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 article raises some of the problems with this thinking. Experiences from the study indicate that most people in the organisation do not consider what they do in their everyday organisational 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 idealised in retrospection. The importance ascribed to technology as the enabler of a chosen future also makes topical the conceptualisation of 'technology' in terms of innovation.

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

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1 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 only 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 organise 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 organisations, and if it is, what do we in that case need to know?

The contribution offered in this article is the focus on the current idealisation of innovation and technology as enablers for economic growth. The human inclination to idealise collectively certain kinds of ideas is related to our desire to generalise 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 organisational phenomena disembodied in space and time from organisational 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 article, a radical process perspective particularly drawing on the theory of complex responsive processes (Stacey, 2001; Fonseca, 2002; Griffin, 2002; Shaw, 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[1]. 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 organisational 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 emphasised by Tsoukas and Hatch (2001).

This article has four parts.

1 A background section providing a brief description of the case study situation.

2 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.

3 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 organisational efforts to create and explore new technology.

4 A concluding section, pinpointing some lessons from the subsea increased oil recovery (SIOR) case study examples.

2 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, 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, organised 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 SIOR. SIOR was based on an ambition to increase oil recovery from subsea fields on the NCS from an average of 43–55%. 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 realisation 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 Norwegian kroner (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, and was granted an employee number and an ID card, an on-site 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 core team 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; targeting remaining oil and reservoir management. Each of the three focus areas were managed by a member of the SIOR core team, 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 initialisation of SIOR and the other R&D programmes, 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 core team 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 core team 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 realisation of the SIOR ambition depended on a lot of people who did not appear to identify with the programme, and even on some who were not aware of being assigned to it.

3 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 (2001) 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 'decontextualised ideal' (Boje, 1991).

Some 25 years ago, strategy management scholars began to recognise 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 criticised 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 emphasised as the key to a resource-based approach to strategy. This perspective implies that organisations can choose different strategic approaches to innovation depending on the resources they have at their disposal. A more recent approach to understanding how the commercialisation 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 organisational aspects, including the economic organisation, 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 article 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. Organisational processes like 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 particularising 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, 2007, p.434). These processes of particularising 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 generalisation and particularisation 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 'generalised 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, 1978).

As well as being generalisations, social objects may take the form of idealisations or cult values (Stacey, 2007). Idealisations rest on generalised 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 idealisations that divert attention from the detail of interaction in the living present'. Idealisations should be distinguished from their functionalisation, which are the specific actions taken by individuals in their local settings. Organisational 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 particularisation processes in which meaning is created, repeated and potentially transformed.

4 Approaching innovation in terms of everyday organisational 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 realising the value creating potential of SIOR activities, worried the core team 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 core team members at the time was characterised 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 core team 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.

4.1 Ideals and the living present

The extent and complexity of the programme activities and the somewhat diffuse role given to the SIOR core team 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 realise 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 such as '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 idealised 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 organisation. 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 idealised organisational 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 generalised narratives of organisational achievements emerge and may evolve into idealised collective identities, or values. Griffin (2002) argues, however, that to ascribe to an organisation idealised values such as 'openness', 'courage' or indeed 'innovation' is the same as idealising the organisation 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 functionalise idealised 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 (1934/1967), 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, 1934/1967, p.79).

4.2 Emergence and control

Even if many of the SIOR members did not recognise 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 generalised characteristics such as 'creativity', 'curiosity' and 'opportunity recognition' as factors of importance for the course and destiny of innovative efforts (O'Connor and Rice, 2001; Bundy, 2002), 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 core team members' consciousness about events turning out to be decisive for the outcome of their efforts, I asked to have a separate item on the core team 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 core team 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 core team 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 generalised 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 organisation, and for the further destiny of such ideas.

4.3 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 idealised 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 characterised in terms of itself. Both technical devices and reified immaterial products (knowledge and 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 organisational decisions about adoption (Wilson, Ramamurthy and Nystrom, 1999; Frambach and Schillewaert, 2002).

In science and technology studies, technology is attributed both physical and social characteristics. Important strands of research cover characteristics about the individual adopters or adopting organisations, and the role of opinion leaders in the acceptance and diffusion of technological innovation (Rogers, 1995; Nystrom, Ramamurthy and Wilson, 2002; Gourville, 2006). 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 optimised for new technology to 'create value out of their presumed 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 (Akrich, Callon and Latour, 2002). 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 further suggest that technology could 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 idealised 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 materialised 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 capitalise on technological innovations should further involve the need for a particular pattern of themes related to the importance of the technological element to stabilise sufficiently long for people to perceive it as a valuable enabler of the future.

5 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 generalised 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 idealised 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 generalised and particularised 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 organisational 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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Note

[1] The examples provided in this article 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.