. Byrd and Brown, 2003; Luecke and Katz, 2003; Snyder and Duarte, 2003). The assumption of management controllability of innovation processes is justified by the observation that many companies survive and renew over time (Tidd et al., 2005).

Fonseca (2002) points out that the tendency to ascribe in hindsight what happens to someone's intentional choice mask the diffuse, uncertain processes of communicative interaction, with their power dynamics of inclusion and exclusion, in which innovation and new meaning may emerge. In this dissertation I fall into line with this view, and argue in favour of the value and potential of moving attention in innovation research away from the quest for factors which stimulate or suppress innovation in organizations towards exploring the basic feature of organizational life, which I see to be *communicative interaction*. This approach departs from the idea I originally described at the initialization of this project. In the following chapters, I will go into more detail about this change in perspective.

3.7 Summary

The field of innovation research has grown into a maze of ideas and suggestions, based on approaches and perspectives from a diversity of fields. In this chapter I have suggested a way to classify relevant research which may make it more manageable to get an overview over existing approaches and results. I find that modern innovation research can be roughly classified according to four concepts: *Innovation type (result), degree of novelty, process (stage),* and *impact of innovation*. Narrowing focus to research on innovation in organizations, I exemplify differences in research approach and conclusions within different disciplines, contributing to make comparison between results more or less impossible.

The task of managing innovation has become a separate, comprehensive field of research. I suggest that present research can be divided into three strands, focusing mainly on *organization, competition*, and *value realization*, respectively. The main objective of these contributions is to provide mangers with knowledge that will ensure success of innovation initiatives.

The majority of papers about innovation processes and innovation management are theoretical works, or quantitative studies based on averaged data from large databases or from questionnaires. Up to now, qualitative case studies have been a scarcity within the field of innovation research. In consequence, most results are presented on a generalized form, usually as unambiguous categories or concepts devoid of context; and 5-step advices on how to increase the innovative capacity of an organization. As a former manager of innovation projects, I should add that I have found many of these contributions very inspiring. There are, however, some problems related to the prevailing ideas within innovation research which need to be addressed. In line with this view, a main message in this dissertation is that even if present research has provided many insightful ideas, there is, nevertheless, a need to question some of the basic assumptions underlying most innovation studies; in particular the assumption of control. This view emerged during the study because of my research situation, which made it possible for me to focus on innovation as ongoing social processes. Together with the choice of complexity thinking as my analytical perspective, this entails that my contribution can not be positioned within the frameworks outlined in this chapter. I will give reasons for this in the following chapters.

4 Attempting to make sense of my experiences

When I started my doctorate study, I had worked as a manager of various innovation projects, mainly within the field of medical technology, since 1994. My experience was that challenges of technological nature by and large could be worked out, but that successful introduction of new solutions to the market was a demanding exercise, in many ways. Moreover, the idealized, constructive win-win collaborative relationships described in innovation literature proved to be rare when it came to practice. Participants in innovation processes quite commonly expressed that they experienced a mutual lack of interest in each others contributions, as well as insufficient knowledge of each other's challenges. Accordingly, it was my belief that if this was not considered by those responsible for the accomplishment of new products and solutions, these were potential areas of conflicts which could become insurmountable barriers to success (Berg[4], 2001). I also felt sure that the situation within an organisation, and the organisational context, were important factors affecting the ability of collaborating partners to develop and exploit new ideas.

Gradually, I realized that my training as a graduate engineer did not adequately support me in the attempts to make sense of my experiences. So I returned to the school bench in 1997, and started to study management, strategy and innovation. Enthusiastic and a little overwhelmed I realized that there was an abundance of thoughts and theories out there to draw on. Amongst others, I found support for my ideas with Thurow (1997), who claimed that in organizations recognizing knowledge as the vital source to innovation, better use of existing knowledge and more effective acquisition and assimilation of new knowledge was becoming a business imperative. I also believed Garvin (1996) and Quinn et al. (1998) were right in their view that the main challenge for companies was to manage professional intellect, and transform it into what Garvin referred to as *frameworks of action*. From Garvin's perspective, the 'mass of knowledge' need to be managed and developed to realise its full potential. Implicitly, the coordinated accomplishment of knowledge related processes, development of

[4] I changed my surname from Berg to Aasen in 2003

organizational capability (understood to be *culture* and *management*) and technology and infrastructure to support the processes, was seen to be requisite. Incidentally, Garvin's approach is based on a definition of knowledge that corresponds with the statement of Sveiby (1997:31), that '*knowledge is a capacity to act'*. To me, this seemed also to be related to the ideas found *inter alia* with Powell (1998), who wrote about the importance of 'extended' networks including the company, its customers, and also competitors; and with Grant (1991), who discussed the implications of a resource based approach on strategy formulation, in particular on the sustained competitive advantages of firms. I was, however, surprised by the large differences in research results concerning typical characteristics of companies viewed to be innovative (Arad et al., 1997; Ravichandran, 2000), and curious about the claim of Damanpour (1996) that to establish an unambiguous relation between company characteristics and actual ability to produce innovative results was not at all a simple matter. From my own experience I had also noticed that the various actors taking part in innovation processes looked upon their role and the evolving processes from widely different perspectives. At the time I saw such perspectives as involving among other things commercial, technological, political and ethical aspects, which influenced the process in various - and often unexpected - ways. Taken together, my idea was that it was of great importance to develop more knowledge of human interaction, and how such interaction resulted in the production of new knowledge and commercial valuable results.

The bulk of existing research on the interrelation between organization, innovation and competitiveness focus on how technology and market forces shape organizational outcomes, and treat companies primarily as units facilitating or creating innovation (Lam, 2005). In recent years, a predominantly normative focus on innovation processes in organizations has resulted in a large number of books and papers offering recommendations on how to innovate, but to a lesser extent offer experiences on how organizational members actually act to achieve innovative results. When I started my SIOR study, I had, I must admit, not really reflected on this fact. Influenced as I was particularly by the thinking within the fields of knowledge management and resource based theory, my attention was on two particular challenges: how to make collaborations for innovation 'work' better, and how to describe better the anticipated connections between innovation efforts and business performance. More specifically, my intention was to contribute to the understanding of organizational characteristics affecting company level innovation, how such characteristics related to business performance and growth in large companies, and the skills of companies to explore and exploit such characteristics. The original title of my research proposal was:

> *Innovation capability and business performance in large companies.*
> *Relationships between company level innovation, organizational characteristics, internal and external influencing factors and value creation.*

The proposal was based, among other things, on a model developed by Neely et al, (2001). The model is shown below. I modified the model by adding the variable 'Adoption', to represent better the petroleum industry processes. From my point of view, this model was well suited to illustrate potential connections between organizational capacity for innovation, innovative results, commercial effects and value creation, and the influence of what is called 'external context environment' in the model.

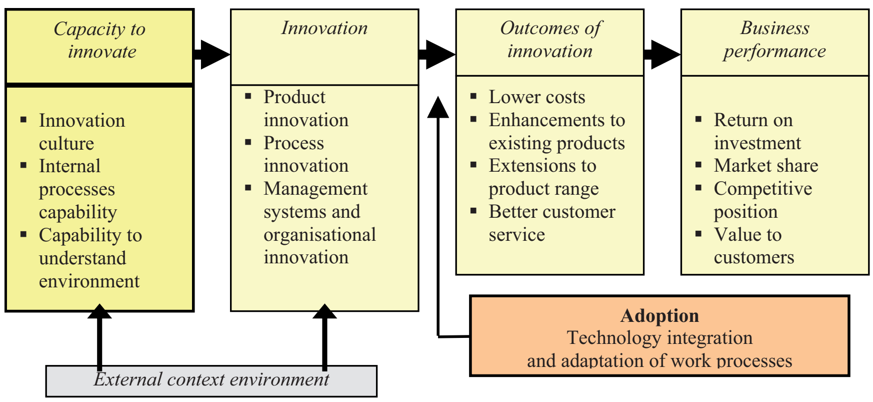

Figure 4-1Relation between organizational capacity to innovate and business performance, as suggested by Neely et al., 2001

The assumption underlying my proposal was that at the organisational level, innovative capacity reflects specific organisational and individual qualities, analytically decomposable to a set of organisational and individual characteristics. I further assumed that innovative performance could be improved through purposeful exploitation of such characteristics.

4.1 The rejection of a plan

As indicated in chapter 1, the engagement with Statoil implied that I became part of many of the everyday interactions between the SIOR program participants and other members of the Statoil upstream organization. The role I was offered was, to my knowledge, quite unique for a researcher. It gave me the opportunity to study innovation processes in Statoil 'at close range' over several years, being both 'insider' and 'outsider' at the same time. As Statoil is known to be a very competent customer and a leading user of advanced petroleum technology, I considered carefully how to approach the study. It was my aim to somehow contribute to knowledge perceived to be of practical relevance to the value creating processes in the company.

In the beginning I had a hard time following the discussions, which were largely dominated by technical terms and company-specific 3-letter acronyms. Because of this, and also because I was unsure which events that would be of importance for my understanding of 'innovation in Statoil', I made a lot of notes. Based on modern knowledge about characteristics of innovative organizations, and the understanding I gradually evolved about the processes for innovation in Statoil, I developed a number of process models during the first year and a half of my study. My idea was that as soon as I had been able to develop an appropriate model, it would provide an analytical basis for my further research. Soon, this approach became a problem. As participant observer in a very including context, I experienced a complexity which could not be captured in a model just like that. Much of what happened seemed to take place as interplay between many people, mostly acting on the basis of intentions given by the various projects they took part in or roles they held. Events led to or affected events to come. These processes could not be seen as following a predetermined course, but it would be equally wrong to claim that they were evolving at random.

Although this was consistent with my former experience, I felt that in the role as researcher, I needed to identify a 'wonderful' model of innovation processes in Statoil, and so, I continued to struggle with this challenge for several months. During this period I had two meetings with my Statoil reference group, discussing my ideas. Although they were interested in my approaches, their response was in accordance with my perception, which was that none of the models captured the complexity of the Statoil innovation processes to satisfaction. This problem, together with my experiences in the SIOR program, gradually moved me away from the quest for factors which stimulate or suppress innovation, towards the idea that a very different approach to understanding was needed. What gradually caught my interest was how new ideas emerge and come to be identifiable themes in organizations; how such themes change over time; and how this could be related to the phenomenon of innovation. Observing what went on among members in the SIOR program, and in the other Statoil groups I came in touch with, it appeared to me that within innovation research, the importance of communication as source to innovation, as well as to any other organizational phenomenon for that matter, is a commonly ignored fact. The extent of communication was, in fact, comprehensive. People talked to each other all the time, in formal and informal meetings, on the phone, through SMS and MSN, over lunch, in the corridors, and over coffee. A not unimportant part of these conversations happened between Statoil members and members of other companies and organizations. Furthermore, most people I met complained about the extensive exchange of e-mail in the company, including the distribution of various kinds of documents they were intended to be familiar with. Another important source of communication was the Statoil intranet, *Ticker*, where people were expected to look for new information and for internal documentation. Verbal and written communication thus appeared to be significant means employed by individuals with the more or less conscious intention of influencing the development and outcome of various processes. Somehow, within all these communication processes, innovation emerged.

This led me to the idea that *the sources of innovation processes can be found nowhere but in the ordinary, everyday communicative interaction between people talking, thinking and writing about their professional responsibilities*. In pursuing this idea, I eventually decided to reject my original research approach. Instead I decided to explore the relevance of taking a complexity perspective on innovation processes, specifically the perspective of complex responsive processes, as it has been emerging in recent years (Stacey et al., 2000; Stacey, 2001; 2007; Griffin, 2002; Shaw, 2002). According to

Suchman (2005:543) this perspective '*catches us in the act of pattern-making, thus giving us an opportunity to be mindful about the process and, perhaps, to change it'*. The complex responsive processes perspective has been developed to provide an alternative way to think about complexity in organizations, and how change come about in relational processes in which knowledge is reproduced and potentially transformed at the same time (Stacey, 2001). With the exception of Fonseca (2002), processes of innovation have not been explored from this perspective to any great extent; and limited research within the field of innovation also exist which is based on other streams of complexity thinking (see chapter 5).

4.2 Emerging research questions

I came to think about innovation neither as rationally planned processes, nor as evolutionary types of processes driven by chance or environmental selection mechanisms. I rather saw it as the result of a number of activities closely integrated in everyday life in organisations. In practice, I wanted to do what Elias (1978) suggested, to try to penetrate to the order underlying change. According to Elias, (ibid.: 366):

> *This order is neither "rational" – if by "rational" we mean that it has resulted intentionally from the purposive deliberation of individual people; nor "irrational" – if by "irrational" we mean that it has arisen in an incomprehensible way.*

Reflecting on my experiences in SIOR as they happened, and then in retrospect, such organized activities appeared to consist of large numbers of local events and interactions involving many individuals, who at the same time were creating and expressing local and widespread patterns of interaction. In the heat of the battle such patterns were difficult to recognize, but as time went by, they gradually emerged in the form of repeated themes of conversations, frequently based on explanations supported by stories of events unknown at the time of some episode, but later on shedding new light on the course of processes. Such new patterns emerged, and were rejected or temporarily stabilized, all in the interplay between simultaneous contradictory intentions and demands. My experiences from the time spent with members of the SIOR program and other people in Statoil made me ask questions which departed substantially from my original research questions. The overall research question guiding my subsequent work came to be based on one of the central insights of the complexity sciences, which is that the spontaneous emergence of novelty depends upon diversity. My approach is thus based on a somewhat puzzling question:

> *How does innovation, understood as novel patterns of talk (action), evolve in the course of everyday professional life?*

The example I use, is Statoil and the SIOR program, and so the research question is embedded in a specific industrial context in Norway. Important questions guiding my experiences in SIOR were:

- *How can the dynamics of the overall SIOR ambition and the local particularizations of the ambition be understood, and how can 'innovation' be recognized as part of this?*
- *What does it mean to 'approach innovation differently', like people co-operating in the SIOR program were expected to do?*
- *How do SIOR members and customers talk about technology, and how are these views acted out in processes intended to lead to innovation?*
- *How can Statoil managers contribute to the more efficient accomplishment of innovation initiatives?*

In the next chapter I will go into more detail about the field of research which has become known as 'complexity theory' (chapter 5), and in particular the *complex responsive processes perspective* (chapter 6). Next, I will describe how I approached this study. Then I will proceed to outline the actual results and ideas emerging as the consequence of the exploration of innovation processes in Statoil through the perspective of complex responsive processes.

5 Complexity science

As explained in the preceding chapter, I did not consciously set out on this dissertation with the idea of building on research done on complexity in organizations. It simply appeared as a suitable template to try to get past the limitations I experienced in my struggle with systems approaches, and to illuminate better the diversity and volatility of my experiences as a participant in the everyday interaction between people directly or indirectly involved in the SIOR program. It may of course be that the combination of ideas from natural and social sciences found in the specific perspective of complexity thinking I ended up using, particularly appealed to my 'multidisciplinary' background. In any case, my strong notion was that directing attention to the evolving patterns of action developing as people interacted in their everyday professional life in organizations could provide a deeper understanding of innovation. These are aspects that have been discussed only to a very limited extent in innovation research up till now.

The perspective I adopted to suggest possible new ways of thinking about and carrying out research on innovation processes is the *complex responsive processes* perspective, which has been emerging in recent years (Stacey et al., 2000; Stacey, 2001; 2005; 2007; Streatfield, 2001; Fonseca, 2002; Griffin, 2002; Shaw, 2002; Griffin and Stacey, 2005). In the next chapter I will go into the fundamental aspects of this perspective, including the clarifying of important concepts, which are *communicative interaction and conversation, power, identity, control, social objects, generalization and particularization, idealization and functionalization*, and *management*. I will, however, begin by making a brief review of the field which has become known as complexity science.

5.1 Strands of complexity thinking

Complexity science is not one science, but covers several strands and modes of thoughts originated from natural sciences like mathematics, physics and biology. In different ways they all show how particular kinds of dynamics arise when interaction is attributed characteristics of non-linearity, diversity and connectivity, which both enable and constrain interaction between entities (Fonseca, 2002). Natural science based complexity perspectives refer to phenomena largely in systemic terms, and like in systems thinking, the position of the researcher is the external observer. A complex system is defined to be a system ('whole') made up of many entities (parts) that interact in complex ways according to some local rule(s) or force(s) (Simon, 1996; Caldart and Ricart, 2004). Incidentally, it is more than 40 years since Thompson (1967) pointed out the existence of similar characteristics in complex organizations, and claimed that such organizations were composed of interdependent parts, amounting to a 'whole' that was interdependent with a larger environment. Snowden (2003:25) have elaborated on the notion of system entities, parts, or agents, and claims that it is about '*anything that has identity'*. Frenken (2006b) further emphasizes that these identities interact with differing strength, from strong to weak, which suggests that different identities influence differently the interaction they are part of.

Three key complexity strands, *mathematical chaos, dissipative structures* and *complex adaptive systems*, have been developed as approaches to the mathematical modelling of the emergent, evolving and essentially unpredictable characteristics of complex, non-linear systems, like ant colonies, turbulent flows, weather systems or genetic material. The theories of *mathematical chaos* and *dissipative structures* provide models that in essence are an extension of system dynamics (Stacey, 2007). These theories are based on ideas of non-linearity, feed-back loops, unpredictability, and distance in time and space between cause and effect, and they focus on a macro level. While chaos theory is built on assumptions of average entities constituting parts of average interaction, dissipative structure models make allowance for micro-events, or variety, which leads to self-organizing activity and to the emergent order of the 'whole'. Stacey (ibid.) points out that since these perspectives do not take into account human ability to learn and evolve; they are unsuitable for explaining human relationships, although they may contribute with some insight into dynamic processes.

The *complex adaptive systems (CAS)* theory was developed by scientists working at the Santa Fe Institute in USA (Kauffman; 1993; Gell-Mann, 1994; Langton, 1996; Holland, 1998). In the 1980s' they started using computer simulations to study the complex behaviour of large populations of autonomous adaptive interacting agents. These models demonstrated that local, self-organizing behaviour evolved in the absence of overall plans or common rules, and yielded emergent patterns of interaction common to the whole system, perceived as 'order'. The prevailing patterns of interaction influenced, and had the potential to change, the individual agents. At the same time, the agents influenced, and had the potential to change, the patterns. This research suggested that the dynamics of self-organizing networks is determined by the number and the strength of the connections between participating agents, but even more importantly by the *differences* between agents. Like the other two strands, the CAS theory is a theory about systems, but attention is on the micro level of the individual, interacting agents. A complex adaptive system is distinguished by four principles (Pascale, 1999:85). First, it exhibits the capacity of self-organization and emergent complexity. Second, it needs to be open and supplied with energy so that it can reach a thermodynamic equilibrium where it continues to move. As distinct to this, a closed system will set at a fixed-point equilibrium, where its capacity to change and adapt is lost and the system either stagnates or disintegrates (chaos). Third, a system tends to move towards a state of chaos, which is seen as 'the edge of instability', and at this stage change and innovation may occur. Fourth, it cannot be directed, only disturbed; and linkages between cause and effect are weak. Implicitly, small disturbances may cause large, transformative effects, while on the other hand; large disturbances may not lead to change at all. The effect of disturbance is therefore unpredictable, and unknowable.

5.2 Complexity science vocabulary

Complex systems are characterized by *non-linearity*, *emergence, self-organization* and *paradoxical dynamics*. In this section I will give a brief account of each of these four concepts.

5.2.1 Non-linearity

When some condition or action varies in strength or intensity, and this leads to variation in outcome, the relation between cause and effect is non-linear (Stacey, 2007). Mathematically, this means that when exposed to infinitesimal differences in initial condition, two entities with similar initial states can end up following radically divergent paths over time. In cybernetic terms, a non-linear system can be seen as a system that operates according to both negative and positive feed-back. This implicates the possibility of non-equilibrium, unexpected system behaviour, which is seen to be a defining characteristic of dynamic systems. The non-linear relation between cause and effect is the origin of the so-called ‘butterfly effect’ (Lorentz, 2000), which indicates that small disturbances in one part of a system may give rise to major change in another, quite distant part of the system. Non-linear properties may however also cause the opposite effect, which is low system susceptibility towards change impulses. The positive/negative feedback properties thus lead to the paradoxical state of instable stability, or stable instability. The system will oscillate in between the two extremes of chaos and stability following an unpredictable path. In organizational terms, non-linearity implies that repetition and change should be seen as coexisting processes which are equally essential for novelty to emerge and evolve (Leana and Barry, 2000).

5.2.2 The concept of self-organization

One of the most important ideas of complexity thinking is that change and novelty emerge in self-organizing processes which cannot be predicted or decided. The understanding of self-organization is fundamentally different from the ideas of systems thinking, where the concept of self-organization is perceived to be dynamic processes contributing to the creation of a holistic ‘system’ (Stacey, 2007). Some complexity scientists see self-organization as a fundamental principle of the universe, where the consumption of energy is needed to create and sustain order (Kelly and Allison, 1999). Such energy consumption is believed to take place under conditions referred to as *bounded instability*, or the *edge of chaos*. This has also been described as forces pulling organizations in two directions at the same time, towards ‘fossilization’ and disorganization (Boisot, 1999). Such paradoxical coexisting tensions are seen as the cause of the edge of chaos (Eisenhardt, 2000).

Nobel laureate Prigogine (1997) was particularly engaged with the phenomenon of self-organization as a source to understand and explain irreversibility, and by that also time. His work confirmed what CAS scientists had found, which is that differences between agents, referred to as micro diversity or ‘disorder’, are prerequisite to the unpredictable self-organizing emergence of order from disorder in nature. The importance of micro diversity has been further elaborated by Allen (1998a, 1998b). He showed that when the assumption of average components and events was abandoned, phenomena displayed the capacity to evolve completely new structures. This suggests that micro-diversity, or *non-average behaviour*, is the prerequisite source to continued movement, and to the emergence of novelty. Taking this view seriously, the search for generalized, average characteristics, whether related to biological systems or innovation processes, should be abandoned.

5.2.3 The concept of emergence

The view that emergent order arise from processes of self-organization contrasts the assumption of cybernetic systems thinking, which is that new order can be imposed on to a system from 'outside' (Goldstein, 2000). The ideas of 'spontaneous' self-organization has however resulted in a view of emergence as random change, it is something that 'just happens', and as such it is the opposite of intention (Stacey, 2007). An example of this, incidentally taken not from science, but from strategy research, is Mintzberg (1987:69), who describes emergent strategies as '*strategies without clear intentions, actions simply converging into patterns*'. Within a spectrum of strategies, Mintzberg thus places deliberate strategies at one extreme point, and emergent strategies at the other.

5.2.4 The concept of paradox

Researchers and managers increasingly use the word 'paradox', largely to describe conflicting demands, opposing perspectives or seemingly illogical or irrational connections (Lewis, 2000). Stacey (2007) points out that these are all ways to deal with contradictions, recognizable as *dichotomies*, which are polarized oppositions leaving us with 'either/or' choices, as *dilemmas*, which are choices between two equally (un-) attractive alternatives also leading to 'either/or' choices, or as *dualities*, which are 'both - and' situations where the two alternatives are distinct, and both are (or have to be) kept. The ideas of dichotomies, dilemmas, and dualities all imply the reduction of contradictions into one or two independent alternatives. Paradox, on the other hand, may also mean contradiction in the sense of the simultaneous presence of opposing forces, tensions or ideas, which can not be resolved, nor eliminated. Some strands of complexity thinking are built on ideas of non-average behaviour and interacting, interdependent agents, and within these perspectives the word paradox is taken to mean *the presence together, at the same time*, of self-contradictory, essentially conflicting ideas, none of which can be eliminated (Stacey, 2007). Accordingly there is no option involving choice between opposing tensions, or of defining them into distinct and separable classes. The move from systemic to heterogeneous complexity thinking therefore is a move towards a view that paradox cannot be resolved, only endlessly transformed.

5.3 A CAS perspective on organization and innovation

Taking the limitations of linear systems thinking into consideration, a growing group of authors are exploring the properties of CAS theory in order to develop new organizational theories embracing change as an emergent self-organizing process rather than as orderly, controllable steps (Levy, 1994; Anderson, 1999; MacIntosh and MacLean, 1999; Pascale, 1999; Van de Ven et al., 2000; Price, 2004). In the next section, I will go into more detail about this theory, and its present application in organization and innovation research. From this perspective complexity in organizations, also referred to as 'organizational non-simplicity' (Price, 2004), tends to be treated as structural, measurable variables characterizing the organization (e.g. the number of hierarchical levels, the number of management events) and its environment (like for example the number of different elements the organization has to deal with at the same time) (Anderson, 1999). Among these studies, only a few discuss innovation processes, although innovation is often mentioned in the same breath as change in the text. The exception is Van de Ven and his colleagues (Van de Ven et al., 1999; Poole et al., 2000; Van de Ven et al., 2000; Poole and Van de Ven, 2004), who have adopted a CAS perspective in their pioneering research to explain the progress of innovation processes. In accordance with American research tradition, they merge empirical observation with computational agent-based simulation. Through this approach they have demonstrated that innovation processes display non-linear and self-organizing characteristics. Furthermore, they have identified general qualitative patterns of behaviour presumed similar to those likely to be experienced in real life situations.

The CAS approach has led to new insight into corporate strategy processes (Olson and Eoyang, 2001; Caldart and Ricart, 2004), knowledge processes (Snowden, 2003) and management processes (Osborn and Hunt, 2007). Among the contributions to innovation research are a few works focusing on innovation networks and systems (Brown and Eisenhardt, 1997; Frenken, 2000; Frenken, 2006a; 2006b; Hirooka, 2006; van Buuren and Edelenbos, 2006), and on alternative explanations for and approaches to the situation of discontinuous innovation (which is also mentioned as *disruptive* innovation by Christensen (1997), *transformational* innovation by Webb et al. (2006) and *paradigm shift* innovation by Tidd et al. (2005). The need for emergent learning strategies in organizations confronting such 'chaotic conditions' is discussed by Carlisle and McMillan (2006) and Webb et al. (2006). Finally, Surie and Hazy (2006) point out the need for *generative leadership* of innovation, implying management structuration of the overall innovative context, stimulation of system-wide innovation and influence of interactions in complex systems.

As indicated, one of the ideas which have evolved as part of the CAS perspective is that companies compete for survival through self-organization and adaptation. Some authors thus suggest that company *comparative fitness* can be represented as a point within a multidimensional *fitness landscape* (Kelly and Allison, 1999; Marion, 1999; Caldart and Ricart, 2004). The complexity of the 'landscape' is determined by the degree of interaction and interdependence between its constituting organizational attributes, implying that the landscape itself is produced in the interactions (Allen, 1994). The metaphor of fitness landscape can be tracked back to biological theory (Wright, 1932), but was suggested by Kauffman (1993) as a means to explain the relationship between biologists' idea of selection and complexity scientists' idea of self-organization. His idea was that order does not emerge because of evolutionary processes of variation, selection and retention, because complex systems inherently are more resistant to environmental changes than envisioned in linear systems thinking. The 'ordering element' is seen to be *self-organization*, in a process where N elements each are influenced by K other elements (the NK-model). One of the ongoing discussions is whether organizations spontaneously self-organize to obtain better fit with their competitive environment, or not, and if and how they should be manoeuvred into peak performance (Osborn and Hunt, 2007). Of relevance to innovation processes research is the suggestion that organizations, in particular large organizations, need to '*dance* *between the edge of chaos and the edge of stability to create a sustainable innovation advantage'* (Carlisle and McMillan, 2006:7).

Frenken (2006b:149) mentions two other approaches to understand the becoming of technological innovation, which incidentally, he defines to be '*more often than not a collective process in which agents are engaged in a process of mutual learning'*. The first is *complex networks*, describing agent interaction, but also network technologies (like information and transportation infrastructures). The second is *percolation models*, applied to model the dynamics of innovation adoption and the role of spillover effects of innovation. Independent of choice of model, Frenken (l.c.) emphasizes the advantage of complexity theory in capturing '*more realistic features of the innovation process'*.

5.4 Problems with natural science based complexity thinking as an approach to explore organizational processes

The complexity science was developed for the particular purpose of capturing the complexity of the interconnected actions of agents in a system and the apparent unpredictable outcome of their interaction. In spite of this, it has been criticized (but also praised) for being a fundamentally reductionist approach developed to represent organizational complexity in simplified, even simplistic, terms or metaphors (Anderson, 1999; Price, 2004), as well as for being vulnerable to faddism (van Uden, 2005). The critiques seems to be based on the concern that 'complexity' may become a self-replicating discourse where important concepts like *emergence* and *non-linearity* are adopted in ways deviating from their original meaning, thereby loosing their value as explanatory concepts for organizational complexity. Incidentally, scientists adopting the ideas of complexity thinking have also been criticised for overlooking or underestimating the value of existing knowledge about organizations.

In my view, one of the major challenges of applying natural science based complexity theories to explain social processes is that they do not take into account the fundamental differences between the physical and the social worlds. Mathematical calculations and computer simulations will never be able to capture the full range of human experience, and they will always fall short in the description of emotional responses, power relations and identity formation; phenomena which are often sustained by unconscious group processes (Stacey, 2003). Such processes serve the function of including persons, ideas and behaviours adhering to established patterns of action (Elias and Scotson, 1994; Dalal, 1998) and excluding persons who represent patterns of action that are new or different, and therefore carry in them the seed to innovation. Furthermore, although the CAS theory treats individual agents as interdependent, adapting entities, when they interact they are not capable of producing novel patterns unless the agents are attributed diverse characteristics. Accordingly, to model innovation processes, heterogeneous complex adaptive systems models are needed. Moreover, as pointed out by Stacey (2007), to apply digital code interaction as an analogue to social systems involves the need for interpretation.

The characteristics of complex systems are in contradiction with the idea that predictors of and prescriptions for long-term innovative success can be worked out (Stacey, 2006). Nevertheless, most researchers seem to understand complexity theories in terms of systems thinking, meaning that the adoption of a CAS perspective involves little else than adoption of a complex thinking vocabulary. Accordingly, the search for generalized tools and techniques continue, rephrased into complexity terms (Eoyang, 2004; Surie and Hazy, 2006; Webb et al., 2006).

5.5 Summary

The chapter provides a brief review of a set of theories which have been conceptualized as complexity science. In different ways they all show how particular kinds of dynamics arise when interaction between objects is attributed characteristics of non-linearity, diversity, and connectivity. Complex systems are characterized by non-linearity, emergence, self-organization, and paradoxical dynamics. Each of these concepts are briefly discussed and explained. Although the research originates from the natural sciences, ideas, in particular from the theoretical strand called *complex adaptive systems* (CAS) are increasingly explored by organizational researchers as a means to obtain new insight in organizational processes. Of relevance to innovation processes research is the suggestion evolved as part of the CAS perspective that organizations, in particular large organizations, need to balance between the edge of chaos and the edge of stability to create a sustainable innovation advantage. The predominant idea is that companies have to perform this balance exercise within a fitness landscape, optimizing their comparative fitness through self-organization and adaptation.

Complexity science has been accused of reductionism and simplification of complexity much in the same way as systems thinking, caused among other thing by the interpretation of concepts like emergence and self-organization into meanings differing from the original. In my view, one of the most important problems of applying natural science based complexity thinking to joint human interaction, like organizations, is that is does not take into account the human aspects of being 'human', such as emotions and spontaneity. In the next chapter, I will describe the *complex responsive processes* perspective, which has been explored as theoretical basis in this dissertation, and explain why I see this perspective as a more coherent and valid organizational theory than the natural science based complexity theories.

6 Exploring organizations as complex responsive processes

Perspectives on organizational change have been broadly classified into *planned* and *emergent* approaches (Burnes, 2005). Ideas of planned change are developed in line with linear systems thinking, and involve rational decision making and management controllability of stepwise organizational improvement. In contrast, emergent change '*consists of ongoing accommodations, adaptations, and alterations that produce fundamental change without* a priori *intentions to do so'* (Weick, 2000:237). The same engagement in organizational dynamics and the emphasizing of complexity, instability, unpredictability, and continuous, emergent change characteristic of system dynamic thinking is recognizable in process traditions, and incidentally also in postmodern perspectives on organizations. In addition, such ideas find resonance with contemporary theories of complexity (Chia, 2003). Some authors, like for example Tsoukas (2005) and Van de Ven and Poole (2005), explore approaches to change and innovation involving a mix of processual thinking and natural science based complexity perspectives. This is also the case in the perspective I have adopted in my research, the *complex responsive processes perspective* (section 6.2). In my view, the complex responsive processes perspective integrate ideas from complexity science, process sociology and social psychology in a well-considered and far more extensive way than in alternative perspectives based on processual or complexity thinking. Nevertheless, many of the ideas offered within these perspectives are unquestionably of value to my work, and deserve some attention.

6.1 Process thinking in organizational studies

Langley (2007) opportunely points out that the word 'process' has come to take on a variety of meanings, which is making communication about it difficult. To her, process thinking involves considering '*phenomena dynamically – in terms of movement, activity, events, change and temporal evolution*' (ibid.:272). This corresponds to one of three definitions of process suggested by Van de Ven (1992), the other two being process as *explanation of a relationship*, and process as a *variable*. The struggle to capture the dynamic characteristics of 'process' in words can be seen also in Bakken and Hernes (2006), where it is interpreted as movement in the sense of flow. The authors emphasize that flow is not only referring to the fluid motion of water, but also to activity, information and the passing of time.

The *time dimension* is of importance in process thinking. 'Time' was introduced by Thompson (1967) as a concept to handle the paradoxical need in organizations for both stabilizing routines, seen as protection of short-term interests, and adaptability, seen as investment in long-term interests. Process thinking can thus be seen to include two considerations. The first is to catch '*reality in flight'* (Pettigrew, 1992:11), involving a focus on how and why things (people, organizations, strategies, technologies, environments) act, evolve and change in ongoing processes. The other is to study organizational becoming (Tsoukas and Chia, 2002), that is how such 'things' come to be constituted, reproduced, adapted and redefined over time. Langley (2007) points out that the need to incorporate dynamic dimensions has been identified not only by process thinkers, but also by authors integrating knowledge from multiple disciplines, like complexity thinkers. The dominance of research ignoring non-linear, time dependent effects of action has so far implied that managers are offered models of organizational processes that do not and cannot capture the temporally embedded accounts that enable them to understand how emerging and evolving patterns come to be. Yet, claims Langley (ibid.:273), '*in practical terms, this is probably the most pressing issue – especially for those who seek guidance on how to improve their performance*'.

According to Bakken and Hernes (2006:1600) the purpose of process thinking is to direct attention to '*the analytical distinctions that we actually draw between continuity and discontinuity, between constancy and change, between entity and flow'*. The crucial distinction between the view of organizations as composed of entities, which is presently dominating the fields of organization and innovation research, and that of organizations as manifestations of processes, is pointed out by Van de Ven and Poole (2005). Chia and Langley (2004) suggest that the *entitative* (being) (Chia, 1999) and the *processual* (becoming) conceptions of the nature of organizations could be seen as a 'weak' and a 'strong' process view, respectively. In the *weak* process view, which appears to dominate much of organizational and social scientific research, processes are seen as important, but ultimately reducible to the action of unchangeable objects, i.e. individuals or things shape processes, but remain themselves unaffected by the interaction. In the *strong* process view, which has been informed by strands of process philosophy, represented among others by James (1996), Whitehead (1978), and Bergson (1946), the world is seen as process. Entities are thus seen as '*manifestations of processes*' (Rescher, 2003:51); as abstractions (or reifications) that are 'becoming' rather than 'being' because they are always in formation and never exist as entities in themselves (Bakken and Hernes, 2006:1610). From this perspective everything is in principle interrelated, connected through process. Organizational phenomena are understood as enactments; that is as unfolding processes where individuals make their choices in their local context, in interaction with the evolving events (Tsoukas and Chia, 2002).

This discussion is expanded on by Tsoukas (2005), who illustrates the ontological difference between the entitative and the processual conceptions of process through two worldviews, which correspond to the weak and strong process views. His point is that in the entitative view, 'organization' (understood as institutionalized categories) is seen as an *input into* human action, while in the processual view 'organization' (in the form of emerging pattern) it is the *outcome of* human action. The second viewpoint, presupposing that organizations are composed of organizing processes, is commented on by Van de Ven and Poole (2005:1380) in the following way:

> *On this view, an organization is simply a reification of a set of processes that maintain the organization by continuously structuring it and maintaining its boundaries in a field of other processes that are continuously breaking down the organization and its boundaries. In this view, stability and change are explained in the same terms: stability is due to processes that maintain the organization so that it can be reified as the same thing by some observer(s), while change occurs when the processes operate in a manner that is reified by observer(s) as changing the organization.*

Van de Ven and Poole continue to emphasize that the most influential model for explaining nonlinear dynamic systems in organization studies is Kaufmann's (1993) theory of complex adaptive systems (CAS, see Chapter 5.3), which exemplifies one of the links made between process thinking and complexity science.

Tsoukas and Chia (2002) adopt a strong process view when they take as their point of departure that change is not the exception in organizational life, but rather an inherent property of human action, implying the view that 'organization' is an emergent property of change. Change, in their terms, is about perceived difference, and accordingly, studies of ongoing organizational change should focus on perception as much as on conception. This view appears to support their assertion that their approach to organizational change is based on a radical process-oriented perspective. In their accounts they do however talk about 'unfolding' phenomena (p. 571), interaction with 'the outside world' of organizations (p. 573), and 'levels of analysis' (p. 575), and the 'organization' is largely referred to as a unit. In my view, this illustrates a challenge which presumably faces all who do research within the field of organizations and organizational processes; that is the difficulty of letting entirely go of the conceptual vocabulary and the associated ideas offered by systems thinking.

Seen from my perspective, this underlines the need for a more comprehensive debate about how people make sense of any phenomenon. I will however only just touch upon the theme in this study, by drawing on Bakken and Hernes (2006). They use the ideas of Whitehead and Weick as an example of two views on sensemaking. While Whitehead argues that humans are incapable of thinking purely in terms of process, and that the process of abstraction, i.e. conceptualization and reification, is necessary for human sensemaking (Whitehead, 1920), Weick sees sensemaking as the interaction between actions and meaning, communicated through a choice of words suitable to capture the dynamics of process. In practice, communication should therefore be carried out by means of verbs rather than nouns, which as an example would mean to talk about *organizing*, rather than *organization*.

The way I see it, two important debates are missing in the studies I have read claiming the adoption of process thinking. One is related to the visibility of social agents in processes (or in entities), and the effects of human individual characteristics like emotions, intention, power, etc. A second debate of interest is that of level-thinking.

The idea that analyses of processes and effects can be made on different levels is widely accepted (see chapter 3). This makes the use of the concept of 'organization' as a synonym for the arena of actions of human professional life, or even as the outcome of human action, a natural thing to do. A few authors, among them Mead (1967), argues however that there is no split between the individual and the social. The individual and the social are not seen to be different levels of a system, but are regarded as two aspects of the same process. This further means that an observer can never be 'outside' or 'inside' a system, because there is no system, only interaction between interdependent humans who experience the dynamics of interaction as participants. Incidentally, the same perspective as claimed by Mead (ibid.) can be recognized in Elias' process sociology (1978; 1991). This view forms part of the basis of the *complex responsive processes* perspective, a perspective in which all human relating is seen as fundamentally communicative, paradoxically involving the forming of the social by individuals; who at the same time are formed in social interaction (Stacey et al., 2000; Stacey, 2001; 2007). According to Taylor and Van Every (2000) organizations do indeed emerge from conversations. Keeping in mind the suggestion of Tsoukas and Chia (2002) that organizations are the emergent property of change, an implication of the two should be that conversation is change. This idea supports the complex responsive processes perspective. Stacey and his colleagues at the Complexity and Management Centre at the University of Hertfordshire do propose that conversation is change, but that it paradoxically is repetition at the same time. What does this perspective mean for the way one could think about organizations; and in particular about the phenomenon of innovation?

6.2 The perspective of complex responsive processes

The recurrent theme in the four articles which form the core of this dissertation is how thinking in terms of *complex responsive processes* of human relating (Stacey et al., 2000; Stacey, 2001; 2007; Griffin, 2002; Shaw, 2002) affects my interpretation of the innovation processes in Statoil in which I have been part for nearly four years, and how this departs from prevailing thinking about innovation in established organizations.

Collectively, the articles describe and discuss important aspects of the complex responsive processes perspective as a basis for an alternative way to understand innovation processes. In this section I outline some of these aspects, and draw particular attention to central concepts, like power, identity and control, which are understood in ways differing from the more established, systems thinking based explanations.

Burnes (2005) points out Stacey (1991) as the first author to link complexity thinking with ideas of emergent organizational change as an alternative to systemic ways of thinking about process in human action. Stacey's concern is with what people are actually doing in their '*ordinary, everyday activities of leading, managing or organizing*', leading to the simultaneous emergence of local everyday interaction and widespread patterns of actions common to many people; the 'organization' (Stacey, 2007:243). The causal framework applied is that of *transformative teleology*, derived from the German philosopher Hegel as interpreted by Mead (Stacey, 2001). This implies the view that the future is under perpetual construction as concurrent continuity and potential transformation, created in responsive processes of relating between individuals. Accordingly, organizations are seen as patterns of joint action between individuals, iterated as the present (Stacey and Griffin, 2005c). Seen from this perspective it is impossible for individuals to take an objective, external position to exert influence on an organization (or a system), because interaction is not understood to create any system existing as a separate entity or level. What is caused by interaction is seen to be nothing but further interaction, meaning that the basic unit of analysis is the *social act* (Mead, 1967). The complex responsive processes perspective therefore holds no notion of a Kantian universal, or 'whole', acting as a causal power on interaction, because interaction is seen to be its own cause. Stacey and Griffin (2005b:21) assert that this perspective should rather be seen as '*an evolutionary theory of values and ideologies arising in social processes of self-formation and ongoing conflictual negotiation*'. Interaction, which is experience, will lead to the emergence of different ideologies, further evolving into imaginary, idealized and generalized 'wholes', temporarily seen to be 'truth'. In their functionalization, such 'truths' may be confirmed and reinforced, or negated and transformed.

According to Stacey and Griffin (2005b) the complex responsive processes perspective is based on a few generalized, idealized propositions, of which the most important is that human interdependence is a fundamental reality of human experience. Human relating is power relating (se below), held to be self-organizing, and leading to the emergence of patterns of thought-talk-action which are the temporary organization of experience. Humans are further seen to have the capacity for spontaneity and reflection, including the capacity to take the attitude of others. This makes them able to evaluate alternatives, to consciously choose their actions, and, implicitly, also make people accountable for their choices. Stacey and Griffin (ibid.) particularly emphasize that the evolving patterns of communication, including figurations of power and ideological ideas, are '*not universal but contingent on the specific interaction of specific people, negotiating the particularizations of their generalizations/idealizations with each other at specific times in specific situations*' (ibid:22).

In my opinion the complex responsive processes perspective takes process-thinking beyond what Chia and Langley (2004) refer to as 'strong' process view, in that systemic ideas about organizations are abandoned. In this perspective individual minds (selves) and social relationships, and individual and collective identity/meaning/knowledge are understood as aspects of the same phenomenon, namely, *relating* (Stacey, 2001:6). This further means that the notions of 'bounded systems' and 'analytical levels' lose meaning. Admittedly, Stacey (2001) and Fonseca (2002) do mention procedures, guidelines and rules as 'systems' designed and charted by people, often in the shape of ICT-based tools, to support organizational activities. These 'systems' are however seen as (temporary) stabilizations of themes (or beliefs, ideas), which enter into conversations as a kind of generalized basic assumptions. The complex responsive processes perspective consequently acknowledges that people, individually and collectively, can and will generalize and idealize emerging and ongoing patterns of themes into imaginative 'wholes' in a way that will affect the experience of belonging and identity to the members of the organization. Generalized, stabilized themes should be understood as themes that are reiterated over time. Such themes will influence the emergence of new themes, the way new themes are perceived, and the way they are particularized and functionalized in specific situations. As such, generalized themes could therefore also be seen as contributing factors of social control. Commonly stabilized themes are for instance what we have become accustomed to refer to as organizational characteristics, like 'culture', 'values' and approaches to 'learning', ‘organizing’ and ‘management’.

6.2.1 Properties of complex responsive processes

In analogue with complex adaptive systems thinking (CAS, se Chapter 5.3) the complex responsive processes perspective hold the thematic patterning of interaction to be *complex, self-organizing, emergent and evolving* (Stacey and Griffin, 2005c). Computer simulations are, however, unable to capture the full range of human experience, and will always fall short in the description of the distinctive characteristics of being human, in particular emotional responses, power relations and identity.

Complexity

From this perspective *complexity* refers to the particular dynamics which is patterned by human relationship and characterized by the coexistence of certainty and uncertainty, predictability and unpredictability, known and unknowable, stability and change. Such complex dynamics is seen as an inherent and natural part of human interaction. In consequence, reduced complexity of patterns of human relating is not seen as a desired end of managerial intervention, but rather as a sign of unhealthiness, either individual (e.g. neurotic or psychotic disorders) or of group processes (like in fascist political regimes). Bouchikhi (1998) notes, however, that theories of organizations often downplay ‘complexity’ in favour of either/or frameworks, such as contingency theories in which distinct categories or classes leading to equally distinctive characteristics are identified. Lewis (2000:769) suggests that organizing should rather be explored as ‘*an ongoing process of equilibrating opposing forces and detail its tensions, cyclical dynamics, and management*’. Managing the paradoxical tensions is therefore not, according to Lewis, about compromise between flexibility and control, but about the awareness of their simultaneity.

Self-organization

The conceptualization of *self-organization* as the interaction of individuals based on their own local organizing principles also corresponds to the CAS perspective. Self-organization is defined as the co-evolving repetitive and transformative patterning of communicative themes created when heterogeneous individuals participate in local interaction (Stacey, 2001). In social processes participation is not seen as a premise for self-organization, '*participation is self-organization*' (Griffin, 2002:125). This indicates that interest in organizational processes should be directed towards the *patterning processes of local communicative interaction* from where the phenomenon of self-organization is emerging. A point of importance is the view that interaction is always *local*, meaning that at any point in time, individuals interact with only a small fraction of the total population of an organization or of a society. Local interaction can be between a small group of people geographically located in the same place, or communicating by use of communication technology (phone / mobile, e-mail, video conference equipment, etc.) Worth noticing is that this local interaction is referred to as *conversation* by social psychologist George Herbert Mead (1972) and as *interplay of intentions* by sociologist Norbert Elias (1978).

Emergence

Elias' choice of words reflects the view that people do plan and do have intentions, but at the same time they will always have to negotiate their actions with other people pursuing other intentions. Communicative interaction should therefore be seen as a *political process*, in which people mutually enable and constrain each other in their social actions. Because all relationships have these characteristics, they are power relations (Elias, 1998). When interdependent people interact in such figurations of power, conflicts between differing actions, plans and purposes are bound to arise. This entails the recognition of the unlikeliness that one person's plan or intention should become prevalent as the long-term reality of all. In the myriad of local interactions between people unpredictable, widespread coherence are rather envisioned to *emerge* without (or in spite of) any program, plan or blueprint for that widespread pattern itself (Stacey and Griffin, 2005a). Self-organization and emergence can thus be understood as the co-evolving repetitive and transformative patterning of communicative themes created when humans interact. People can and do generalize existing and emerging patterns of themes (Stacey, 2005). To be able to act, it is however necessary for people to particularize and functionalize the patterns into specific situations, and this inevitably involves some kind of conflict related to interpretation and the formation of meaning. The non-linearity of human interaction means that differences in particularization, even small ones, have the potential to amplify into new general patterns completely different from the preceding, and in this way, patterns of themes *evolve*, and even transform.

One of the problems connected with the concept of emergence has to do with causality. From the perspective of *rational* 'if-then' causality particular individuals can choose the development of an organization. Emergence - seen as chance development - is therefore ruled out. If managers can decide a future and manipulate organizational qualities to support the materialization of that future, then organizational development is about the unfolding of events which are enfolded in the system beforehand, meaning that causality is *formative*. In an evolutionary perspective, ideas about rational and formative causalities are, however, rejected in benefit to *adaptionist* causality (Fonseca, 2002), which explains the emergence of novelty as natural selection on chance variation at the level of entities ('survival of the fittest'). Both the formative and the adaptionist causalities seem to imply that managers must comply with developmental processes on which they have no influence. To me, the three alternative ways to think about causality, whether they involve the idea of specific humans being in total control of processes, or without the means of influence at all, seem to exclude the possibility of spontaneous emergence of unplanned ideas and events and the intentional following up on such ideas. In systemic perspectives the concept of 'emergence' is therefore more or less irrelevant, because the dual causality of rational planning and formative implementation leaves no room for surprise, and the formative and adaptionist views do not take into account human intention and free will.

In complexity theories, including ideas of micro-diversity, emergence takes on a very different meaning. The causality is *transformative* because new patterns are seen to emerge in paradoxical processes of stability and change, where the evolvement of patterns over time is unknowable and unpredictable. Accordingly, the future is seen to be under perpetual construction (Stacey, 2001). This point was of main concern to Elias (2000), who aimed at explaining the becoming of social order and civilization through history without someone having made long-term plans for the evolution. In terms of Elias, 'emergence' is the emergence of pattern in the interplay between human intentions, and not a product of chance. Emergence leads to population-wide patterns which continually evolve and change in local interaction. Elias (ibid.) links the interplay of intentions with the development of identity and power relations. His reasoning leads to the idea that when people articulate some global pattern, or attempt to design or change it, they are doing nothing more than making a gesture, although this can be a very powerful gesture. The crucial point is that the emerging pattern can be found only in the local responses to this gesture (Stacey, 2005), and that what is emerging, is novel patterns of themes which no one individual could have decided, and which may involve the emergence of novelty.

6.2.2 The generalized other, social objects and processes of particularization and functionalization

People have the ability to simultaneously recognize the general and the particular of an object, a situation or about human behaviour. We see a Cocker spaniel, and may at the same time recognise it as the particular race, as 'dog', but maybe also as 'Lady' or 'the sweetheart of Tramp'. In the same way, specific social acts tend to produce situational responses which we recognize as typical of that situation, or for a certain group of people, in spite of obvious individual variations. The human capacity to generalize the attitudes of many makes the task of participating in complex social acts more manageable. In their acting, each individual will usually take up the attitude of a few specific others, and, at the same time, the attitude of one or more 'generalized others', which may be a group of people, an organization or the society (Stacey, 2007). 'The generalized other' is a notion suggested by Mead (1967). In his elaboration about the inclination of people to take the attitude of the generalized other, he does not mean that people should assume some predominant group opinion. What he points out is that in their social relating people tend to take into account generalized tendencies to act towards themselves and other members of the group, organization or society they are part of. Because social acts are complex and involve a multitude of interacting individuals who at the same time enable and constrain each other, the interdependency pointed out by Elias (1978) is created, and so is the unpredictability of the outcome of human interaction. The determination of 'generalized others' could be seen as a way to increase the predictability of peoples' responses towards particular actions, made by 'you' and 'me'. People's assumption of the attitude of the 'generalized other' can therefore be seen as a form of social control, reflected in figurations of power relations (ibid.). As stated by Stacey (2007) the claim that no one individual can 'be in control' of a social process is thus not a claim of a situation of anarchy, but of a situation in which social control, expressed among other things as socially acquired self-control, has a decisive influence on the outcome of social processes.

To be able to act in their everyday life and to make meaning of other peoples' actions, individuals have to interpret generalized expectations about behaviour and responses into the specific situation they are in. In many situations individuals will come up against the challenge that there is more than one generalized expectation related to their joint efforts, like the concurrent requirement in many companies for innovation and efficiency. The particular interpretation of how to handle a situation in practice may therefore differ between those involved, bringing to the forth the significance of *conflict* in organizations. According to Mead (1967), conflict is a political process of persuasion and negotiation where people explore differing interpretations to seek the particular understanding which enable them to go on together. Such conflicts of interpretation paradoxically also enable the further evolution of the generalized ideas. I perceive Mead's notion of conflict negotiations to have a lot in common with prevailing ideas of consensus. A more common approach to conflict is however to see it as polarized dissension (Stacey, 2007), entailing the entering of individuals into a power struggle by taking up opposed positions, and seeking to defeat each other. Irrespective of how conflict is understood, its influence on the paradoxical processes of concurrent particularization and generalization of socially evolved patterns seems to me to be underestimated in innovation research, whether it contribute to further evolvement, positive or negative, or to cementation of prevailing patterns.

From this perspective *generalizing* denote both articulated and unconscious population-wide patterning, while *particularizing* is seen as local interacting. Mead (1972) suggested several formulations of the generalization and particularization processes, one of which is the notion of the 'generalized other'. Another formulation is the concept of *social object*. In connection with 'social', Mead employs 'object' in the sense of 'tendency to act', rather than as a physical concept or a thing. Incidentally, Blumer (1998), who was Mead's student, also makes mention of social objects. In his theory of *symbolic interactionism*, three types of objects are distinguished, which are physical, social and abstract objects. These are generally defined as something that can be indicated, pointed to or referred to. In Blumer's definition a social object is a human being, an understanding which differs clearly from the meaning derived by Mead (1972). In Mead's terms social objects evolve and are being formed in social interaction, and are at the same time forming the social interaction. Social objects can thus be understood as '*generalized tendencies on the part of large numbers of people to act in similar ways in similar situations*' (Johannessen and Stacey, 2005:143). Social objects should be distinguished from physical objects, which are seen by Mead to be things which are definable in terms of themselves. A social object can only be defined in terms of itself, and can be seen as a way to be able to interact coherently in social life (Stacey, 2007:311). Since it is nevertheless a generalization of social interaction, processes of interpretation and particularization are needed for people to come to a decision as to what they are actually going to do in a specific, contingent situation.

As well as being generalizations, social objects may take the form of *idealizations* or *cult values* (Mead, 1923). Idealizations rest on generalized ideas which have emerged in the evolution of a society, and which are perceived by a group of individuals as the 'right' way to do things, independent of time and space. Griffin (2002:116) explains cult values to be the '*collective idealizations that divert attention from the detail of interaction in the living present*'. Idealizations should be distinguished from their functionalization, which are the specific actions taken by individuals in their local settings. Organizational mission and vision statements, and desired capabilities like 'innovation', are commonly articulated and specified by managers in the form of cult values. This encourages the idea that a particular process can be intentionally designed, and its outcome chosen. What we do by this, is to attribute meaning to patterns of action as if they were a substance or a thing, rather than emerging processes of communicative interaction. By reducing processes to states in this way, we lose sight of the particularization processes in which meaning is created, repeated and potentially transformed. From a complex responsive processes perspective, social objects have evolved in the course of history, and each individual is born into a world of such social objects. In line with Mead's view, such population-wide patterns of action are seen as generalisations that exist only by virtue of their particularisation and functionalization in the ordinary, everyday interactions between people.

6.2.3 The emergence of meaning

To render possible the coordinated action between many people, local interaction must produce '*emergent, coherent, meaningful patterns of interaction both locally and population-wide at the same time*' (Stacey, 2007:434). As indicated, this happens in social processes of particularization involving reflection, emotion, imagination, and conflict. Mead (1967) emphasizes that *meaning* is an implicit part of all such processes, even if awareness of it has not occurred. In Mead's perspective, a *social act* is a gesture by one individual calling forth a response from another, which together constitutes meaning for both of them. The point of major importance here is the view that meaning is a social act resulting from complex responsive processes, and not a state of human consciousness. 'Meaning' is brought out by the *responses* provoked by a gesture, not by the gesture itself. As social acts usually involve many people, meaning arises in the responsive interaction between numerous actors. This leads to the alternative understanding of the concept of *social object* as being a generalised gesture taken together with the expectation that the response called forth in an individual will be within a predictable range of particular responses.

Another important point, which was indicated in the preceding paragraph, is that if people are going to 'share' a meaning, the response, or attitude, called forth by somebody's gesture must be evoked in everybody taking part in the interaction, including the person who made the gesture. This view also forms the basis for the explanation of thinking, which can be seen as (silent) gestures made by an individual, calling forth responses in him or her perceived as meaning. Accordingly, in social acts human consciousness is not seen to be related only to the responses evoked in others, but also to the responses brought out in ourselves, particularly in situations unfamiliar to us. The more habitual a situation is; the less attentive are we of the interplay of responses (Tobin, 2005). Mead (1967) used the concept of 'significant symbols' to denote a gesture that '*calls forth the same response in the gesturer as in the one to whom it is directed*' (Stacey, 2007:272). Such gestures can be of various kinds, but in Mead's opinion, vocal gestures are of particular utility to seek resonance between responses, and by that the perception of joint meaning and the possibility of conscious cooperation. Mead (1967:79) emphasized however that while meaning can be expressed by the means of language, it is not created by language, because '*language simply lifts* *out of the social process a situation which is logically or implicitly already there'*. Stacey (2001) further reminds us that although the principal enabling and constraining social process is communication in words, communication, whether expressed by words or body language, it is also in the medium of feelings.

Shaw (2002) draws attention to the importance of ordinary conversations in organizations as sources to emerging organizational change. Consistent with Mead (1967) Shaw argues that human interaction is a conversation of gestures, where people responsively adapt what they say to the ongoing conversational process. Her observation that people subjected to rigid meeting agendas (and probably also to the general feeling of involuntary stress) tend to reproduce habitual responses, should attract interest by those engaged with organizational change and innovation. In order to increase joint experience of diversity and multiplicity and encourage the introduction of new themes, Shaw underlines the need for the deliberate introduction of slack in meetings and other organized conversations. Furthermore, she points out the importance of 'shadow activity' as a source of primary interest for the emergence of new organizational realities. To recapitulate, one of the core points of the complex responsive processes perspective is that no individual can avoid being in local interaction, where they at the same time express both particularities and organization-wide themes. They are generalizing as they are particularizing and vice versa; simultaneously as the same process, and in their acts of expressing, they contribute to the emergence of new local meaning and further generalization of themes and actions. This has led to the view that organizations consist of numerous local communicative interactions, covering themes perceived as legitimate, but also as illegitimate and concealed. In the ordinary, everyday life it is almost impossible to identify and separate the unofficial shadow interactions from those considered by organizational members as interactions officially accepted. Everyday conversational themes will evolve in relations that may differ with regard to legitimacy, quality and potential for innovation. This communicative interaction can be seen as *participative self-organization* (Griffin, 2002), where that which is being organized is our individual-collective experience of being together. Self-organizing processes form and are formed by interacting, interdependent individuals, and do involve paradox and the continuous movement of legitimate and illegitimate themes in an organization. An important aspect in this is what happens when unofficial 'shadow' themes are introduced into the official organizational patterns of themes.

6.2.4 Power relations, ideology and the dynamics of inclusion and exclusion

In the complex responsive processes perspective power is seen as those aspects of human life through which people are continually enabling and restraining each other (Elias, 1991). Power is consequently understood as a structural characteristic of all relationships, in every situation, rather than as something possessed by an individual or a group. According to Dalal (1998) power is another way of saying that people are interdependent, and therefore constrained by others, where 'others' may be both people and things (tools, technology). To be constrained does not, however, mean that individuals are powerless and without influence. Power is an intrinsic characteristic of all human relations (Elias, 1978), and its asymmetric and changing nature is seen as an important reason for the emergence of dominant ideas, or trends, in an organization, and for the further destiny of such ideas. The many functions and roles in organizations could be seen as power structures causing various co-existing themes to emerge, resulting in differing opinions on the purpose and importance of particular activities. Influential individuals may suppress new themes while on the other hand they are empowered to legitimatize new themes. These power structures could paradoxically be seen as contributing to the inefficiency of conversational processes, while at the same time promoting positive attention towards emerging new themes.

Stacey (2007) points out that power relating should also be seen as an important aspect of organizational as well as professional identity. Resistance to new ideas could therefore be understood as attempts to uphold established power and identity structures. Power relations, emotional responses and the perception of identity are phenomena which are often sustained by unconscious group processes (Stacey, 2003). Such processes serve the function of including persons, ideas and behaviours adhering to specific patterns of action (Elias and Scotson, 1994; Dalal, 1998), and excluding persons who represent patterns of action that are different, or new. This directs attention to the question of inclusion and exclusion in groups (Elias and Scotson, 1994). Such inclusion-exclusion dynamics is an aspect of all communicative interaction which humans cannot decide to do without just like that. The human inclination to categorize and classify their experiences makes this dynamic inevitable. In this way, experience tends to be polarized into similarity and difference, and the paradox of simultaneous similarity and difference within and between categories is lost sight of. Dalal (1998) points out that these processes of group categorization and inclusion-exclusion dynamics are unconscious social processes in that the differences between groups emerge in an essentially self-organizing process which no one is really aware of or actually intends. The phenomena of group identification and power differentials may create a powerful dynamics in organizations, which, according to Stacey (2007), probably constitute one of the main reasons for the failure of attempts to realize strategic intents. Power differentials are commonly preserved or emphasized by the use of even trivial differences to establish and maintain different membership categories (Elias and Scotson, 1994). Such differences may be given an ideological form and used to stir up antagonism, even hatred, thus sustaining power positions in a dynamic of inclusion and exclusion.

A key aspect of *ideology* is the binary oppositions that characterize it. The most basic of these is the distinction between 'them' and 'us'. Ideology can be understood as a type of communication which preserves the current order in a way that makes this specific order seem natural. In accordance with this, Ritzer and Goodman (2003) claim that ideology is an 'idea system' that seeks to conceal and conserve the present by interpreting it from the point of view of the past. In a similar line of thought Stacey (2007:347) suggests that ideology can be thought of as an imaginative 'whole' which is simultaneously the obligatory restriction of the *norm* and the voluntary compulsion of *value*, constituting a set of evaluative criteria for the choice of actions. Such ideology is largely habitual, and ideological themes will organize people's experience of being together as power relations and 'natural order'.

6.2.5 Identity: Them, us, me and I

Fundamentally, 'identity' can be understood to be that which defines who a person is; a persons' understanding of self in relation to others. A common way for people to describe their identity is to account for 'who I am' (perception of individual identity) and 'who we are' (perception of collective identity) (Stacey, 2007). In this way people make a distinction between 'me' and 'the others', and between 'us' and 'them', and label themselves as belonging to, or not belonging to, particular groups.

Neither Mead (1967) nor Elias (2000) makes any analytical distinction between 'the individual' and 'the social'. Their thinking implies the view that what is emerging from processes of human interaction is simultaneously and inseparably individual and collective identity. This is also the view adopted in the complex responsive processes perspective. From this perspective, individual-collective identities will continue to evolve, and potentially change, in ongoing processes of interaction between people. Mead (1967:154) claimed that a human being is given its '*unity of self*', i.e. its perception of individual identity (self-consciousness), by a social group or an organized community (conceptualized as 'the generalized other'). The self develops within social processes of particularization and generalization in specific situations, in conscious conversation between gestures, and with simultaneous reference to others and to itself. Mead (1934) made a distinction between the 'I', which is the response of an individual to the attitudes of others, and the 'me', which is the organized set of attitudes of others which an individual assumes. The 'I' and the 'me' are inseparable phases of the same social act, which is the perpetual iteration of the self in interaction with others and oneself (Stacey, 2007). The emergence of individual identity cannot take place without the sophisticated communicative interaction between people leading to emerging patterns of collective meaning, that is identity, and such communicative interaction cannot take place without the existence of self-conscious individuals. Elias (2000:184) made a similar point, emphasizing the 'indissolubility' of a person's existence as an individual from his or her existence as a social being: '*One could not distinguish oneself as an individual from other people if there were no other people'*, that is: '*There is no I-identity without a we-identity*'. Identity could thus be redefined to be about an individual's sense of self ('I' as a social object to myself) and at the same time to be a social object arising in the perceptual field of others (Williams, 2005a). As identity is seen to emerge from social processes, identity formation will be enabled and constrained in processes of power relating. From a complex responsive processes perspective, the intertwinement of the individual and the collective entails that '*an organization is evolving identity'* (Stacey 2007:435). Incidentally, establishing an 'organization' is generally recognized as an important way to accomplish coordinated goal-oriented activity. From the complex responsive processes perspective an organization is however an abstraction that does not possess any meaning in itself. New meaning and the evolvement of identity can only emerge from the ongoing communicative action of the involved actors, in processes recognized as ‘change’, or ‘innovation’.

6.2.6 Management and the paradox of control

Underlying many conventional approaches to innovation management studies there seems to be an assumption that ‘properly’ informed managers will be able to control the progress of innovation processes in such a way that the results will be, within defined limits, in accordance with some strategic intent. Griffin (2002) points out that management is action, including the formulation of strategies, orders and so on. From a complex responsive processes perspective the management of knowledge processes, including innovation, involves the management of power relations and ideology, as well as the unpredictable dynamics of emerging legitimate and illegitimate themes and private fantasies. In my view, this makes it reasonable to question whether there are other, more useful ways to think about the acts of managing and leading than those currently dominant.

Seen from a complex responsive processes perspective, the future is not decided by an individual or a particular group, but emerges as a result of the joint actions of managers and other members of an organization, as well as numerous people in other organizations and groups. In consequence, the essential function of managers cannot be ‘control’, because it would be impossible for any one individual to be in control of development (Streatfield, 2001). From this perspective, management is thus understood primarily in terms of social processes, involving relational phenomena like power, meaning and identity. The notion of managers as objective observers is abandoned, and management is rather seen to be about participation and reflection. ‘Participation’ is the participant presence in complex responsive processes where people engage in emergent, explorative conversation about what they are doing and what their nest actions are going to be. ‘Reflection’ is the reflexive enquiring of the individual manager into their own complex responsive processes of relating (Stacey, 2007). This means that attention is refocused from the idea that managers should strive to adopt some prescribed approach to their work, to encourage their joint reflection about how they actually work, and their acknowledgement of ‘*the uniqueness and non-repeatability of the experience*’ (ibid.:

442). Such refocusing of attention is likely to lead to very different kinds of action, where the quality of relations becomes of crucial importance. When participation is no longer about interaction with the 'whole', but about everyday conversations with other people, it immediately becomes clear that each and one of us is always in local, personal conversation, and only with a limited number of people at the time. Although some individuals or groups of individuals have the opportunity to influence more the themes of future conversations in own or other local groups than others, what is created in any communicative interaction is but further interaction, and no abstract change of the 'whole'. According to Streatfield (2001:132) the key to managing organizations therefore lies in *courage*, which from this perspective means the courage to carry on to participate in the ongoing responsive processes of meaning creation, despite the fact that they are not 'in control'. 'Not being in control' should however not be understood to mean that mangers drift randomly along according to whatever ideas which come along. Managers are paradoxically 'in control' and 'not in control' at the same time, and what they are in control of - or can intend - is their next gesture (Mead, 1967; Streatfield, 2001). Seen in the light of the preceding discussion about Mead's thinking related to gesture-response processes, and the concept of 'the generalized other', a manager can anticipate, but never know for sure, the response that will be produced by the members of an organization to the gesture he or she makes. Incidentally, any gesture made by a manager will always arise as a response to one or more previous gestures made by others, thus emphasizing the interdependent nature of leadership and the fundamentally erroneous presumption that intentionality can be equalled with the elimination of the unexpected. To manage means to accept the paradox of '*being in charge but not in control*' (Shaw, 2002:117).

From the perspective of complex responsive processes, it can be argued that management attention should be on how intention emerges; on the interplay of intentions and its influence on organizational evolvement and change; and on diversity, including both legitimate and shadow themes, and the amplification of differences in change processes (Stacey, 2007). This means that managers will be in need of skills which are rarely demanded today, like the ability to articulate emerging themes; to stand anxiety-provoking states of diversity, opposition and conflict, and resist the urge to rapidly draw conclusions and 'move on'; and to acknowledge and reflect on their own role in what is happening (ibid.:412). Griffin (2002:213) reminds us of the important point that the act of managing and leading inevitably involves the question of ethics, where '*ethical values emerge in interaction as a reflection of the emergence of leaders*'. Values are thus not seen as something a leader can decide; they are not universals. Values are ways of thinking which are present in the details of everyday local conversations, influencing on, and being influenced by, the conversations in processes of particularization and globalization of their meaning. In the end, the complex responsive processes perspective implies that the role of the leader or the manager itself is an emergent phenomenon, which can only exist by virtue of the recognition of its importance or necessity by others.

6.3 Summary

The need to incorporate dynamic dimensions in organizational research has been identified by several authors applying systems and complexity approaches, as well as processual thinking. The main focus in the chapter is on important concepts and insights of the *complex responsive processes perspective*, although a brief account of recent process-thinking based organizational studies is also included. In analogue with strands of complexity science, the complex responsive processes perspective holds the thematic patterning of interaction to be *complex, self-organizing, emergent* and *evolving*. In my view, this is a perspective on human action and interaction in organizations which integrates ideas from complexity science, process sociology and social psychology in a well-considered and far more extensive way than in alternative perspectives based on processual or complexity thinking.

From a complex responsive processes perspective, 'organization' is considered as purposive joint human action. This involves a shift from thinking about change as deliberate transfer from one organizational state to a new one, towards a view that the future, and accordingly organizations, are under perpetual construction by interdependent humans' engaged in communicative interaction. A crucial consequence is that the essential function of managers cannot be 'control', because it would be impossible for any one individual to be in control of development. Moreover, the role of 'manager' itself is a social phenomenon, which can only emerge and exist by virtue of the recognition of its importance or necessity by others.

From a complex responsive processes perspective, processes are *human relating*. Such relating is seen as fundamentally communicative, involving the forming of the social by individuals; who at the same time are formed in social interaction. Communicative aspects seen to be of particular importance are power, identity, meaning and control. New patterns of themes are seen to emerge in paradoxical processes of stability and change, cooperation and competition, possibility and constraint, where the evolvement of patterns over time is unknowable and unpredictable. Such patterning processes inherently involve the potential for novel ideas and innovation. A core idea is that meaning is not determined by a gesture (like a statement or a move), but by the responses brought out by that gesture, leading to a cyclic movement of further gestures and responses in which meaning is formed, and power relations and senses of identity potentially affected. Another basic idea is that individuals and the society are not separate levels, but aspects of the same phenomenon, which is relating, implying that ideas that humans develop about 'wholes' are imaginative constructs. Communicative interaction leads to further communicative interaction, and not to any separate system, although experience of 'system' can emerge caused by a (temporary) stabilization of themes, materialized for example as procedures or ICT-based tools, or recognized as 'culture'. From this perspective *generalizing* denote both articulated and unconscious population-wide patterning, while *particularizing* is seen as local interacting. Several formulations are suggested of the generalization and particularization processes, including the notion of the *generalized other* and concept of *social object*, which both indicates that individuals being parts of the same 'culture' tend to act in predictable ways in similar situations, although not always.

Adopting a complex responsive processes perspective implies a shift of focus towards individual characteristics, like emotion, intention, spontaneity, and reflection, and to the dynamics of human interaction as a source to conservation, disruption and change. While this perspective emphasizes aspects of human communicative interaction to be of more generalized validity, the emerging, evolving patterns of such communication are not seen to be universal, but contingent on time, place, situation, and the persons involved.

7 Research approach

This dissertation is based on longitudinal empirical studies carried out in Statoil ASA from January 2004 to October 2007. During this period, I participated in a number of events related to the R & D program Subsea Increased Oil Recovery (SIOR). The processes I have been following were intended to result in the creation, realization and adoption of new technology elements and work processes to support the profitable, increased recovery of oil from subsurface fields. I therefore refer to these processes as *innovation processes*. The R & D program was organized in the Statoil Research centre, within the business area Technology & Projects, and was carried out in cooperation with another business area, Exploration & Production Norway, holding the role as 'customer', and with external suppliers, who could be seen as co-partners in R & D, or invention, processes.

To be able to study innovation processes from 'within` Statoil (Shotter, 2006), I was engaged with the company for a period of four years from January 2004, and invited in as an associated member of the SIOR core team. Incidentally, this engagement was prolonged in 2008, and our cooperation concerning 'innovation' continued. The engagement implied that I was given free access to the Statoil premises in Trondheim, and partly to the main office in Stavanger. It also made possible participation in SIOR meetings and, to some extent, in other events of relevance, and enabled me to become closely involved with both the formal and informal flow of conversations related to the SIOR program activities. Furthermore I could request meetings with anyone I wanted to talk to during the study. In certain cases, when I wanted to speak to leaders in high positions, the four people in my reference group acted as 'door-openers'. The SIOR program and the related Statoil activities involved several hundred people, and numerous meetings and events. Although the bulk of data material gathered during the study is extensive, it goes without saying that in practice, I was able to experience only a fraction of the activities going on. I tried to fill in with stories referred to me both in formal and informal conversations, as well as with project related documents and news and information available on the Statoil intranet.

7.1 Methodological orientation

The methodological orientation of the complex responsive processes perspective, which is the perspective I have adopted in this study, is grounded on the methodological thinking of George Herbert Mead (Stacey and Griffin, 2005b). Mead asserted that human social life is always in movement as perpetual negotiation and constructions of 'reality', and that the development of mind, consciousness, self-consciousness and society is this ongoing process in which individuals act and always relate in cooperative-conflictual interdependencies with other people (Mead, 1967). As explained in paper A, this orientation is based on a certain idea of causality, a *transformative process ontology*, in which reality is seen to develop because of social interaction. This implies a view that people do not create any social phenomena outside their own relationships. Accordingly, the perspective of complex responsive processes does not make a claim to result in absolute, objective truths about organizations and organizational processes. It is important to emphasize, though, that the idea that useful generalizations or insights about human interaction can be found which are valid in most social processes, is not rejected either. Accordingly, epistemologically the complex responsive process perspective does neither take a realist, nor a postmodern, position, but rather a position consistent with American pragmatism (Stacey and Griffin, op.cit.). Truth is seen to be contingent on the specific situation people are in, determined by experience, and the sense people in joint, conflictual interaction are able to make of such experience (ibid.). In short, 'truth' is what is temporarily 'true for us'. It should be emphasized that from the complex responsive processes perspective, 'experience' is understood as the *personal experience* of interaction, reproduced primarily as narratives of relating between self and others (Stacey and Griffin, 2005a), although propositional themes are also considered. Another core point is that people, whether researchers or practitioners, are seen to always be 'in practice'. That is, the distinction between 'theory' and 'practice', which has been extensively discussed (Weick, 2003), becomes blurred, as 'thinking' and 'acting' are both interpreted as actions.

The above explanation imposes implications on the methods of research. The complexity perspective is about temporal participation in local organizational interaction and the emergent explorative character of such participation (Christensen, 2005; Stacey and Griffin, 2005b). Researchers who take this perspective as their starting point develop their understanding as participants in organisational activities, and the method used is that of intentionally reflecting on the details of one's experience as participant in organizational processes, as basis for new insights and practice. In other words, the method is itself complex responsive processes.

7.2 Research process

Approaching research the way I ended up doing in my SIOR study is by some referred to as *emergent participative exploration* (Christensen, 2005). This approach was developed '*grounded in a need to make sense of identity and difference, and the themes that emerge in conversations in daily work*' (ibid.:100). Several examples of organizational research conducted in this way have been published in recent years (Streatfield, 2001; Fonseca, 2002; Shaw, 2002; Johnson, 2005; Christensen, 2005; Taylor, 2005; Tobin, 2005; Williams, 2005a; 2005b; 2005c).

The particular intention of the present research was to study innovation processes in Statoil from an organizational perspective, based on the actions of people belonging to a definable group (although the number and composition of participants changed throughout the study), which were 'members, customers and supporters of the SIOR program'. Consistently, I consider it as a case study. Because the SIOR program embraced many projects involving different persons and groups within and external to Statoil, it could be looked upon as representing at the same time a single and a multiple case. If, however, the definition of 'case study' offered by Yin (2003) should form the basis for my research, my characterization of the SIOR study is erroneous. Yin (ibid.) emphasizes that to be a case study; theory must be developed as part of the design phase of the study, prior to any data collection. This is not what I did. According to Yin, case studies are therefore distinctly different from related methods such as ethnological and 'grounded theory' (Glaser and Strauss, 1967) approaches, which do not make such demands on prior theory development. On the other hand, 'grounded theory' is about the generation of sociological theory from empirical description, based among other things on the validation and generalization of 'facts' (Randall et al., 2007). In my view, this is not what I have been doing, either. As the approach of *emergent participative exploration* implies the active participation of the researcher in organizational processes, it seems reasonable to place it within the tradition of ethnographical research, or fieldwork (Wadel, 1991; Becker, 1998; Magolda, 2000; Randall et al., 2007). Stacey and Griffin (2005b) describe it as a narrative approach distinguished by its explicit reflexivity, involving the narrator's (i.e. the researcher's) explanation of how his or her particular focus and past experiences influence the selection of events to participate in, which stories to communicate; and the interpretations offered. As such, this is a reflexive approach in an individual sense, but it is also viewed to be reflexive in a social sense (ibid.), implying that the researchers also relate their way of thinking to the traditions of thought within their field, sometimes also within their society. These ideas are in harmony with the approach I ended up adopting, as during my study, I have been exploring a number of theories and perspectives appearing to be of relevance to my understanding of innovation processes, and sought to evaluate them in the light of my SIOR experiences. I have therefore come to base my understanding of 'case study' on the definition of Ragin (1994), who, not unlike Stacey and Griffin (2005b), describes the research process as a continuous dialogue between images that emerge through empirical investigation and previous analytical frames. A way to see my own movement of theoretical perspective towards a complexity based point of view is just that it was based on the 'dissonant dialogue' between my experience in SIOR and the systems based theoretical framework I had selected as my point of departure.

The term *emergent participative exploration* can be understood to describe the intention or attitude researchers take in their approach to their research activities, rather than pointing at a particular method. In my view, the term 'emergent' further indicates the recognition that research is about seeking genuinely new knowledge, involving the need for the researcher to adapt their approach according to the emerging events. According to Christensen (2005) the fundamental intention should in fact be that a prescribed scientific method should *not* be followed, but that the researcher should rather do what I did in my study, that is to '*engage in a process of ongoing sensemaking of the experience of participating in fluid interactions with other people*' (ibid.:99). The way the exploration and inquiry is manifested is a matter of emergent patterns formed by the relating of the researcher to the people engaged in the organizational processes.

Such interaction is patterned primarily as narrative themes, or 'stories', which we tell each other, and of which the evolving content and meaning can not be predicted. As a consequence, different kinds of research methods as we know them traditionally may be used without this being inappropriate.

The lack of explicit definition of the role of researchers engaging in *emergent participative exploration* could also be seen as a challenge. Although researchers working within the complexity perspective come to a research situation with a particular purpose, they are nevertheless encouraged to hold themselves open to the exploration of the relational phenomena emerging in the situation, and so attempting to construct coherent meaning from this relating. My experience was that the continued critical reflection encouraged in complexity research implied the need for me to engage actively and persevering in the action of making sense of ongoing events in the SIOR program. For me, this involved a need for frequent conversations with people (and books!) willing and able to challenge my evolving interpretations. From my point of view, this approach appears to be neither more or less scientific, nor more or less valuable, than other approaches to social research. The value of the approach adopted by a researcher can be seen to be connected to meaning, or belief which can credibly be justified as knowledge (Williams, 2005b). I see the distinguishing feature of the perspective of complex responsive processes to be the strong emphasize placed on the continuous and courageous reflection on the detail of human (i.e. own) experience of change as it happens, including emotional responses. Another characteristic is the connection made between research and identity, implying the view that researchers, as participants in organizational everyday life, influences the processes they study, but even more importantly, that at the same time they themselves run the 'risk' of changing in the process. The complex responsive processes perspective permits a freedom of academic reasoning, yet provides a cogent vocabulary to explore human interaction. In my view, an important challenge related to this perspective is, however, what Tobin (2005:73) refers to as the '*terminology problem*'. In narrating, in writing or orally, about human interaction, the paradoxically simultaneous presence of contradictory considerations and emotions in most situations at most times is difficult to describe without the apparent simplification of the problem into a question about either/or alternatives. Furthermore, to be recognized as a researcher within the present academic paradigm, and also as a contributor to the understanding of organizational processes, it is necessary to seek not only to make sense of own experience, but at the same time to continuously '*sustain connection to the sense-making of others*' (Johnson, 2005:168).

The focus of methodological attention in the perspective of complex responsive processes is knowledge creation as storytelling, or narration. Narrative researchers, like Boje (1991), Gabriel (1998) and Rhodes (2001), have become increasingly attentive to the processual characteristics of organizations, to the plurality of different possible stories and storytellers, and the role of the researcher as an active co-author in the narrative 'reconstruction' of organizational processes (Rhodes and Brown, 2005). Incidentally, I use 'narrative' according to Stacey (2007), who considers organizational narratives as constructions of experience, in which a story ('data') is inseparably connected to some kind of evaluation ('interpretation'). Narratives about the whereabouts of 'me', 'us' and 'them' is related to who I am and who we, or they, are. In consequence, the methodological orientation of the complex responsive processes perspective is linked to an emerging transformation of individual and collective *identity*. Then, organisational research is not only a question of gathering information regarding organisational phenomena, but also a question of who the researcher(s) become through the research effort. The suggestion that the act of doing research may potentially transform the identity of those involved, makes topical the question of how the researcher deal with his or hers vulnerability and emotional responses to experience, that is, to courage. This underlines the need to broaden the discussions about research approaches from a mere question about how to collect and analyze 'data', to include how the researchers' reflections about his or her engagement in own experience influences interpretations (Stacey and Griffin, 2005a).

7.2.1 Collecting data

The basic method for my data collection was participative observation. From January 2004 to September 2007 I participated in 157 meetings, including SIOR core team meetings and a range of other meetings and events, as indicated in table 7-1. The table also shows the other sources to data (including 47 interviews conducted by me with Statoil employees, and the transcriptions of 30 interviews conducted by SINTEF consultants in relation with the preparation of a SIOR strategy for *Integrated operations*), a large number of informal conversations, examination of internal documents and power point presentations, and - on a three occasions - consultative intervention.

Table 7-1 Data material

Data category	**Registration**	**#**
SIOR core team meetings	Field notes	55
IO strategy development meetings / ASTI meetings (SIOR & Tail)	Field notes	12
Other meetings • SIOR core team / activity manager meetings (2) • SIOR / Tail meetings (incl. reference group meetings) (4) • Formal and informal meetings with T&P and E&P members (44) • Formal meetings with Statoil supplier representatives (10) • IO arrangements (7) • SIOR core team / business asset meetings (3) • Statoil summer project students 2004 & 2007 (8) • PhD reference group meetings (7) • San Francisco / Silicon Valley excursion 2005 (1) • Tyrihans development project meeting (1) • Technology Arena secretariat members (3)	Field notes	90
	Total Meetings – 157	
Semi-structured interviews	Digital recorder, transcription	47
Interviews performed by SINTEF consultants in relation to the preparation of a SIOR-Statoil IO strategy	Copy of edited interviews	30
	Total Interviews – 77	
Informal 'coffee break & lunch' conversations, ca # of people	Sparse notes	**~80**
Consultative intervention (Two in cooperation with S.Johannessen)	Sparse notes	**3**
Documents: Strategies, reports, presentations, steering documents, intranet news	Copy of documents	**~50**

The first of the consultative interventions was in 2004. I was asked by the SIOR core team to prepare and facilitate a one-day meeting where the intention was that they should discuss their role as leaders of SIOR, including the various tasks and priorities. The second and third interventions were planned and carried out in cooperation with one of my supervisors, Stig, and included a 2-days meeting in 2005, and a one-day meeting in 2006. As distinct from the first intervention, these were planned and carried out based on the thinking of the complex responsive processes perspective. The meetings were with two different groups of project managers responsible for different activities within the SIOR target area called *Integrated operations*. The intention was to let the members of the groups spend time together sharing experiences as project managers in the SIOR program, to encourage their will and skill to support each other in the search for alternative approaches to everyday challenges related to tasks experienced as problematic by the individual. Although on all three occasions the participants expressed a desire to continue to spend time in the group on a more regular basis to discuss their experiences, nobody followed-up on this.

The respondents interviewed by me were persons recommended by my Statoil reference group, but I also included persons I met during the study which I assumed would help me widening my perspective on Statoil innovation processes. I was given unrestricted access to the respondents I wished to interview, and my request for interview was accepted by all with only one exception. Most interviews lasted between one and one and a half hours, but some were even longer. In two instances the respondent asked me to come back later on to continue the interview because we ran out of time before the theme of 'innovation' was exhausted. All interviews were recorded and transcribed, and then translated into English by me. Table 7-2 shows the then organizational unit and the position of the respondents.

Table 7-2 Organizational unit and position of respondents at the time of interviews

Organizational unit at time of interview	Position
Corporate initiative IO (UPN)	Core team manager / SIOR – IO Steering committee member Core team member
Corporate initiative IOR (T&P)	Core team manager / SIOR reference group member
Development projects (T&P)	Project director
Exploration & production Norway (UPN)	Executive vice president
Facilities technology (T&P)	Executive director
HNO Business development (UPN)	General manager
HNO Business unit (UPN)	Executive director / SIOR steering committee member
HNO Heidrun (UPN)	Vice president operations / Project manager IO

Organizational unit at time of interview	Position
	HNO
HNO Operations & maintenance (UPN)	General manager
	Operations manager
HNO Subsurface (UPN)	Technology coordinator
HNO Tyrihans (UPN)	Core team manager
Industrial development (T&P)	Project manager
INT Exploration	Senior vice president
INT IDP West Africa	Vice president / SIOR steering committee member
IO e-Field (TO, UPN)	Project manager
New Business Options (Research Centre, T&P)	Core team manager
Procurements	Advisor / ASTI process manager
Research Centre (T&P)	Research director
SIOR (Research Centre, T&P)	Activity manager
	Activity manager
	Core team member
	Core team member
	Core team member
	Core team member
	Core team member
	Core team member
	Program director
	Specialist
Statfjord (TO)	Senior production manager
Statoil innovation (T&P)	Investment manager
Subsurface technology (T&P)	Chief engineer Drilling&Well / SIOR reference group member
	Chief engineer Subsurface / SIOR reference group member
	Chief geophysicist / Process owner
Tail (Research Centre, T&P)	Activity manager
	Core team member
	Core team member
	Program director
Tampen (TO) Business unit (UPN)	Executive director / SIOR steering committee member
TO Gullfaks (UPN)	Production director / Former SIOR core team member
	Senior production manager
TO Resource exploitation (UPN)	Leading engineer Drilling&Well
	Technology manager
Trend-breaking technology (Research Centre, T&P)	Core team manager
Troll/Sleipner Business unit (UPN)	Executive director
UPN Exploration	Senior vice president

As another ‘tool’ to collect data I was allowed an item on the fortnightly half-day SIOR core team meeting agenda that was called ‘event log’. My idea was that this would help me see in retrospect which events that turned out to be of importance to the progression of the SIOR activities. I used this opportunity to ask the core team members about recent events judged by them as particularly important to the project. The events were registered chronologically, and roughly grouped according to themes. An example of this ‘event log’ is provided in table 7-3.

7.2.2 Reflections on own approach to data collection

My research situation gave me in many ways the opportunity of getting a ‘panoramic view’ of the processes caused by the SIOR program. I nevertheless felt somewhat uncomfortable about my situation throughout the study. I was partly an ‘insider’, yet clearly not an adequate member of SIOR as I had no responsibility for the outcome of program activities. This was a situation I was not accustomed to, as my background principally was as a manager of projects defined as ‘development’ or ‘innovation’ projects.

I was anxious to be seen as somebody supportive of the efforts of people involved in the SIOR program, and not a fault-finder. This made me preoccupied with not evaluating the specific events as thus, especially during the first two years of the study, but to try to understand the various challenges ‘seen through the eyes’ of the different people I met. I kept asking the core team members about themes I did not grasp and terms I did not know, and gradually I got used to the ‘Statoil way of speaking’ and felt that I comprehended better the challenges faced by different persons and groups related to the SIOR program. Being originally educated as a graduate engineer, I identified more and more with the people and the challenges in the SIOR program, and was in many ways ‘going native’, as an anthropologist would express it. To test and challenge my emerging viewpoints, I discussed the way I saw the various processes and events with a number of people in the company, and also with some of my colleagues in Studio Apertura, of whom many had worked in research collaborations with Statoil for years. Now and again I asked for time in the SIOR core team meetings to discuss particular themes, and I met with my reference group 2-3 times a year to discuss evolving ideas.

Table 7-3 SIOR Event log February – June 2006

February 06	Mars 06	April 06	May 06	June 06
Shared Earth Model is granted a session in this years R&D Summit SIOR is asked to indicate long-term plans for the activities. Snorre, Heidrun and Gullfaks are establishing separate IOR projects	HNO have made an IOR- strategy for the area supportive of SIOR and TAIL Steinar carry out IOR phase 2; discussing with all the business assets. Is met with interest. The core team had a meeting at Storlien Mars 28-29	SIOR was presented in the Norwegian Petroleum Directorate, and achieved , positive acknowledgement TEK Arena process: Meetings with TO, HNO and T-S. Demands for reporting are advanced by several groups	The open-plan office is discussed. Some SIOR members feel uncomfortable with working this way, and the team worries that the possibility of SIOR to get (human) resources is negatively affected because of this	Audits for decision processes and procurement in SIOR June 28: Reference group meeting Recommended budget limits for SIOR 2007: NOK 220 mill. (+ licence money). Application was for NOK 235 mill.
ASTI contract negotiations concerning Shared Earth Model concluded without reaching agreement	ASTI – one contract is OK, clarification for the remaining 4 is still wanting		ASTI contract with S. signed May 22.	The possibility for obtaining an ASTI contract within 4D applications is still not clarified
Important joint venture agreement concerning Subsea MMX is nearly ready, ANS has objections	Mars 21: Expandable liner installed on Kristin for the very first time (in the world). Important milestone for this technology		*$target* product presented for head of *IO concern initiative*	Contract signed with NN about subsea MMX
LWI agreement OK – met with '*rounds of applause from the licenses – this has been a maturation process'*.	Decision about procurement of wet gas compressor on Åsgard. Has passed the first peer, implies recognition of the technology	Main conclusions of the IWS Option Study presented to the LWI steering committee. Positive acknowledgement	4D workshop arranged at Rotvoll, ca 60 participants, positive acknowledgement Seismological 4D acquisitions on 16 fields are to be completed this year, record activity and great interest.	Tyrihans: Focus areas for future work clarified. Existing agreement prolonged as is.
Fiord test if Ocean Bottom Seismology went well. Presented to Snorre members, who show great interest.		Acquisition of seismological data works well after 3 months testing		

Among the challenges I faced from the start, was the selection of arenas for participation. Even if I tried to limit the study to mainly keeping up with the SIOR core team members, the task was insurmountable, as they - and everybody else I met - were involved in a multitude of meetings, conversations and communications with people both in the company and in many other organizations. It was impossible to predict which events, meetings or individuals that would be most valuable for my research. Influenced by the activities and conversations I became engaged in, my judgement of where to participate, what to read and who to talk to therefore evolved and altered with time.

7.2.3 Data representation

In three of the four individual papers constituting the ground work of this dissertation, narratives are used to emphasize important aspects of innovation processes, as interpreted from a complex responsive processes perspective. The narratives I have developed could be seen to be of three kinds. One is the 'factual' story about evolving events, followed by the emphasizing of points which I see to be of particular importance. The second kind is narratives told to me by people in or related to the SIOR program, which are cited or referred to as examples of aspects appearing to me to be of importance in connection with the efforts of the people in Statoil to create and get acceptance for novel themes. The third kind of narrative is based on own reflections about my experiences in SIOR. This is the approach which seems to be the closest to what is encouraged by Stacey and Griffin (2005b).

Although I make account for the evolution of the SIOR program processes in somewhat different ways, it would be impossible to claim that these stories are not in some way or other connected to some kind of evaluation made by me. The SIOR program made a very rich case, and in going through my notes and memories, I have intentionally picked out and composed the stories which I wanted to use to pass on my understanding of the innovation processes I have been participating in. On a few occasions I have included excerpts and quotations from conversations between members of the SIOR program, or persons whose support was of importance to SIOR, and myself.

Reflecting on all the conversations I was part of, and not part of, what I obtained could be seen to be my understanding of the particular and general themes discussed by people I spoke to. The analytical challenge resulting from this research situation seemed to be analogue to the observation made by Geertz (1973:9), namely that:

> *What we call our data are really our own constructions of other people's constructions of what they and their compatriots are up to.*

The particular suitability of narratives to reveal not only the complexity of processes, but also the subjectivity of the researcher attempting to understand complexity, is emphasized by Tsoukas and Hatch (2001:980). They refer to this as a *second-order complexity*, which is '*the thinker thinking about complexity'*, and in this way making available for discussion his or hers reflections about an assumed objective world (first-order complexity). Basically, the research method suggested both by Tsoukas and Hatch, and also by Stacey and Griffin (2005b), is reflection on ordinary everyday experience. The difference between the two is that while Tsoukas and Hatch (op.cit.) mention complexity as the feature of a system and a way to organize our thinking about such systems, adopting a complex responsive processes perspective involves the rejection of systems thinking. From a complex responsive processes perspective, there are only other human persons beyond ourselves as human persons. This recognition is the crucial starting point for all struggles to make sense of what happens in our everyday working lives, and to cooperate with others.

When approaching organizational research with the explorative attitude of the complex responsive processes perspective, the creation of research based knowledge is not seen as being a fundamentally different activity from the creation of knowledge in other human activities. Christensen (2005) suggests that 'research' can be recognized as the intentional activity of studying the processes of relating themselves, in such a way that the study will be accepted as research in academic communities. In my view, this immediately links the question of what can be accepted as research to the issue of *power*, as discussed by Williams (2005b). An essential point in his argument is the question about what it means to make a contribution to knowledge, 'who' it is that is entitled to decide what a 'contribution' is, and what should be accepted as valuable knowledge. Williams (ibid.) quotes Rorty (1991:44), who asserts that '*the image of the* *great scientist [should] not be of somebody who got it right but of somebody who made it new'*. Fundamentally, this discussion is about who are the rightful claimants of truth, understood to be the persuasive justification of belief.

Christensen (op.cit.) further discusses the resistance the researchers may feel; in themselves as well as from others, when searching to explore own and collectively emerging experience. His experience as consultant for many years coincide with mine, which is that people are inclined to reject the idea of spending time together to reflect on the experience of working together, in particular if this involves themes related to emotions perceived to be 'negative' or problematic. Hiding behind statements about time pressures, people usually ask for the rather more abstract tools and techniques to implement characteristics facilitating change and innovation into the organization, and more often than not refuse to take seriously consultants or researchers who do not provide, or aim at developing, such tools. Several authors have discussed the need for researchers to reflect about own role and position as participant observers of organizational processes (Cohen, 2000; Hong and Duff, 2002; Labaree, 2002), and some, like Finlay (2002), goes far in focusing almost exclusively on own reactions during field work. My experience is that there are obvious challenges related to the role as 'participant observer' over time, and as in my case, over many years. In a small group like the SIOR core team, my presence was very evident, and during the study I strongly felt a need to contribute to the continued relationship of trust, and in some cases even friendship, through actively engaging not only in the ongoing themes in the SIOR program and in Statoil, but also in themes related to the personal life of those I was 'studying'. Yet, as discussed by some authors, I also frequently reflected on the need to keep a certain distance, to be able to 'rationally' evaluate my experiences (Cohen, 2000; Hong and Duff, 2002). To me, the paradox of *detached involvement* (Tobin, 2005; Williams, 2005c) seems to be a useful concept to describe what I have been doing in Statoil, although my possibility to be involved was confined by own capacity, and also sometimes by people in Statoil not wanting my presence in meetings; and my ability to be detached in specific situations probably limited by my predisposition for spontaneity and vulnerability.

7.2.4 Subjectivity, ideology, ethics and validity

A key objection to all participative research methods is the biased subjectivity by which the results are obtained and presented. Huberman and Miles (2002:221) make reference to Peller (1987), who emphasizes that:

> *Investigators do not have direct access to another's experience. We deal with ambiguous representations of it – talk, text and interaction, and interpretation. It is not possible to be neutral and objective, to merely represent (as opposed to interpret) the world.*

In paper A, the methodological orientation of the complex responsive processes perspective is discussed. In line with Peller (ibid.), we argue that in the end, research results always depend on the subjective choices of the researcher about what to do, how to do it, and how to interpret, analyse, and present the material. We further argue that:

> *… emergent participative exploration shares its justification and its challenges with similar approaches, like ethnographical methods (e.g. participative observation), intervention methods (e.g. action research) and other participative methods generally accepted within organisational research. This justification is associated with certain ontological and epistemological views. The main argument for emergent participative exploration in this context is the coherence it has with the theoretical approach of the complex responsive processes theory.*

The basic idea of the complex responsive processes perspective is the importance of taking the experiences of human action and interaction seriously, and in consequence, research involves participation.

As emphasized by Stacey and Griffin (2005b) there are three important questions which need to be addressed by any research method, related to the aspects of *ideology, ethics* and *validity (*or *legitimacy*).

Ideology

The ideology of the complex responsive processes perspective has been discussed in section 6.2. This perspective is based on a view that all human relating is fundamentally communicative, and that interacting people co-create only further interaction, and not a system or a 'whole' separate from the ongoing communicative processes. On the contrary, the individual and the social are seen as inseparable aspects of the same process. What are co-created in human interaction are seen to be temporary patterns of individual/collective identity, including individual/collective perception of power figurations, of 'right' and 'wrong', which is ethics, and of belonging and future.

Ethics

According to Stacey and Griffin (2005b) there are two ethical matters being of particular importance when researching organizations from a complexity perspective. The first is related to the accounting for experiences involving specific events and references to particular individuals, and the need to sometimes conceal identities and to leave out information seen to be confidential. To comply with this, I decided at the beginning of the study that I should not use names or recognizable descriptions of events, nor quotations, as part of my dissertation. Consequently, for the first 2 ½ years this was what I told the people I spoke to about SIOR, including those I formally interviewed. This promise gradually proved difficult to fulfil. What I finally ended up doing, was to avoid the mentioning of names in the papers, although people well acquainted with the SIOR program probably will be able to guess who some of the persons mentioned are. Also, I placed emphasis on developing the accounts of SIOR program events in such a way that they were illustrative of my points, yet not offensive to the persons involved in the program.

This last point is connected to the second ethical issue discussed by Stacey and Griffin (ibid.), which is the risk for the researcher of provoking hostile responses from the people he or she writes about. To seek to minimize this problem, I sent the individual papers to 3-4 people in Statoil for approval, of whom one was the SIOR program director, before they were submitted to journals for publication. In chapter 2 – describing Statoil and the SIOR program - I have, however, mentioned some of the key persons in SIOR by name. These were people of great importance for the development of the activities of the program, and for my study. As my intention has not been to evaluate whether they did something 'wrong' or something 'right', but to learn from them about how they approached their tasks, I feel confident that they will not take offence. My objective has not been to sit in judgement on anybody's actions, but to seek to explain the evolving processes of innovation in a way that made sense to me, and hopefully also to some of the SIOR members and Statoil managers, - and which at the same time can be seen as acceptable by an academic community.

Validity

A research approach of participative exploration into organizational processes cannot be ascribed objective validity. In line with Stacey and Griffin (2005b) I do however claim that the reflections and interpretations I make about my experiences are not random. During the study I intentionally enacted the evolving processes to try to make sense of what happened. Even more important is that to make a difference, the accounts I made about the processes of exploration have to make sense to others, as discussed above. Accordingly, it was important for me to write papers and receive others responses to my work.

From my perspective, the value of my research is the move of attention from the idealized to the experience based accounts of innovation processes; including the explicit recognition of everyday interaction between professionals as the source to evolving individual and organizational identity, power figurations, ideologies, and indeed to novelty. The bias of research, from the perspective of complex responsive processes, is the bias of participating in ordinary daily life. Validity, and also the concept of reliability, cannot be dealt with in any other way than as experience, which means that they take the form of emerging sense-making between people negotiating their practice in conflict with – and in recognition of – each others viewpoints. Validity can therefore be seen as a generalized theme, which emerges *intersubjectively* (Williams, 2005b) as the result of a number of local, particular conversations, which are at the same time influenced by ongoing generalized and particularized themes.

7.2.5 Generalizability

My research situation implied that the view of innovation processes and innovation management in Statoil presented in this dissertation largely came to be based on my experiences from activities going on in the Research Centre. It can therefore not be seen as being generally valid for the other divisions and departments of the company just like that. I was, however, given the opportunity to interview about 40 leaders in the divisions for Exploration & Production Norway and International, in addition to the division for Technology & Projects, many in key positions in the company. This gave me the opportunity to challenge and supplement my impressions of ongoing activities for change and innovation in the company, including managers' contributions to these processes. Furthermore, most of the members of the SIOR core team, whom I spent a lot of time with, had worked in several other positions in other Statoil divisions, and they frequently compared their experiences in the SIOR program with previous experiences. In this way, an impression also formed of more generalized ideas about dissimilarities in behaviour and conduct between people in the various Statoil units. The view that such 'truths' are nevertheless temporal, contingent on the specific time, place and situation people are in is supported e.g. by Brunsson (2000:10-11):

> *It will not be claimed, however, that any particular factors or processes are invariably important to every action for change. This kind of striving for generality is inappropriate in a social science, at least in connection with research at a deeper level. Claims to general validity beyond the limited section of reality and the point in time actually studied are necessarily unfounded and should therefore be avoided. […] Instead the main purpose should be to generate theories formulated for and based on specific social situations, which have been studied empirically. These theories form 'languages' that provide means for understanding the situation studied.*

Brunsson's claim is that people who are in similar situations can use such theories to obtain an insight into a contingent situation, but that he or she must decide for themselves whether the theory represents a useful tool, or not. The 'proof of the pudding' of the more generalizable validity of my research will thus be the possible interest it may be met with among people trying to make sense of their professional challenges.

The question about generalizability can however also be approached in another way. As my explanations about innovation processes in Statoil are built on a theoretical perspective proposed to be generally valid as basis for the exploration of changing complex responsive relationships between humans, it is reasonable to assume that some of the aspects of innovation processes derived as part of my research can be seen as having a more generalizable character. My suggestion is that the adoption of a complex responsive processes perspective on innovation leads to the identification of relational aspects of which managers should be conscious. The identification of such effects does not, however, imply that predictable, generalizable patterning processes of human communicative interaction will result.

7.3 Summary

The complex responsive processes perspective adopted in this study is based on a transformative process ontology in which reality is seen to develop because of social interaction. From this perspective people, including researchers, are seen to always be 'in practice', and practice is experienced through participation. In accordance with this view, my approach to the present study can be seen as that of 'emergent participative exploration', bearing strong resemblances to approaches within the tradition of ethnographical research. A characteristic of this approach is the connection made between research and identity, implying the view that researchers, as participants in organizational everyday life, influences, and are at the same time influenced by, the processes they study.

Emergent participative exploration coheres well with the theoretical approach of the complex responsive processes perspective. This perspective takes a position consistent with American pragmatism, meaning that the idea that useful generalizations about human interaction can be found is neither adopted nor rejected. As the perspective is also proposed to be generally valid as basis for the exploration of changing complex responsive relationships between humans, it is reasonable to assume that some of the aspects of innovation processes I have derived as part of my research can be seen as having a more generalizable character. Other aspects considered are *ideology, ethics* and *validity (*or *legitimacy*). An important point regarding these aspects is that from a complex responsive processes perspective, 'experience' is understood as *personal experience* of interaction. Accordingly, 'truth' is seen to be contingent on the specific situations people are in, determined and validated by experience and the sense people in joint, conflictual and cooperative interaction are able to make of such experience.

The present study chiefly involved participation in ongoing formal and informal processes intended to lead to innovation in Statoil, but also interviews, consultative intervention and studies of written material. The ideas I present as my results emerged as the consequence of purposive reflection on my own experiences as well as on accounts of present and previous events given by Statoil members, influenced and supported by the complex responsive processes perspective thinking. Based on such reflection I developed three kinds of narratives: 'Factual' stories about evolving events, reproduction of narratives told by people in or related to the SIOR program, and narratives based on own reflections about my experiences in SIOR. A part of my experiences was the challenge of holding a role as participant researcher for a long time, in particular a feeling of discomfort of being 'just a hang-around', and a continuous evaluation of what to do to understand innovation in Statoil in the 'best' way . My discussion therefore also concerns the idea that as researchers we should engage in a reflective debate about how we think and talk about what we are doing, and how this affects the data and reflections we refer to as our results.

8 Innovation as complex responsive processes

As indicated in chapter 4, the similarities I experienced between processes for innovation provoked by the SIOR initiative, and innovation processes I had been part of in the past, made me eventually abandon my original intention to find generalizable connections between 'innovation' and 'business performance' because I no longer believed that such connections could be found. It is important to emphasize, though, that I did not leave the basic assumption that innovation is of essential importance for business development.

Innovation in Statoil, as I experienced it, did not appear as a distinct process, but seemed to result from a number of activities closely integrated in the ordinary, everyday life in the company. This made me gradually assume the view that innovation is a social process, shaped and formed by the responsive relating of humans. Implicitly, I see the nature of innovation to be communicative, and inherently collective. I therefore moved my attention to the communicative interaction between Statoil members engaging in activities resulting of, or interfering with, the SIOR program. As already accounted for, I chose to explore the complex responsive processes perspective to seek explanations of innovation reflecting better my experiences in a role as 'participant observer' in the SIOR program. The overarching research question, brought forth by these experiences, developed to be:

> *How does innovation, understood as novel patterns of talk (involving decision/action), evolve in the course of everyday professional life?*

The ideas I present as my main findings in this chapter are extracted from the papers A – D, which constitute the groundwork for this dissertation. The papers are reprinted in Part II:

A. Johannessen, S. and Aasen, T.M.B (2007) Exploring Innovation Processes from a Complexity Perspective. Part I: Theoretical and Methodological approach, *International Journal of Learning and Change*, Vol 2, No. 4, pp. 420 - 433

B. Aasen, T.M.B. and Johannessen, S. (2007) Exploring Innovation Processes from a Complexity Perspective. Part II: Experiences from the SIOR case, *International Journal of Learning and Change,* Vol 2, No. 4, pp. 434 - 446

C. Aasen, T.M.B. (2008) A complexity perspective on innovation processes for subsea technology development. *International Journal of Learning and Change,* Special issue on Complexity, Leadership and Change Processes, VOl 3, No. 3, pp. 294 - 307.

D. Aasen, T.M.B. and Johannessen, S. (2009) Innovation management as communicative processes: Experiences from the Statoil SIOR R&D program. Accepted for publication in *International Journal of Business Science and Applied Management, Vol 4, No. 3, pp. 22 - 33*[2].

The point of departure for all the papers was the observation that the progression of SIOR development activities and the individual opinions of them in the company appeared to evolve as results of dynamic, interdependent interaction between many people holding different responsibilities and attending to various interests. Experience also indicated that SIOR innovation processes depended more on the quality of relations between people in Statoil and in other organizations than on formal decisions, organizational design or systems for management, planning and control. This is in line with Elias (2000), who holds that human action should not be viewed as rational or irrational, but as intentional. To ensure the validity of SIOR ideas within the abundance of themes and views in the company, the SIOR core team had to perform what one of

[2] According to reviewers' suggestions, the paper "*Innovation management as communicative process: Experiences from the Statoil SIOR R&D program"* was substantially revised after the submission of this thesis. Among the changes is the suggestion to re-title the paper "*Managing innovation as communicative processes: a case of subsea technology R&D".* The paper is somewhat restructured, and the distinguishing features and the methodological orientation of the complex responsive processes perspective are discussed in more detail. A table is added to illustrate the key issue and key findings. Finally, an outline of some of the possible practical implications of our findings, and a suggestion of direction for further research, are added.

the members very expressively referred to as '*a giant talk job'*.

As elaborated in paper A, the recognition of the fundamental ideas of the complex responsive processes perspective led me to the view that in order to move our understanding of innovation processes ahead, it was necessary to study the *self-organising emerging nature of human communicative interaction in terms of ongoing everyday activity in organizations*. Notice that in this context, self-organization is defined as the co-evolving reiterative and transformative patterning of communicative themes created when humans interact. Themes of interest to my research have been related to questions about how broadly accepted ideas of 'innovation' emerge from the diversity of local conversations in Statoil, and how such processes can be managed. The research question guiding the work was detailed into four subthemes, which are:

- *How can the dynamics of the overall SIOR ambition and the local particularizations of the ambition be understood, and how can 'innovation' be recognized as part of this?*
- *What does it mean to 'approach innovation differently', like people co-operating in the SIOR program were expected to do?*
- *How do SIOR members and customers discuss technology, and how are these views acted out in processes intended to lead to innovation?*
- *How can Statoil managers contribute to the more efficient accomplishment of innovation initiatives?*

Table 8-1 provides an overview of the individual papers and the subthemes discussed in each paper. The main findings of relevance to each of the subthemes are highlighted in the next sections.

In paper A focus is on the theoretical and methodological position of the complex responsive processes perspective, and the relevance and implications of applying this perspective to explain innovation processes. In papers B-D comprehensive empirical information from the SIOR study is provided; selected to support, supplement, and develop the emerging conceptions of innovation processes as they appear from the perspective of complex responsive processes.

Table 8-1 Focus of individual papers

	Paper A	Paper B	Paper C	Paper D
How can the dynamics of the overall SIOR ambition and the local particularizations of the ambition be understood, and how can 'innovation' be recognized as part of this?	X	X	X	x
What does it mean to 'approach innovation differently', like people co-operating in the SIOR program were expected to do?		X		X
How do SIOR members and customers discuss technology, and how are these views acted out in processes intended to lead to innovation?			X	
How can Statoil managers contribute to the more efficient accomplishment of innovation initiatives?	X	X		X

I see the empirical examples provided in the papers as being representative for my experiences. Still, the bulk of data material gathered during the study includes a substantial amount of information (field notes, transcriptions of interviews, SIOR program documents and presentations) which has not been directly reproduced as part of the papers. Together, these data and my recollections of undocumented experiences form the aggregate basis for the ideas and arguments proposed in this dissertation. I acknowledge that results are presented in the papers, and also in this chapter, in a way that may lead to the impression that I attribute universal validity to them. The clear answer to this is that I do, and that I don't.

In chapter 1, I quoted Elias (2000:xii), who emphasizes the need for researchers to penetrate to the order underlying the emergence and change of historical phenomena, and '*to the laws governing the formation of historical structures'*. I see the works of Elias (e.g. 1978; 1991; 2000), and also of Mead (e.g. 1967; 1972; 2002), as approaches to understand such underlying order. By adopting their views as interpreted by Stacey and his colleagues (e.g. Stacey et al., 2000; Stacey, 2001; 2007; Griffin, 2002; Shaw, 2002) in the complex responsive processes perspective, I base the explanations of innovation processes offered in this dissertation on ideas developed as a generalized approach to understand change processes in organized life. The view that local and global patterning processes emerge simultaneously as local interaction justifies the assumption that widespread patterns can be found and studied within local interaction, and provide support to the idea that generalizable aspects of innovation can be recognized within particular processes. My view is, however, also in line with Tsoukas and Hatch (2001:993), who point out that '*the local, the particular and the timely cannot be escaped in the context of practical reasoning*'. The processes developing in Statoil because of the 55 % SIOR ambition and the subsequent SIOR program were characterized by aspects which were clearly connected to person, situation and time. This means that the general validity of my findings may be limited to the interest and recognition they may get as basis for further research, or as a 'tool' for individuals to obtain insight into other contingent situations. I will get back to this in chapter 9.

8.1 Before I go on …

One of the questions that troubled me throughout the SIOR study was how the phenomenon of 'innovation' can be understood from a complex responsive processes perspective, and how (or if) this can be distinguished form the concept of 'change'. Basically, what is 'innovation'? Before I go into detail about the published results, I will pursue this topic, because - although it may seem strange - a controversial theme among the people I talked with in Statoil was whether the activities in the SIOR program were in fact 'innovation', or not. As elaborated on in paper C, quite a few of the SIOR members alleged that what they did was not innovation. Some saw innovation as something magic, involving development in disciplines unknown to them. Others meant that innovation was uninteresting, involving high-flying, incomprehensible ideas, or even that it was mainly an irritating cult word. On the other hand, the program was profiled by Statoil managers as being indeed innovative. As a digression, I found it amusing that, according to the SIOR director, the program was seen as 'more innovative' than the other five R & D programs because of my presence. It is, however, not for me to judge whether the activities of the SIOR program were more or less 'innovative' than other activities ongoing in Statoil in the same period, or if they were 'innovative' at all. To me, it is sufficient that innovation was intended.

At present, I still feel that none of the approaches developed in the papers capture the phenomenon of innovation to satisfaction. The numerous definitions offered in modern innovation literature indicate that I am not the only one disturbed by the sense that although it is clear that innovation has to do with the coming into existence of something that was not there before and putting it into good use, the concept remains diffuse. I suggest that the problem is chiefly related to the human inclination to reify processes of communicative interaction between people, including phenomena emerging because of such interaction. This makes us continue to neglect the subtle, complex responsive processes played out between humans. In my view, it is in these processes innovation, change or any other phenomenon in social life can be found. In the next sections I provide some further reflections on the phenomena of innovation and change, based on the complex responsive processes perspective.

8.1.1 Understanding innovation from a complex responsive processes perspective

In systems based thinking, knowledge is referred to in the same way as power, that is as something which can be possessed by somebody, making them superior to others. Moreover, knowledge is mentioned as something organizations can own, and which can and should be managed and controlled (Stacey, 2001). In this way purposeful knowledge creation and the exploitation of creative combinations of existing knowledge can be formulated as long-term designs to achieve successful innovation (e.g. Hargadon, 2003; Pavitt, 2005). The impression of controllability of knowledge and innovation processes is reinforced by the prevailing tendency to speak of innovation not as a process, but as a state, referred to in reified terms.

From the perspective of complex responsive processes, knowledge is created, recreated and potentially transformed in ongoing interaction between individuals (Stacey, 2001). Knowledge is emerging as meaning within the conflicting, enabling constraints of power relations, and thus, it is closely related to identity. This means that changes bringing about the need for new types or combinations of knowledge have a potential impact on individuals' perception of identity, including established relations of power and perceptions of 'we' and 'them'. Knowledge can thus be seen as thematic patterns which organize peoples' experience of being together (ibid.). Seen like this, change and innovation can be perceived as changing power relations, and should be expected to provoke feelings not only of inspiration, but also of anxiety and resistance. 'Learning' is seen to be part of the same process, hardly distinguishable from the knowledge processes. In other words, knowledge and learning are understood to be social acts, emerging as change in local communicative interaction '*whether people are conscious about it or not'* (ibid.: 189). The knowledge assets of an organization lie therefore not in artefacts like reports, strategic plans, ICT tools or technology, but are co-created in cooperative, competitive relationships between organizational members and non-members. This leads to the assertion that knowledge assets alter when relational patterns are disrupted (ibid.).

Research based on the complex responsive processes perspective has been focusing in particular on change in organizations, including learning processes and the emergence of new knowledge. Less attention has been paid to the phenomenon of innovation. The exception is the work of Fonseca (2002), who defines innovation as '*the new meaning that is the emerging product of the dissipation occurring in conversations characterized by redundant diversity experienced as misunderstanding'* (ibid.:92), as well as '*the process of transforming both collective and individual identities'* (ibid.:111). Fonseca continues to state that '*the new meaning may be embodied in some new "thing" that is apparently detached from the messy process of its creation*'. In his view, the diffuse, 'illogical' and uncertain processes of communicative interaction in which innovation and new meaning may emerge, are masked by peoples' inclination to ascribe in hindsight what happens to someone's intentional choice. One of the issues Fonseca brings up, is how the apparently structured development projects of for example R&D departments, relate to the 'messy' emergent processes of innovation (Fonseca, 2002:91). He argues that such projects are the visible phases of innovation. In line with Van de Ven et al. (1999), he further suggests that this phase is preceded of '*a long period of conversations and ambiguous actions*' (l.c.), or, in the terminology of Van de Ven and colleagues, a *gestation phase*. The gestation phase involves speculation, imagination and fantasy on the part of numerous people in the organization and in other organizations, inspired among other things by books, journals, multidisciplinary conversations, and social practices. Gradually, recognizable patterns may emerge as the consequence of recurring themes and negotiations of the meaning of such themes. If accepted by sufficiently many, or supported by somebody who have the power to authorize the use of resources, openly or covertly, the recurrent themes, perceived as ideas, may be attempted realized through experiments and development activities. This is exemplified in the following narratives about the prelude to SIOR, told by one of the core team members, and the then Research Centre director:

> *I worked in a subsea department where we had started to worry about benchmarks made by the Petek department (i.e. Petroleum technology) showing that in practice, production from subsea wells were in the magnitude 7-12 % lower than from top side fields. I felt that it was important that Statoil, which had decided that future fields should be subsea fields, got at least half of its production from subsea wells. In stead of talking about how much less they produced, we could turn it around and say: What do we need to do to produce as much from subsea fields as from platform fields? And then collaboration between the Drilling- and Petek-departments and me started. We initiated a preparatory study to see if we could establish new activities involving all of us. This was picked up by the system, and suddenly it was part of the strategy, and some cut through and did some calculations. And then suddenly that billion came up. One billion barrels extra. And they made a portfolio analysis to see if recovery could be increased by so and so many percentages. They had data from Gullfaks and Statfjord and some other fields, and meant that it was possible to get the extra billion, and that we should spend research money to get it. That was the way it started, in a way, and we got that technology strategy and the R & D programs …*

> *When we decided the 55% subsea IOR target some time in 2002, people shook their heads round about the organization wondering if we knew about anything at all. It was decided by T., who was the executive vice president for Technology at the time, and me, just before he entered the podium in one of those summits. Naturally, I had asked the specialists what would be possible, and they had come up with a lot of reservations, things we could not do. Neither T. nor myself had any attitude to much of that, because, even if they said that it was difficult, it did not*

sound difficult, because there were no numbers. And we knew that if we translated most of what they said about volumes of oil into percentages, we would end up around 50-52 % oil recovery. So, I don't really know where 55% came from, but anyhow, that is what it ended up with. And process owners and everybody threw themselves upon me and asked how I had fooled the executive vice president into introducing such a silly number.

In Fonseca's (2002) terms, official development projects are initiated based on knowledge (meaning) which is already *stabilized*, at least in some parts of the organization. Incidentally, this is the phase which is usually identified as the starting point of the innovation process in the major part of established literature on innovation. The development activities may result in new tools, technology or work process descriptions, but are also the source of further conversation, which may be redundant in nature, and thus has the potential of leading to new ideas and further innovation.

The work of Fonseca (2002) is based on three cases. As distinct to my study, none of them take place in large industrial organizations. His discussions are nevertheless of great relevance to my work. To me, his discussion of innovation as being dependent on high levels of redundant diversity in conversations represents the same line of thought which can be found with Shaw (2002). They both point out that to be able to come up with, and reflect on, new themes, people need the freedom to fantasize and exchange ideas without the constraints, for example, of strict meeting agendas and fixed expectations. Neither Fonseca (op.cit.) nor Shaw (op.cit.) does however follow up on how such freedom, or slack, can be encouraged in organizations. Fonseca (op.cit.) is occupied with the idea that the redundant diversity, pointed out to be so important for innovation, is experienced in conversations as *misunderstanding*. By 'misunderstanding' he seems to mean the lack of joint meaning, leading to a continual shift and evolvement of the patterning processes of new themes because of the current introduction of new themes and ideas into the emerging patterns. Such continued disturbance may prevent premature or unwanted stabilization of patterns of themes. I perceive this interpretation of 'misunderstanding' to support the view that innovation emerges from prolonged conversational processes characterized by conflict, ambiguity and persuasion, involving negotiation activities caused by diverse interpretations of the ongoing, evolving themes. As discussed in paper D, my experience was that there was relatively little tolerance for such misunderstanding in connection with the SIOR program.

In papers A-D some alternative formulations of *innovation* are suggested. They build on the view that new ideas should be seen as propositions of new themes of conversations, which in turn are propositions of organizing experiences of being together in different ways. This includes experiences of power and identity, leading to the view that innovation is *creation and adoption* of *new patterns of communication which are emerging between people as everyday power and identity struggles where leaders play a particularly influential role*. The new patterns of communication emerge in irreversible, self-organizing social processes, which are shaped and formed by complex interactions of human relating. As distinct from Fonseca (2002), I suggest that particular importance should be attached to the ordinary, everyday aspects of innovation, and that processes of innovation should not be seen as separate or separable from other organizational activities. I further suggest that, generally, processes of human interaction are recognized and reproduced as 'innovation processes' only if they result in tangible effects, such as increased profitability or improved reputation.

The view of innovation processes as emerging patterns of action consciously and unconsciously influenced by a lot of people through their ongoing participation in work related social interaction clearly indicates that such processes may lead to outcomes that were neither planned nor wanted. This obviously contrasts the message given in most books and papers on innovation, which is that innovation processes can be subject to human control. In this context, the ideas of Mead (1972:419-420) appears to be of importance:

> *In the undetermined future of action a new object, a new* terminus ad quem[6], *can arise, the necessity of which cannot be said to exist in the conditions to which it must conform. [...] The novel element may be very slight, especially in comparison with the given world in which it appears, but in the experience of the individual it was not involved as a necessity of its past. [...] This amounts to the*

[6] *Terminus ad quem* ('limit to which') is used in archaeology / history, and refer to the latest possible date of a non-punctual event (period, era, etc.) (en.wikipedia.org)

> *affirmation that all the novelties of living experience are as novelties essential parts in the universe; the fact that when they arose they were unpredictable means that in the universe as then existing they were not determinable, nor in the universe as then existing did there exist the conditions that were the sufficient reasons for their appearing.*

As observed by Griffin (2002), Mead (op.cit.) does not place emphasis on the degree of novelty of the new elements. In his view, the distinguishing feature of novelty is not how large the change is, but that the change is *unpredictable*; implying that it cannot be determined by the past, and therefore, cannot be specified in advance. Mead's perspective offers an explanation to the often surprising and unexpected outcome of innovation processes. In accordance with the preceding argumentation, it is however my opinion that the perceived difference between 'the new' and 'the existing' should also be attributed importance as an aspect generating a spectre of responses, including resistance and recognition. Such responses reflect temporary individual-collective perceptions of meaning, knowledge, identity, and the power relations in which the responding persons are part, and may substantially influence the course of the ongoing innovation initiatives.

8.1.2 Innovation and change

From a complex responsive processes perspective, change is seen to emerge in self-organizing processes of human communicative interaction, implying disturbance and even disruption of current patterns of themes and of power relations. Compared to the understanding of innovation proposed by Fonseca (2002) and in the present study, the distinction between change and innovation appear difficult to point out. They are both about evolving, altering patterns of talk, leading to the evolution and potential transformation of knowledge, meaning and individual-collective identity. A question of relevance thus seems to be *whether change and innovation should be seen as intertwined, inseparable processes, or if distinctions between them should be made*. Stacey (2001) emphasizes that change and the creation of meaning are perpetually emerging even if people are not always conscious about the growth of new themes. Drawing on process philosophers like Bergson (1946), Bateson (1979), and James

(1996), Tsoukas and Chia (2002) emphasize that people perceive change as *difference*, involving the view that the undifferentiated is imperceptible (ibid.:571). In my view the specification made by Tsoukas and Chia (ibid.) is useful to discuss the possible distinction between innovation and change. Seen from their perspective, people will not respond to different patterns of talk as 'change' until they *perceive* them as change. Perceived change may lead to the purposeful attempt of adaptation through the invention and adoption of new tools and habits. Thus, innovation initiatives can be understood as a *response* to change. Such change may be caused by processes of communicative interaction, but also by events beyond human influence, like natural disasters or changes of climate. With reference to established literature on innovation, innovation processes intended to lead to novelty in the form of material and non-material commercially valuable 'artefacts' are of extreme importance for company competitiveness. From this perspective innovation initiatives, such as the SIOR program, could be seen as a *gesture*, usually made by managers, to bring about change. From my point of view, the phenomenon of innovation as response to change can not be separated from the phenomenon of innovation as a gesture to bring about change; they are two aspects of the same process of gestures and responses.

The original meaning of the word 'innovation', from the Latin *innovare*, was 'renewal', or limited change, - a combination of both continuity and discontinuity (Girard, 1990). In the West, the meaning of the word has departed from its Latin meaning, and has become associated largely with the processes of producing novelty, and the results of such processes, leading to economic and social progress. Companies' clear expectation about growth and competitive advantages related to innovation could be seen as a distinguishing characteristic which has not in the same way been attributed to 'change'. As discussed in paper C, innovation efforts leading to the invention of new technology or new approaches to work were, in fact, only recognized as 'innovation' by Statoil managers if they resulted in commercially valuable outcome. In my view, it is of importance to keep the above discussion about innovation and change, in particular the aspect of expectation presently associated with the phenomenon of innovation, in mind when immersing into the discussion about the research subthemes.

8.2 The dynamics of generalization/particularization processes, and the emergence of innovation

The first research subtheme I engaged on, was: *How can the dynamics of the overall SIOR ambition and the local particularizations of the ambition be understood, and how can 'innovation' be recognized as part of this?* To approach this question, attention was focused on communicative aspects emphasized in the complex responsive processes perspective as being of significance in human interaction. The aspects were meaning, identity, power, and leadership, all of which my co-author Stig Johannessen and I presumed to be of particular interest to the discussion about Statoil innovation processes. The significance of moving attention to such aspects for the understanding of innovation processes is discussed in papers A, B and C, and suggestions of how innovation processes can be understood from a complexity perspective are offered.

My experiences indicated that the evolving processes caused in Statoil because of the SIOR program could not be seen as rationally planned; nor as evolutionary processes driven by chance or environmental selection mechanisms. They were rather the result of numerous activities closely integrated in everyday life in the company, where people in managerial positions played a particularly influential role. This observation led to the suggestion that innovation emerges within the dynamics of the changing nature of human relations. Moreover, we proposed that innovation should be approached as processes involving self-organising, irreversible emergence of changing communicative patterns, identity formation, power relations and leadership.

The innovation processes I was studying could be envisioned as company-wide enactments of the vision of a specific, wished-for future, which in this particular case was the production of an average of 55 % oil recovery from Statoil operated NCS subsea fields. They could also be seen as processes moving ideas about how individuals should act and interact, and how they should see their roles and functions in relation to other professionals. As suggested in paper A, an implication of the latter view is that innovation can be seen as processes of changing pattern of themes, involving the probability that individuals will experience a sense of shifting identity (understood as meaning, direction, structure, flow, continuity) as they struggle to structure the patterning processes in each living moment. Such 'structuration' processes take place within a multitude of local organizational principles and ideas about ‘who we are’ and ‘how we do things’. It is therefore reasonable to assume that new ideas, such as the 55 % SIOR ambition, will be particularized in unlike ways in different local settings, as was indeed what happened in Statoil. As the meaning of some generalized idea is interpreted into a specific situation, the general meaning of the idea will be affected as part of the same process. This perspective involves the recognition that human communicative interaction, seen as ongoing responsive processes of generalization/particularization and idealization/functionalization of themes, has the inherent potential of leading to novel, unforeseen ideas. The overall themes connected with the SIOR program, including the 55 % ambition, structures of collaboration, and visions of technology elements, were discussed in numerous local meetings involving Statoil members, and also suppliers’ representatives. This led to the simultaneous emergence of a diversity of interpretations of the meaning of SIOR ideas, and about their value. The comprehensive engagement of the SIOR core team members in such local conversations, and the support widely expressed by the top management to the program, nevertheless resulted in the gradual, widespread acceptance of the strategic importance of the program. My observation was, however, that while in some situations apparently agreed-upon ideas seemed to support the emergence of results regarded as promising and innovative, in other situations they seemed to restrain or even destruct the innovation processes.

Taking the complex responsive processes perspective as my starting point, I see the communication taking place in the wake of the introduction of the 55 % ambition and the subsequent SIOR program as power struggles between people holding different functions and roles in the company. Professionals and managers put forward weighty arguments against or in favour of the SIOR ideas, apparently intending to influence, shift and control the potential stabilisation of patterns of power relations according to their view. In this context I regard ‘power’ as the ongoing negotiation of acceptance and execution of influence between people. This means that the unstable balances of power can be seen as an essential element in innovation. Certain individuals always influence more than others the escalation of new themes. Such individuals may be recognized as leaders, executing leadership in processes of innovation. We argue, however, that these may not necessarily be formally appointed managers, although people accepted in formal power positions do have increased possibilities of conducting leadership, and as such may considerably influence new patterns of communication. As part of this interpretation, it is suggested that resistance to new ideas can be understood as attempts to uphold established power and identity structures.

My experiences indicate that the SIOR program was formed by the various interests in Statoil, but at the same time it was gradually forming, and also transforming, the interests of those who in some way were engaged in the activities. I find the multitude of meetings, conversations and communications between persons in Statoil as well as in many other organizations concerning SIOR to be an important indication that even if individuals may be very influential in innovation processes, such processes involve the interweaving of the actions and intentions of a large number of people, exerting themselves to persuade others about their ideas and negotiating the meaning of new proposals. In any particular meeting, meaning would arise to what the SIOR idea might mean for those attending, and for Statoil. These discussions are clearly influenced by the relationship between those who meet, and the quality of their relating. An example of this is given by one of the business unit managers:

> *... it is about dialogue, to meet is important. Equally important is that if SIOR has an activity which is important for us, then it is easier to involve, and if the activities are less important then it is harder to involve, and maybe it should be like that. ... If we are to pilot something we don't believe in, and don't see why we should use it, we don't see the profit potential, but OK, we do it because we are told to, then there are small chances of succeeding, and we go back to the old way of doing it. ... The concern initiatives and demands for oil recovery factor are important; we need to close the gap between what we do today and the new demands, so we need new things, new technology, and new ways of doing things. And this gap – that is the opportunity set for SIOR. So innovation is the combination of local and professional knowledge.*

As argued in paper B, the progress of SIOR activities came about in the tension between individual opinions and objectives, and has to be seen in a much broader context where people had to act in accordance with formal routines, deal with business demands and political considerations, but also were able to exert influence through both formal and informal channels. The informal channels, referred to by SIOR members as working ‘off-stage’, seemed to me to be a powerful arena in Statoil.

In the case of SIOR, innovation processes were boosted by the top managements’ deliberate intervention, intended to ultimately result in increased profitability of operations. I see such ‘enforcement’ of new themes into ongoing responsive processes of communication as a proposition that predominant patterns of ‘how we do it in our company/group’ (i.e. identity, culture) are replaced by new patterns suggested by a few people. What is neglected in this kind of intervention is the multitude of particularization-generalization processes leading to the unknowable development of the themes introduced. This discussion may be of particular relevance to Statoil, where principles of involvement and consensus appear to be generally accepted.

To my surprise, I also found that in contrast to the high profiling given by the top management of Statoil as an innovative company, most people engaged in SIOR activities, even researchers, did not consider what they did in their everyday work life as ‘innovation’, but rather as the provision, testing and use of technology. In paper C I argue that the recognition of everyday activity as ‘genuine’ acts of innovation is an emergent phenomenon, expressed and potentially idealized and even mystified in retrospection. This clearly links ‘innovation’ with ‘time’, emphasizing the problem of reducing innovation processes to states or distinct steps. I base my explanation of this phenomenon on Mead (1967), and suggest that in the course of the perpetual construction of presence, particularities of past events will fade. This provides a breeding ground for the emergence of generalized narratives of organizational achievements, which may be further evolved into idealized collective identities, or values. In line with Griffin (2002) I maintain that to ascribe to an organization idealized values like ‘innovation’ is the same as idealizing the organization as a cult, where values are applied as universal norms to which people have to conform. By doing that we tend to ignore that different people and groups of people will functionalize such idealized values in various ways depending on the situation they are in, the role they possess and their previous experiences. More often than not, the diversity of interpretations leads to disagreements and even conflicts. To be able to go on together, people have to negotiate these conflicts and adjust their actions towards one another, as was clearly demonstrated in the SIOR study.

Independent of whether innovation is materialised in new technology, different from what has been available before, or is immaterial, experienced and described as 'new ways of doing things', my principal argument is that innovation is new general/particular patterns of action escalating from the diversity of particularizations of the existing and enforced communicative themes of everyday life. Emerging patterns recognized as 'innovation' involve the re-organizing of people's experience of being together, involving experiences of changing meaning, and of shifting individual-organizational identity and power relations. The emerging patterns may lead to results regarded as innovative and successful, while in other situations they may become restraining or even destructive to innovation initiatives.

8.3 Approaching innovation differently

The SIOR program (and also the 'sister' program Tail) rested on the idea that members of Statoil operational units and the Research Centre should cooperate in a way referred to as 'new' in Statoil to implement the ambition of increased oil recovery. In papers B and D the second subtheme, w*hat does it mean to 'approach innovation differently', as people co-operating in the SIOR program were expected to do,* is pursued.

In the next chapter I will give examples of how Statoil members described habitual innovation processes as collaborations mainly between operational field members and suppliers, and sometimes between researchers and specialists. The 'new way of working' implied that members of the Research Centre were intended to play a more prominent role in joint development processes than before. All SIOR development processes were expected to involve members of one or more of the operational fields, existing or under development, and more often than not also representatives from external suppliers. The SIOR program and the sub-activities were organized as projects, gradually subjected to comprehensive routines of planning and control similar to those valid for other Statoil development projects. An interesting observation was that for quite some time, most participants in SIOR activities did not seem to identify with the program, and some did not even know that their work was seen as a part of it. Accordingly, in paper B it is suggested that although the concepts of 'project' and 'program' are recognised as an important working method to accomplish coordinated goal-oriented activity, they could also be seen as abstractions of which meaning and identity emerge only through ongoing conversations. Many of the researchers who were formally members of SIOR were only a sporadic part of such 'SIOR-identity'-forming conversations, and even when the program was terminated in 2007, many SIOR members identified primarily with their own field of research. As one of the core team members commented:

> *When we initiated SIOR, we discussed how to organize the program, and we decided to go for a structure derived by program objectives... The idea was to bring these objectives 'all the way down' in the project, but so far* [late 2005, my comm.] *we have not succeeded in doing this.*

In accordance with the above argumentation, the introduction of new ideas of how work is to be accomplished can be related to shifts of experiences of individual-collective identity. Such shifts, or transformations, emerge as new themes in the everyday, ordinary power relating of professional life. Johannessen and Stacey (2005) draw on Mead (1967) to point out that such patterns also take the form of 'social objects'. As explained in section 6.2.2, social objects can be understood as generalised tendencies on the part of large numbers of people to act in similar ways in similar situations. Such objects exist, evolve and are being formed in social interacting, forming that social interacting at the same time. The ideas of new ways of working outlined in the Statoil Technology strategy could therefore be seen as a proposal of enforced change of peoples' experience of the social object of innovation, causing a diversity of particularized responses among involved Statoil members, including responses of support and resistance.

In paper D the above discussion is related to a question of inclusion and exclusion in groups. Drawing on Elias and Scotson (1994), it is suggested that ideas of cooperation across established groupings of people who have not traditionally worked together can be seen as a challenge of 'insider' and 'outsider' relations. This may bring about objections from all or more of the groups involved, like it did in connection with the SIOR program. This is exemplified by the following quotes from conversations between Statoil specialists cooperating with SIOR members, and me:

> *We went all out for it, but then the drilling people decided that, no, the researchers shouldn't come and tell them how drilling was to be done in the future. And it became a major clash, and we had to stop the project.*

> *For example, if you think about this seawater pump, the specialist was the one driving the process forward as part of our project. He was engaged in SIOR, but we never saw him as part of the SIOR project, he was one of us. He worked independently of SIOR; it was merely a kind of umbrella…*

The SIOR study further supported the view that ascribing generalized characteristics to large groups of people is of limited value as basis for understanding the detail of human interaction. As an example, my experiences in SIOR demonstrated the absurdity of discussing collaborative relations as interactions between 'roles', 'functions' or ' organizations'. The intention to change patterns of cooperation related to the development of SIOR technology elements proved to involve a need for frequent participation of SIOR core team members and other people with managerial responsibility in conversations with people intended to work together. In Statoil persons holding managerial and specialist responsibilities change their internal positions time and again. This rather frequent 'recasting of characters' implied that the core team and other members of SIOR repeatedly had to persuade people new to their role about the importance of the SIOR ideas about collaboration and innovation for their local situation:

> *The relation to NN was OK, he knew the SIOR activities; he had been there a long time. But suddenly he is no longer there, it is a new guy. Now we have to start all over, and build relations. We know many of the others in that department, but not him who has to sign the collaboration agreement.*

Experiences from the SIOR program indicate that management demands for new ways of working at can result in a range of responses, from the establishment of fruitful new collaborative relations, to conflictual situations potentially destructive of innovation processes.

8.4 The meaning and impact of 'technology' seen from a complex responsive processes perspective

The SIOR program was about the development and adoption of advanced, complicated technological solutions. This made the third question, *how do SIOR members and customers discuss technology, and how are these views acted out in processes intended to lead to innovation*, an obvious theme to address. When I started to reflect about 'technology' more in-depth, I found that the conceptualization of 'technology' in the complex responsive processes perspective appeared inadequate in the context of innovation in SIOR. This is focused in particular in paper C.

In the Statoil *Technology Strategy 2006-2015* technology was defined as 'knowledge, tools and methods'. This indicates a modern view of technology, including immaterial products which may be describable only in more ambiguous terms. The view is in contrast to most innovation research, where technology is treated as if it was completely definable in terms of its physical characteristics. In Statoil the adoption of new technological solutions, including the reorganizing of work processes needed to fully take advantage of the technology, is at the heart of the ability of the company to capitalize on its R & D efforts. In other words, technology is ascribed great importance as the enabler of commercial success. The link made between 'enabler' and 'technology' indicates that there are people in Statoil attributing meaning to technology beyond its specific physical characteristics or description. In modern organizations, tools, which can be technological objects, but also guidelines, strategies, and work processes, are extensively used to induce or adapt to change, but also to surmount the physical limitations of the human body and to support people in their work. Innovation, which can be seen as the intentional, collaborative generation and adaptation of such tools, can thus be seen as an essential aspect of social development. According to Stacey (2001) such processes are conditioned by the human ability to communicate, i.e. language.

Consistent with the fundamental ideas of the complex responsive processes perspective, the meaning of technology is not seen to lie in the physical characteristics of the technology, but in the processes of gesture-responses which are influenced by, and influencing on, the use and perception of the technology. The understanding of technology (tools) from the complex responsive processes perspective is elaborated on by Johannessen and Stacey (2005). In brief, the meaning attributed to technology can be seen as embedded in the *social object of technology* (Mead, 1972; Johannessen and Stacey, 2005). Accordingly, the social object of technology may affect our thinking in areas seemingly unconnected with the physical technological object itself. Characteristic of the technological innovation in SIOR was that the various technology elements did not exist in a final state, but could be seen as being in different development 'phases'. In paper C, I therefore introduce the concept 'diffuse technology' to denote technology which is being developed. I further suggest that the significance of a 'diffuse' technology element is derived from the social act of communication between professionals. This may be a lengthy process; in the petroleum business there are several examples of time spans of 20-30 years from ideas were articulated to technologies were completed. During this time, it is reasonable to believe that the physical and social objects of a 'diffuse' technology evolve and change in the ongoing processes.

The official Statoil view of technology as an enabler of commercial success is an idealized one, suggesting that technology has become a 'cult value' in the company. In paper A we suggest that functionalization of cult values will lead to conflict, and to negotiation of compromises around such conflict. This forms a possible way to explain the opposition to SIOR ideas and technologies, and the increasing support arising as particular meaning of technology elements emerged in the different operational units (negotiation of compromise). It did, however, not seem to me that technology brought about the same associations with everybody in the company. For many of the researchers and specialists, technology was a very specific professional challenge of attempting to solve a complicated problem through technical skills. For people responsible for operations, technology involved opportunity, but potentially also substantial risk. From what I could judge, the main risks connected to technology development and adoption was that it would not work as anticipated, that it failed, that technology adoption did harm to people, environment or to existing installations, or, seen from the perspective of off-shore employees and trade union representatives, that jobs were lost.

Interestingly, the view on such risks varied among those responsible for operations. While some saw the many elements of risk as arguments against technology development, others saw them as stimulating factors. Those emphasizing the latter viewpoint interpreted the concept of risk to include engagement in new ways of working and doing things, and, according to them, this form of risk taking was both desired and demanded in the company. This view was supported by the many organisational 'cult'-narratives about former bold decisions and great engineering achievements, resulting in the development of extremely profitable fields, and by the international acknowledgment of the company's ability to adapt and integrate advanced technology. Accordingly, there were people more willing than others to discuss unfinished ideas about the SIOR ambition, and to commit to the testing of unproven technology.

This is consistent with the idea that social objects exist only in the experience of human interaction, and implicitly, that the social object of technology would give rise to differing local opinions about the significance for them of specific technology elements. My experience indicated that discussions about technology were not only discussions about particular perceptions of opportunity and risk, but involved power struggles which apparently had nothing to do with the specific technology in question:

> *Our world is filled with pumps and pipes and tanks and wells and production and HME – practical, operative, commercial things. Money. So we do not understand what people talk about until it is translated into these practical aspects. You have to talk to us about the dinguses – compressors, well branches, well intervention, that's what it is about – and our ability to adopt it… If those who come to us know the 'native tongue', the operational units will listen. It is about credibility, about realism of projects, and the understanding our processes, licensee processes, decision processes, all that.*

Consistent with this statement, which was made by a manager high up in the operational unit hierarchy, I noticed that the emergent and continued interest for SIOR technology among operational unit members depended on the purposive participation of SIOR members in communication about the technologies in such a way that particular and general meaning of their significance evolved. Far from all members of SIOR were accepted as credible in this connection, and in some cases, the selection of persons accepted were narrowed down to the SIOR director.

A related experience was that innovation, understood to be the improved performance brought about by novel technology and immaterial solutions, did not only depend upon the emergence of the positive conception of technology among some members of operational fields. Innovation required that such meaning diffused and stabilized sufficiently long for people of decision-making powers to actually conceive the technology as an 'enabler' of a desired future. Only then did they allow for the allocation of the resources needed to develop, test and implement the technology.

8.5 Innovation management as communicative processes

The last subtheme, *how can Statoil managers contribute to the more efficient accomplishment of innovation initiatives,* focuses on how individuals assigned or taking on a responsibility for innovation processes can understand their task. The theme is mentioned in all of the papers, but in paper D the discussions about how innovation management can be seen from a perspective of complex responsive processes is broadened towards a more specific understanding of what it could mean to manage innovation processes in large industrial companies. In my approach to this subtheme, I have once more lent my ear to Stacey (2007), who maintains that the activity of making generalized organizational themes particular (such as business strategies, value statements and ambitions), is in the core of what the activity of management is about.

My discussions about innovation management are based on the two intertwined experiences that a large number of people seemed to influence the SIOR activities and the local and widespread opinions about the program in various ways, and that the SIOR core team members engaged extensively in communications about the program ideas. Individuals influencing the program were people in executive positions, or holding responsibilities such as researchers, specialists, licence members, people in support departments such as quality assessment, human resources, procurement, budgeting and planning, and many people employed in other companies. I see this observation as one of the most evident indications that predominant ideas maintaining that innovation can be predetermined by the actions of particular individuals, such as managers, are problematic. As suggested in paper A, what is lost sight of in the predominant way of thinking about innovation, appears to be the understanding that meaning does not lie in innovation thought of as if it were a physical object, but can be found only in the particularising processes in which innovation is recognized.

An important problem of the prevailing management thinking is, as precisely observed by Shaw (2002:116), that '*our sense of our own agency is tied up with being able to account for ourselves in these terms* [which are terms of control, my comm.]*, to show that we can realize prior intention in the face of all kinds of difficulty and think in very sophisticated ways prior to action'*. Another problem is related to the ideas of 'empowerment', because if every organizational member is empowered to take their own decisions independent of others, organizational change would be random and uncontrollable. To my knowledge, these problems are not discussed in innovation research literature. Another absent discussion, is that for people to be able to enact generalized ideas (including 'how-to' recipes), such ideas must be interpreted in local processes of particularizing and functionalizing. These processes involve the interplay of many intentions and values, and cannot be designed or controlled by any one individual, not even managers.

The basis of the present research is the view that innovation is a social process, leading to new patterns of themes which emerge in the interplay between large numbers of interdependent individuals. Characteristic of innovation is that movement is towards images of desired future situations, supported by novel objects that were not part of the past in the experience of individuals. The aspect of novelty makes it reasonable to expect that the ideas on which innovation processes are based at first will be perceived as controversial. As previously indicated, this was indeed the situation facing the SIOR core team members. In paper A, it is suggested that innovation can be seen as emerging tendencies among many people to act in similar ways, involving for example the inclination to protest against new ideas, or to praise them. Incidentally, there appeared to be a view among Statoil top managers that generalized tendencies to act 'innovatively' should be encouraged in the company. This was reflected in the Statoil

Technology strategy 2003-2012, where 'innovative attitude' was demanded, and through the introduction in 2005 of the corporate value 'imaginative' (which is no longer explicitly stated among the new StatoilHydro values).

The above discussion should be seen in connection with one of the main claims in this dissertation, which is that innovation is responsive processes of human relating closely integrated in everyday professional life. To support such processes towards a desirable outcome, the key activity of innovation management is suggested to be the deliberate participation in everyday communicative interaction intended to lead to the emergence of new meaning, rather than to search for enhanced 'control'. Incidentally, 'control' is seen as a phenomenon inherent in human communicative interaction, implying the view that individual control of any organizational process is constrained, although also enabled, directly and indirectly, by many other people. According to Tobin (2005), a way to see leadership is that it is an emergent phenomenon, arising in social processes involving professionals engaged in collaborative action. My understanding of this is that individuals can emerge as leaders without formally being assigned management responsibility, provided that they are 'permitted' major influence on the development of some processes, whereas people assigned managerial responsibility not necessarily emerge as such leaders. The view that being assigned managerial responsibility for innovation may not automatically imply being accepted as a 'leader' of innovation is emphasized by this deep sigh from one of the SIOR core team members:

> *The paradox is that you are given a task, a role, and a lot of money to do the job, and then you have to run around for years to justify your existence, and to convince people about the idea.*

According to my way of thinking, it may be of particular value to emphasize the above distinction in connection with innovation. A problem in the present study is nevertheless that I tend to use the word 'management' synonymous with 'leadership'. This is partly due to the fact that in traditional innovation literature, 'innovation management' is used as a general term for all managerial responsibilities suggested to be of importance for the successful outcome of innovation processes, and my use of the word is in line with this. I know that in other parts of management literature, a distinction between the two concepts is commonly made (e.g. Maccoby, 2000). Briefly, this involves a view of managers as principally being administrators; writing business plans, setting budgets, and monitoring progress, while 'leader' characterizes individuals who inspire their co-workers (or 'followers') to the joint movement of a company into the future through change and innovation.

In support to claims made for example by Groot (2007); Shiel (2005); Taylor (2005) Tobin (2005) and Williams (2005c), it is my view that the joint performance of individuals, commonly referred to as organizational performance or business performance, may be improved primarily as the result of managers' purposive focus on participative processes and on the quality of relations. This does not mean that I do not se the value of adopting structure and control mechanisms to support organizational processes; I even think they may be important for success. While Shaw (2002) claims that the tendency in organisational thinking to focus on leadership and influence in terms of managerial ability to articulate strategies, goals and desired outcomes should be abandoned, I found that for the SIOR program, such actions also showed to be of value to keep attention focused on desired outcomes, although not always, and not in every situation. I realize, however, that this view does not appear clearly in the papers. In my view, what should be questioned is the idea that managerial 'orders' will lead to predetermined, improved outcome, as prevailing innovation management literature encourage us to think.

In the SIOR core team meetings, a frequent question was, nevertheless, whether they were 'in control'. The question was said to come from 'the top'. As discussed in paper B, if 'being in control' should signify the power of a leader to manage a project according to a prearranged plan, towards a predetermined result, then in my best judgement the core team members were not in control of SIOR. As an example, one of them gave voice to worry that patterns of talk emerging in his presence did change as they were further evolved in conversations between other people, and not always in ways seen by him as favourable. On the other hand, claiming that the SIOR program activities evolved by random would be equally wrong, as it was obvious that the SIOR core team, and the SIOR director in particular, greatly influenced the progress of the program activities. My observation was that much of what happened took place in interaction between many people, who met locally in small groups, and who mostly acted on the basis of intentions given by the projects they took part in, or their Statoil roles and functions. Events led to or affected events to come and the SIOR core team members adjusted their input to the current situations.

In relation to this experience, one of my assumptions were that the SIOR core team members would be able to point out to me specific experiences, judged to be of significance to support or counteract innovation success. This showed not to be the case. Only when an activity had reached a milestone or come to a conclusion, were some members, but not all, able to point out and reflect about situations perceived as particularly influential on the final result. I take this as an indication that innovation management involves improvisation and spontaneity, and the recognition that everyday events, planned and unplanned, form a significant basis for the emergence of new meaning. Moreover, I suggest that the management of innovation involves the movement of attention towards such aspects, concurrently guided by the insight that the future, and thus the outcome of their efforts, is largely unknowable. Emphasizing again that I do not claim that the recognition of such aspects will lead to increased 'control', I suggest that this approach to innovation management may result in improved individual skills of participating in ongoing innovation processes, and in reflecting individually and with colleagues about their experiences.

The possible consequence of new explanations about how innovation comes to life is therefore a shift of attention in organizations towards managers' increasing skills of participation. As elaborated in paper D, the view that innovation emerges from prolonged communicative interaction characterized by conflict, ambiguity and persuasion suggests that innovation management involves the courageous, continued exploration of collaboration in spite of potential conflicts. I noticed, however, that Statoil managers were strongly encouraged to focus on performance indicators, milestones, and forecasts, while themes such as participation, exploration and meaning formation were rarely discussed. In spite of my argument that patterns of social interaction emerge in unpredictable ways when individuals relate, my experiences in SIOR do support a view that such patterns may be perceived, articulated and indeed influenced. This substantiate my view that while the introduction of propositional and visionary themes are important tools in the process of leading, the most important task of innovation management is the explorative and participative actions intended to inspire, motivate, and also ‘force’, the members of an organization towards the joint creation of an anticipated desirable future organizational situation. The quality of such relations strongly influences whether people will be able to go on together in the face of uncertainty, or not.

8.6 Key contributions

My experiences as participant observer in a number of the SIOR program activities indicate that although traditional approaches to innovation research are convenient as a basis for the development of generalized knowledge, they fail to capture the fluid, complex and situational properties of the processes, and leave us with the erroneous impression that innovation can be designed and controlled. While it is understandable that such idealized ideas are appealing to corporate managers, this view largely ignores that innovation is the outcome of direct and indirect relations between many people attending to their responsibilities at work, and involving communicative aspects such as power, control, meaning and identity. Implicitly, innovation should be seen neither as designable courses of action, nor as events evolving by chance, but rather as an emerging phenomenon; paradoxically generalized and particularized in the experiences of everyday social interactions.

The main contribution of the present study is the exploration of the relevance of taking a *complex responsive processes perspective* on innovation processes in meeting this need. In paper A the theoretical and methodological approach of this perspective is compared to dominant ideas in established theory, and the differences are discussed in some detail. Together, the research presented in this dissertation addresses theoretical and practical consequences of adopting a complex responsive processes perspective on innovation processes in the particular context of Statoil, and on the management of such processes. To the best of my knowledge, this is the first time a longitudinal participative case study has been carried out with the focus on the inner life of a large industrial organization, to understand innovation efforts in terms of everyday organizational activity.

Among the basic assumptions apparently underlying most innovation studies today, I question in particular the idea of controllability of innovation processes by individuals (managers). Seen from a complex responsive processes perspective organizations are social processes of joint interaction, making the notion of individual, or even group, controllability of the processes devoid of meaning. Another issue is the expediency of models based on linear systems theory, and even on non-linear system dynamics including complex adaptive systems thinking, in depicting innovation processes. An important argument is that even if computer simulations have convincingly demonstrated a non-linear, dynamic nature of innovation processes (Van de Ven et al, 1999; 2000), such simulations can never capture the full range of human experience. I find that the complex responsive processes perspective is a more coherent and valid theory to explain organizational phenomena than complexity approaches directly translating computer simulation results into understanding of social action.

A key argument is that in order to move our understanding of innovation processes in organizations ahead, it is necessary to study the self-organizing emerging nature of communicative interaction in terms of ongoing everyday activity in organizations. The argument goes in favour of the value and potential of moving attention in innovation process research away from the quest for factors which stimulate or suppress innovation towards exploring the basic feature of organizational life, which I argue can be seen to be communicative interaction. This study indicates that the complex responsive processes perspective can provide a deeper understanding of innovation by directing attention towards how patterns of action recognized as 'innovation' evolve in everyday life in organizations, and towards questions like what it is that makes some groups of people (companies) more susceptible towards innovative ideas than others. I suggest that by following this line of thought, new ways of thinking about and carry out research on innovation processes can be found.

9 Significance and implications of findings

The motive power of the major part of innovation research initiatives could be seen as managers' and shareholders' need to uncover the secrets of innovation to ensure profitability of every innovation effort. Factors perceived to be of importance for the outcome of innovation processes acknowledged as successful (e.g. Verona and Ravasi, 2003) or unsuccessful (Chapman, 2003) have been extensively studied, leading to a diversity of suggestions about how innovation should be stimulated, organized and managed. My impression is, however, that the sources to this diversity are generally overlooked in the apparent eager of researchers to average and abstract findings into static categories, preferably labelled in a new and original way. Moreover, there is a glaring lack of evidence that the adoption of such results by organizations other than those studied has increased innovative capacity. This claim is supported by Andrew and Sirkin's (2003:76), observation that '*most new products don't generate substantial financial return despite companies' almost slavish worship of innovation'*. As discussed in section 3.6, among the challenges is the problem that a major part of the innovative technological solutions never become commercial successes (e.g. Cozijnsen et al., 2000), and the fact that only a minority of ideas seen to be innovative are realized into inventions (Freeman and Soete, 2000; Thamhain, 2003; Wijnberg, 2004).

In my opinion, one of the major problems within modern innovation research is exactly the problem of *large variances of findings*. The present study could be seen as a way of challenging this problem by seeking to penetrate '*to the order underlying this transformation* [of history, my comment] *and to the laws governing the formation of historical structures'* (Elias, 2000:xii). What I observe, is nevertheless that the experiences and events developing under the influence of such 'laws', which from my perspective are about universal aspects of human communicative interaction, will differ in different situations, at different times, leading to the diversity and unpredictability characteristic of joint human action. However recognized in academic circles, one kind of understanding that is usually neglected when human experience is generalized, simplified, reified, and ascribed universal validity, is the insight provided by complexity science into the non-linear characteristics of social processes. This involves the requirement for dissimilarity of ‘agents’ to generate genuine novelty (Prigogine, 1997; Allen, 1998a; 1998b), and the possibility that even small differences can lead to major change, known as the ‘butterfly effect’ (Lorentz, 2000). What is also commonly neglected is the fundamental understanding of organizational development which can be derived from Elias (2000), and of communicative interaction as explained by Mead (1967), making allowances for the particular, subjective and interdependent aspects of human experience and human interaction. A relevant insight emphasized by Mead, is that similar gests (statements, body language, symbolic actions) may provoke a diversity of individual responses, while at the same time, there is a tendency among people to respond in similar ways in similar situations. Incidentally, in this connection I understand ‘situation’ to be human interplay of gestures and responses, in a specific context, related to time and place, but also to individual and joint experience, expectation and intention. In accordance with this understanding, the concept of context can be seen to offer a possible explanation to the problem of variance in innovation research. I will elaborate on this issue in section 9.2. Before I do, I will pursue a previously mentioned question (chapter 3), which is about the possible contribution of the diversity of approaches and perspectives applied within innovation research to the variance in research results. To substantiate this discussion, I will provide examples of three common approaches to understand innovation, based on the same set of Statoil data, yet leading to three rather different analyses.

9.1 Variance in innovation research – the importance of different approaches

The examples in this section were developed based on about 40 interviews and a number of informal conversations with Statoil employees undertaken in 2005/2006. These are the same data that were used as a basis for the description of organizational characteristics of Statoil in section 2.3. The characteristics include predominant principles of involvement and consensus, making many Statoil decision processes elaborate; as well as empowerment of managers and specialists, making many decision processes decentralized. My conversation partners also indicated that they saw the Statoil work force as very skilled, but that the complex and fragmented company structure had an inhibitory effect on required 'flows of knowledge'. To this I would like to add that over the years the nature of the core activity; production of oil and gas; has resulted in comprehensive specialization and standardization of tasks, and that ownership interests increasingly seem to encourage principles of control and efficiency. Furthermore, during the years I was engaged in Statoil, I noticed that more principles apparently based on *value based management* (Black et al., 2001) were adopted. Among other things, this involved the introduction of visionary themes intended to direct the attention of employees towards specific objectives, like the needs for control and innovation. Two additional factors, which have not been explicitly discussed in the present study, are the strong trade union traditions within Norwegian petroleum business, and the Norwegian licence system. Together, these factors place obvious restrictions on the opportunity of operational unit managers to make decisions about new technology and new ways of organizing work.

9.1.1 Example I: Comparing Statoil company characteristics to modern innovation research results.

The first example shows how Statoil can be evaluated in terms of company characteristics assumed to affect overall innovative capacity. The evaluation is based on a comprehensive review, titled '*A framework for the study of relationships between organizational characteristics and organizational innovation*', prepared by Arad et al. (1997). The researchers have emphasized five characteristics as being of importance for innovation: *Organization structure, management, human resource systems and practices, objectives,* and *organizational values.* In the review a distinction is made between the influence of aspects of these characteristics on innovation *creation* (or: invention) and on innovation *adoption* (or: use).

According to Arad and his colleagues, organization structure will affect coordination and integration of organizational activities, and support information flows. Structural factors like specialization, formalization, standardization and centralization are pointed out as inhibitors of new ideas and invention. It is, however, indicated that centralization may have positive effects on the possibility for adoption and diffusion of innovative solutions in an organization. Flat hierarchies, autonomy and the use of work teams are emphasized as enablers of new ideas and invention, provided that they are related to the empowerment of employees, that is, to the delegation of authority to make decisions and solve problems. Large organizations are commonly claimed to be less innovative than smaller, but, again according to Arad et al. (ibid.), results are ambiguous. The impression is also that large organizations struggle to develop path-breaking innovation, whereas they are better than smaller ones in adopting innovation.

Aspects of *management* suggested to be of particular relevance to innovation are the development of organizational culture, direction and vision, motivation, evaluation and strengthening of desired behaviour and results, as well as adaptation of the organization for performance and success. Skilful companies are typically associated with values like innovation, involvement of employees, goal-orientation, vision, growth and flexibility. Incidentally, it has been shown that congruence between individual and organizational values is necessary for individuals to feel loyal to an organization and experience job satisfaction. Concerning culture, organizations oriented towards participation more than towards control appear to be more innovative, but these results are ambiguous, too.

Target-setting is seen as an important tool for managers to be able to steer an organization towards a desired outcome. Research results indicate that targets focusing on quality rather than on efficiency will increase innovative capacity. To ensure that employees can and will contribute to the realization of organizational targets the implementation of human resource systems and practices is common. In this connection, two factors stand out as particularly relevant for innovation; selection and incentive systems. 'Selection' is about the process of identifying persons for employment, promotion or other decisions related to individuals. 'Incentives' include economic and non-economic rewards, for instance to encourage individual readiness to experiment and take risk, which is seen as prerequisite for innovation. Moreover, Arad et al. (1997) bring up evidence indicating that rewarding innovation efforts and innovative results may have a positive effect.

A comparison between characteristics emphasized by my respondents as typical of Statoil, and those emphasized by Arad et al. (1997) as potentially distinguishing of innovative companies, indicates that Statoil has several characteristics apparently counteracting to innovation capability. The size of the company, its many development triumphs, and principles of consensus and control are factors pointed out as possibly inhibiting of new ideas, particularly of ideas suggested by people without formal or informal influence. Employee empowerment and opportunity for managers to make local decisions could, on the other hand, render probable the development of local, innovative groups. If so, the influential force in the company of such groups will be of importance for the overall innovation capacity. Moreover, the frequent rotation of specialists and managers between positions and organizational units could contribute to the diffusion of ideas. This may encourage innovation, but could also render it more difficult, depending on their view of some new idea, and power to influence the further destiny of that idea.

When it comes to management policy, it seemed to me that in Statoil principles of participation were severely challenged by principles of time-, cost- and risk control. The message communicated through the current values of Statoil appeared to reflect the same tension. Regarding Statoil human resource systems and practices, these were not explicitly discussed as part of my study. A reflection on my part is nevertheless that the bonus schemes introduced in relation with the SIOR program, demanding that at least 80 % of deliveries were completed according to plan and to customers' satisfaction, did not seem to take into account the unpredictable aspects of innovation. The ambition was supported by a corresponding demand on production directors for increased oil recovery, introduced in 2005. This could be seen as an encouragement of risk-willingness to adopt new technology, and implicitly, to new technology development. Yet, simultaneous demands for regular production seemed to lead to a situation where Statoil members accountable for oil and gas production continuously had to balance the evaluation of advantage and risk connected with technology testing against the need for steady operations.

This rather superficial analysis is summarized in table 9-1. It should be emphasized that the evaluation is based on reflections on company innovative capacity made by a limited number of Statoil employees, and on my interpretation of these reflections. The summary in table 9-1 should therefore primarily be seen as an example developed to illustrate my point.

Table 9-1 Statoil innovation capacity judged by recent innovation research, as summarized by Arad et al., 1997.

Organizational characteristics related to innovation capacity (based on Arad et al., 1997)	**Statoil characteristics**	**Innovation creation**	**Innovation adoption**
Organization structure	Increasingly specialized, formalized, standardized	-	-
	Increasingly centralized	-	+
	Company fairly large	-	+
	Former innovation successes	- / +	+
	Employee empowerment and opportunity for managers to make local decisions	+	+ / -
Management	Value based leadership	+ / -	+ / -
	Consensus and control	-	- / +
	Participation	+ / -	+ / -
	Specialist and manager rotation	+ / -	+ / -
Human resource systems and practices	Individual research managers' bonus schemes	-	+ / -
Objectives	Operational managers' MIS measures of IOR	+	+
	Demand for regular production	- / +	- / +
Organization values	Tension between principles of participation and of control	+ / -	+ / -

As the table shows, the analysis does not lead to a clear picture of the general innovative capacity of Statoil measured with these variables, although results indicate that company ability to adopt new technology is stronger than the capacity to create innovation. Several of the company characteristics, in particular those related to management, can be seen as both supportive and inhibiting of innovation, presumably depending on situation. The distinction made by Arad and his colleagues between company ability to create and adopt innovation nevertheless brings forth the idea that there may be a need to cultivate different characteristics in different parts of the company; dependent on whether the main task is technology development or use. According to Arad et al. (1997) a focus on adoption would demand further centralization of decisions, organizational targets focusing on quality, and bonus schemes rewarding operational unit managers willing to test and use new solutions. The encouragement of new ideas and technological invention should, on the other hand, imply a need for less centralization; and also less formalization and standardization. Moreover, it should involve the establishment of local work teams allowed to make their own decisions as well as to involve in corporate decision processes.

A possible consequence of this approach is a need to 'split' Statoil into two organizational models, or even into two companies. This kind of dilemma is discussed in particular by Christensen (1997), and by Tushman and O'Reilly (2002). While Christensen recommends that creative, innovative groups working with 'disruptive technology' possibly requiring different business models should be spun out, Tushman and O'Reilly suggest that leadership teams must be able to handle existing operations and technologies even as they develop new ones. To further complicate the discussion, suggestions made by Ravichandran (2000), who has also prepared a review on characteristics of innovative companies, could be considered. Ravichandran has pointed out nine organizational characteristics as being the most important in relation to innovation: *Sensitivity, learning, problem solving skills, experimentation, communication, risk-readiness, absorption (of new ideas, innovation), slack,* and *cosmopolitanism*. I will not pursue this, but as can be seen, taking these characteristics as the point of departure would lead to a rather different set of conclusions.

9.1.2 Example II: A narrative approach to understand paths to innovation in Statoil

My questions about innovation in Statoil were usually met with examples of previous development processes seen as successful. The stories I was told indicate that there are several roads to Rome. To illustrate this, I have chosen to compose three small stories about the Statoil innovation journey, based on the various examples. Although focus is on innovation in Statoil, it is worth noticing that usually technology (with the exception of some software solutions) is produced by suppliers, and not by Statoil employees. The development activities preceding commercialization may be performed by Statoil specialists and researchers with or without the cooperation of external partners, or by external partners working under the direction of Statoil project managers. Commercialization of results is, however, accomplished by a relevant supplier, or through the establishment of a new company. Incidentally, my experience indicated that an important source of conflict in collaborations between suppliers and Statoil project members was related to the issue of intellectual property rights (IPR), that is, to ownership of technology.

A. The official story

Development of new technology in Statoil happens through the purposive corporate selection of target areas, described in a technology strategy plan. The responsibility for the implementation of these areas is in the technology division; and from 2003/2004 the role of Research Centre members has been assigned particular importance. As an example, the SIOR program and five other R & D programs were based on the 'Statoil Technology strategy 2003-2012'. The strategy identified *exploration, reservoir management, subsea development, gas chain technology* and *environmental technology* as important development areas. The areas were among other initiatives supported by the establishment of several corporate initiatives in 2005/2006, headed by project managers reporting directly to the chief executive officer.

The selection of target areas are succeeded by the identification of ambitions, objectives and secondary goals, which are made specific through the identification of technologies and methods seen as essential to develop and implement. The process is illustrated below:

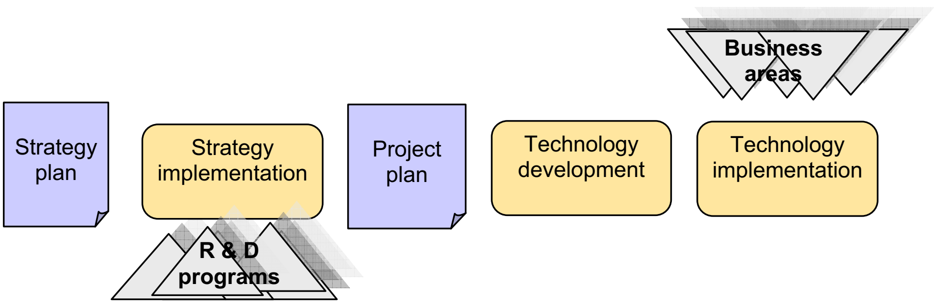

Figure 9-1 Technology development in Statoil – formalized process

B. The story about problems seeking solution, and the other way around

In Statoil, the major part of technology development work happens in collaboration between members of new and ongoing operational field organizations, and external suppliers. Specialists organized in the technology division are usually involved in these projects, whereas the researchers most often are not. Collaborations between Statoil units and suppliers are commonly initiated based on a specific problem in a field development project or in an on-stream field. Collaboration can also be based on a new solution suggested by a supplier, judged as useful by managers or specialists in one or more Statoil fields. Many of these development activities are not seen as innovation, but as stepwise improvements which may entail large changes over time.

For suppliers, the access to technology test pilots (fields) is essential. Accordingly, in development contracts it is quite common that a section is included committing Statoil to test technology if development is seen as promising. The rather large differences between operational units concerning structure, work processes and culture at the same time facilitate and inhibit technology testing and implementation. Thus far, such differences, combined with the insufficient communication between operational units, have made it possible for suppliers, including members of the Research Centre, to knock on the next door if the technology they suggest is turned down in one part of the company. Although this may increase the opportunity for innovation, it means that suppliers need to know the company very well to avoid ending up running between doors. Moreover, it has lead to a tendency that operational units provide different solutions to similar problems, which is seen as inefficient by many.

C. The market driven model

Quite a few Statoil employees, particularly in the Research Centre, disagree that innovation in Statoil happens according to any formal strategy or plan:

> *… you have to understand how technology development is done in Statoil. It happens according to a very specific model, and I have never seen that model outlined the way it really happens…*

In this narrative, I attempt to provide the essence of this model, which was referred to as the 'market driven model'. The process is initiated when somebody in Statoil, no matter where he or she works, gets an idea. It can be about anything; a great idea emerging in a project or somebody just coming up with something really smart. To enable the testing of the idea, some money and a little time is needed. I was told that almost anybody in Statoil can obtain this if they are sufficiently insistent. If the preliminary test indicates that you are on to something smart which may be applicable in one or more of the operational units, the next step is to find somebody who believes in you, and is willing to try out the solution. Testing can be very costly, so the necessary money has to be provided by one of the operational units. It may take some effort to find the 'someone' willing to stake on your idea. The way to do this is to talk with persons you already know in the operational units. This should be colleagues among the specialists; it is referred to as 'hopeless' to go to the managers first. If you find somebody who agrees that the idea is interesting, he or she will talk with colleagues in the operational unit, and the idea is gradually sold to them until at some point, your ally in the operational unit decides to go to his or her boss and market it. If the boss is receptive, things start to happen, and if technology testing proves to be a success, then the news about it spreads like fire. The other operational units will hear about it through their networks, and demand to know more about it:

> *… an example of this was the Ocean Bottom Seismology solution. It was a crazy success, and it was never decided anywhere. The top management had some presentations, maybe, but it was never any targeted strategy, it only happened through market forces. Those tests, if they do not succeed, then the rumours spread even faster, and everybody will say 'forget it', it doesn't work. Then nobody is interested, and the thing dies away.*

The three stories are summarized in table 9-2, with emphasize on characteristics of technology development and adoption. A reasonable conclusion of this example could be that in Statoil, innovative ideas may form everywhere in the company, and that the characteristics of the person or persons having the idea, and of those supporting it, are as important for the destiny of the idea as are the official strategic targets and values. This assertion is supported by my observation that it was not at all unimportant who were involved in the processes related to the SIOR program. Moreover, although not particularly emphasized in the example, the stories I was told indicate that there are great differences between field organizations and divisions regarding the willingness and ability of their members to engage in innovation.

Table 9-2 Statoil innovation processes

	Innovation creation	**Innovation adoption**
A. The official story	According to strategy, headed by Research Centre members	According to strategy.
B. Problems seeking solution and the other way around	Based on need or interest. Headed by suppliers in collaboration with specialists and operational unit members	Based on need or interest in the operational units.
C. The market driven model	Based on ideas, more often than not suggested by researchers or specialists. Development partly outside official target areas and budgets.	Based on internal market forces.

9.1.3 Example III: Inter-organizational differences

The previous analyses focus on company characteristics and habits, and external conditions are not considered. Another common way to describe an organization is to compare it to other organizations, sometimes leading to a ranking of the organization as being 'stronger than X', or 'weaker than Y' in specific fields. This could also include evaluations of differing framework conditions. Such comparisons were frequently made when I asked respondents to characterize Statoil innovation capacity. The general opinion seemed to be that Statoil was less conservative than large international companies like Exxon, Total, BP, and Chevron; in particular in the areas of *reservoir* and *oil recovery*. I was told that the robust economy in Statoil and the strong social democratic values had caused the development of a culture encouraging people to focus on exploration, evaluation and discovery. According to my respondents few other petroleum companies allow their employees similar freedom to spend time and money to pursue technological innovation. The culture in Statoil was said to be comparable to Shell, but very different for example from Chevron. Statoil and Shell were both characterized as consensus driven companies with a strong focus on technology development. Chevron, on the other hand, was referred to as being more entrepreneurial, but also more aggressive in business. Interestingly, the former oil and gas division of Hydro, which is now merged with Statoil in StatoilHydro, was also compared to Shell, but in different areas. The common denominator for Hydro and Shell was said to be that neither of the companies wanted to employ 'engineers'. Apparently, this signified that they were on the lookout for specialists who were not primarily focused on their special field, but for 'business people with engineering skills'. In contrast to this, I was explained; strategic thinking and business instinct were not typical characteristics of Statoil engineers.

More differences between Statoil and the former oil and gas division of Hydro were pointed out which could be of potential interest to a future understanding of evolving practices and ideas in the merged company. It should be emphasized that the interviews forming the basis for this section were performed before the merger was known. At the time Hydro was a smaller petroleum company than Statoil, distinguished by its origin in a much older industrial tradition. While Statoil was said to have a 'replay' culture, involving informal power networks which were actively exploited to influence decisions, particularly after they were made, employees in Hydro were seen to be more loyal to top management decisions. Hydro was further seen as a company where purposive effort was made to realize decisions, in particular if they were of a strategic nature, while Statoil was described to be more open to suggestions made by others, and more willing to give up on original plans. As an example, Hydro employees were known for not putting up with licence partners voting down suggestions in the first round, and for repeating the suggestion until it was accepted. Statoil, on the other hand, was said to have a culture for not being that demanding, and to rather tend to set own interests behind those of the licence partners. The openness of Statoil was seen as positive, indicating a general will and ability to learn. It was also seen as negative, and partly naïve, making many of the employees inclined to be unreflective about areas of strategic importance to the company. Statoil and Hydro were also seen to be different in that Hydro apparently selected distinct areas of excellence, while Statoil tried to be good at everything. In sum, technology development in Hydro was seen to be more strategy driven than it was in Statoil, substantiated by the view that in Hydro decisions of excellence were followed by the enforcement of widespread implementation of selected technology. Because many Statoil decisions about technology development and use were made in the operational units without the involvement of the top management, development tended to be a local licence activity, and not a corporate business. The advantage of this was seen to be that in spite of there being '*too many yuppies'* in the corporate executive committee, the freedom given to specialists at all levels nevertheless enabled the development and adoption of a lot of technology.

A factor pointed out by some as contributing to the willingness of Statoil managers to adopt technology, is the Norwegian legislation related to employees' job protection rights. This was assumed to render employees more willing to take risk than people employed for example in American companies, which are known to easily give notice to people who are unsuccessful in some way or other. Another factor seen as decisive for the story of success for Norwegian petroleum technology development and use is that new technology has been demanded by the authorities. Present regulations imply that petroleum company applications for exploration licenses on the NCS have to include argumentation for a work program where technology development and use are important aspects. The authorities expect field development concepts to be renewed from one licensing round to the next, and this, together with the complex and diverse geological and geophysical characteristics of the various petroleum fields, are seen as important incentives for technological innovation. Another important principle developed by Norwegian authorities to support innovation, is a statutory provision entitling operators on the NCS to get a share of the oil revenues to invest in research and development. So far, this has been 'free' money, representing a unique opportunity to develop and mature technology in particular for Statoil, which has held the majority of operatorships on the NCS. At present StatoilHydro rank on top among Norwegian companies with regard to research investment, but with an increasing international activity, this may change.

Norwegian licenses' assignment policy differs substantially from what is customary for example in south-American or northern-African countries. In such countries, petroleum companies compete about making the highest bid for a drilling block. In Norway, on the other hand, technological innovation is an important strategic means to get access to exploration rights. Another factor distinguishing Norwegian (and also British) petroleum industry from the rest of the world is the work processes in the licences. In Norway, the company holding the operator's licence do all the work, but is co-financed by the licence partners.

The measured effects of these characteristics seems to be a large degree of transparency between petroleum companies on the NCS, as licence partners also have the right to evaluate and sanction technology. I was explained that the legislation in, for instance, the Gulf of Mexico, where StatoilHydro has ownership in several fields, is on the other end of a scale. In the Gulf the licence partners do not pay for development activities in the same way, implying also that they have very limited access to details about technological and work process solutions. Licence partners can vote down suggestions for example about drilling new wells, but not the use of new technology. A comment to the Norwegian system among Statoil employees was, by the way, that they expected the authorities to make sure that the joining together of future licence groups would not inhibit further development on the NCS.

This analysis, which is briefly summarized in table 9-3, indicates that the innovation capacity of Statoil as compared to other companies is influenced by two factors in particular. One is the general openness towards technology and knowledge, which partly can be ascribed to the Norwegian petroleum legislation, partly to the prevailing national principles of social democracy on which the company was established. The other factor is the local freedom granted to operational field management, including licence partners, to make decisions about technological change without involving the top management. This makes the company flexible, and is seen by Statoil members as a motivation to solve problems locally. As the table indicates, company characteristics apparently supportive of innovation can also become inhibitors of development processes, for example by making company processes less coordinated, and render joint strategic efforts difficult. In conformity with the previous two analyses, this suggests that innovation capacity is conditioned by situation and, implicitly, that the cultivation of certain organizational characteristics is not sufficient to ensure innovation capacity in itself.

Table 9-3 Statoil innovation capacity judged by employees' comparison with competitors

Statoil characteristics	Statoil employee evaluation of own innovative capacity compared with other petroleum companies	Apparent impact on overall innovation capacity
Employees encouraged to focus on exploration, evaluation and discovery	Stronger than most competitors	+
Employees more focused on technical details than on business related considerations	Weaker than many competitors	-
'Replay' culture and possibility of influence through informal networks	Decision processes more time demanding	+ / -
Openness to changes and new ideas	Decision processes more time demanding	+ / -
Tries to be good at 'everything'	Areas of excellence less distinct	+ / -
Field organizations empowered to pursue local innovation initiatives	Less driven by corporate strategy, more by internal 'market' forces	- (corporate capacity) + (local capacity)
Increasing internationalization	Less experienced than most competitors	+ / -
NCS based frame conditions		
Characteristics of NCS fields diverse and complex	More willing to take technological risks than most competitors	+
Norwegian working environment legislation	Better employee protection increases risk willingness	+
New technology demanded by Norwegian authorities in connection with field developments	More focused on new technology than many competitors	+
Norwegian statutory provision entitling NCS operators a share of oil revenue to invest in R&D	Invests more in R&D than many competitors	+
Licences' work process	More transparent than most other national systems	+ / -

Lately, strengthened efforts to internationalize the company, combined with negative publicity caused by incidents on the NCS, cost overruns, and other problems, have led to a situation where Statoil managers appear to consider suggestions about testing and implementation of new technology more carefully than before. Even if the view is that the company is still courageous in connection with field developments, the general view seems to be that the 'cowboy culture' of the past has been replaced by a focus on short-term profitability and risk assessment. Some Statoil employees give voice to worry that this will make the company less innovative. An interesting issue is whether the level of innovation actually affects business performance, or not, because thus far, apparent differences in innovation capacity between petroleum companies (or even between Statoil operational fields) do not appear to be reflected in corresponding variations of earning capacity. This observation supports the claim made among others by Neely et al. (2001), that understanding of the relationship between innovation capacity and business performance is still limited.

9.1.4 Understanding innovation in Statoil from a complex responsive processes perspective

The preceding examples are all based on the same data, but the analyses are approached in different ways and with different foci. What the examples have in common, though, is that there is just cause to question the quality of the results. An important reason is that I have largely averaged my 'data', which are narratives and impressions, and assumed that, by and large, these abstracted qualities are generally valid as characteristics of Statoil as a whole. Another reason is that the analyses build on what could be seen as 'snapshots of understanding', further limiting their validity. My objection against the predominant argumentation in innovation research is just that it appears to be based on these kinds of assumptions of universal, invariable organizational understanding and intention, and the predictability and controllability of processes of human relating. Another problem with the preceding analyses is that I am not specific at all about the theoretical perspectives I use. Still, since within the field of innovation research there does not appear to be a tradition for discussing the impact on research results of different theoretical and methodological approaches (with some exceptions, like Gopalakrishnan and Damanpour, 1997), I should be on solid ground in that respect.

When I first met the persons from Statoil having generously decided to finance my PhD study, I interpreted what they demanded to be an analysis of typical company characteristics supportive or inhibiting of innovation, not unlike the examples above. My decision to take the risk of not solving the task the way we originally agreed was largely based on my increasing doubt that such analyses would actually help Statoil managers to improve innovation processes. Two experiences were of particular importance for my change of view. One was that innovation apparently emerged while Statoil members did what they were supposed to do in their everyday life. The other was the experience that ‘innovation’ could be easily recognized in management ambitions and in generalized Statoil narratives about past achievements, but was very hard to catch sight of in the middle of the diversity of everyday activities in the SIOR program. This could be seen as a support to the suggestion that true innovation and creativity is not in the past, neither in the present (Stacey, 2006), and clearly indicates that innovation is difficult to foresee, and even harder to control. Human inclination to generalize and reify organizational themes and processes makes communication easier, yet more complicated, and it is likely that this habit is an important source to the surprising experience that, in practice, ‘things’ do not evolve as smoothly as planned, or not even according to plan at all. The recognition of innovation as human communicative interaction in which new themes are introduced or emerge, develop, and change, moves attention towards the ‘messy’ everyday responsive processes taking place between people at work. From this perspective, the prevailing idea that one, or a few, persons can design and control innovation, means that the contributions of everybody else taking part in the process erroneously are attributed little or no significance. Moreover, assumptions of innovation managers’ need to control and monitor subordinates should be challenged by the assertion made by Shaw (2002) that, generally, management is about the paradoxical situation of being in charge but not in control.

These ideas are probably suited to frustrate any manager accountable for successful innovation. On the other hand, my SIOR experiences also promoted a view that careful management attention to themes influencing and influential of the communicative interaction between persons directly and indirectly involved in innovation processes enhanced managers’ chance of recognizing patterns supportive and destructive of innovation. Implicitly, my claim is that it is possible for innovation managers to obtain a huge say in innovation processes. The view of managers as participants in the social processes of organizational life, and not as designers and controllers of such processes, however implies that as much as they are free to choose their own actions, their freedom is also paradoxically constrained. This means that the actions they decide on will at the same time expose their colleagues/subordinates to possibilities and constraints, bringing about shifting experiences of identity and difference, inclusion and exclusion, inspiration and anxiety, freedom and control, and of structures of power. This is likely to cause a diversity of responses including enthusiasm, doubt and resistance.

9.2 Variance in innovation research – the importance of context

My experiences in SIOR have led me to emphasize power relations, identity, meaning and leadership as communicative aspects which stand out as being of particular relevance to explain innovation processes in Statoil. It is my view that purposive, open reflection on these aspects can help managers to understand better the development of innovation processes, and the impact of their personal contribution as participants in the processes. The insight gained through such reflection may be of support to managers seeking to influence innovation processes, but should not be seen as a tool to get 'in control'. The last claim is based on the additional view that all individuals act on intention, and thus, that the outcome of human interaction is largely unpredictable. Furthermore, it is assumed that individuals are not entirely free to express themselves or act according to their liking. Although in different ways, everybody are constrained, but also enabled in social relations. Some of these enabling constraints can be hard to point out, but can be found for instance in local and widespread taken-for-granted 'rules' of how people should act in specific situations, which incidentally constitute powerful mechanisms of social control. Another important consideration is that individuals have the capacity of imagination and emotion. This makes us able to fantasize about future situations, and direct our actions according to such fantasies. It also makes us inclined to ascribe value to ideas and objects which surpass the 'rational' significance of the idea or object, like the 'Statoil view' of technology as an enabler of the future. An obvious assumption therefore is that similar ideas and objects will have different meaning for different persons, or in different situations. A more common way to express this is that ideas and courses of events are *context-dependent*.

The focus in most research on innovation is not on basic aspects of human relating, but on what could be understood as the context-dependent products of human communicative interaction, such as technology, tools, and dominant ideas about organization, business models and management. As already pointed out, researchers nevertheless tend to present their results as if they were of general validity across contexts. This could be seen as a problem in my study, too. The papers of this dissertation provide several examples from the SIOR program as basis for discussions about different aspects of innovation. The examples are stories of actual events, yet composed to emphasize certain ideas. Interpretations are made from a complex responsive perspective, based on own experiences as well as stories and point of views offered by a number of different people. My intention has been to seek ways to understand the phenomenon of innovation which better reflect individuals' 'real-life' experiences, and in the process of doing so, ideas emerged resulting in an understanding of innovation which may appear as generalized and disconnected from the original events as most other explanations of innovation.

As indicated in the previous chapter, I see my contribution to innovation research to be dependent and independent of the 'Statoil context' at the same time. The reason for this is that, seen from my perspective, 'context' is inseparably related to human communicative interaction. At the same time, the complex responsive processes perspective is based on a view that human interaction is distinguished and 'structured' by communicative aspects which can be recognized across groups, communities and cultures. This suggests the possibility that more generalized ideas about how phenomena, like innovation, emerge from and influence on human interaction, can indeed be developed. I see the validity of such ideas to be based on a generalized recognition of their value as explanatory factors to obtain insight into other contingent situations.

9.2.1 Conceptualization of context

The potential significance of context for the outcome of research is barely mentioned by innovation researchers. As opposed to this, the methodology researchers Huberman and Miles (2002:359) emphasize that social scientists should contextualize the phenomenon they study in an attempt '*to keep it alive in the world of interacting individuals, to locate it in the biographies and social environments of the persons being studied*'. This view is supported among others by the organizational researcher Weick, who maintains that '*people learn about events when they can put them in a context'* (Weick, 2001:447). Several authors suggest that narration is an important approach to bring context to the forth as a basis for interpretation of organizational phenomena (Boje, 1991;

Czarniawska, 1998; O'Connor, 2000; Tsoukas and Hatch, 2001). Boje (1991) even argues that without being a participant in the organization providing context for research data, it will be difficult, if not impossible, for a researcher to grasp the meaning of events. Pushing this claim to an extreme would mean that most innovation research should be seen as more or less 'qualified guesswork'.

Weick(2001) puts forward a somewhat different view of 'context'; regarding it as a selectable, transportable frame of reference. His suggestion that researchers should consciously step 'outside' and invoke various possible contexts of their experience indicates that his ideas are based in the systemic view that phenomena can be understood as 'wholes' having an inside and an outside, and that this is also true for 'context'. Yet, Weick's selection of words also suggests that he sees context to involve human experience. The same view is explicitly advanced by Huberman and Miles (op.cit.), who maintain that their intention is to show how lived experience alters and shapes a phenomenon, at the same time as '*the structures of any experience are altered and shaped as they are giving meaning by the interacting individuals*'. Apparently, they see human interaction as involving the influence of present and former individual experience on joint and individual perception of a phenomenon. Such influence leads to a changing sense of meaning of that phenomenon, and at the same time, of own experience. This indicates that their view is rooted in ideas of human interaction similar to those forming the basis for the complex responsive processes perspective.

Seen from this perspective, the conceptualization of 'context' is not obvious. The perspective is not based on a notion of conceptual space, although it is of course recognized that human interaction takes place in physical locations. The fundamental idea is that beyond us as human persons there are only other human persons; there exists no social system (organizational, political or other) outside human communication. This means that processes of communicative interaction are not inside or outside anything, and therefore, there can be no separate or separable system or context existing outside of interaction. This recognition is seen to be the crucial starting point for all struggles to make sense of phenomena in organizational life. In accordance with this, a factual situation (like time and place of events, who were there, and the subject discussed) is seen to be inseparably connected to some kind of individual evaluation which, over time and in the light of subsequent experience, may alter. Concerning ideas, bodies of rules, software solutions, and technological concepts, these are seen as products of human communicative interaction that will influence the interaction, but which may also evolve and change in the same process.

As far as I can see, the concept of 'context' is not explicitly discussed by authors basing their research on the complex responsive processes perspective. Within this perspective, several notions have been adopted which in my view are inherently context-dependent, yet do appear as decontextualized ideas. I see the concepts of 'figuration', suggested by Elias (1978), and of 'social object', suggested by Mead (1938), as examples of such concepts. *Figurations* consist of interdependent, interacting individuals, and can represent a few persons, but also an organization, a city or a nation. Elias (ibid.) emphasizes that in the instance of figurations involving large numbers of people, they cannot be perceived directly because the 'chains of interdependence' linking people together are longer and more differentiated. Accordingly, complex figurations must be understood by '*analyzing the chains of interdependence*' (Elias, 1978:131). The concept of figuration emphasizes a view that no single individual can change the history alone. Elias (1991) states that even people we have been taught to regard as great personalities in history, acted on and within the actions, ideas and products of other people.

The concept of *social object* is one of several formulations of human processes of generalization and particularization suggested by Mead (ibid.). To recall, a social object can be understood as the generalized tendency of humans to act in similar ways in similar situations. This tendency means that individuals participating in specific social acts tend to produce situational responses which they will recognize as typical of that situation, or of a certain group of people, in spite of obvious individual variations. In Mead's terms social objects form the social interaction, but at the same time, they evolve and are being formed in social interaction.

In my view, the notion of 'context' can be understood as coherent, changeable patterns of past and present experience, relevant considerations, present intentions, and fantasies of future situations, particularized by individuals in local interaction in physical locations. Experiences of 'context' emerge and are reiterated in processes of human relating, simultaneously leading to widespread and local ideas about what is possible and what is fiction, some more persistent than others. This means that in a particular situation, individuals will perceive certain patterns of ideas and beliefs as being truer than other patterns. A patterns shift, so does power relations, rendering some interpretations and responses more probable than others.

9.2.2 The significance of time

From a complex responsive processes perspective time is seen in a circular, paradoxical view. This means that the past is not seen as finite, but is '*retold in the present in the light of expectations people are forming in the present for the future'* (Stacey, 2007:263). This idea is based on Mead's notion of an emerging present, which evolves in the interplay between intentional humans and become part of a novel future. Mead further claimed that the emergent present inherently would lead to a reinterpretation of the past. As a consequence, the present, the future and the past can all be seen as temporal dimensions.

In my view, this provides a way to think about the relation between situated local everyday activity and idealized organizational characteristics (Mead, 2002). It also implies that organizational themes recognized as routine, culture and tradition can only be found in their particularizations in local interaction. Such particularizations will reflect a history of individual and joint experience, abstracted into generalizations or reiterated as personal accounts. As observed by Mead (1967:256), the attention of historians is largely on tracing out development '*which could not have been present in the actual experience of the members of the community at the time the historian is writing about'*. This is in line with my finding, discussed in paper C, that the individual SIOR members could not identify actions decisive for the development of innovation processes as they happened. Only when looking back, like research is mostly about, will it be possible to '*bring out changes, forces, and interests which nobody at the time was conscious of*' (l.c.). Mead suggests that this can explain why '*the arrangement which may appear at one time in terms of means and ends appears at another time in terms of cause and effect*' (ibid.: 126). The way I understand Mead's thinking, is that participation in the living moment is experience, while retrospective reflection is the 'structuring' of experience. Because humans determine each other and are mutually dependent, human experience must be understood in terms of interrelation, and this involves time.

9.2.3 De-contextualization / re-contextualization

A tendency among humans is that we construct 'unities of experience' (Stacey, 2007:263), or imaginary 'wholes', and relate these 'unities' to perceptions of value. This could be seen as a way that humans organize own and others' narratives of experience, making it possible for them to reflect on and respond to previous experiences and to include them as part of the context in future situations. Such 'unities of experience' may also form the basis for idealizations of generalized phenomena, like the idealization of innovation and technology apparently prevailing in StatoilHydro: *'For us, technology and innovation have always been the keys to commercial successes'* (www.statoilhydro.com). In consequence, 'unities of experience' may profoundly influence our thinking, although Mead (1967) also mentions that they will be reflected to varying degrees in the self-conscious life of the individual.

A similar line of thought can be recognized in Washbourne and Dicke (2001), who with reference to Hatch (1997) point out that over time, humans tend to evolve 'grand narratives of progress' which are no longer associated with the original, situated events. Such narratives have also been referred to as '*decontextualized ideals'* (Boje, 1991), and can be seen as human efforts to understand the universality of historical accounts (Washbourne and Dicke, 2001). The grand narratives of progress are founded on the idea that scientific and technological inventions lead to an increasingly more advanced industrial society, distinguished by rationality, control and the belief in principles of universal, general and time-independent applicability. As indicated in paper C, I see most of the explanations and models within innovation research as being parts of the same grand narrative of progress. As an example, Poole and Van de Ven (2004:xi) suggest that innovation can be seen as '*an important partner to change, and the wellspring of social and economic progress, and both a product and a facilitator of the free exchange of ideas that is the lifeblood of progress'*.

Although it is a small digression, some will perhaps be intrigued by learning that even the association connected to the word innovation has changed over time. The word came into widespread use as late as in the 16th century (Girard, 1990). At the time it was associated primarily with theology and politics, and signified a departure from what by definition should not change. 'Innovation' stood for rebellion, revolution ('may God forbid'), and even heresy. Girard also claims that at the time '*a taste for innovation was* *supposed to denote a perverse and even a deranged mind*' (Girard, 1990:9). Paradoxically, the seed to change was sowed during the French revolution (1789-1799). Most people in France experienced that revolution did not involve disaster, although not paradise either. It just involved difference. What was gradually changed by this, was not the core meaning of the word 'innovation' (which is renewal), but the context within which it was interpreted. The shift was from religious doomsdays prophecies, towards science and technology and expectations of social and economic progress.

9.3 What can be learned from the SIOR initiative?

The development of innovative ideas is officially encouraged in StatoilHydro. From my perspective, this could also be seen as an encouragement to change communicative patterns, involving shifts and (re-)stabilisation of structures of power and identity. One of the implications of such shifts may be that some individuals holding expert roles feel that the relevance of their qualifications is reduced, involving an experience of loss of prestige. This could be an underlying reason that new ideas are met with objections. New leaders of innovation may emerge in the shape of individuals capable of particularizing new patterns of talk in a way perceived by some as future-oriented, although by others as a challenge to predominant truths about 'how we do it in our company'. In such processes new themes are promoted, but at the same time their acceptance may be perceived to be inefficient because of the resistance they may be met with. Knowing 'the rules of the game', that is, the more or less unconscious organization-wide agreements commonly referred to as 'culture', including informal rules of interaction, could show to be of great importance for individuals trying to influence the destiny of an innovative theme, whether their intention is to weed it out or to fertilize it. As previously discussed, this showed to be true when the 55 % SIOR ambition was suggested. A majority of relevant Statoil members objected to the realism of the ambition for quite some time, and in the beginning the SIOR core team members to some extent had to 'knock in doors' to make their colleagues engage in conversations about its potential. They emphasized in particular their extensive internal network, their experience and their credibility as factors enabling them to influence their colleagues in the direction of increasing acceptance for the 55 % target. Another interesting discussion in this is related to individuals' possibility to go on together in the face of the paradoxical dynamics of conflict and cooperation, which seems to be commonly provoked in processes that are intended to lead to innovation. Continued collaboration requires the establishment of a sense of joint meaning among implicated parties, involving local processes of negotiation and adjustment among individuals. The present study indicates that Statoil innovation processes are facilitated if the experience of the manager(s) pointed out as being responsible for innovation activity includes knowledge of the processes in which he or she will have to interfere, and of arguments likely to be used for and against the idea of innovation.

In this section I will draw attention to some aspects of the implementation of the SIOR initiative which in my opinion may fruitfully be discussed by StatoilHydro managers and other employees, to increase their awareness of how individual and joint actions may influence innovation processes, but also be influenced by such processes. The importance of this is substantiated by my observation that innovation in SIOR emerged and developed under the influence of very many persons, of which quite a few did not seem to be aware of the impact of their actions on SIOR activities. I also noted that the ideas of the SIOR program was formed by the various interests in Statoil, but at the same time they appeared to gradually form, and transform, the interests of those who in some way were engaged in the activities. Another observation was that 'innovation' was difficult to recognise among everyday work activities, yet that the importance of the details of ordinary business life should not be underestimated in reflections about innovation processes.

9.3.1 The importance of top management support

One way to identify possible lessons from the SIOR program is to look at the influence of individuals and of dominating ideas on the program. To recall, SIOR was intended by the top management to encourage technological innovation supportive of increased oil recovery from subsea wells. The realism of the ambition on which the program was founded was broadly questioned for quite some time, and the approach adopted to realize the ambition was seen as unusual:

One has to be aware that SIOR is exceptional; it is exceptional the way they did it. First, the intention and objective of SIOR is very special, because we are going to increase the recovery factor of subsea fields to 55%. Basically this is an absurd objective for a research project, because we do not operate fields, we do not increase production – the operational units do that. And if the objective should be obtained, the operational units will say that they did the job, SIOR will never be given credit for increased oil recovery…

The SIOR core team members clearly indicated that the support of the top management had been of vital importance to get acceptance for their roles and messages in the company. The program director seemed particularly aware of the importance of this, and continued to provide the top management and Statoil public information associates with news about SIOR achievements. Still, collaboration between Research Centre members and operational unit specialists appeared to be strongly influenced among other thing by the opportunity of local operational unit managers to take decisions independent of top management initiatives, which also involved the freedom to reject new ideas. One of the first tasks the SIOR program director attended to was thus the need to mirror the ambitions of increased oil recovery imposed on the SIOR core team in the Key Performance Indicators of the affected operational units. Even if the SIOR core team members were supported by a steering committee and the executive vice presidents of the divisions for Technology and Exploration & Production Norway, two years went by before this change was accomplished:

… we have to get somebody in the operational units to stick their neck out, or, we just about have to draw their necks out by somehow to get it on their target board. Because it is their target board which determines the testing of new technology.

When expectations about increased oil recovery were finally included among the Key Performance Indicators of the operational unit managers, it caused a clear increase in their attention towards the SIOR activities. This substantially improved the possibility for the SIOR core team members to accomplish the task assigned to them.

In my view, innovation processes are encouraged based on expectations of improved business performance, yet are inevitably met with opposition because development and adoption of novelty inherently also involves risk. This makes innovation a top management responsibility. The experience from the SIOR program emphasizes the importance of top management support. It further indicates that the demand for joint corporate effort to prolong the profitable production phase of maturing fields to some extent is in opposition to established principles of operational field autonomy. It is my impression that the communication between the top management and business unit managers about innovation challenges should be strengthened.

9.3.2 The importance of management actions

During the SIOR program period several major change initiatives were implemented which seemed to support, but also to disturb SIOR activities. The introductions of corporate initiatives, distinct technology areas, and a revised technology strategy in 2005/2006 are examples of initiatives which strengthened the SIOR idea, but that also made it necessary for the SIOR core team to adjust program scopes and objectives to align with the new initiatives several times. The extent of SIOR activities made this a time-consuming job. Moreover, the generally high level of project activity in Statoil made it necessary for SIOR to constantly compete for resources and attention. The need for SIOR members to develop and keep up good relations with key persons in the operational units and among specialists and researchers was, however, complicated by some of the top management initiatives. For example were large parts of Statoil reorganized at the end of 2004, meaning that many persons new to their positions had to be convinced about the SIOR idea. At the end of 2006, disclosure of the merger to come made the major part of Statoil employees shift their attention towards the future situation, although they were instructed to continue 'business as usual'. In my view, their response was indeed understandable, among other thing because everybody were demanded to reapply for their jobs, whether they wanted to continue in their current situation, or take on new responsibilities.

Another SIOR management challenge was related to the need for new ideas of SIOR solutions, as the ongoing activities were not assumed adequate to make Statoil reach the 55 % target. In the beginning, the SIOR core team decided to focus on the implementation of close-to-finished technology, to obtain a few 'quick wins'. Some of the researchers gave voice to a certain concern that this indicated the beginning of a more permanent move of attention away from genuinely new, innovative research. Because of an apparent tightening of demands on delivery made by line managers 'upwards' in the hierarchy throughout the program period, the concern seemed partly relevant. The biased focus on delivery, seen together with a continuous short-handedness in the program, could be part of the explanation that few SIOR members appeared to come up with genuinely new ideas, although this was frequently demanded.

My experiences in SIOR emphasize a view that management actions may support, but at the same time also constrain, innovation. There seems to be a need that Statoil managers (including resource owners and managers with administrative responsibilities) engage more often in conversations about the influence of their actions on ongoing and emerging innovation processes, and about the apparent tension between demands for efficiency and for innovation.

9.3.3 The importance of individual credibility

To me, the efforts of the SIOR members appeared to be of great importance for innovation in Statoil, owing in particular to the fact that they managed to arouse widespread attention to the importance of increased oil recovery in the company, and in other organizations. A role developed by the SIOR core team members in relation to operational unit managers and specialists, was the 'technology broker'. This was referred to as a new role in the company, and seemed to be appreciated by everybody I talked to in the operational units, as well as among the researchers:

> *They went to the operational units and said that 'we are going to develop technology and you have to make forecasts for future recoveries', and they actually succeeded in persuading them to do that. ... So only by talking, without doing anything, they realized that the recovery factor could be increased, and this was what they did the first year. Four persons went about just selling the idea, and before SIOR had really started, a certain success was ensured.*

Many of the operational unit managers admitted that they had considered the targets outlined in the technology strategy only to a limited degree until SIOR and the other R & D programs were initiated. The previous plans were referred to as '*distant to the everyday life in operations*', and I was also told that they used to be written in a '*language contributing to uphold a distance between research and business*'.

I noted that the notion of credibility appeared to be very important to get the attention of Statoil operational units' managers, and in relation to the SIOR program, the person clearly attributed most credibility was the program director. Every time conflicts emerged, he was called to mediate, and if operational unit members did not commit or follow-up the way the SIOR core team needed them to, he was asked to work 'off-stage'. In my opinion, this emphasizes that the position as 'technology broker' could not have been held by anybody. Another equally important understanding was that none of the actors taking part in the SIOR program processes was interchangeable just like that. Even if in innovation research, individuals are hardly visible at all, using a football analogue, we all know that changing one player may substantially affect the match. My experiences in SIOR indicated that replacing a person, whether in the core team, in the various activities or among the collaborators in the operational units, changed the ongoing processes, sometimes favourably, sometimes not. To 'push' innovation, looking for the right persons to man activities and encouraging the continuation of personal relations promotive of innovation, appears to me to be a wise strategy.

9.3.4 The importance of the Research Centre management

Returning to 2004, an interesting observation was that most of the SIOR researchers I spoke to did not feel obliged to relate to the Research Centre managers, including the SIOR director. Instead, they related to people holding roles as 'resource owners', and individuals referred to as their 'professional network'. I gradually understood that, over the years, there had been frequent restructuring of the Research Centre, involving changes of formal leaders. Apparently, this had led to a certain self-organization of the Research Centre members into research groups headed by strong professionals who worked independently of current management ideas. To me, this seemed to involve that researchers and specialists largely decided on which development activities to take part in themselves, leading to the situation that activities seen to be less 'cool' tended to get undermanned or manned with less experienced researchers. Apparently, projects seen as 'cool' were field development projects and high profiled technology developments, while for instance long-term projects related to mathematic modelling were seen to be less attractive.

There also seemed to be strong notions of 'us' and 'them' among Research Centre members, and I was told that many of the researchers felt that there was in fact a 'soundproof' layer between themselves and the management. Several SIOR researchers did for instance express doubt that they would be given support from their superiors if needed. During the first two years of SIOR, this situation appeared to be reflected in a lack of interest in the SIOR ideas from researchers assigned to the program. This meant, for example, that some did not relate to SIOR tasks assigned to them, implying that deliveries were not completed according to expectations. Others did not show up in meetings they were expected to take part in, justified by the argumentation that they did not believe in the processes. To me it appeared that it was not until 2006, supported by the inclusion of the SIOR activity managers in the core team, that SIOR researchers started to acknowledge the actions of the core team members as efforts to increase the interest for their work in the operational units.

I was surprised by the seemingly ambiguous role played by the Research centre management in relation to innovation. Six of the members were, of course, heading the R & D programs. With the exception of the responsibility these six carried in their respective programs, the Research Centre management team did not really seem to engage in the research activity. Incidentally, I also found it a bit surprising that although they financed my study, I was never invited by the Research Centre management to discuss innovation. The conversations I was part of left me with an impression that focus in their team meetings was on 'control' and not on 'research' or 'innovation'. Paradoxically, it appeared that while the Research Centre management fell into line with the top management, and gradually tightened the demand for proofs of control, such as accounts and forecasts, the SIOR members largely wanted managements' attention towards their professional skills and challenges. Comparing these experiences to ideas of management participation emphasized by the complex responsive processes perspective suggests that increased attention of Research Centre managers to the challenges and needs of the researchers may stimulate and support innovation efforts, provided that measures of support are focused more than measures of control. Moreover, it is my impression that the importance of the Research Centre need to be the subject of continued strategic discussion in Statoil, because of the apparent diffuse role of ‘the researchers’ in company innovation processes.

9.3.5 The importance of communication

Another experience, which was also emphasized by many of my respondents, was an apparent lack of curiosity among Statoil employees about others’ fields and ideas. Some explained this by the limited rotation of specialists in parts of the company, some by the general situation in Statoil, which was seen as ‘safe’ and ‘unchallenging’. Others argued that many of the operational unit members considered their challenges as ’special’, implying that achievements somewhere else were of little interest to them. An aspect nobody mentioned, which seemed to me to be of relevance, is that to be curious about a specialist field of which you are unfamiliar, is demanding. Few are used to ask relevant questions in areas they do not know, and within the experience of a tight agenda or a generally busy day, it is probably not that surprising that few invest the time needed to get a hold on something completely new to them.

To me, it seems as if ‘conversation’ is a largely under-exploited approach to share experience and information, and encourage innovation. This may appear as an odd statement to make, because I was frequently told that Statoil members like to share what they know, and this was my experience, too. I found that interest was always welcomed, and that most people willingly spent time to tell me about their projects and their field. However, assertions made by my respondents that Statoil employees share information only when they are asked, and that they tend to show more interest in their own fields and opinions than in those of others, also seemed to be largely true. An apparent consequence for the SIOR program was that managers and specialists had to spend a lot of time trying to convince their colleagues about their ideas, and answer to arguments against the ideas. The first concept I established for my self when I started to spend time with SIOR members, was, in fact, ‘persuasion culture’. My reflection is that there is a need that more Statoil employees train their ability of openness towards new or unusual ideas. By this, I do not mean to encourage processes for quicker decisions on the quality or utility of ideas, but for the increased awareness among employees, including managers, of approaches to explore, clarify, and possibly develop emerging patterns of themes.

9.3.6 Characteristics of the SIOR activities

Another way to approach the question about what can be learned from the SIOR initiative is to take a look at 'typical' characteristics of program activities that seemed to develop well, and of those that did not. An overall impression was that the program members, directly or indirectly, profited from the large Statoil network of the SIOR core team members, and of their ability to use it. The core team members were judged as competent, credible and experienced, and the program activities were supported by the top management. On the other hand, SIOR members were not in a position to realize the 55 % ambition; their possibility was limited to render probable the realization of the ambition through development of new technology and adapted work processes. Moreover, it showed difficult to establish accurate connection between SIOR activities and presumed IOR contributions, although careful calculations were made. Although the SIOR core team members appeared to agree that additional or alternative development activities were needed to approach the 55 % ambition, they never really immersed themselves in this problem. From what I could observe, this could largely be explained by a general time pressure in all SIOR activities. SIOR members appeared to get into a squeeze in many areas; between professional performance and administrative tasks, between the need to inform and persuade, and the need to 'actually do the work', between short and long term targets, and between numerous enquiries from other Statoil units. In addition, they had to constantly compete for attention and resources, and deal with the current question whether the motive power of the researchers was knowledge development or technology adoption and use.

Concerning the different SIOR activities, my impression was that they progressed without too much problems if individuals in one or more operational units who believed that the technology in question was important, collaborated with individuals in the Research Centre who engaged in the development activity in a way that made the operational unit members continue to believe in the potential of the technology. This involved among other things that communication between collaborating partners was effective, that SIOR members were perceived to show real interest in and knowledge about the challenges of the operational unit(s), including business challenges, that actual progress of technology development corresponded to expectations, and also that collaboration with external suppliers was based on terms acceptable for both parties. It also clearly helped that individuals collaborating actually liked and respected each other, that technology proved promising during initial testing, that the operational unit(s) management openly supported the collaboration, and also that the SIOR program director involved personally in the processes. On the other hand, activities seemed to suffer when it was difficult to find people in the operating units willing to commit to collaboration with SIOR members, when operational unit members did not believe that 'SIOR researchers' were sufficiently competent, when expectations about scope and outcome of the collaboration differed, when development activities and results deviated from plan, or when external suppliers and Statoil members did not agree on terms, particularly terms related to economy and intellectual property rights.

To me, the above account elucidates one point in particular, which is the significance of power relations in Statoil. In conversations I was part of, individuals commonly evaluated each other in terms of words like 'credibility' and 'knowledge'. My impression was that this more often than not was about conflicting opinions concerning themes such as 'who knows best' and 'who is the most credible predictor of future company needs', and about conditions under which the individual saw it acceptable to contribute to some specific task. Such conflicting opinions could be understood as power struggles. As mentioned above (chapter 6.2.4 and papers), I base my understanding of power on Elias (1991). This means that power is seen as a phenomenon inherent in all human relations, being one of the aspects of human life through which people are continually enabling and restraining each other. In Statoil, this kind of power struggles appeared to affect innovation in ways which could sometimes seem to be unfortunate, sometimes fortunate. My suggestion therefore is that managing innovation involves the courage to focus on power relations, especially those resting on ideas taken for granted, and potentially being ready for replacement.

9.3.7 Concluding reflections

I see the most important lesson to be learned from my experiences in SIOR to be the understanding that *while employees of a company will be influenced by innovation, they* *will also influence the processes, consciously or unconsciously*. Accordingly, innovation should be seen as a collective achievement, and thus, a collective responsibility. In my view, this insight forms a basis for rethinking how innovation should be approached in Statoil, and in other companies, and for potential shifts in managerial priorities. A consequence of the reflections made in the papers A-D is the proposal that 'innovative capacity' emerges because of relational phenomena in organized life. I find that this capacity may be positively influenced by Statoil employees, in particular by managers and leaders, by paying competent attention to such relational phenomena.

A way to look at the complex responsive processes perspective is that it is an invitation to reflect on the manner in which people are reasoning as one of many aspects of human action in organized life, instead of taking rationality for granted. This is a view radically different from the focus of most current theories and prescriptions on what innovation managers should do. Approaching organizations as complex responsive processes could be seen as an opportunity for managers to take seriously their own experiences as leaders, instead of striving to meet with idealized ideas of management. Focus is on what individuals are actually doing, and not on what they did or plan to do. It follows that a key question for any manager is what the consequences of adopting this perspective may be for him or her, and for the company. Incidentally, this is a main theme among the participants in the Doctor of Management (DMan) program at the Business School of the University of Hertfordshire in England. Most of the DMan participants are experienced managers and experts who base their dissertations on reflections on own experiences in their professional life, supported by the ideas of the complex responsive processes perspective and other theoretical contributions seen to be of relevance. Examples of their work can be found in Griffin and Stacey (2005), Groot (2007), Stacey and Griffin (2005), and Shaw and Stacey (2006). Drawing on this work, I suggest that Statoil management team members, including projects managers, senior experts and members of teams connected to corporate staff and services, would profit from spending more time in joint reflection not only about how to solve technological problems and meet with targets on production, safety and economy, but on own, relevant everyday experiences, such as conflicting demands, clash of interests, time pressures, colleagues' apparent lack of cooperativeness, or even unexpected progress. Such reflection involves the individual making his or her experience of own current problems and contributions to innovation available for discussion, and the joint exploration in the group of what the experiences may mean. At the same time I believe that for managers of innovation, a shift of focus towards communicative aspects such as those recurrently discussed throughout this dissertation, will support the emergence of a different understanding of innovation processes which may enable them to take part in such processes in a more competent way. I therefore suggest that the primary management approach to enact 'innovation' is not the creation or insertion of new organization-wide measures, nor the search for control, but the purposive participation in relevant human communicative interaction, where the intention is to influence the emergence and development of conversational themes seen as expedient.

9.4 Implications for future research on innovation

Presently, innovation is broadly recognized, and even idealized, as the most important enabler of economic growth. In the world of finance credibility is connected to predictability, and so it should not be surprising that increased controllability of innovation processes is demanded. In the petroleum business, this is further substantiated by the strong focus on safety and environmental considerations. The demand for control has been the source of numerous studies aiming at producing generic knowledge about how to organize and manage innovation processes towards successful outcomes. The findings presented in this dissertation indicate that it is reasonable to pose the question of whether it is actually possible to be more certain of succeeding with innovation if we understand better how such processes are acted out in organizations, and if it is, what would we in that case need to know? Although preliminary, the results of the SIOR study encourage continued exploration of the complex responsive processes perspective as an alternative way to research and explain processes intended to lead to innovation in companies.

In my view, the principal objective of further research should be to extend our understanding of human interaction related to the development and exploitation of innovation in and between commercial companies and other organizations, to learn more about communicative aspects salient in innovation processes, and how these are enacted in different contexts. This includes a need to pursue my preliminary exploitation of the concepts of 'technology' (paper C) and 'context' (section 9.2) in terms of innovation. With regard to technology, further conceptualization should include not only technology development and adoption, but also the influence of technology and 'systems' intended to support or instruct the processes of innovation.

The intention of further research would be to understand better how such processes can be managed and supported, and to explore alternative approaches to describe innovation in terms of profitability and growth. Issues of interest are: How do business organizations actually innovate? How do new ideas about what is the 'best' or 'right' way to perform innovation emerge? Why are some organizations (or groups) more responsive to emerging patterns of innovation? How do properties of everyday conversational activities affect the course of innovation processes? What is the role of leadership and control in business organizations seeking to pursue innovation? In everyday terms, what does it mean to focus on the quality of relations?

For individuals to be able to enact 'innovation' in ordinary, local interactions in the living present, generalized ideas must be particularized and functionalized. Such enactment produces and is produced from reiterated and changing patterns of themes. In my view, it is these processes of particularization and functionalization which are most interesting. Accordingly, researchers' attention should be on issues and aspects emerging from the responsive processes of relating between people, in which among other things thematic patterns caused by considerations related to profit, politics, safety and reputation, but also by technology, written documentation, physical environments, and habit, intertwine and evolve in unpredictable ways. There are several areas of research interest which have barely or not at all been touched upon in this dissertation. I will mention three themes that I see to be of particular relevance to the understanding of innovation and the management of such processes, seen from a complex responsive processes perspective.

Theme A: Exploring innovation as risky processes

The first theme is connected to the fact that innovation is not only associated with progress, but also with the risk of failure (Cozijnsen, 2000). Innovation efforts involve the inevitable risk of unsuccessful technology development and testing, and of customers not giving preference of 'your' solution to your competitors. In the petroleum business, unsuccessful implementation of technology can be extremely expensive, and at worst cause harm to humans and environment, and to existing installations and wells. This means that the management of innovation, whether it is about the recognition of new ideas, the process of turning ideas into material and non-material objects, or of making new objects part of our everyday life, is also the management of risk of failure. Consequently, the phenomenon of anxiety should play a part in the discussion (Walker, 2006). Other communicative aspects of interest to this theme are spontaneity and improvisation (Shaw, 2002; 2006; Larsen, 2006). Moreover, it is my view that such discussions may fruitfully inform and be informed by existing literature on improvisation in jazz and organization (e.g. Kao, 1997; Barret, 1998; Kamoche and Pina e Cunha, 2001).

Theme B: Exploring the meaning of control systems, regulations and visions in terms of innovation

The second theme is the need for further elaboration of the meaning of control systems, regulations and visions in terms of innovation. From a complex responsive processes perspective, the experience of control is paradoxical (Streatfield, 2001). 'Control' is seen to be a necessary condition for joint human action, serving among other things as a defence against managers' anxiety of not 'being in control', and of subordinates' anxiety that managers are not up to what they are trying to do. At the same time, control can provoke experiences of constraint and stress in individuals, causing them to lose sight of the meaning of their work. Although not particularly emphasized, my experiences in SIOR indicate the relevance of focusing on this paradox. Questions of research interest is how decision makers think about their intentions when they are suggesting propositions and even orders; how target setting, planning and monitoring affect individual actions and interaction in processes intended to lead to innovation; and how the use of such means as basis for long-term organizational performance enables and constrains the evolving events.

The present study indicates that the effect of target setting (or ambitions) on innovation processes is another theme of research interest. The 55 % SIOR ambition was decided by the top management to stimulate innovation. It was referred to as a target to strive for by most of those I spoke to, but quite a few, including the SIOR program director, gave voice to doubt that the target was actually attainable. A question of relevance is how individuals respond in the face of 'impossible' targets, and whether these responses differ from actions and interactions emerging when targets perceived as attainable are suggested.

Theme C: Exploring new ways of working and business model innovation

The third theme is the exploration of processes intended to lead to business model innovation and new ways of working. As a consequence of the increasing demand for new and potentially 'path-breaking' ideas, more and more managers search for new approaches to innovation and the organizing and management of such processes. This development is encouraged and boosted by researchers and consultants. The search for new ways of working has lead to research interest in collaboration between members of different legal entities (at present mainly referred to as 'open innovation'), but also in other types of collaboration, like with private individuals (such as retired experts, or 'the world', see for example the Procter & Gamble model *Connect & Develop*, Huston and Sakkab, 2006). This development increasingly involves suggestions about the use of advanced technology to support cooperation. Even more importantly, such changes could be seen to involve the transformation of power relations, identity and thinking about work related insider/outsider relationships. In my view, an essential question to be considered is therefore what these developments may mean for our understanding of 'organization', and of organizational phenomena like 'culture', 'leadership', and 'innovation'.

9.4.1 Research considerations

A point of importance is that from a complex responsive processes perspective, *research is participative exploration, involving the intentional activity of experiencing interaction*. Experience is reproduced primarily as narratives providing reflections of the responsive processes of relating between self, which in this context is the researcher, and others. As pointed out by Weick (2003), one of the particular challenges researchers who aim at providing knowledge about 'the real world' have to face, is the problem of how to conceptualize situational experience. Christensen (2005) calls attention to an additional challenge, which is that the explorative activity should be performed in such a way that it will be accepted as research in academic communities. In my view, the predominant format of academic papers encourages generalization, and imposes limitations on the opportunity of researchers adopting the complex responsive processes perspective to develop narratives and arguments which adequately capture the subtle interplay between professionals. This underlines the importance of pursuing the debate brought up by Williams (2005b) on the significance of ‘contribution’ in terms of knowledge, and who it is that is entitled to decide what are ‘valuable’ contributions. This discussion could be connected to the observation made by Weick (2003:453) that:

> *When practitioners refer to ‘the real world’, they do so when theorists comment on practice, but elide context, overlook constraints, take the wrong things for granted, overestimate control, presume unattainable ideals, underestimate dynamism, or translate comprehensible events into incomprehensible variables.*

The active participation of the researcher in organizational processes presupposed by the approach of *participative exploration* also points to another challenge. Traditionally, it has shown to be problematic for researchers to get ‘insider’ access to organizational processes, and in particular processes seen to be in the core of business. The fact that researchers approaching organizations as complex responsive processes may not be able to be particular about what they assume to ‘find’ in advance, potentially adds to the problem. This makes topical the development of a new kind of role for researchers, implying the dual responsibility of exploring organizational processes in which they at the same time take active part, e.g. in roles like project manager, specialist, process consultant, or conversation partner for manager(s). A theme which in my view is inseparably connected with this is the discussion about ethical aspects of performing participative exploration in business organizations.

9.5 Summary

The results of the present study are based on the complex responsive processes perspective. Special attention is drawn to basic aspects of human communicative interaction suggested to be essential for the emergence and development of innovation. The essence of the findings is that innovation is not caused by single individuals, neither by any system, but that it is a phenomenon inherent in everyday human interaction. This involves the view that innovation cannot be controlled, but do not develop at random, either.

In the first part of this chapter focus is on the strong element of variance in innovation research. The discussion is based on two aspects: How do researchers make meaning of the phenomenon of 'innovation', and what is the significance of context. My present understanding of the concept of context is that it involves more or less habitual, more or less temporary patterns of themes, paradoxically influencing on and being influenced by local human relating in each living moment. No individual can be 'outside' context, and so, emerging and evolving events will always be formed by the particularities of the current situation. At the same time, I see human interaction as being distinguished and 'structured' by communicative aspects which can be recognized across contexts.

In the second part of this chapter, some practical implications of the present study for the implementation of innovation processes in Statoil are suggested. Essentially, I suggest that Statoil management team members would profit from spending more time in joint reflection not only about how to solve technological problems and meet with targets on production, safety and economy, but on own relevant everyday experiences, to explore what these experiences may mean to their individual and joint possibility of and capacity for innovation. Finally, suggestions are made for further research, connected with a perceived need to further extend our understanding of processes related to the development and exploitation of innovation in and between commercial companies and other organizations, and how such processes can be managed.

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PART II

A. Exploring Innovation Processes from a Complexity Perspective. Part I: Theoretical and Methodological approach. Johannessen, S. and Aasen, T.M.B, 2007. *International Journal of Learning and Change, Vol 2, No. 4, pp. 420 – 433.*

B. Exploring Innovation Processes from a Complexity Perspective. Part II: Experiences from the SIOR case. Aasen, T.M.B. and Johannessen, S., 2007. *International Journal of Learning and Change, Vol 2, No. 4, pp. 434 – 446.*

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Paper A

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Exploring innovation processes from a complexity perspective. Part I: theoretical and methodological approach

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Abstract: In two consecutive papers, we will be exploring the relevance of taking a complexity perspective on innovation processes. In this first part, we discuss why there is a need for novel perspectives in this research field and why the theoretical and methodological approach of the *complex responsive processes perspective* is relevant in meeting these needs. Some central aspects and implications of this approach are outlined. Our key argument is that in order to move our understanding of innovation processes in organisations ahead, it is necessary to study the self-organising emerging nature of communicative interaction in terms of ongoing everyday activity in organisations. From our empirical findings – to be outlined in the second paper – we have found that the phenomena of leadership, power and identity are crucial for the explanation and understanding of innovation. Consequently, we give particular attention to the nature of these phenomena from a complexity perspective.

Keywords: complex responsive processes; identity; innovation processes; leadership; methodology; power.

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1 Introduction

Since the pioneering work of Schumpeter (1934), innovation has been the subject for researchers from many fields. Typical issues addressed are the characteristics of product innovation processes (Arad, Hanson and Schneider, 1997; Ravichandran, 2000), models and contingencies of innovation (Van de Ven et al., 1999; Tidd, Bessant and Pavitt, 2005), the influence of innovation on growth or disruption of organisations or entire industrial segments (Utterback, 1994; Christensen, 1997), and the management of innovation (Burns and Stalker, 1961; Van de Ven, Angle and Poole, 1989, 2000; Tidd, 2001; Trott, 2005). Traditionally, the phenomenon of innovation is investigated at different levels. At the organisational level, complex relationships have been proposed between organisational qualities, conception and development of innovation, adoption of innovative results and business performance (Neely et al., 2001; Van de Ven et al., 1999).

A company's potential for producing innovative, commercially valuable results is referred to as its capacity to innovate (Neely et al., 2001). This capacity is defined as a multidimensional, complex variable, which may be connected among other things to the resources and capabilities of a company and its ability to use these to explore and exploit opportunities (Prahalad and Hamel, 1990; Grant, 1991; Verona and Ravasi, 2003). A common denominator for the different perspectives on innovation research is that innovation can be subjected to human control. However, some see the possibility of deriving competitive advantage from innovation as a highly intricate process involving technical complexities, functional interdependencies, high levels of uncertainty and highly complex forms of work integration (Thamhain, 2003). Nevertheless, the dominant message in innovation research continues to be that distinct steps and characteristics can be identified, and particular measures can be implemented in organisations in order to increase innovative capacity (Byrd and Brown, 2003).

We argue that the nature of the phenomenon of interest – innovation – is *communicative interaction*. Hence, we want to explore the meaning of innovation processes in terms of such communicative interaction. Furthermore, we centre our exploration around *leadership, power and identity* as communicative aspects of particular interest in an understanding of innovation processes.

In pursuing this, we build on research done on complexity in organisations, specifically *the theory of complex responsive processes*, which have emerged in recent years (Stacey, Griffin and Shaw, 2000; Stacey, 2001; Fonseca, 2002; Griffin, 2002; Shaw, 2002; Johannessen, 2003; Johannessen and Stacey, 2005). By doing this, we want to suggest possible new ways of thinking about and carrying out research on innovation processes.

This paper proceeds as follows. First, there is a brief literature review on the main strains of innovation research, which highlights some of the challenges remaining in this field. Secondly, we outline what it means to take a complexity approach to the exploration of innovation processes. Then, we explore the central phenomena of leadership, power and identity in terms of communicative action before embarking on a new way of formulating our understanding of innovation. As a preparation for the empirical study in the second paper, we end this paper with a discussion of the methodological position and implications of the complex responsive processes perspective for research method. Finally, some comments are made about future research before the conclusion of the paper.

2 Exploring innovation processes

Innovation is often thought about as the creation of new ideas, and, for companies, the conversion of such ideas into something profitable. Consequently, a central question for many studies of organisational innovation is why some companies are more successfully innovative than others are. Several contributors seek to identify organisational characteristics, or qualities, associated with innovative capacity, in order to describe the premises for innovativeness better. However, the results differ among the large number of studies that have searched for the most important characteristics affecting the innovative capacity of companies (Arad, Hanson and Schneider, 1997; Ravichandran, 2000).

Different models have been developed to describe innovation processes (Rothwell, 1994). The first models were linear, phase-based models (e.g. Crawford, 1991; Rothwell, 1994; Tidd, Bessant and Pavitt, 2005). Although these processes are viewed in different ways, like creative processes (Amabile, 1997), technology development processes (Christensen, 1997; Kash and Rycroft, 2002), strategic processes (Teece, Pisano and Shuen, 1997; Markides, 1998), evolutionary processes (Moore, 2005) or value chains (Hanson and Birkinshaw, 2007), the models usually invoke innovation as successive steps. A growing acknowledgement that innovation consists of both social and technical processes across formalised organisational borders has gradually resulted in a stronger focus on relations between participants, and on processes for organisational learning (You and Wilkinson, 1994). The assumption of linearity and explanations based on cybernetic systems theory are being abandoned in favour of interactive models based on systems dynamics as an alternative way of analysing innovation processes (Van de Ven, Angle and Poole, 1989, 2000; Hargadon, 2003; Caloghirou, Kastelli and Tsakanikas, 2004). The systems dynamics perspective involves non-linearity, positive feedback and the possibility of non-equilibrium, and leads to a more complex, richer insight into the dynamics of systems.

An important challenge applying to non-linear systems thinking in an efficiency-focused business context is that the links between cause and effect often become distant in time and space, undermining the possibility of predicting future outcomes. To compensate for this, computer-based quantitative simulations have been employed to identify general qualitative patterns of behaviour presumed similar to those likely to be experienced in real-life situations. In the Minnesota studies, extensive empirical support is given to the view that innovation processes follow non-linear system dynamics (Van de Ven el at, 1999). Characteristically, such processes are neither stable and predictable nor stochastic and random (Cheng and Van de Ven, 1996).

A serious problem with system dynamics simulations of innovation processes, however, is that they do not actually take an account of the emergence of novelty (Stacey, 2007). Without external influence, the system will cease to evolve and approach a state of equilibrium. Accordingly, one still faces the problem that any radical change (novelty) must be designed outside the system and then installed. Furthermore, as Stacey (2007) also points out, system dynamics attributes importance to behavioural patterns, but the emergence of such patterns is often unexpected, and may just as well counteract change as contribute to it.

Considering these limitations, a growing group of authors are exploring the properties of complex adaptive systems in order to develop new organisational theories embracing change as an emergent self-organising process rather than as orderly, controllable steps (Anderson, 1999; Price, 2004). This approach has led to new knowledge about innovation processes (Poole and Van de Ven, 2004; Frenken, 2005; Carlisle and McMillan, 2006; Frenken, 2006; van Buuren and Edelenbos, 2006), and on the management of innovation (Van de Ven et al., 1999; Surie and Hazy, 2006). Many of these contributions merge empirical observation with computational agent-based simulation, demonstrating non-linear and self-organising systems behaviour.

However, computer simulations are unable to capture the full range of human experience, and they will always fall short in the description of emotional responses, power relations and identity, phenomena often sustained by unconscious group processes (Stacey, 2003). Such processes serve the function of including persons, ideas and behaviours adhering to established patterns of action (Elias and Scotson, 1994; Dalal, 1998) and excluding persons who represent patterns of action that are new, different and hence innovative.

Consequently, we argue that it is of limited value to analyse innovation processes and organisational capacity for innovation without taking into consideration organisational power relations, individual responses to diverse perspectives, emergence of new meaning and the impact of this on collaborative relations.

Furthermore, we argue that the exploration of the communicative nature of these human aspects can be productively moved forward if we draw on insights from the theory of complex responsive processes. This is a complexity theoretical approach, which is founded both in sociological theory and at the same time draws on analogues from complexity studies. Hence, it is a more coherent and valid organisational theory than those directly translating computer simulation results into an understanding of social action.

3 A complexity approach to the exploration of innovation processes

The phenomenon of self-organisation is crucial in complexity research. In the natural sciences, it has been the subject of research by the Nobel Laureate in chemistry, Ilya Prigogine. He showed that differences between agents, referred to as micro-diversity, are a prerequisite to the unpredictable emergence of order from disorder in nature (Prigogine, 1997). The importance of micro-diversity is further elaborated by Allen (1998a, b). He has shown that when the assumption of average components and events is abandoned, phenomena display the capacity to evolve completely new structures. The amplification of micro-diversity, or non-average behaviour, is the source of transformation and the emergence of novelty.

This has led to the view that self-organisation in human terms would mean heterogeneous individuals participating in local interaction (Stacey, 2001). Interest is directed towards the patterning processes of local communicative interaction whence the phenomenon of self-organisation is emerging. Self-organisation is then the co-evolving repetitive and transformative patterning of communicative themes created when humans interact with each other.

When this view is taken seriously, *innovation can be seen as the self-organising patterning of new themes of communication*. Thus, when exploring innovation processes from a complexity perspective, what we seek are the sources of the paradox of transformation and stabilisation as two sides of the same communicative process.

In the theory of complex responsive processes, the account of the structure of human communicative interaction is derived from the social psychologist George Herbert Mead. His main concerns were with the complex patterns of social interaction in which humans produce structure and change in social life through the social acts of communication (Mead, 1934). Here, a key point has to do with meaning, which emerges from the experience of communicative interacting where power enables and constrains our possibilities of moving on together. New knowledge (new meaning) and identity are perpetually created and recreated from the communicative interaction between people in each living situation.

This theory sees organisations as patterns of joint human action experienced as temporary stabilisations of conversational themes (Stacey, 2001). Such themes are continuously reproduced in the form of beliefs, habits and variations on them. As people interact, various organisational phenomena will emerge, independent of any conception of organisational boundaries. Furthermore, by the responding processes they create, the reality of both themselves and their environment is transformed in unpredictable ways. Seen in this way, the quality of relations becomes decisive for the organisational capacity for change and innovation, i.e. for the creation of emergent new meaning.

Thus, innovation may be perceived as a self-organising emergent and irreversible process. The process is paradoxical and as such continuously patterns novel structures, identities or patterns of meaning, at the same time as repetitive patterns are created and destroyed. From a complexity perspective, it is of greater interest to explore how such paradoxical patterns emerge, and thus to study the phenomenon of complexity in organised human life, rather than to reduce and simplify innovation processes into simple categories and individual factors.

3.1 Local interaction and global patterning

A main focus of attention in understanding organisational phenomena from a complexity perspective is the study of the simultaneous emergence of local everyday interaction and widespread patterns of actions common to many people. Both I and We identities are emerging and re-emerging in local interaction where global patterns always are expressed and implied. The sense of identity (meaning, direction, structure, flow and continuity) is experienced by each individual as they are structuring the generalised patterns of action in each living moment. The generalised patterns are experienced as global themes played out as the experience of local interaction or local themes of communication.

An example is when managers in a meeting are talking about what measures to take to stimulate innovation in their company. The theme of ‘innovation’ is clearly a global theme, a theme that many other managers are talking about all over the world at the same time. Simultaneously, in any particular management meeting, meaning will arise as to what this might mean for their company and for them. These discussions are clearly influenced by their relationships and the quality of their relating, where power is always experienced. In what way do they understand their individual contribution to the discussion, their role and their influence? How is their understanding of what is going on between them expressed and made available for discussion? How do they see their own ability to keep on working with emerging themes? How do they understand what it means to go on working with these themes in interaction with others whom they are supervising or in charge of?

The ways in which all of these questions are dealt contribute to wider patterns of interaction between many people, which in turn are the generalised/globalised patterns. Seen from a complexity perspective, the widespread generalised patterns and the local particularised interactions are emerging at the same time. These different aspects of patterning, the global and the local, cannot be separated from each other. Any pattern is acted out locally. No human being can avoid being in local interaction: and when doing this, individuals are expressing both their particularities and global themes at the same time; and as they are expressing this, they are contributing to the emergence of both local meaning and further generalisation of themes and actions. They are globalising as they are particularising and vice versa – simultaneously as the same process.

4 Leadership and communicative action

From our perspective, innovation is neither a rationally planned process nor an evolutionary type of process driven by chance or environmental selection mechanisms. It is rather the result of a number of activities closely integrated in everyday life in organisations. Organised activity consists of large numbers of local events and interactions involving many individuals who at the same time are creating and expressing widespread patterns of interaction.

Establishing an 'organisation' is generally recognised as an important way to accomplish coordinated goal-oriented activity. However, an organisation could also be seen as an abstraction that does not possess any meaning in itself. Meaning and identity can only emerge from the ongoing communicative action of the involved actors. This indicates that even though individuals are important in innovation processes, such processes involve the interweaving of the actions and intentions of a large number of people bound together in complex patterns of interdependencies. Certain individuals (leaders) are recognised to influence the escalation of new themes more than others do. However, these people are not necessarily the same as the formal managers, although people accepted into formal power positions can more legitimately influence these patterns of communication.

The dominant message from the management literature leads us to believe that such communicative patterns of action may be implemented systematically or manipulated in such a way that a particular type of behaviour – innovative behaviour – becomes predominant. This includes the introduction of different control routines in order to regulate the organisation towards a preset goal, which indicates that organisations are thought to evolve as cybernetic systems. In mainstream literature, management is often used synonymously with control, and the assumption often seems to be that particular individuals (leaders) can choose, manipulate and control organisational developments – including innovation processes – into the future. Complexity research questions whether this assumption actually reflects real-life experience (Stacey, 2007).

However, if control systems and plans are expected to have only limited influence on organisational futures, why do people continue to design them? The experience that no one is in control or nobody knows anything about the future is for many people anxiety provoking. Therefore, the experience of control is paradoxical (Streatfield, 2001). It serves as a social defence against anxiety, and as such is a necessary condition for joint human action. At the same time, control provokes anxiety and may cause people to lose sight of the meaning of their work.

However, from a complexity perspective, control cannot be ascribed to systems or individuals standing on the outside of organisations. Control is a phenomenon inherent in the interaction processes. The implication of this is that it is impossible for any individual to be in control of organisational evolution. Therefore, leadership in innovation processes cannot be understood as identical to being in control.

Interaction between many people continuously produces outcomes that no one is planning and, in some cases, that no one wants, even though everyone influences the production of patterns of action through their ongoing participation in social interaction. No one is in control, even though many people, including those in powerful positions, exert leadership by influencing, seeking support, enabling and constraining other people through their communicative action in different local situations.

5 Power and identity

Ongoing power struggles are another important feature of organised activity, which is relevant to innovation processes. Operational units, experts, research managers, project managers and others all try to influence and control activities. As projects progress, paradoxical phenomena emerge, such as conflicting interests and cooperation, doubt and trust, support and counter-argumentation.

The many functions and roles in organisations could be seen as power–identity structures causing various co-existing themes to emerge, resulting in differences of opinions on the purpose and importance of particular activities. Influential individuals may suppress new themes while on the other hand, they are empowered to legitimise new themes. These power–identity structures could paradoxically be seen as contributing to the inefficiency of conversational processes, while at the same time, promoting positive attention towards emerging new themes.

A role of particular interest in research and development communities is 'the expert'. When looking at innovative solutions, experts might tend to use their expertise to explain why a new idea would not work, rather than to discuss its possibilities. Ultimately, new ideas could leave experts less influential. Hence, lack of support from experts could be understood as being related to anxiety associated with potential shifts of power relations and identities and changed patterns of interaction suggested by the presentation of new ideas. New ideas are propositions of new themes of conversation, which in turn are propositions of organising experiences of being together in a different way. This includes experiences of power and identity. Subsequently, this defines who a person is and a persons understanding of 'me' in relation to others. Even if the development of innovative ideas is officially encouraged in many companies today, at the same time, this is an encouragement for changes in conversational patterns, which potentially can shift power relations and the experience of identities. Seen in this way, new ideas will not only have a positive value for people in an organised context but are also threatening experiences, which might mobilise all kinds of defensive feelings and actions. From this point of view, innovation projects become ongoing power-identity forming processes shaped by various interests, at the same time shaping and transforming interests of individuals who in some way are engaged in the activities.

New ideas, whether connected to 'the way we do it around here', to the way the activities are organised, or to development and change, all emerge from a multitude of conversations, being challenged and changed, accepted and rejected. When innovation is materialised in new technology different from what has been available before, or it is experienced as immaterial new ways of doing things, its existence is nevertheless in the form of new themes of communication. New generalised patterns of action are emerging at the same time as multitudes of particular local understandings of everyday life. These paradoxical patterns are sometimes recognised as innovation and new thinking.

6 Innovation as idealisations and social objects

From the discussion so far, we can infer that innovation is a new pattern of communication emerging between people as an everyday power and identity struggle where leaders play a particularly influential role. These everyday activities are processes of communicative interaction and power relating between human bodies in which thematic patterns of relating emerge as individual-collective identity. Johannessen and Stacey (2005) draw on Mead to point out that these patterns also take the form of social objects. These are generalised tendencies on the part of large numbers of people to act in similar ways in similar situations. They evolve and are being formed in social interacting, forming that social interacting at the same time.

These generalised tendencies to act are iterated in each living moment as repetitive, habitual and thus unconscious patterns of action. However, in their continual iteration, these general tendencies to act are normally particularised in the specific situation in which the actors find themselves. Such particularisation is inevitably a conflictual process of interpretation as the meaning of the generalisation is established in a specific situation. The possibility of transformation, that is, further evolution, of the social object arises in this particularising of the generalisation because of the potential for spontaneity to generate variety in human action and the capacity of non-linear interaction to amplify consequent small differences in their particularisation.

Johannessen and Stacey (2005) also argue that as well as being generalisations, social objects may take the form of *idealisations* or cult values (Griffin, 2002). Such cult values present people a future free of conflicts and constraints, evoking a sense of enlarged personality in which they can accomplish anything. Cult values or ideologies have the effect of including those who adhere to them and excluding those who do not, so establishing collective or ‘we’ identities for all of the individuals in both groupings. Thus, social objects and cult values are closely linked to power. Social objects as generalised tendencies to act in similar ways both enable and constrain the actors at the same time. Thus, social objects are forms of social control reflected in figurations of power relations between people.

Mead draws a distinction between cult values and their functionalisation (Mead, 1923). Cult values are idealisations that emerge in the evolution of a society. Examples are mission and vision statements formulated in organisations. Innovation can be one such formulation of a cult value-presenting people with an image of an idealised future shorn of all constraints. If the cult value of innovation is applied directly to action, without allowance for variations required in specific situations, then those undertaking such action form a kind of cult in which they exclude all who do not comply. However, this does not usually happen as people act on present interpretations of cult values. This functionalisation of the cult value of innovation inevitably leads to both conflict (instability) and the negotiation of compromises around such conflict (stability). Functionalising innovation is the enactment of innovation in the ordinary, local interactions between people in the living present. This enactment both produces and is produced from stability and instability at the same time. From a complexity perspective, it is the processes of functionalisation that are of research interest, as is demonstrated in Part II of this article.

Mead's notions of social objects and cult values have something in common with the notions of social structure, habit and routine. What is distinctive about Mead's approach to these matters, however, is how he avoids positing social structure as a phenomenon that exists outside individuals. Social objects and cult values are processes of generalisation that only have existence in their particularisation/functionalisation in the ordinary, everyday interactions between people.

People can and do reify social objects, that is, they treat them as if they were physical objects. They are then thought to constitute a system outside people and that system is thought to have some kind of life of its own. In practical terms, this takes the form of articulated ideals or set objectives and the broad, generalised actions required to achieve them. In Mead's terms, people are then articulating and specifying cult values. As soon as this is done, it becomes easy to think that innovation can be designed or intentionally chosen and then implemented. Innovation and new knowledge then have to do with the formulation of long-term designs to change widespread patterns of action directly. Meaning is located in the patterns of action as a substance or a thing. The notion that innovation is a generalised tendency to act is lost in the reduction of a process to a state. What is lost sight of is the process of particularising. Meaning does not lie in innovation thought of as if it were a physical object but in the particularising processes in which innovation is found and transformed. Instead of thinking of the social object of innovation as if it were a physical object open to intentional design, we come to think of innovation as emerging tendencies to act and this brings us to focus on innovation processes as processes of particularisation of the social object of innovation.

The suggestion is that innovation is a social process shaped and formed by the complex interactions of human relating. This produces capacity for coherent patterning, paradoxically displaying both continuity and potential transformation at the same time. The possible consequences of this explanation are a move away from thinking about innovation as something that can be managed, planned and analysed. The explanations of how innovation comes to life point to a shift of attention in organisations towards increasing skills of participating in the relationships, in particular conversational participation. These are processes that take place every day in organisations, thus being the sources of innovation and organisational futures.

7 Methodological orientation

The methodological orientation of the complexity perspective is developed and clarified from the methodological thinking of George Herbert Mead. Mead took a radical process perspective of human development in asserting that human social life is always in movement, it is perpetual action and construction, and the development of mind, consciousness, self-consciousness and society is this ongoing process in which humans act and always relate in some interaction or dependency with other humans.

This approach is based on a certain idea of causality – a transformative process ontology – in which reality is seen to develop because of social interaction. People do not create any social phenomena outside their own relationships. This also goes for the phenomenon of knowledge. Knowledge is not created inside people who are outside the phenomena they obtain knowledge about. Therefore, knowledge is relational and must be created from relationships with other people or with a person's own self, in the form of reflection and thinking.

This imposes implications on the methods of research. The complexity perspective is about temporal participation and the emergent explorative character of such participation (Christensen, 2003; Johannessen, 2003). The researchers develop their understanding as participants in organisational activities. They develop their insights and practice from their experience of the relationships in which they participate.

This approach does not define the role of the researcher very explicitly. The researcher might become very influential and powerful in certain situations or emerge in the role of the more traditional 'detached observer'. Understood and reflected on as part of emerging unpredictable patterns of local power–identity structures in the various situations, this is an explorative attitude that could be seen as a method of *emergent participative exploration*. Although researchers probably come to a research situation with some kind of intention, they are nevertheless holding themselves open to the exploration of the relational phenomena emerging in the situation, and so attempting to construct coherent meaning from this relating.

The difference between this and other interventional, observational or participative methods is that emergent participative exploration does not happen according to a clear intention or prescriptive scheme designed to tell organisational members what they should do or how to produce 'data'. The way the exploration and inquiry is manifested is a matter of emergent patterns formed by the relating of the researcher to the people employed in the organisation. In this way, the focus of methodological attention is knowledge creation as an emerging transformation of identity. Then, organisational research is not only a question of gathering information regarding an organisational phenomenon, but also a question of who the researchers become through the research effort.

Examples of research conducted in this way have been published in recent years within organisational studies (Streatfield, 2001; Fonseca, 2002; Shaw, 2002; Christensen, 2003; Johannessen, 2003; Stacey, 2005).

A key objection to all participative research methods is the biased subjectivity by which the results are obtained and presented. Ultimately, it is the researcher who decides what to do, what to take notice of, who to talk to, what to analyse, how to analyse and how to interpret the material. In addition, the researcher has the responsibility of presenting the findings in a convincing, coherent and reasonable way. In this, emergent participative exploration shares its justification and its challenges with, for instance, ethnographical methods (e.g. participative observation), intervention methods (e.g. action research) and other participative methods generally accepted within organisational research. This justification is associated with certain ontological and epistemological views. The main argument for emergent participative exploration in this context is the coherence it has with the theoretical approach of the complex responsive processes theory. As the centre of attention in this theory is human (inter-) action and taking the experience of relating seriously, it follows that the method of research is participative. The creation of research knowledge cannot fundamentally be seen as being a different activity from the creation of knowledge in other human activities. The bias of research – from this point of view – is the bias of participating in ordinary daily life. Validity and reliability in this sense cannot be dealt with in any other way than as in ordinary daily life, where experience of validity and reliability take the form of emerging sense making between people negotiating their practice in conflict with – and in recognition of – each other.

8 Implications: re-orientation of research attention

The implications of the complexity perspective are a re-orientation of research attention, which could open new doors and bring important insights to the processes of innovation. From our perspective, innovation can be seen as conversational activities involving a large number of individuals. We suggest that novelty emerges from ongoing repetitive patterns of conversation with the potential for transformation. Innovation, defined as the processes of creating and adopting novel patterns of action, can be explained as a participative self-organising process. Innovation efforts are influenced by multitudes of patterning, structuring and organising of themes of experience, which are continuously taking place between the individuals involved in organised activities. Shifts and stabilisations of power and identity are always an issue in this, which means that the opportunity to influence the themes of conversation is not evenly distributed. Although it could be argued that patterns of social interaction emerge in unpredictable ways when individuals relate, we believe that such patterns may be perceived, articulated and indeed influenced, although not controlled. The patterns of communication are recognisable, yet unpredictable. We thus propose that innovative capacity emerges because of relational phenomena in organised life. We also suggest that this capacity may be positively influenced by competent noting of the importance of such phenomena.

Further, we propose that innovation is not a distinct organisational process, but the result of a number of activities closely integrated in everyday organised life. As innovation inherently implies developing something that has not been there before, we choose to explore the paradoxical and self-organising nature of this aspect of human experience, in which new patterns emerge as old patterns are repeated. We find that these patterning processes cannot readily be understood by reifying and simplifying them into categories and individual factors. Such processes emerge- and are only to be found in – our experience of participating in everyday interactions. Phenomena such as leadership, control, power, identity – and indeed innovation – arise as specific experiences of the dynamics of these patterning processes. Because such dynamics are influenced by everyone, yet controlled by no one, the idea of managing innovation becomes problematic when managing is understood conventionally as 'being in control'.

One implication of our research is the need to reformulate important research questions related to innovation in organisations. Instead of identification of organisational characteristics, attention should be focused on questions like: Why is it that people in some organisations more easily produce widespread communicative patterns sufficiently repetitive and transformative for them to continue to find them meaningful? Why are some organisations more responsive to emerging patterns (or to innovative ideas) and to opportunity? In addition, in everyday terms, what does it mean to focus on the quality of communicative action? These are some of the questions, which we will further pursue, in our empirical work, which is the focus of attention in the following second paper.

9 Summary

We argue in favour of the value and potential of moving attention in innovation process research away from the quest for factors which stimulate or suppress innovation towards exploring the basic feature of organisational life, which is communicative interaction. Reproduction and transformation of phenomena such as leadership, power and identity become essential and imply the need for research into how innovation emerges from the experiences of everyday organisational life.

We suggest that the complexity perspective can provide a deeper understanding of innovation, if we direct attention to the exploration of just how this pattern of action – or social object – evolves in everyday life in organisations. The possible consequences of new explanations about how innovation comes to life are a shift of attention in organisations towards increasing skills of participation.

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Paper B

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Exploring innovation processes from a complexity perspective. Part II. Experiences from the Subsea Increased Oil Recovery case

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Abstract: In this second part of the papers, exploring innovation processes from a complexity perspective, we present an empirical example to strengthen further the relevance of the approach. The example draws on a longitudinal research initiative conducted in cooperation with the Norwegian petroleum company Statoil ASA. We conducted our research into the Subsea Increased Oil Recovery project in an attitude and understanding of emergent participative
exploration, an approach rooted in the complex responsive processes perspective. We demonstrate how this perspective reorients attention towards the everyday communicative action which constitutes innovation processes. Our findings suggest that innovation could be understood as self-organising emergence of conversational patterns, identity formation, power relations and
leadership. We argue that seeking to explain innovation efforts in complexity terms opens up potential for the movement of thought in innovation research.

Keywords: complex responsive processes; identity; innovation processes; leadership; power; Subsea Increased Oil Recovery; SIOR.

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1 Introduction

The extreme importance of innovation for company competitiveness is repeatedly stressed in the literature (Arad, Hanson and Schneider, 1997; Hamel and Getz, 2004; Koc and Ceylan, 2004). Accordingly, a major focus in innovation research is to uncover what makes some companies more innovative than others, and understand how company innovation capacity can be stimulated. Up to now, however, little research is reported from the inner life of large business organisations that is focused on understanding innovation efforts in terms of everyday organisational activity.

As associate participants in an industrial research community in the Norwegian petroleum company Statoil ASA, we have had the opportunity to study innovation processes as they evolve. This has led us to the view that innovation processes are emerging from everyday conversational activities. As a consequence, we direct our attention towards this basic feature of organisational life. Research questions guiding our analysis are: what characterises such 'everyday conversational activities'? How do such properties affect the course of innovation processes? and regarding innovation as an emerging phenomenon, what does it mean to 'manage innovation'? The Subsea Increased Oil Recovery (SIOR) initiative is a rich case, opening a range of discussions about these and other themes. In this paper, we interpret some of our experiences, bringing into particular focus the social phenomena of power, identity and leadership. The interpretation is done from a perspective which draws particularly on the theory of complex responsive processes (Stacey, 2001). The relevance of this perspective to the exploration of innovation processes is further outlined in the first part of this two-part article.

2 The Subsea Increased Oil Recovery project

Statoil ASA is the largest oil company in Norway, and is benchmarked by consultant groups such as the PA Consulting Group and Arthur D. Little to be a highly innovative company because of its ability to adapt and integrate advanced technology. It enjoys a comprehensive internal R&D activity, as well as extensive cooperation with other companies and research institutes, aiming at new technology as solutions to not-yet solved challenges, or as improvements or alternatives to existing solutions. Accordingly, innovative activities involve a considerable number of people both employed and not employed in Statoil. Many of those who are not employed in Statoil, are engaged part-time or full-time in projects, often closely integrated in Statoil teams, and given extended access to Statoil premises as well as to internal sources of information.

For the last 30 years, the oil- and gas-producing activities of Statoil have been concentrated off the coast of Norway in the geological structure called the Norwegian Continental Shelf. Given this core activity of Statoil, the purpose of every innovative effort is not the technology itself, but the positive effects of technology implementation on the efficiency and safety of the production processes. The need to expand to oil provinces outside the Norwegian Continental Shelf makes the strategic dimension of demonstrating will and skill to exploit new technology to find and produce oil and natural gas under complex and exposed conditions increasingly important.

In 2003, a new strategy document – *Statoil Technology Strategy 2004–2012* – was prepared which pointed out important technology development areas. The strategy included five development areas. Two of the five areas were about increased oil recovery, from platform fields (Tail-end production – shortened to *TAIL*) and from subsea fields (SIOR).

The SIOR development project, was based on an ambition to increase oil recovery from subsea fields on the Norwegian Continental Shelf from an average of 43 to 55%. The full realisation of the ambition was not feasible through the implementation of commercial available technology, and development of both new technologies and new work processes in many areas was, and still is, essential.

Worth noting is that most of the SIOR sub-activities were already ongoing projects in the Statoil Research centre when the idea of SIOR was introduced. Through a comprehensive process involving operational units, Statoil experts and suppliers, these activities were picked out as valuable to the realisation of the SIOR ambition, and redeployed underneath the SIOR 'umbrella'.

During the period SIOR has existed, a lot of changes have taken place in Statoil. Of particular importance was the change of chief executive in the autumn of 2004. This involved a restructuring of Statoil, with the result that quite a number of persons in executive positions got new responsibilities in other parts of the organisation. About one year later, volume target figures were introduced for both operational units and for

SIOR, with an expectation that the ambitions for increased oil recovery set by SIOR would be mirrored in the ambitions of the affected business units. This was of importance to increase company attention towards the SIOR activities. As some operational units began to report increased petroleum volume reserves as a result of technology made available by SIOR, interest was further aroused.

As part of this change process, a number of so-called *corporate initiatives* were introduced. These were development areas picked out as being of particular importance to Statoil, and received special attention from the top management. Two areas of great relevance to SIOR were among these corporate initiatives, making SIOR more than an important technology development initiative – the project was referred to as a requisite tool to reach the ambitions outlined in the corporate initiatives. However, this also meant that SIOR had to coordinate their activities with an increasing number of other development projects.

In addition to changes initiated by corporate management, the turnover of persons connected to SIOR, be it project participants, customers or support persons, was rather high throughout the project period. Moreover, most of the SIOR activities were constantly undermanned, and the workload on the project management was heavy. Recently, a merger between Statoil and the oil and gas division of the Norwegian industrial company Hydro was put into effect. The impact of this on the IOR initiatives remains to be seen.

3 Research approach

A review of current perspectives and themes within innovation research is presented in the first part of this article. To approach the research questions, we have adopted a complex responsive processes perspective (Stacey, Griffin and Shaw, 2000; Stacey, 2001; Fonseca, 2002; Griffin, 2002; Shaw, 2002; Johannessen, 2003; Johannessen and Stacey, 2005; Stacey, 2007). This theory draws on analogues from the natural complexity sciences as well as from Mead (1934) and Elias (1939/2000) to explain human organisational action.

Our SIOR study was initiated in January 2004. At the time, the SIOR project was established with six target technology areas and an annual budget of about 25 million €. A development team was established, with the participation of nearly 60 Statoil employees, as well as a number of suppliers (companies and research institutions). The project was managed by the Core Team (CT) of four persons. An additional group of activity managers was established to take care of the day-to-day administration of the many SIOR activities. To be able to study innovation processes from the 'inside' of Statoil, the first author of this paper was given an engagement with the company, and invited in as an associated member of the SIOR CT, which *inter alia* meant participating in most of the fortnightly CT meetings. The initial aim of the study was to contribute to the understanding of organisational characteristics affecting company level innovation, and how such characteristics relate to business performance and growth in large companies.

Participating in the CT meetings as well as in a range of other events enabled us to become closely involved with the flow of conversations related to SIOR. Experiencing innovative capacity from the everyday interactions in Statoil proved to be a bewildering activity, owing to the complex and unpredictable nature of the experience. We gradually recognised that a search for generalised categories and connections would limit rather than extend our understanding of innovation processes. In our efforts to make sense of our experience, we turned to the theory of complex responsive processes, as previously explained.

We were given access to the internal databases, e-mail system and intranet. In addition, the first author was given the opportunity to establish a workplace in the Statoil Research centre. This provided the opportunity to request attendance at SIOR meetings. In the beginning, a lot of time was spent in informal conversation with project participants and others pointed out as key persons related to innovation efforts in Statoil. As we became more familiar with the project and the organisation, we intentionally sought out situations and individuals we thought would help to make our understanding of the innovation activities as broad as possible.

Among the challenges, we faced trying to learn about Statoil innovation processes was the selection of arenas for participation. Everybody we met seemed to be involved in a multitude of meetings, conversations and communications with people in the company as well as in many other organisations, and it was impossible to predict which events, meetings or individuals would be most valuable for our research. We found ourselves selecting the arenas of participation and the documentation to read neither as a representative selection nor at random and by intuition. Rather, our judgement of where to participate and whom to meet evolved and altered with time, influenced by the activities and conversations we became engaged in.

Given the large number of events, we were able to experience only a fraction of the activities going on. We tried to fill in with stories told to us in both formal and informal conversations. As one of our tools we were allowed an item on the fortnightly half-day SIOR CT meeting agenda that we called 'event log'. We used this opportunity to ask the CT members about recent events judged by them as particularly important to the project. The events were registered chronologically, and grouped according to themes. Formal interviews were recorded with a digital voice recorder, and then transcribed. Written notes were made from observations and informal conversations. Both transcribed data and notes were grouped and adapted to a narrative style. We acknowledge the analytical challenge resulting from a research situation so precisely described by Geertz (1973), where

> *"what we call our data are really our own constructions of other people's constructions of what they and their compatriots are up to."*

Rather than seeking to uncover an objective, 'true' nature of innovation, however, our intention has been to redirect attention to phenomena already there yet largely ignored in innovation research. Accordingly, to discuss innovation processes in Statoil, we have used an inductive approach to analysis, seeking to 'reconstruct' (Coffey and Atkinson, 1996) social phenomena emerging as important to the processes of innovation. We think that the term 'emergent participative exploration' used by some researchers (Christensen, Unpublished DMan thesis; Johannessen, 2003) about the research approach taken from a complex responsive processes perspective covers very well what we have been doing. In our view, the term does not describe a particular method which is restricted to certain activities or research approaches. It is rather describing the intention or attitude researchers take in their approach to their research activities. This means that different kinds of methods, as we know them traditionally, might be used without it being seen as inappropriate. The key point is that there is no particular method that will guide the sense-making of research. What lies in the term 'emergent' is the emergence of meaning from the exploration of one activity or situation (or 'data'), guiding the suggestion of the next activity of exploration. It was what seemed to make sense for us, and the people we interacted with, that were decisive for our next step.

4 Understanding SIOR from a complex responsive process perspective

Joining the SIOR project, we soon learned that even though great strategic importance was associated with the project in the *Statoil Technology Strategy*, and support was given at corporate level, this did not imply a general reorientation in the company towards the realisation of the ambitions of SIOR. Even if the target of 55% oil recovery was perceived as courageous by some, even more questioned whether it was realistic. The two managers who introduced '55%' as a target figure told us that quite a few of their colleagues had maintained that this was impossible, and many questioned their qualifications. To get positive attention and support from their colleagues in different parts of the organisation, the CT therefore singled out as their principal task a demonstration of the feasibility of the SIOR ambition.

Accordingly, during a six-month period before we joined the project, the CT had worked very determinedly to convert the 55% oil recovery ambition into something their colleagues in the operating units could identify with. Project objectives were set as an outcome of a series of meetings with the 24 Statoil operational units at the Norwegian Continental Shelf, as well as with collaborating partners, suppliers and professionals in Statoil. Many struggled to see how profitable production of the demanded extra volumes could be brought about, and were reluctant to meet the CT members. However, the CT consisted of people who were all experienced professionals, representing different disciplines within petroleum engineering. They had all worked for several years in the Statoil organisation, and were engaged in an extensive network of relationships with people employed by Statoil and others. Moreover, the project was supported by the corporate executive management. The importance of these factors for the operational units' decision to meet the CT is emphasised by both parties. The attention in these preliminary meetings was primarily on petroleum cubic metre accounts, representing the added value of successful development efforts. New technology supporting development towards profitable recovery of increased subsea volumes of oil and gas was identified and graded according to the expected contribution to the overall ambition.

4.1 'Project' as the emergence of meaning and identity

Because of the scepticism shown towards the SIOR ambition, the first one and a half year the CT's attention was mainly directed towards their (internal) customers, i.e. the operating units and the field investment projects. For many of those actually developing the new technology in the Research centre, including the SIOR activity managers, this was perceived as lack of interest in their work. From the many meetings, interviews and coffee break conversations we had, it became clear that many felt that information was neither demanded from nor offered by the CT, and that being assigned to SIOR did not involve any perceptible change in their everyday working routines. In the beginning, this partly seemed to be true. Although recognised as an important working method to accomplish coordinated goal-oriented activity, the concept of *project* could also be seen as an abstraction of which meaning and identity would emerge only through the ongoing conversations. Most of the project participants were only a sporadic part of such SIOR identity-forming conversations, and even today many primarily identify with their own field of research.

One particular challenge was that of the SIOR project group continuity. Among the contributors were quite a few who were internally referred to as '10% researchers', that is, researchers participating part-time in the project, many of them so loaded with tasks in different projects that SIOR project progress seemed to suffer. Even though this was gradually changed, and most people engaged more or less full-time with the project, activities continually struggled to get sufficiently manned, competing for expertise with several other projects. This implied, and still implies, that professionals, as well as customers have to be persuaded by the SIOR idea to contribute to this project in preference to other activities.

It added to the SIOR project's complexity that it was divided into a lot of dissimilar sub-activities, many of which had been ongoing for several years. While some were about testing close-to-complete technology, others followed what was at the time an unfinished idea, unsure of where the path was leading. Yet, others tried out new ways of collaborative work. In the beginning, some of the project participants did not see how their activities contributed to the overall ambition of 55% oil recovery, and only reluctantly accepted being part of SIOR. For a long period of time, the realisation of the SIOR ambition depended upon a lot of people who did not identify with the project, and even on some who were not even aware of it.

In 2006, the activity managers were included in the core team, and the CT grew to 10 persons. Of the original CT, only two members remained. The new team seemed to meet the need for closer communication with SIOR participants, although lack of information from the CT is still pointed out as a problem among the project participants. There is still a challenge associated with the manning of the project. Another persistent problem has to do with identity. While most employees in the Statoil Research centre see themselves as *researchers*, the operational units put a higher value on two other roles: the *expert* solving today's problems, and the *technology broker*, a role quite successfully developed by the SIOR CT. The *expert* is a role of particular interest in this context. Statoil has a lot of outstanding experts in the petroleum disciplines, responsible in large measure for the developments on the Norwegian Continental Shelf over the past 30 years. However, when facing innovative solutions several people claim that the experts tend to use their expertise to explain why some new idea will not work rather than to discuss its potential. While innovation is fundamental to the continuous development of the company, faced with genuinely new ideas current expertise may become more or less irrelevant (Stacey, 2007). Lack of support from the experts may thus be related to the potential shift of power relations concomitant with the introduction and acceptance of new ideas. Stacey (2007) points out that power relating should be seen as an important aspect of organisational as well as professional identity. Resistance to new ideas could therefore be understood as attempts to uphold established power and identity structures.

From our standpoint, partly taking part in SIOR activities, partly being outsiders, life in Statoil appeared as processes composed of a large number of local events and interactions involving the interweaving of the actions and intentions of many people. Seen from the perspective of everyday life, the organisation did not appear as a unit, but rather as a large number of people who were working within the frames of a common purpose, bound together in what Elias (1991) refers to as 'complex patterns of interdependencies'. People could be seen as taking part in conversational processes in which paradoxically generalised and particularised patterns of interaction were created and expressed at the same time. Generalisations, like 'the company', 'innovation' or '55% oil recovery', constitute the basis for the 'we' identities in groups (Mead, 1923). However, people cannot act on generalisations, but only on the interpretations of what the generalisations may mean in the specific situations that they are in. According to Mead (1923), generalisations can be perceived as idealisations, emerging in the evolution of organisations. Idealisations should be distinguished from their functionalisations, which are the specific actions taken by individuals in their local settings. This line of thought suggests that the actions of the CT could be understood as managerial actions supporting the process of identity formation through the functionalising of the SIOR ambition in the different local settings they are engaged in.

4.2 Innovation management, power structures and the paradox of control

The legitimate Statoil power structures consist of a hierarchical line management as well as transverse groups of experts within technical, quality-related and strategic issues, resource management and trade union representatives. SIOR and other strategic technology development areas were organised as projects with project directors reporting to the line management. This rather complicated organisational structure implied that at any time a large number of meetings and conversations took place, some of which obviously had more influence on future events than others. The SIOR participants, in particular the CT members, were involved in countless meetings to present and discuss SIOR activities and potential, both with Statoil colleagues and people in other companies. These conversational processes were referred to by CT members as *extensive talk jobs*, and were very time-consuming. As frequent changes of positions and roles are common among Statoil specialists and managers, these talk jobs had to be done over and over again.

The many functions and roles in Statoil could be seen as power structures causing several parallel, potentially contradictory, themes to emerge, resulting in differing opinions on the purpose and the importance of particular ideas or activities. Influential individuals may suppress the potential for development by putting new ideas down on a 'non-theme' list: on the other hand, they are also empowered to support development by legitimising themes. These power structures could be seen as paradoxically contributing to the inefficiency of conversational processes while at the same time promoting positive attention towards emerging themes.

From most perspectives on innovation research, it seems to be a presumption that innovation can be subjected to human control. Given that the realisation of the SIOR ambition depended upon a lot of people exerting different functions in various local settings, the idea of control became problematic. If 'being in control' should signify the power of a leader to manage a project according to a prearranged plan, towards a predetermined result, then the CT was not in control of SIOR. On the other hand, claiming that SIOR evolved by random would be equally wrong, as the SIOR CT greatly influenced the progress of the project. Rather, much of what happened seemed to take place in interaction between many people, mostly acting on the basis of intentions given by the projects they took part in or the organisational roles and functions they held. Events led to or affected events to come and the SIOR CT adjusted their input to the current situations.

Reflecting critically on the intentions of the SIOR project, one could regard it as another attempt to justify rules to control innovation processes. This would be in line with the dominant message in the management literature, which leads us to believe that patterns of action may systematically be implemented or manipulated by individuals in such a way that a particular behaviour – for instance 'innovative behaviour' – becomes predominant (Byrd and Brown, 2003; Luecke and Katz, 2003; Snyder and Duarte, 2003). The complexity of the processes we experienced and the number of people involved indicates that it would be very difficult for any single person or group of people to choose intentionally what was going to happen and then proceed to control the process. Even if the 55% oil recovery ambition could be seen as a vision on the part of a few people, the actions that followed the launch of the ambition and the subsequent project establishment could hardly be seen as the realisation of the ideas of one individual, or of a limited group of individuals, even if some individuals strongly influenced the development. The project results emerged in the context of tension between opinions and objectives, and have to be seen in a much broader context where people had to act in accordance with formal routines, deal with business demands and political considerations, but also were able to exert influence through both formal and informal channels, the informal channels being a powerful arena in the organisation.

Our experiences correspond to the argumentation presented by Elias (1978), who points out that human social interaction continuously produces outcomes that no one is planning, and, in some cases, that no one wants, even though everyone is influencing the production of patterns of action through their ongoing participation in social interaction. This stands in clear contrast to the message in much of the literature on innovation management, which is that proper design of the innovation process, in combination with the nurturing of some important factors in the organisation, will provide the manager with the required control over the processes.

4.3 Everyday actions as a source of innovation

We argue that narratives are well suited to get a notion of how such everyday actions are evolving. The following story is meant as an example to support this idea:

One of the research areas in SIOR (and also in Tail) was Integrated Operations (IO). Incidentally, IO is now also among the selected priority areas from the corporate management in Statoil. IO is about creating ICT-based, uniform and integrated solutions to support the petroleum operations in a way that makes them more effective, thus making it possible to recover more of the oil. At the time SIOR was initiated, activities in the field of IO (of which the actual content was still somewhat diffuse) were spread out in the Statoil organisation as projects and initiatives, many of them without connection to the others. The CT member responsible for the IO activities in the Research centre (referred to as CT-IO in the rest of this story) was convinced that Statoil had to concentrate on a joint development effort. Furthermore, the availability of commercial products was considered a prerequisite for the success of the implementation of this kind of technology. Thus, collaboration with suppliers was seen as imperative. Another aspect of this has to do with the fact that Statoil is a small petroleum company, compared with most of its competitors. For it to accomplish the ambitions set out in the technology strategy, access to company-external specialists was therefore essential.

This made acquisition an important issue for SIOR. At the time SIOR was initiated, acquisition procedures in the Research centre were less professionalised than in the other divisions, and approaches to acquisition were thus an ongoing discussion. The discussion was boosted by the Research centre management, who indicated that something in the order of half of the annual research budget should be spent buying research and development services from suppliers. At the same time, staff were mooting the possibility of establishing joint research projects with suppliers co-financing the development work. How could all these ideas and expectations be combined into an acquisition process supporting the SIOR IO ideas?

The question remained open for several months. Then one day, browsing through an issue of Harvard Business Review, the CT-IO came across an article discussing the importance of multidisciplinary collaborations to stimulate innovation. Inspired by the ideas in this article, he began to outline an acquisition process intended to justify collaboration between the Research centre and suppliers on specific development tasks within the field of IO, presupposing co-financing by Statoil and the external partners. The basic reasoning was that if SIOR and the 'sister' project Tail could mobilise a larger part of the suppliers to collaborate on the targets set within this field, both parts would benefit. Another hoped-for benefit of the acquisition process was the development of a more 'commercial' way of thinking among the employees in the research centre, intended to lead to an increased focus on defining and completing technology elements.

The proposal for the acquisition process represented a completely new way of solving the need for innovation and development in the Statoil Research centre, and met with a lot of objections. The first proposal was described in generalised terms, and ideas on how to carry out the process in practice were incomplete. Some months later, CT-IO was participating in a Paris meeting. On the way back to the airport, he ended up in a taxi with a Statoil colleague, who at the time was deeply involved in rounds of negotiations with suppliers not unlike the process CT-IO intended to actuate. Therefore, he decided to talk over his ideas with his colleague. This was the prelude of a series of meetings where premises for the acquisition process and the resulting collaborations were discussed with people representing the Statoil acquisition department, the operational units and also suppliers. It was also considered to be of great importance to inform Statoil employees of the planned acquisition process, listen to responses and obtain the necessary support. During this period, which lasted for more than a year, CT-IO alone participated in numerous meetings and conversations concerning the acquisition process. Because of the scepticism he met with in the first few months, he decided not to meet with more than 10–15 people at a time, so he could challenge the different views he was confronted with.

The acquisition process turned out to be an extensive process, which dominated the attention and the work capacity of a large part of the SIOR and Tail project members for almost two years. Finally, in the spring of 2006, four binding three-year contracts for development collaborations with suppliers were signed, thus committing quite a large share of the R&D-budgets. For many in the Research centre, this was a new situation, as until then they had been used to planning year by year, with a lot of freedom to change plans according to their own ideas. It is too early to tell whether these joint projects will be successful or not, as they will be judged by the positive effects on oil recovery volumes and other important business target parameters. Irrespective of this, the overriding view seems to be that this process has been an important contribution to arousing interest in new ways of working in the Research centre.

The everyday and common situations touched on in the IO example – browsing a journal, bumping into a colleague – are obviously not planned and designed by someone leading or managing an innovation process. Neither can such events be integrated into innovation process models other than in generalised terms like ‘openness to new ideas’. Nevertheless, managing innovation is about appreciating the significance of everyday actions as the basis for the emergence of new meaning.

4.4 Innovation as new themes of communication

Reflecting on our experiences from participation in meetings, events and conversations, we found a picture of innovation processes which was rather different from the one we started out with. We noticed how new ideas, whether connected to ‘the way we do it around here’, to ‘the way we organise our activities’, or to development and change, emerged in a multitude of conversations, were challenged and changed, accepted or rejected. Thus, we claim that innovation cannot be seen as originating from one individual, although individuals may powerfully influence innovation processes. Rather, innovation could be thought of as emerging, ongoing, communication patterns organising people’s experience of being together. As conversations progress, some of the themes might recur, creating patterns that gradually are perceived as new meaning. Such emerging ideas may or may not be accepted by the individuals in an organisation. If accepted by enough people, or supported by somebody who has the power to authorise the use of resources, openly or covertly, the ideas may be realised through experiments and development activities. Sometimes innovation is materialised in new technology, different from what has been available before. Sometimes innovation is immaterial, experienced and described as 'new ways of doing things'. Nevertheless, we are talking about new themes of communication, new generalised patterns of action escalating from the diversity of particularisations of existing patterns of everyday life. These new generalised patterns may lead to results regarded as innovative and successful, while in other situations they may become restraining or even destructive to innovation.

5 Conclusions

Our experiences in the present study of innovation processes in the Norwegian petroleum company Statoil ASA have moved us away from the quest for factors which stimulate or suppress innovation towards exploring the basic feature of organisational life, which is communicative action. From an approach of emergent participative exploration, of which an example is provided in this paper, we suggest that innovation emerges from the experiences of everyday social interaction, where patterns gradually perceived as meaningful are created and adopted. In pursuing this view, we have interpreted our experiences from the perspective of complex responsive processes.

In doing this, we find that the SIOR project was formed by the various interests, but at the same time, it gradually was forming, and also transforming, those interests, of individuals who in some way were engaged in the activities. We see this as an ongoing identity-forming process. We noticed that as promising results were achieved, more and more people wanted a role in the project, and former sceptics came forward to take part of the credit for the achievements. Accordingly, in the course of the project, the general attitude towards its purpose became increasingly cooperative. The conversations taking place between SIOR ambassadors and SIOR sceptics could be interpreted as ongoing power struggles in order to influence, shift and control the potential stabilisation of patterns of power relations and identity. The multitude of meetings, conversations and communications between persons in the company as well as in many other organisations also indicates that even if individuals are important in innovation processes, such processes involve the interweaving of the actions and intentions of a large number of people.

An essential element in this is the unstable balances of power, where we regard power as the ongoing negotiation of acceptance and execution of influence between people. Certain individuals are always able to influence more than others the escalation of new themes. Such individuals are recognised as leaders, executing leadership in processes of innovation. These are not necessarily the formal leaders, however, although people in formal power positions do have increased possibilities of conducting leadership and considerably influencing new patterns of communication. We thus suggest that innovation processes are emerging from everyday conversational activities and can be understood as self-organising emergence of conversational patterns, identity formation, power relations and leadership.

Our ongoing research interest is to explore how we can understand the dynamics of overall corporate ambitions and the local functionalisation of such ambitions. How do people in organisations understand their individual contribution to the acceptance or rejection of emerging ideas? And what are the managerial consequences of taking seriously the experience of complex responsive processes? Our continued research effort is to apply the complex responsive processes perspective to describe the complex dynamics of innovation processes, including the adoption of technological solutions, which is at the heart of the ability of a company to capitalise on its technological R&D efforts.

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Paper C

A complexity perspective on innovation processes for subsea technology development.

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Abstract: In today's business thinking, innovation is commonly equated with progress, indicating an underlying assumption that company management have the power to choose a specific future and control the way into it. Drawing on examples from a longitudinal research initiative in the Norwegian petroleum company StatoilHydro, this paper raises some of the problems with this thinking. Experiences from the study indicate that most people in the organization do not consider what they do in their everyday organizational life as 'innovation', but rather as the provision, testing and use of technology. This suggests that the recognition of everyday activity as acts of innovation is an emergent phenomenon, expressed and potentially idealized in retrospection. The importance ascribed to technology as the enabler of a chosen future also makes topical the conceptualization of 'technology' in terms of innovation.

Keywords: complex responsive processes; idealization; innovation processes; meaning; social object; technology.

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Introduction

The hoped-for reward for innovation in for-profit companies is sustained competitive capability and economic growth. Experience proves, however, that innovation efforts should not be associated with prosperity alone, but also with risk (Freeman and Soete, 2000), among other reasons because innovation processes are usually initiated based on assumptions rather than on established facts. As credibility is connected to predictability in the world of finance, a prevailing view is that the controllability of innovation processes needs to be increased. In the petroleum business, this is further substantiated by the strong focus on safety and environmental considerations. The demand for control has been the source of numerous studies aiming at producing generic knowledge about how to organize and manage innovation processes towards successful outcomes. In my view, it is reasonable to pose the question of whether it is actually possible to be more certain of succeeding with innovation if we understand better how such processes are acted out in organizations, and if it is, what do we in that case need to know?

The contribution offered in this paper is the focus on the current idealization of innovation and technology as enablers for economic growth. The human inclination to idealize collectively certain kinds of ideas is related to our desire to generalize and simplify experiences, and ascribe to them universal validity: a desire tempting us to ignore the timely, situated aspects of everyday interaction (Griffin, 2002). The approach of isolating organizational phenomena disembodied in space and time from organizational processes is increasingly questioned (Elias, 1978; Stacey, Griffin, and Shaw, 2000;

Tsoukas and Hatch, 2001; Tsoukas and Chia, 2002; Weick, 2003; Dopson, 2005). In this paper, a radical process perspective particularly drawing on the theory of complex responsive processes (Stacey, 2001; Griffin, 2002; Shaw, 2002; Fonseca, 2002; Johannessen and Stacey, 2005; Stacey, 2007) is adopted to supplement and extend this stream of research. This perspective has been applied to explore the course of events of a four-year strategic research and development (R & D) initiative in the Norwegian petroleum company StatoilHydro[7]. Innovation is interpreted as an emergent phenomenon evolving from everyday communicative interaction (Aasen and Johannessen, 2007), involving the suggestion that attention in innovation studies should be on the details of interaction between people in daily organizational life. The present study was carried out with the explorative attitude referred to as *emergent participative exploration* (Christensen, 2005). In this frame of reference, the term 'emergent' signifies the emergence of meaning for the participating researchers from the exploration of one activity or situation, guiding the suggestion of the next activity of exploration. Examples from the Statoil study are described and analysed by use of a narrative style. The particular suitability of narratives to reveal not only the complexity of processes, but also the subjectivity of the researcher attempting to understand complexity, is emphasized by Tsoukas and Hatch (2001).

This paper has four parts: (i) a background section providing a brief description of the case study situation, (ii) a theoretical section presenting some of the existing literature within innovation research relevant to this study, as well as some of the key features of the complex responsive processes perspective, (iii) an analytical section, in which the complex responsive processes perspective is applied to the study of innovation processes in Statoil, focusing in particular on the importance of meaning in relation to human perception of organizational efforts to create and explore new technology, and (iv) a concluding section, pinpointing some lessons from the *Subsea Increased Oil Recovery* case study examples.

[7] The examples provided in this paper are derived from a study carried out from January 2004 until September 2007. The references are therefore made mainly to Statoil, and not to StatoilHydro, which was formally established on 1 October 2007 after a merger.

Background

The petroleum company StatoilHydro is majority owned by the Norwegian State, and has a dominant position as operator on the Norwegian Continental Shelf (NCS). Since its establishment in 1972, the development of operating fields under the harsh conditions off the Norwegian coast has made considerable demands on the company's ability to develop, explore and exploit technology. To maintain profitability within a limited set of business opportunities, it has been necessary to face the challenges of production in ever deeper waters, from deeper and more complex reservoirs, in increasingly remote and inhospitable areas. Ever higher environmental standards and heavy competitive pressures to reduce costs have promoted a view of technology as a key strategic enabler to meet both present and future business challenges.

The Statoil activity on the NCS has been dominated by a few large fields, such as Statfjord, Oseberg, Gullfaks and Troll. Many of these fields are now maturing, meaning declining production and increasing operational costs. Despite this, the existing NCS fields are seen to constitute a potential that can generate significant value for the petroleum companies for many years, if exploited prudently. Accordingly, in 2003, the Statoil Corporate Executive Committee decided that the current NCS production volumes were to be maintained beyond 2010. Challenges related to the maturation of older fields and the more modest size of newer fields did, however, call for the development of a broad range of new, cost-efficient, 'safe' and 'green' technologies, as well as for new approaches to technology exploitation. These challenges were framed in Statoil's subsequent *Technology Strategy 2003–2012*, and constituted the basis for the establishment of six comprehensive strategic R & D programmes, organized in the Statoil Research Centre. Two factors were pointed out as being of particular importance to succeeding. The first was to make available 'enabling' technologies in close cooperation with suppliers identified as 'the best'. This was the responsibility of the technology division. The second was to adopt and cash in on technological inventions, which was seen mainly as the responsibility of the business assets.

One of the R & D programmes was called 'Subsea Increased Oil Recovery', or SIOR. SIOR was based on an ambition to increase oil recovery from subsea fields on the NCS from an average of 43% to 55%. Over the estimated lifetime of the NCS subsea fields, this corresponds to the added production of approximately 1.4 billion barrels of oil. The full realization of the ambition was not feasible through the implementation of commercial available technology, and for quite some time it was seen as an unattainable and even unrealistic target by most managers and specialists in the company. Their main objection was that the profitable production of these extra volumes demanded the costly development of technology being substantially cheaper and a lot more efficient than existing solutions. As an example, the most important way to increase the recovery factor of oil generally is to drill more wells. The initial work of the SIOR core team indicated that to approach the 55 % ambition, costs related to the drilling of subsea wells had to be reduced from 200 million NOK to 60 million NOK, which was a considerable challenge. On the other hand, the profit potential was essential. Assuming an oil price of 50 US$ a barrel, which was reasonable at the time, the extra gross profit of the SIOR volumes would be about *70 billion US$.*

Despite an impressive company history of successful field developments, some Statoil directors gave voice to concern that the innovative 'spirit' was fading, as the company expanded and the focus on profitability and efficiency increased. They decided to invite a researcher to study their innovation processes based on the SIOR activities, so I joined in. My collaboration with Statoil lasted for four years, from January 2004. Consistent with ethnographic research methods, I entered a role as an associated member of the SIOR core team (CT), and was granted an employee number and an ID card, an onsite working place, and access to the internal databases, e-mail system and intranet. Research activities included participative observation, formal and informal conversations, semi-structured interviews, studies of internal documents and presentations, and, on a few occasions, consultative intervention. The research approach is described in detail elsewhere (Aasen and Johannessen, 2007).

When my engagement in SIOR started, the SIOR CT had just concluded a six-month initial process to single out specific technology elements assumed to support the SIOR ambition to recover 55% of the oil from subsea fields. Three focus areas were singled out as being of major importance to the programme: *accelerated oil production*; *low-cost drainage points and interventions*; and *targeting remaining oil and reservoir management*. Each of the three focus areas were managed by a member of the SIOR CT, while the SIOR director was charged with the overall responsibility for the programme. Few of the approximately 25 specific development activities started from scratch, as most were already ongoing projects in the Statoil Research Centre, or resumptions of previous unfinished development activities. To coordinate the programme's activities, a fortnightly, half-day core team meeting was established, in which I participated regularly.

Until the initialization of SIOR and the other R & D programs, collaboration between members of the Research Centre and specialists in the Business Assets had happened a little by chance. While some research groups had made close connection with people in the Business Assets, others seemed to know very little about the core business of Statoil. For this reason, the original SIOR CT members were all hand-picked, experienced professionals. Like the researchers, they represented different disciplines within petroleum engineering, but their previous experience was mainly as members of Statoil Business Assets. While this seemed to be an important advantage for them in their conversations with colleagues in the operating units, it gradually became apparent that it also involved the maintenance of a certain distance to the SIOR workers in the Research Centre. Moreover, while the SIOR CT members gradually developed a strong 'SIOR' identity through their intensive effort to get acceptance for the 55 % ambition, most of the SIOR researchers were only sporadic part of what could be seen as 'SIOR identity-forming conversations'. Accordingly, for a long period of time the realization of the SIOR ambition depended on a lot of people who did not appear to identify with the program, and even on some who were not aware of being assigned to it.

Theory

'Innovation', from the Latin *innovare*, signifies 'renewal', or limited change, - a combination of both continuity and discontinuity (Girard, 1990) In the West, the meaning of the word has departed from its Latin meaning, and has been associated largely with the processes of producing novelty, and the results of such processes, leading to economic and social progress. The view on how to interpret and represent such innovation processes has changed over the years (Rothwell, 1994). The different explanations and models could, however, be seen as being part of the same 'grand narrative of progress'

(Washbourne and Dicke, 2001). With reference to Hatch (1997, p.44), Washbourne and Dicke (ibid.) explain that grand narratives concern 'the universality of historical accounts' and, as such, are efforts of general understanding. According to them, the grand narrative of progress is founded on the idea that scientific and technological invention leads to an increasingly more advanced industrial society, distinguished by rationality, control and the belief in principles of universal, general and time-independent applicability. This is also referred to as the 'decontextualized ideal' (Boje, 1991).

Some 25 years ago, strategy management scholars began to recognize technology as an important element of business definition and competitive strategy (Burgelman, Christensen, and Wheelwright, 2004). Accordingly, a view has evolved that a company's technology strategy is an instrument of more comprehensive business strategies for innovation and change (Tidd, Bessant, and Pavitt, 2005). Within the established literature on innovation strategy, two streams of explanation of the creation of company competitive advantage have been dominant. One builds on neoclassic micro-economy, in which innovation, defined chiefly as new technology, is seen as an unexplained variance in economic growth (Fonseca, 2002). This approach is criticized for failing to provide motives for innovation, among other reasons because of its lack of attention to dynamic environments and competitive processes. In contrast to this, evolutionary theories place emphasis on profit as the consequence of innovation, and so the objective becomes the development of innovations, and not the demarcation of competition (Jacobsen, 1992). This leads to a dynamic view of a competitive environment in which innovation continuously creates and disrupts business opportunities. The evolutionary view is the basis for the other explanation, the resource-based theory (Grant, 1991). The understanding of connections between resources, capabilities, competitive advantages, profitability and, in particular, the understanding of mechanisms enabling sustained growth and competitive strength are emphasized as the key to a resource-based approach to strategy. This perspective implies that organizations can choose different strategic approaches to innovation depending on the resources they have at their disposal. A more recent approach to understanding how the commercialization of new technologies creates market outcomes is suggested by Chesbrough, Vanhaverbeke, and West (2006). This 'profiting from innovation' framework presupposes a broad understanding of various organizational aspects, including the economic organization, business strategy, technology and innovation, and appears to be based on ideas similar to the resource-based perspective.

Independent of perspective, the motivation for most studies is the need for knowledge, enabling managers to control better the course and outcomes of innovation processes. Fonseca (2002) argues that the assumption of controllability is the distinguishing feature of systems based thinking about innovation. The approach adopted in this paper implies taking a radical process perspective of human development, based on a fundamental idea that social life is always under construction by the intentional actions of interdependent humans. Organizational processes, such as innovation, should therefore be explored and explained in terms of *communicative interaction*, involving an implicit need to reconsider dominant ideas about control and management (Johannessen and Aasen, 2007). Seen from the complex responsive processes perspective, local interaction can be understood as the particularizing of population-wide general experience, where the general can only be found in the experience of the particular, and has no existence outside of it (Stacey, 2007). To render possible the coordinated action between many people, local interaction must produce *'emergent, coherent, meaningful patterns of interaction both locally and population-wide at the same time'* (Stacey, ibid., p.434). These processes of particularizing are interpretive processes of human interaction involving reflection, emotion and imagination. Conflict is an inherent part of such processes, and so is the possibility of transformation and novelty.

Mead (1938/1972) suggested several formulations of such generalization and particularization processes, one of which is the concept of *social object*. In connection with 'social', Mead employs 'object' in the sense of 'tendency to act', rather than as a physical concept or a thing. Social objects can be understood as *'generalized tendencies on the part of large numbers of people to act in similar ways in similar situations'* (Johannessen and Stacey, 2005, p.143). The social acts are complex, involving a multitude of interacting individuals who at the same time enable and constrain each other, and by so doing create the interdependency pointed out by Elias (1978). In consequence, social objects can be seen as forms of social control, reflected in figurations of power relations between people (Elias, ibid.).

As well as being generalizations, social objects may take the form of *idealizations* or cult values (Stacey, 2007). Idealizations rest on generalized ideas, perceived by a group of individuals as the 'right' way to do things, independent of time and space. Griffin (2002, p.116) explains cult values to be the *'collective idealizations that divert attention from the detail of interaction in the living present'*. Idealizations should be distinguished from their functionalization, which are the specific actions taken by individuals in their local settings. Organizational processes, like innovation, are quite commonly articulated and specified in the form of cult values, encouraging the idea that a particular process can be intentionally designed, and its outcome chosen. We attribute meaning to patterns of action as if they were a substance or a thing, rather than emerging processes of communicative interaction. By reducing processes to states in this way, we lose sight of the particularization processes in which meaning is created, repeated and potentially transformed.

Approaching innovation in terms of everyday organizational activity

Throughout the first year after I joined SIOR, one of the current discussions in the core team meetings concerned their opportunities as managers of an R & D programme to influence decisions about technology testing and use in the operating fields. I gradually understood that until then the major part of the development activities had happened as a result of direct contact between external suppliers and managers and specialists in the Business Assets, and that less importance had been attached to the contributions from Statoil researchers. Accordingly, the task to push increased oil recovery given to SIOR was perceived as unusual by most, both in the Business Assets and in the Research Centre. An additional challenge was that the SIOR programme, although comprehensive, was but one of a large number of development activities in the company. Consequently, the competition for the attention of line management, Business Asset directors and specialists was strong. The impact of this on the opportunity to test and implement SIOR technology on operating fields, which was crucial to realizing the value creating potential of SIOR activities, worried the CT members throughout the programme period, and put forward a need to make SIOR activities visible in as many groups and ways as possible. A typical discussion between the SIOR CT members at the time was characterized by questions like: 'If we are going to do this, how can we do it?'; 'If we succeed in developing this technology, where is it going to be adopted?' and 'Will we be able to follow it up?' The last question was indeed relevant as, during the first two years of SIOR, the CT consisted of only four persons, while more than a hundred people, including Statoil researchers; specialists and suppliers' representatives, were engaged in the many development activities. In addition a large number of (internal) customers and managers in key positions had to be followed up.

Ideals and the living present

The extent and complexity of the programme activities and the somewhat diffuse role given to the SIOR CT members implied that they were continuously involved in a multitude of meetings and conversations. As my given role was to identify characteristics of these processes which were influential on programme activities' failure or success, I participated in as many of the events as possible. At the time, the petroleum business was new to me, and I struggled to grasp the company jargon and figure out the roles and relations. My mind was largely on how Statoil 'worked', and how my evolving understanding fitted in with various existing theories and models of innovation. It therefore took me some time to realize that the subjects of 'innovation' and 'innovation management' were actually never explicitly discussed in any of the meetings in which I participated. From time to time, general remarks were made about innovation, but these were usually made with a glance or a smile at me, and I got the feeling that the word 'innovation' would not have been mentioned had I not been present. Surprised by the experience that the majority of the people I met showed so little interest in the theme of 'innovation', yet willingly talked to me about their activities and responsibilities, I began asking SIOR members about this. Gradually, I found out that they associated their activities with concepts like 'problem solving', 'technology development' or 'research', but to a very little degree with innovation. Quite a few pointed out that it was not they, but the external suppliers, who were creative, and that their own job was merely to coordinate and push joint projects. Many had only vague conceptions of how they could contribute to innovation, but suggested that it would have to do with looking at things with fresh eyes and challenging established truths. Others explained that the rate of development was so slow in the petroleum business that the next step was always a matter of course and, because of this, what they did was not innovation. For these persons, innovation had to do with thinking ‘genuinely new thoughts’, leading to ‘almost magic’ ideas which they could not fully understand. Interestingly, this made many of them point out as innovation what their colleagues did in fields of research in which they themselves were less knowledgeable. Several of those I talked with seemed unfamiliar with the concept of innovation, and a few openly said that to them, it was nothing but an irritating cult word.

The contrast between the dominant perception among SIOR members that what they did was not innovation and the high profiling given by the top management of Statoil as an innovative company intrigued me. I decided to turn to the complex responsive processes perspective to seek new ways of understanding my experiences. From this perspective, innovation can be understood as an idealized value in the company, which has evolved on the basis of a history of commercial successes starting with the Statfjord oil field in 1979. Gradually, this value has been ascribed to the company itself, as an intrinsic characteristic of the organization. This view has been strengthened by benchmark analyses prepared by acknowledged international consultant groups, pointing out Statoil as a highly innovative company because of its ability to adopt advanced technology.

Mead’s (1932/2002) notion of an emerging present provides a way to think about the relation between situated local everyday activity and idealized organizational values. Mead saw the present as an emergent phenomenon, evolving in the interplay between intentional humans and constituting a part of a novel future. He also claimed that the emergent present inherently will lead to a reconstruction of the past. Incidentally, the same idea can be seen with Drucker (2002, p.100), who observed that *‘a change in perception does not alter facts. It changes their meaning, though – and very quickly’*. As a consequence, the present, the future and the past can all be seen as temporal dimensions.

The processes of present construction will be connected to themes such as who we are and what we are doing, and can therefore also be seen as identity-forming processes. In the course of such processes, the particularities of past events fade, and generalized narratives of organizational achievements emerge and may evolve into idealized collective identities, or values. Griffin (2002) argues, however, that to ascribe to an organization idealized values like ‘openness’, ‘courage’ or indeed ‘innovation’ is the same as idealizing the organization as a cult in which values are applied as universal norms to which people have to conform. What we tend to ignore in doing this is that different people and groups of people will functionalize idealized values in various ways depending on the situation they are in, the role they possess and their previous experiences. This, inevitably, will lead to conflicts. To be able to go on together, people have to negotiate these conflicts and adjust their actions towards one another (Mead, 1934/1967). A factor pointed out as central to this adjustment process is 'meaning', which, according to Mead (ibid.), is an implicit part of all social processes even if awareness of it has not occurred. Meaning is expressed by the means of language, but is not created by language, because '*language simply lifts out of the social process a situation which is logically or implicitly already there'* (Mead, ibid., p.79).

Emergence and control

Even if many of the SIOR members did not recognize the concept of innovation as being suitable to describe their everyday activities, I continued to regard the SIOR programme processes as processes of innovation. My idea was that some of the decisions, conversations and events would be more important for the outcome of the programme than others. Furthermore, I interpreted the identification of generalized characteristics like 'creativity', 'curiosity' and 'opportunity recognition' as factors of importance for the course and destiny of innovative efforts (Bundy, 2002; O'Connor and Rice, 2001), to mean that unplanned, unforeseen ideas and events should be anticipated, and that these would be at least as important for the patterning of innovation processes as were the planned ones.

Given the large number of events in the programme, I was able to participate in only a fraction of what was going on. To fill in my knowledge of activities at which I was not able to be present, and to raise the SIOR CT members' consciousness about events turning out to be decisive for the outcome of their efforts, I asked to have a separate item on the CT meeting agenda. This was approved by the SIOR programme director, and the item was called 'event log'. In practice, what I did was to note everything the SIOR CT members said during the meeting that I perceived to be of importance for the project activities. At the end of the meeting, I summed up my notes, and everybody commented and supplied items for the log in turn. This exercise went on for more than three years, and in this way I learned about important problems and achievements, and about planned events attributed particular importance. In their accounts of ongoing activities, the SIOR CT members were, however, not able to point out to me specific experiences, planned and unplanned, judged to be of significance to support or counteract innovation success. Only when an activity had reached a milestone or come to a conclusion were some members, but not all, able to point out and reflect about situations perceived as particularly influential on the final result.

This leads me back to Mead (1934/1967), and the concept of meaning. It is important in his view that meaning is not seen as a state of human consciousness, but as a social act resulting from complex responsive processes. Meaning is brought out not by a gesture, but by the responses the gesture provokes. This offers an explanation to why it seems to be only in retrospect that we are able to see the 'whole' picture and point out events perceived as vital to the development and final outcomes of innovation processes. The collective recognition of social acts as 'acts of innovation' can therefore be seen as an emergent phenomenon. To me, this view indicates another paradox, related to our struggle to control the unpredictable processes we refer to as 'innovation'. This need for control makes us focus on planning, performance indicators and deviation analyses, rather than on meaning. In my view, understanding 'meaning' from the complex responsive processes perspective makes it reasonable to question the idea that generalized advice on how to enact or control the course of innovation will be of value to future innovation initiatives. A similar argumentation can be found with Elias (1978). He points out the human inclination to ascribe an objective reality to social processes, and claims that this makes us overlook the dynamic, complex character of intentional interaction between interdependent individuals. When we speak about groups, rules or actions in reified terms, this leaves us with an impression that these are entities existing apart from ourselves, and that they may therefore be subjected to human manipulation and control. This may explain why, when unintended and unplanned outcomes of innovation processes emerge, it surprises us. Dalal (1998) indicates power as another way of saying that people are interdependent, and therefore constrained by others, where 'others' may be both people and things. To be constrained does not, however, mean that we are powerless and without influence. 'Power' is seen as an intrinsic characteristic of all human relations (Elias, 1978), and its asymmetric and changing nature is seen as an important reason for the emergence of dominant ideas, or trends, in an organization, and for the further destiny of such ideas.

Technology as enabler of ambition

A core point in the petroleum business is that value creation is not based on technology ownership, but on the ownership of production licences. Accordingly, when StatoilHydro points out technology as a principal key to commercial success on their website (www.statoilhydro.com), the primary goal is not the technology itself, but the enabling of oil discovery, field development, and safe and efficient petroleum production. The StatoilHydro statement can be seen as an embracement of the idealized idea of technological innovation as the vital source of progress. Incidentally, this is also in line with a resource-based view of technology (Grant, 1991). From this perspective, as in most technological and economical perspectives, the innovation process is described as a process designable and controllable by managers of innovation. It starts with an idea, and concludes with the implementation of a predetermined result, commonly in the shape of technology. According to the prevailing knowledge paradigm, the definition of technology has gradually been broadened to include both material products and services, and the theoretical and practical knowledge required for their creation (Burgelman, Christensen, and Wheelwright, 2004; Trott, 2005). In spite of this 'expansion', technology is still referred to as something that can be accurately characterized in terms of itself. Both technical devices and reified immaterial products (knowledge, services) are treated as if they have inherent levels of energy which make them diffuse in a market independent of human action (Latour, 1988). Innovation research within this tradition typically focuses on the characteristics of technical inventions influencing individual and organizational decisions about adoption (Frambach and Schillewaert, 2002; Wilson, Ramamurthy, and Nystrom, 1999).

In Science and Technology Studies (STS), technology is attributed both physical and social characteristics. Important strands of research cover characteristics about the individual adopters or adopting organizations, and the role of opinion leaders in the acceptance and diffusion of technological innovation (Gourville, 2006; Nystrom, Ramamurthy, and Wilson., 2002; Rogers, 1995). A perspective which has been looked at with renewed interest in recent years is the socio-technical tradition (Emery and Trist, 1973). From this perspective, humans and technology are seen as interdependent 'systems' which must be jointly optimized for new technology to *'create value out of their pre-*

sumed qualities' (Akrich, Callon, and Latour, 2002, p.195). Innovation is understood as the first positive sanction of the users, and sanctions are based on compromise (ibid.). Typical of this perspective is that the intrinsic energy level of technologies is seen as insignificant, and the 'movement', or diffusion, of technological invention into successful innovation is assumed to demand the continuous supply of energy through a communication process referred to as 'translation' (Latour, 1988).

Johannessen and Stacey (2005) point out that, while the resource-based perspective pays some attention to team ability to develop and share knowledge in connection with technology development, it scarcely mentions how technology acquires meaning for individuals. Seen from the complex responsive processes perspective, our intellectual and emotional response to a physical object will depend on the meaning the object has to us, where meaning is to be found only in social acts. Johannessen and Stacey (2005) suggest that technology should rather be seen as a physical object, describable in terms of itself, but at the same time as a social object. Implicitly, the social objects of technology will affect our thinking in areas apparently unconnected with the technology itself, and may consequently impact not only on what we do, but also on how we perceive ourselves and the situations we are in, and the iteration and potential transformation of patterns of social relations. As indicated, social objects can be idealized into cult values, and in this way become embedded in our ideologies (Stacey, 2007). Building on this argument, 'technology' in Statoil can be understood as a cult value associated with the movement towards a desired future. Since, paradoxically, technology is also an important source of risk in petroleum operations, there is no reason to expect that members of the company should support this cult value without debate.

Most perspectives deal with the physical object of technology as if it is clearly definable. The distinguishing feature of innovation processes is, however, that they give rise to novel products, material or immaterial. This can be seen as the simultaneous emergence of new physical and social objects. As an example, none of the SIOR technology elements were completed when the programme was initiated, and some barely existed as ideas or early prototypes, which evolved and materialized into technological elements in the course of the programme. To approach the case of diffuse technology, I turn once more to the ideas of Mead (1934/1967), who claims that objects have 'phases' to which we respond. Our responses depend on our past and present experiences, and give rise to the intellectual and emotional content of the object. Mead sees novel objects as hallmarked not by the degree of newness of the object, but by its unpredictability, meaning that *'…in the experience of an individual it was not involved as a necessity of the past'* (Mead, 1938, p.419). His stand is thus that all objects, which in my interpretation mean physical-social objects, emerge, and are only to be found, within the social processes of experience, by the complex responsive processes going on between interdependent individuals. As a consequence, in terms of innovation technology, this can be seen as the simultaneous emergence of new social and physical objects. Conditional for the emergence and continued existence of new technology elements is that individuals participate in social processes in such a way that the particular and general meaning of the technologies appears. Implicitly, the significance of a technology element is derived from the social act. To be able to capitalize on technological innovations should further involve the need for a particular pattern of themes related to the importance of the technological element to stabilize sufficiently long for people to perceive it as a valuable enabler of the future.

Concluding remarks

Towards the end of April 2008, the average recovery factor from NCS subsea wells was approaching 47 %, which means that substantial effort still remains to reach the ambition of 55 %. The SIOR programme was terminated in October 2007, in consequence of a merger between Statoil and the oil and gas division of Hydro, but most of the activities are continued within a new R & D programme. According to the SIOR programme director, the most important outcome of SIOR was the very clear focus in the company, especially in the top management, on the importance of increased oil recovery. This had resulted in an expectation about mutually binding cooperation between Statoil researchers and members of the business assets, which was a new way of working in the company. The SIOR programme also resulted in the completion and implementation of several technology elements, and the development of even more, which will gradually be in pipeline for testing. As an example, the world's first *subsea through-tubing rotary drilling* operation was performed from a mobile unit on the Norne field in the Norwegian

Sea in 2006, and when the Tordis field in the North Sea is put on stream in 2009, it will be the world's first commercial field with *subsea processing*. Some projects developed in a way that rendered necessary a redefinition of their scope and schedule, but it is still too early to predict if some projects will fail. During the programme, one entirely new concept, called *Subsea MMX*, emerged. The concept combines several approaches to marine operations with the objective of obtaining a 50% reduction of total costs of subsea wells within 2010.

The processes of developing SIOR technology elements were not without problems, and neither were the processes to get technology approved, tested and adopted. In my view, this study suggests, therefore, that although traditional approaches to innovation research are convenient as a basis for the development of generalized knowledge, they fail to capture the fluid, complex and situational properties of the processes, and leave us with the erroneous impression that innovation can be designed and controlled. While it is understandable that such idealized ideas are appealing to corporate managers, this view largely ignores the fact that innovations are complex social processes, implying that it should be seen neither as designable courses of action, nor as events evolving by chance, but rather as emerging phenomena, paradoxically generalized and particularized in the experiences of everyday social interactions. Innovation processes can also be seen as the enactment of visions of a wished for future, involving the creation of objects which are not part of our past experience, and which will lead to human actions differing from what we did before.

Mead (1934/1967) reminds us that the present comprises not one, but numerous futures, which may be expressed by different persons as fantasies and ideas. When a company decides a business or technology strategy, what is selected can be seen as one specific future, judged to be more desirable than others. Sometimes, visions of the future are based on technological advances. Other times, like in the case of the 55 % SIOR ambition, the vision of a future comes first, and the means perceived as necessary to move to that future, like the development of novel technology, are chosen afterwards. But it is only in retrospect that we will be able to decide whether a process 'qualifies' to become part of an organizational narrative of innovation success, or if it appears as unsuccessful or even foolhardy, and is retold as a 'narrative of caution'

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Paper D

Innovation management as communicative process: Experiences from the Statoil SIOR R&D program

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Abstract

We have studied innovation processes in a research community in the Norwegian petroleum company Statoil ASA over a period of four years, using a participative approach. In this paper we provide some findings from this research interpreted from a complex responsive processes perspective. Our attention is on innovation management as everyday communicative action between organizational actors.

Our findings suggest that innovation processes can be seen as communicative patterning processes which at the same time uphold and change patterns of power relating and identity formation. These processes are influenced by a number of people, having their own intentions and plans, and are not controllable by any one individual or group in the organization. Management of such processes is therefore not about 'being in control', but rather about the intentional participation in everyday conversations where the

quality of relations influences peoples' ability to go on together. From this perspective top management inclination to over-focus on control and monitoring of processes of innovation could be seen as a disregard for the significance of participation as a management 'tool' in innovation processes.

1. Introduction

Research on the phenomenon of innovation began to grow and proliferate in the 1960s, but did not truly gain momentum until about 20 years ago. Today, innovation is seen as the main enabler of long-term company viability, and is broadly recognized as being about thinking "outside the box" (Borgelt & Falk, 2007). The comprehensive interest in understanding the "innovation journey" (Van de Ven, Polley, Garud & Venkataraman, 1999) has been accompanied by a concurrent interest in identifying the managerial moves necessary to ensure safe arrival at a predetermined destination (Davila, Epstein, & Shelton. 2006; Ettlie, 2006; Goffin & Mitchell, 2005; Snyder & Duarte, 2003; Tidd, Bessant, & Pavitt, 2005). The results are ambiguous, but the apparent challenge of innovation management is to create an environment of perpetual innovation, where everyone is committed to excellence, resulting in growth and sustained competitive advantage.

Drawing on a quadrennial research collaboration with the Norwegian petroleum company Statoil[8], and adopting a complex responsive processes perspective (Griffin, 2002; Shaw, 2002; Stacey, Griffin, & Shaw, 2000; Stacey, 2001; 2007), we have suggested elsewhere that the fundamental nature of innovation, defined as the development and adoption of novel solutions, is *communicative interaction,* leading to evolving patterns of themes experienced as unpredictable and uncontrollable (Johannessen & Aasen, 2007). We have further argued that the communicative interaction can be seen as joint patterning processes of power and identity, influenced by everybody, although certain individuals always have a larger say (Aasen & Johannessen, 2007).

[8] The examples provided in this paper are derived from a study concluded in September 2007. The references are therefore made mainly to Statoil, and not to StatoilHydro, which was formally established on 1 October 2007, following a merger.

Our view of innovation as emergent patterns evolving in the interplay between interdependent individuals has exposed a problem concerning established ideas of innovation management. From a complex responsive processes perspective organizational processes are joint human interaction, where individual and organizational characteristics evolve as two aspects of the same process. Human interaction is not seen to lead to any process-independent 'system', only to further communicative interaction. The management of such processes is understood to be an activity *'emerging in groups of interacting individuals engaged in collaborative action'* (Tobin, 2005, p.67). This brings to the fore a question whether individuals are able to efficiently take on the responsibility as a manager of innovation, whether the responsibility is formally assigned or informally assumed, if their claim of the role is not generally accepted by those who are somehow involved in the processes?

This paper seeks to progress our discussions about innovation management seen from a perspective of complex responsive processes, towards a more specific understanding of what it could mean to manage innovation processes in large industrial companies.

2. Perspectives on innovation management

Much effort is invested to generate knowledge about the challenging role of managing innovation (e.g. Ettlie, 2006; Tidd et al.; 2005; Trott, 2005). Underlying many conventional approaches there seems to be an assumption that properly informed managers will be able to control the progress of innovation processes in such a way that the results will be, within defined limits, in accordance with some strategic intent. The main challenge of innovation management appears to be the simultaneous handling of demands on *profitability*, seen as a necessity for company short-term survival, involving cost control, workforce reduction, efficiency, and value-chain optimizing; and *innovation*, seen as essential for long-term viability, involving creativity, experimentation, uncertainty, and the risk of failure. The complexity of this challenge is emphasized by Tidd (2001), who has made a comprehensive review of current research on innovation. He points out the random unpredictability of innovation and the diversity of research approaches as the main reasons that knowledge about innovation management still appears to be incoherent and difficult to translate into clear prescriptions.

From our view, the literature on innovation seems to bring into focus three particular areas of management responsibility, which are *organization, competition* and *value realization*; respectively. The main objective of *organization* focused innovation research is to indentify organizational characteristics promoting company innovativeness (e.g. Arad, Hanson, & Schneider, 1997; Ravichandran, 2000; Siguaw, Simpson, & Enz, 2006). The intention is to generate knowledge which managers can implement into their organization so as to increase general innovative capacity. Researchers focusing on *competitive conditions related to innovation* analyze decisions seen to be of strategic importance, cooperation and alliances, selection of markets and market strategies, and areas for innovation. This research is largely based on resource based theory (e.g. Grant, 1991; Teece, Pisano, & Shuen, 1997), and involve the view that managers can choose a strategic approach to innovation dependent on available resources and the competitive context.

The third area, which we refer to as *value realization*, includes research focusing on factors having impact on the outcome of innovation processes (e.g. Durand, 2004; Neely, Fillipini, Forza, Vinelli, & Hii, 2001). In this context, organizations can be seen as actors which create and take ownership of value (Wijnberg, 2004). The realization of value as the outcome of innovation processes is related to the ability of a company to convert new knowledge, scientific breakthroughs, and technological advances into economic success. This view has engendered vast interest in theories of knowledge management (Quinn, Anderson, & Finkelstein, 1998), organizational learning (Nonaka & Takeuchi, 1995), collective knowledge (Glynn, 1996), communities of practice (Wenger, 1998), and indeed, innovation management (Davila et al., 2006; Tidd et al., 2005; Trott, 2005). Furthermore, the recognition that organizations cannot 'own' the knowledge needed in every situation has led to an emerging view that learning, problem solving and innovation involves close cooperation between people in many organizations, often referred to as networks (Powell, 1998) or social capital (Becker, 1975; Bourdieu, 1986). The effect of collaborative processes on innovation and business performance is discussed by several researchers (Cohen & Levinthal, 1990; Durand, 2004; Tsai, 2001; Chesbrough, Vanhaverbeke, & West, 2006).

Although the defining feature of processes of innovation is pointed out to be complexity and uncertainty (Tidd, 2001), most authors hold on to assumptions of management controllability of such processes, justified by the observation that many companies survive and renew over time (Tidd et al., 2005). As distinct from most researchers, Van de Ven et al. (1999, p. 66) point out that managers at many hierarchical levels are involved in the management of innovation, and that in spite of a widespread view that managers have a uniform, common perspective, managing innovation does involve diversity and conflict. Accordingly, their suggestion is that innovation processes may be inherently uncontrollable, and that a relaxation of 'traditional notions of managerial control' is needed.

In our approach to studying phenomena similar to those described by Van de Ven et al. (ibid.), we have adopted a complex responsive processes perspective as the theoretical basis. This perspective has been developed to offer a radical different explanation of organizational evolution and change (Stacey et al., 2000). The distinguishing features of this perspective are that all human relating is seen as fundamentally communicative, and that ideas of the autonomous individual and the objective observer/manager are replaced by assumptions of the simultaneous social construction of group and individual identities and the methodological position of reflexivity in both individual and social terms (Stacey, 2007). An important source of inspiration of this perspective is Elias (2000). He argued that social evolution happens as the result of local interaction between people following their own intentions, while being at the same time enabled and constrained in their social action. In his view people do plan and they do have intentions, but inevitably also participate in figurations of interaction in which power is always an intrinsic property (Elias, 1978). Such figurations of power are seen to be asymmetric, meaning that individuals influence the communicative interaction they are part of to a greater or lesser extent. A further implication is the improbability that one individuals' plan or intention should become dominant as the long-term reality of everybody in the organization.

Elias (ibid.) saw conflicts between actions, plans and purposes of interdependent people as a source of completely new ideas and events that nobody could have foreseen. In his view, individuals form the social *while being formed at the same time*. He therefore suggested a non-linear, paradoxical, transformative causality between human action and the outcome of social processes. The non-linearity imply that even small variations in themes have the potential to lead to radical global re-patterning of conversations and power relations, sometimes referred to as the 'butterfly effect' (Lorentz, 2000). For organizations, this perspective implies that repetition and change should be seen as the same process, being essential for novelty to emerge and evolve (Leana & Barry, 2000).

3. Statoil and the SIOR case

The Norwegian oil and gas company StatoilHydro is the leading operator on the Norwegian continental shelf (NCS). With its modest 29,000 employees (current numbers), StatoilHydro is a relatively small company compared to its competitors[9]. The conditions on the NCS have, however, made extreme demands on technology. This has lead to the recognition of the company as a world-leader in the use of innovative technology, and brought it to the position of being the world's largest operator of deepwater fields. Over the years, more than 20 oil and gas fields on the NCS have been developed under the leadership of Statoil, each field having its own unique geological and geophysical characteristics, and its unique challenges related to the exploration of oil, well drilling, oil and gas production, and the separation of oil and gas from unwanted by-products such as sea water, sand and stearates. The objective of StatoilHydro is the ensuring of *long-term value creation for its shareholders through engaging in exploration for and production, transportation, processing and marketing of petroleum and petroleum-derived products* (www.statoilhydro.com). According to their web-site, long term profitable growth is to be sustained through increased international activities and renewed efforts on the NCS. The latter scope is not only connected to increased oil recovery, but also to a need to avoid the hidden threat of having to close down fields which are becoming unprofitable.

Characteristic of the petroleum business is that technology production times generally are lengthy, up to 20 – 30 years, involving not only technological development but also comprehensive test and acceptance procedures. As innovation in Statoil largely is based on needs in field development projects, a limit is thus set to how 'new' technol-

[9] In comparison, Shell employs 108,000 people, Chevron 56,000, Total 95,000, and BP 97,000.

ogy can be. Accordingly, innovation often means the application of existing technology in new contexts. Recent NCS fields are smaller than those already on-stream, and development budgets more limited. Present value estimates leave little time for technology development, but the need for innovation is as pressing as ever. This has promoted a demand for increased collaboration within the company to develop new technology and work processes across business assets. As most Statoil projects and operations are conducted in cooperation with other companies, the management of development activities by and large imply managing collaborative teams composed of people from various Statoil departments and from one or more external companies.

In 2003/2004 six strategic research and development (R&D) programs were initiated in the Statoil Research Centre as an important measure to promote the 'renewed efforts on the NCS'. These were umbrella programs intended to embrace and adapt ongoing research activities according to program ambitions, as well as to frame new initiatives. In total, the programs were granted an annual budget of about 130 million Euros. One of the programs was called *Subsea Increased Oil Recovery* (SIOR). The objective of SIOR was to provide technology making probable the increased production of oil from existing and future Statoil operated subsea fields on the NCS from the 2003 average of 43% to an average of 55% in 2008. This would mean the production of about 1.4 billion barrels of extra oil over the estimated lifetime of the fields, corresponding at the time to an added gross profit of about 70 billion US$. Since then, the oil price has nearly tripled.

The SIOR ambition was judged to be unattainable through the use of existing technologies, and implied the need for accelerated development and testing of technologies in the pipeline, as well as for the generation of completely new concepts. Characteristic of the SIOR program in terms of innovation was that it was assigned a specified, measurable end target, but that there were 'many roads to Rome'. No single concept could meet the 55 % SIOR ambition, so the program eventually embraced about 25 different ongoing development activities, spanning technology connected with the identification of drainage points and intervention needs, improvement of production management, provision of low cost drainage points and intervention, reduction of well head pressures and increase of liquid handling capacity. The activities involved more than 100 persons, of whom about half were employed in other companies. Statoil was taking on the dual role of customer and technology provider, assigning the role of provider to its Research Centre. Until then, most of the larger development projects had been performed in collaborations between Statoil operating unit members and external suppliers, and the role of the employees in the Research Centre had been relatively minor. The authorization given to SIOR to take a leading role in business development was therefore seen as unusual, and was referred to as a 'different way of working'.

At the time SIOR was terminated, in September 2007, some of the technology elements developed within the program had been adopted, and therefore, SIOR could be referred to as a success story. On the other hand, there were several technology elements which were not completed at the time. These were included in a new research program, which is presently ongoing. If, by some reason or another, these technologies should not be completed or adopted, then the story about SIOR would also be a story about innovation process unpredictability, even failure.

4. Research approach

In connection with the establishment of the strategic R&D programs, an idea had developed among a few managers in the Technology division, within which the Research Centre and SIOR was organized, that the program provided a good starting point for evaluating their internal processes for innovation. The four members of the SIOR core team (CT) agreed to accept the presence of a researcher as part of their team, and so the first author of this paper was invited to join them. Consistent with ethnographic research methods, she was engaged in Statoil for four years, and granted an employee number and an ID card, the opportunity to work on-site, and to access internal databases, e-mail system and intranet. The study lasted from January 2004 to October 2007, but the collaboration with StatoilHydro is still ongoing, and follow-up activities are being prepared.

The study was carried out with the explorative attitude referred to as *emergent participative exploration* (Christensen, 2005). The term 'emergent' is conceptualized to represent the formation of meaning for the participating researchers from the exploration of one activity or situation, guiding the suggestion of the next activity of exploration. In our view, this is about the researchers' intent of experiencing everyday social processes in organizations, rather than being about a particular method. Implicitly, different methods as we know them traditionally may be used without this being inappropriate. A broader discussion of the basis for the theoretical and methodical approach can be found in Johannessen & Aasen (2007). Our research situation implies that our view of innovation management in Statoil is based on our experiences from the Research Centre. We were, however, given the opportunity to interview about 40 leaders, both in the division for Technology & Projects, and the divisions for Development & Production Norway and International, many in key positions in the company. This gave us the possibility to evolve and challenge our impressions of ongoing activities for change and innovation, including managers' contributions to these processes. In addition to interviews and participative observation in SIOR CT meetings and a range of other meetings and events, our research activities included formal and informal conversations, and, on a few occasions, consultative intervention. We describe and analyze examples from the Statoil SIOR case by use of a narrative style. The excerpts and quotations included are from conversations between the first author of this paper and managers in SIOR, or managers whose support was of importance to SIOR. We take a complex responsive processes perspective to make sense of the documentation. .

5. Innovation management as acts of participation

The SIOR activities were not started from scratch. Work had being ongoing in the Research Centre and in other parts of Statoil for a long time, aiming at the development of various technologies to render possible the recovery of increased volumes of oil. The experience of those involved, among them future members of the SIOR CT, was that it was hard to attract attention towards this kind of initiatives in the company, and that it generally did not result in anything. The idea of framing individual projects having similar intentions into a 'whole', an umbrella program with an overall ambition, was launched as a way to direct the top management's attention towards the potentiality of such activities, and to facilitate communication about them in the company. The approach appeared to work, in that the SIOR idea gradually got fully backed up by the top management.

The idea on which the SIOR program became based was that the combination of operational unit requirements and the creative capabilities of Statoil researchers, specialists and experts from other companies, would lead to the generation of new technologies tailored to enable the increased efficiency of subsea oil production. The argumentation was in line with Thamhain, who claims that the hallmark of capable R&D teams is that they not only generate innovative ideas, but also *'transfer newly created concepts through the organizational system for economic gain',* (Thamhain, 2003, p.297) and with von Hippel (2005), who asserts the importance of user-centred innovation. But SIOR was also about the introduction and implementation of new ways of working in the company. This involved three important organizational change initiatives. Firstly, key performance indicators for increased oil recovery were imposed on production managers; and a company-wide routine for determining producible oil volumes and relate this to specific technology elements was introduced. Secondly, closer collaboration between Statoil researchers and members of operational units was demanded. Finally, a new approach to the procurement of technology development expertise as well as to collaboration between Statoil researchers and experts from other companies were developed and implemented. So, in this particular case innovation management was not only about managing technology development, but also about preparing for the adoption by Statoil-operated fields of new technology elements, as well as bringing it all about through processes which in several ways were unfamiliar to the persons involved.

The processes led by the SIOR CT were influenced by a large number of people in executive positions, or holding other responsibilities such as researchers, specialists, licence members, people in support departments such as quality assessment, human resources, procurement, budgeting and planning, as well as on many people employed in other companies. In our view, this underlines the problem attached with the idea that innovation can be predetermined by the actions of particular individuals, such as managers, and emphasizes the intrinsic collective nature of innovation processes. Human inclination to reify innovation processes as tangible 'things' individuals can manipulate makes us neglect the complex dynamics of everyday communicative interaction, in which the phenomenon of innovation emerges. A change of perspective on organizations from conceptions of a 'whole' to notions of joint human interaction suggests that increased management attention is needed on the detail of local interaction between people striving to particularize the significance of new and ongoing themes for the company and for them. Implicitly, the present rather one-sided focus on management acts as the development and following-up of steering documents and key performance indicators need to be replaced by the recognition of the potentially even greater significance of management as acts of participation.

Leadership, collaboration and identity

To handle the SIOR program challenges, a core team was composed of four hand-picked people, all of them experienced managers and specialists having worked many years in Statoil operational units, and representing different disciplines within petroleum engineering. As given account for by the head of the team, at the time the scepticism, even reluctance, towards the SIOR ambition was substantial, both among members of operational units and the Technology division:

> *That the executive vice president for Technology so clearly signalled that he was willing to stick his neck out for what was evidently an unrealistic objective, was crucial. If it had been something we'd hatched down the corridor, we wouldn't have had a snowball's chance in hell… After three years, many still think that what we do is unrealistic, but it used to be worse. Chief engineers and even business unit directors went around saying that this was nonsense for quite some time after we'd started the program, so I had to tell them that they had to stop doing that.*

In addition to questioning the 55 % ambition, a main objection against SIOR was related to the 'new way of working', which implied that members of the Research Centre were intended to play a more prominent role in innovation processes than before. A common response to this among operational unit members was that they understood better the business challenges facing Statoil than did most of the researchers, and that they were far better trained as project managers. While the Research Centre was acknowledged to have a lot of excellent niche experts, a widespread view seemed to be that most researchers showed little interest in the company core activity, which is the production of oil and gas. From their side, many of the researchers expressed the view that operational unit members, and even the SIOR CT, lacked the insight that inventing technology was somewhat more complicated than to '*to sit down and just decide to get a break-through'*.

This suggests that attention should be directed to the question of inclusion and exclusion in groups, and to identity. 'We' identities in groups are based on generalisations (Mead, 1967). As 'we' identities develop, simultaneous perceptions of 'them' evolve, resulting in a paradoxical dynamics of inclusion and exclusion of individuals. Activities of inclusion and exclusion, which will always be part of the process of forming and identifying with a group, are accompanied by the tendency to label groups of people in ways that enforce the difference between 'them' and 'us' (Stacey, 2007). Such generalisations leave us with an impression of the uniformity of group characteristics. Elias & Scotson (1994) argue that raising issues of 'us' and 'them' relationships can uncover insider and outsider relations in which diverse groupings develop or damage their co-operation. As exemplified by one of the members of the Technology division, the movement in the company towards the new ideas of co-operation showed indeed to become conflictual in some cases:

> *We went all out for it, but then the drilling people decided that, no, the researchers shouldn't come and tell them how drilling was to be done in the future. And it became a major clash, and we had to stop the project.*

A consequence of the preceding elaboration is the view that what people 'produce' when they interact in the living present is the continuous creation and recreation of individual-group (organizational) identity. From this perspective the task of the SIOR CT members could therefore be seen to be the re-patterning of individual-group identities of people involved in SIOR, with the intention to organize their experience of being together in new ways.

The role of the SIOR CT members gradually evolved to be that of 'technology broker', or intermediary between development and adoption. We were told that this was a new role in the company, seen to be very important for the realization of the SIOR ambition. Worth noticing is that the acceptance by operational unit managers of the role of CT members was attached to their former experience from operational management and business development. Their knowledge of current business processes provided the credibility many of the researchers were not attributed. From our position it seemed, however, that the SIOR CT members did not get accepted by members of the Research Centre in the same way, leading to a situation where agreements about deliveries to the operational units were not always kept to satisfaction (Aasen & Johannessen, 2007).

Elias (2000) suggests that when people attempt to design or change some global pattern, like established 'us' and 'them' relationships, they are doing nothing more than making a gesture, although this can be a very powerful gesture. The crucial point is that the emerging pattern can be found only in the local responses to this gesture (Stacey, 2005, p.13), and that what is emerging, is novel patterns of themes that no one individual could have decided, and that may involve the emergence of novelty. It is, however, not given that the emerging patterns are perceived as 'suitable' or 'successful'. From our perspective this is a particularly important point in innovation research, which is rarely taken into account when innovation processes are discussed. Power differentials between groups may create a powerful dynamics in organisations (Stacey, 2007), probably constituting one of the main reasons for the failure of attempts to realise strategic intents, like the SIOR ambition.

The dominance of research ignoring phenomena of group dynamics and non-linear, time dependent effects of action has so far implied that managers are offered models of organizational processes that do not and cannot capture the temporally embedded accounts that enable them to understand how emerging and evolving patterns come to be. Our experience has given us reason to question the realism of the idea that individuals and groups of individuals intentionally can articulate, and even design, a jointly desired generalized pattern, such as future organizational states or guidelines for collaborative behaviour. From our position, the issue is rather what purpose such formulations serve, what the emerging patterns of communication in ordinary everyday organizational life in response to such formulations are, and how we can understand innovation processes as being a part of this.

Participation as creation of meaning

The SIOR study showed that the reputation of the head of the SIOR CT as an able manager holding broad knowledge about Statoil processes opened doors to managers and meetings of great importance to SIOR. This did not, however, mean that conversations progressed without problems. In a 2006 meeting with members of one of the operational units, this was commented by the head of the SIOR program:

> *The SIOR team, based on meetings with all assets as well as own experience, allocated the added volumes to the various assets and defined corresponding technology elements. When we came back a second time to the assets presenting the result of our findings, the reactions were as expected – this is not possible. But when we asked what the assets needed from us in order for them to achieve the 'impossible', the discussions became very interesting and constructive. The result of the process between the operational units and SIOR is that this spring* [2006] *the assets have been confident enough to increase their IOR* [increased oil recovery] *targets substantially.*

Characteristic of the actions taken by the SIOR CT was that they were continually participating in meetings and conversations, sometimes involving two persons, sometimes twenty. They kept repeating the 55 % ambition, but at the same time they spoke of specific technology elements, such as *Light Well Intervention; Wet gas compression;* or *Shared Earth modelling*, and the business opportunities related to the adoption of such technologies by specific fields. In concurrence with this, they made contact with Statoil information associates, who they 'educated' by inviting them to relevant expositions. They also made sure that the top managers were always provided with the latest SIOR presentation material. After about two years it was commented in a CT meeting that they had been talking so much about the SIOR technologies that people in other petroleum companies started to implement them before Statoil did. Gradually, what emerged in the wake of this intensive communicative effort was a widespread opinion in the company that the 55 % ambition and the activities performed as part of the SIOR program were 'appropriate'.

Seen from a complex responsive processes perspective, coordinated action between many people depends on the production of '*emergent, coherent, meaningful patterns of interaction both locally and population-wide at the same time'* (Stacey, 2007, p.434). Emerging patterns of themes spread out and evolve because people are involved in many local conversations. According to Mead (1967) such processes inevitably involve reflection, emotion, imagination, and conflict. Through the reiteration and potential transformation of themes in all these everyday, ordinary, local meetings, joint action is enabled, and inhibited. In consequence, innovation, understood to be altered performance brought about by novel material and immaterial solutions, depends not only upon the emergence of novel patterns of themes, but also on the diffusion and temporary stabilization of the evolving patterns among people whose cooperation is needed to render possible the enactment of the new themes.

Consistent with this idea, the continued intention of the SIOR CT members was clearly to bring locally evolving patterns of themes under the sway of the SIOR ideas in such a way that the decisions made by field directors or others whose actions affected the program activities were in favour of the realization of the SIOR ambition. The problem frequently discussed was how to ensure this. As expressed by one of the CT members: '*The problem is not the conversations I am part of, the problem is those conversations in which I am not a part'*. His experience was that patterns of talk emerging in his presence did indeed change as they were further evolved in conversations between other people, and not always in ways seen by him as favourable. This supports the observation made by Streatfield (2001) that the essential function of managers can not be 'control', because it would be impossible for any one individual to be in control of evolving patterns of communication. Our suggestion is that the most important task of managing innovation is the purposeful participation in communicative interaction, where what is intended is the creation and temporary stabilization of novel patterns of meaning, enabling joint effort towards a desired future organizational situation.

Our discussion parts somewhat from Fonseca (2002), who is occupied with the idea that redundant diversity in conversation is of importance for innovation, and that such redundant diversity is experienced as *misunderstanding*. By 'misunderstanding' he seems to mean the lack of joint meaning, leading to the continual shift and evolvement of the patterning processes of new themes because of the current introduction of new themes and ideas into the emerging patterns. Fonseca (ibid.) argues that the continued disturbance of emerging thematic patterns of experience may prevent premature or unwanted stabilization of themes. We see this interpretation of 'misunderstanding' as a support to the view that innovation emerges from prolonged communicative processes characterized by conflict, ambiguity and persuasion. In consequence, innovation management involves the courageous, continued exploration of the experiences of being together in spite of potential conflicts. Seen this way, our experience in SIOR is in line with Fonseca's observation. On the other hand, our experience also indicate that the frequent introduction of new themes by the Statoil top management and by other people in managerial positions represented a diversion of attention in the company from the SIOR ambition towards competing tasks and ideas, and so the re-stabilization of the SIOR 'message' through the repeated communication of possibilities and promising results appeared to be an aspect as important for innovation success as was the maintenance of ambiguity. Another experience was that the tolerance for the kind of misunderstanding described by Fonseca (ibid.) was relatively low in the meetings between SIOR members and people working in the operational units. A widespread expectation in Statoil seemed rather to be that the particular intention of the SIOR CT should be the enabling of controlled movement towards a desirable future organizational state. It appeared that the main expectation was that managers' participation in communicative interaction should lead to the emergence of joint meaning in the specific shape of plans and milestones.

A problem with participation

In line with prevailing management values (Miles, 2007), efficiency, monitoring, control and short-term profit are strongly emphasized in Statoil, also in connection with processes referred to as 'innovation'. Given the prevailing idea of the significance of innovation for business prosperity, it is no surprise that people in executive positions are prone to the temptation of subjecting innovation processes to the same procedures for strategy and control as other business processes. The design of propositional themes (Tsoukas & Hatch, 2001), usually introduced in the form of prescriptive statements, rules, procedures or models, is a common way for managers to try to mark out a better course for the organization. In addition to ideas of control and efficiency, the overall management in Statoil appeared to be inspired by the principles of *value based management* (Black, Wright, Bachman, Makall, & Wright, 1998). Among other things this implied the introduction of visionary themes intended to direct the attention of company members towards specific objectives, like the need for innovation. Propositional and visionary themes can be seen as tools in the ongoing communicative interaction, and can be understood as contributing factors to the creation of meaning, but not as contributors to the achievement of control. The actions following the introduction of propositional and visionary themes emerged as the outcome of interplay between rules, plans, intentions, and choices, primarily patterned as *narrative themes*, affected by and affecting ongoing and emerging patterns. Consistent with Stacey (2007), I observed that the importance of the mainly narrative, interpretive character of ordinary, everyday conversations seemed to be largely overlooked by most managers.

According to the booklet 'We in Statoil' the generally communicated expectation to Statoil managers was that they should be *enthusiastic, hands-on to business and employees, deliver results, carry through changes, develop and inspire employees, and show enthusiasm towards the Statoil values*, and make *clear demands on performance and personal responsibility*. Dependent on the position held, objectives were set for the individual managers in line with these expectations, apparently with emphasize on measurable achievements. To illustrate an important challenge with this thinking, related not only to processes of innovation, but to all processes involving uncertainty, we have included an excerpt from a conversation between a then member of the management team in Statoil division Technology and Projects and the first author of this paper. Our conversation was about her understanding of the current Statoil values, which at the time were: *Imaginative, hands-on, professional, truthful* and *considerate*, in relation to her ideas of innovation management, and how she as a manager "high up" in the formal hierarchical structure acted to influence her subordinates to be more "imaginative":

> *R: I have been discussing with my boss about that "hands-on" thing. In her opinion, this means to know about all the details … like whether the rig holds or where the connections on the Tordis field are, and – I am not a detail person, but I do spend a lot of time together with the people I am responsible for, and I try to understand how they work and how they should adjust their work, and challenge*

them on things like how they cooperate, and in that way be "hands-on". But what I do is not visible; it is completely invisible, isn't it? You cannot boast of it in any way, you cannot talk big about anything.

I: It does not work in this culture, does it?

R: No, I do not know if it works in any culture, but you have to believe that it leads to results, and I do believe it will – and it is much more fun for me, but that is another matter, - and I do believe that it will lead to results. But it is so difficult to see.

I: Maybe what you do is the most important you can do, to talk to people?

R: Yes, all along. Again and again. I repeat my messages and tell the stories again and again and again.

I: Do you feel that they start to repeat what you say?

R: Yes, but it is a slow process.

I: One of your colleagues told me that you do not really have to make plans in Statoil, you just have to keep repeating things, and then gradually they become the truth.

R: Yes, that's it.

I: So, in a way, this is the same idea that you have?

R: Yes, and that is the way it is, every change, cultural change or other, happens through repetition, it cannot happen through resolution. Change is a vast process in an organization when you sit at my level, and there are extremely many people you need to convince. You have to make people see themselves in all the "us", you know. It is so easy to say that we are to become this and this, but if individuals aren't able to see themselves in the new picture, and understand how they can contribute, it will not work.

A major worry for this manager was the lack of curiosity and ability to recognize colleagues who had originated good ideas among Statoil employees. She also called attention to important problems connected with the comprehensive use of email as a means of communicating, which in her experience tended to lead to misunderstanding and conflict rather than to cooperation. She therefore spent a lot of time trying to make people communicate face to face within and across disciplines. In our view, what she tried to do was to actually focus on the quality of relations. Her problem was that within the prevailing ideas of monitoring and control, her actions were not directly measurable, and thus, she felt that she was not recognized as performing a good job as leader.

It is worth noticing that this manager was not representative for most managers we met. Although very obliging, the majority spoke about their work in generalized terms. When we asked about innovation processes, most talked about some development process of which they had been part, or were aware. Some offered their opinion on particular themes, mostly related to innovation and change, but most seemed surprisingly uncomfortable about using the word "I".

The quality of relating

The enabling constraints inherent in all human interaction and the dynamics of inclusion/exclusion created between groups indicate that paradox is an inevitable part of everyday organizational life. We see the experience of paradox as being of particular importance in relation to innovation, which inherently entails the emergence of novelty, and the certain uncertainty that unanticipated responses will be called forth in others. While much of the existing management literature is about punctuating such paradoxical situations by for example setting unambiguous, measurable ambitions and objectives, we would encourage managers to try to capitalize on the pluralism which is the inherent property of paradox. The complex responsive processes perspective can be seen as an invitation to reflect on the manner in which people are reasoning as one of many aspects of human action in organized life, instead of taking rationality for granted. We see this as an opportunity for managers to take seriously their own experiences as leaders, by focusing on what they are actually doing, as the manager cited in the preceding section tried to do, and not on what they did or plan to do. Shifting experiences of identity and difference, inclusion and exclusion, inspiration and anxiety, freedom and control, and of structures of authority, are likely to cause enthusiasm with some, and doubt and resistance with others.

A question of particular interest is how decision makers think about their intentions when they are suggesting propositions and even orders, and of the possibilities and limitations of using target setting, planning and monitoring as basis for long-term organizational performance. A perspective on organizations as patterns of interactions implies the view that ongoing processes are influenced by many individuals in many roles, deliberately or unconsciously. This indicates that while the introduction of propositional and visionary themes are important tools in the process of leading, the task of managing innovation involves explorative and participative actions intended to inspire and motivate, but also 'force', the members of an organization towards the joint creation and realization of an imagined future, concurrently guided by the insight that the future is unknowable. Incidentally, this suggests that as participants in the social processes of organized life, managers are free, and at the same time constrained, in choosing their own actions, and at the same, that the actions they decide on will expose their colleagues and subordinates to both possibilities and constraints. It is argued that managers' focus on the quality of relations is decisive for the organisational capacity for change and innovation, i.e. for the creation of emergent new meaning (Johannessen & Aasen, 2007). To focus on the quality of relating does, in our view, mean to focus on aspects of participation such as those just discussed.

6. Conclusion

To approach innovation from a complex responsive processes perspective means to focus on human action and interaction intended to lead to the phenomenon of innovation. The perspective brings to the fore a view that innovation management is about intentional participation in social acts of relating at work, in which ideas about an emerging future are evolving and changing as people engage in local communicative interaction. Mechanisms for structure and control are non-responding, response provoking 'tools', causing organizational members to feel enabled and constrained by their implications, depending on situation.

Movements of thought, whether deliberately imposed or unconsciously emerging, are changes in action, and form the basis for learning and innovation in organizations. Innovation involves the introduction of novel ideas into ongoing communicative processes, meaning that reproduction of currently stabilized themes is disturbed. Accordingly, it is reasonable to expect that such novel ideas will be seen as controversial, and cause uncertainty, conflict, and the inclination among individuals and groups to attempt to re-establish habitual patterns of themes. Implicit in this perspective is the view that neither knowledge and intention, nor meaning and identity, can be attributed to individuals alone, but are relational phenomena produced in communicative interaction between individuals. Such processes should not be seen to approach a mature or final state, but as being continued by individuals participating in local, everyday interaction, perpetually creating and recreating ideas about their intentions and possibilities.

Note

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Abbreviations and definitions

- Oil industry and SIOR program terms

Appraisal (delineation) well	A well drilled to determine the extent and size of a petroleum discovery
Barrel (bbl)	Oil is usually measured in barrels, with production specified in barrels per day (b/d or bpd). One barrel equals 159 litres, 35 imperial gallons, 42 US gallons or 0.159 standard cubic meters.
Barrel of oil equivalent (boe)	Oil and gas volumes expressed as a common unit of measurement. One boe is equal to one barrel of crude oil, or 159 standard cubic metres of gas.
Continental shelf	The relatively shallow submarine margin around the continents. It extends from the coasts, getting gradually deeper, to the point where the seabed abruptly descends to ocean depths.
Crude oil	Oil produced from a reservoir after associated gas (which is natural gas dissolved in oil, or forming a gas cap over the oil in a reservoir) has been removed by separation. A fossil fuel formed from plant and animal remains many millions of years ago, comprising organic compounds built up from hydrogen and carbon atoms. From this reason it is often referred to as *hydrocarbon*. Crude oil also contains small quantities of oxygen, nitrogen and sulphur.
Cubic meter – m3	6.29 barrels
Discovery	One or more deposits, or accumulations of petroleum in geological structures, which have been proved through testing, sampling, or logging to contain flowable petroleum
Exploration well	A collective term for wildcat and appraisal wells drilled to search for oil and gas
Field	In Norway, one or more discoveries which the licensees have decided to develop and which either has a plan for development and operations (PDO) approved by the authorities or has been exempted from providing a PDO.
Hydrocarbons	Compounds of hydrogen (H) and carbon (C). If a petroleum deposit consists primarily of light hydrocarbons, it is called a gas field (natural gas). Similarly, one with a preponderance of heavier hydrocarbons is an oil field.

IOR	Increased oil recovery
Integrated operations - IO	IO is about creating ICT-based, uniform and integrated solutions to support the petroleum operations in a way that makes them more effective, thus making possible the profitable recovery og more of the oil
KPI	Key Performance Indicator
Licence	A licence can embrace all or part of one or more blocks, and specifies who the licensees are. The licensees group is made up of representative from the operator and the other petroleum companies who are joint owners in the field. Together, they are responsible for the exploration and production of petroleum within a block, or oil field.
LWI	Light Well Intervention. The principal driving force behind the development of this technology is the reduction of the cost of maintenance. With increased access for only at one-third of the cost of a typical intervention, oil companies can better monitor and gather more information from the reservoirs worldwide.
Nm3 – Normal cubic meter	Volume at a reference condition of $0^{o}C$ and a pressure of 1.01325 bar
Oil equivalent – o.e.	Used when adding together volumes of oil, gas and natural gas. It is defined as the energy obtained from burning the various types of petroleum.
Operator	A company with the right to explore oil and gas in a licence and to develop a field for production after a commercial discovery. Usually acts on behalf of a partnership.
PEP - Project execution plan	The principal plan for project execution, prepared (or revised) once a year as basis for evaluation and prioritizing of activities in the company.
Petoro	The objects of the company are, on behalf of the state and at the expense and risk of the state, to hold the responsibility for and to attend to the commercial aspects related to the state's direct involvement in petroleum activities on the Norwegian continental shelf, and business associated herewith.
Petroleum	A collective term for hydrocarbons, whether solid, liquid, or gaseous
Plan for development and operation – PDO (Norwegian: PUD)	In Norway, a plan submitted by the operator to the authorities for official approval to bring a field into production

Platform	An installation used to produce oil and gas. Can either be fixed or floating.
Production costs per barrel oil equvalent	Operating expenses associated with production of oil and natural gas divided by total production (lifting) of oil and natural gas
Production well	Drilled to recover oil or gas from a reservoir
Recovery factor	The percentage of petroleum resources originally contained in a field which can be recovered through production
Reserves	Originally recoverable reserves are distinguished from remaining reserves, which are the volumes of petroleum which can still be produced on the basis of the likely recovery factor
Reserve replacement ratio	Additions to proven reserves, including acquisitions and disposals, divided by volumes produced.
Reservoir	An accumulation of oil and gas in a porous rock such as sandstone. Gas is usually found at the top and water (the aquifer) at the bottom, with oil in between.
Resources	Resources originally in place are distinguished from originally recoverable resources/reserves. The former are the resources calculated by geological and petroleum technology methods to be present in a field before production starts. The latter are the resources/reserves judged – on the basis of prevailing knowledge about volumes present and recovery factor – to be recoverable during the production period.
RNB	Report to revised National Budget
Seismic surveying	A method for describing the geological structure of the subsurface. At sea, sound signals created by surface detonations (shots) are projected below ground and the echoes recorded. Such surveys can be used to locate likely hydrocarbon deposits.
SEM - Shared Earth Model	The term Shared Earth Model has emerged to describe an earth model (or set of models) that can be used simultaneously by all the asset team members in a collaborative environment. It allows team members to work within their own area of expertise while ensuring that key information is made available to everyone in an expedient and timely manner. 'Shared' refers to the fact that common information is used throughout the operating decision support system. 'Earth model' refers to the fact that the goal is to understand 3-D volumes that are petroleum reservoirs. Spatially oriented interfaces along with capabilities to visualize many different types of data are fundamental aspects of a SEM.

SIOR	Subsea IOR, or Subsea increased oil recovery
Sm3 - Standard cubic meter	Volume at a reference condition of 15°C, and a pressure of 1.01325 bar
TTRD	Through Tubing Rotary Drilling. The technology is an important building block in recovering more oil from subsea wells. Production from new drainage points from subsea wells, by means of sidetracking through existing completions into new reservoirs, has traditionally been time consuming and costly. The development of a TTRD technology provides a more cost effective method to increase the production from subsea wells, compared to drilling and completing new wells.
Upstream	Operations pursued up to the point where petroleum leaves the production facility – the export terminal for oil and the treatment plant for gas. Exploration, development and production are examples of upstream operations.
Well	A hole drilled to a reservoir structure to seek for or produce hydrocarbons
Wildcat	The first well drilled to a new, clearly-defined geological structure (prospect).
4-C OBS	Four components Ocean Bottom Seismic. The four components are pressure waves in three dimensions (xyz), and share wave, which can only be measured at the ocean bottom. Enables continuous seismic survey
4-D seismology	Four dimension seismology. The four components are volume (xyz), and time. Seismology is shot at different points in time, and the difference between the results can be compared.

Interview themes

Introduction:

- Length of service in Statoil
- In which divisions / groups; positions / responsibilities?

Innovation - development:

- What is your understanding of the Statoil value 'imaginative'?
- The Statoil technology strategy emphasizes the importance of developing an *innovative attitude* in the company. How do you understand this, and how do you contribute to the development of such attitude in Statoil?
- Where in Statoil does innovation happen?
- What makes Statoil benchmark on top on innovation?
- Reflections about innovation and the management role?
- Examples of innovation in Statoil, successful or not?

Adoption of new technology / new work processes:

- Where and how are decisions about adoption of new solutions made?
- Are there particular company characteristics or considerations which affect adoption? (including demands on suppliers)
- Typical argumentation for and against adoption? (Profitability, competitive strength, risk, etc.)
- Controversial themes related to innovation? Themes which support innovation?

Everyday life:

- Characteristics of your everyday life at work?
- Priority-setting and communication

Wrapping up:

- Future Statoil – target areas, development areas?
- Things you expected to be asked, but didn't?