Micro foundations of coping with innovation paradoxes in networked NPD processes: Two prospective longitudinal cases

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Abstract

Innovation has always been central within IMP (Mattsson, 1978; Håkansson, 1987, 1989) and continues as a topical theme (e.g. Freytag and Young 2014; Hoholm and Olsen 2012). This paper aims to add to current knowledge by addressing how managers cope with the tensions underpinning innovation paradoxes when managing innovation processes in network settings. Paradox is a long-standing theme in organisation studies and involves 'interesting tensions, oppositions and contradictions' (Poole and Van de Ven 1989:564). However, there are few studies investigating the micro foundations of coping with paradox over time (Andriopoulos and Lewis 2010; Luscher and Lewis 2008; Raisch et al. 2009) and especially in inter-organisational settings. The paper presents two complementary case studies of longitudinal NPD processes. Four main tensions are identified from each multi-phase case; strategy, standards, product/market/resource base, and project organisation. These are then related to four key paradoxes from the innovation literature; incremental-radical innovations, path dependence-path creation, convergence-divergence cycles, and evaluation criteria-actual outcomes respectively.

1.0 Introduction

Innovation is a key theme of interest within IMP. Empirical research has emphasized how relationships and networks are key organising forms for innovation (e.g. Gemünden, Ritter, and Heydebreck 1996; Johnsen and Ford, 2000; Holmen, Pedersen, and Torvatn 2005; Vercauteren 2007; La Rocca and Snehota 2014). In particular, the central role of resource configurations (Håkansson and Waluszewski, 2002a; Waluszewski, Baraldi, Shih and Linne 2009) has been considered. IMP researchers have also investigated both the development (Håkansson and Laage-Hellman 1984) and commercialization (Harrison and Waluszewski 2008; Aarikka-Stenroos, Sandberg, and Lehtimäki 2014) phases of interactive new product development (NPD).

This conference paper aims to add to current knowledge by addressing how managers cope with the tensions underpinning innovation paradoxes when managing innovation processes in network settings. Paradox is an established theme in organisation studies. The nature of paradoxes and how these are to be reconciled is the subject of current debate (Lewis 2000; Smith and Lewis 2011). The organisational settings in which paradoxes have been examined include governance (e.g. Sundaramurthy and Lewis 2003), identity construction (e.g. Fiol 2002), knowledge management (e.g. Cohendet and Simon 2007), and strategic management (e.g. De Witt and Meyer 2010). However, there are few studies investigating the micro foundations of coping with paradox over time (Andriopoulos and Lewis 2010; Luscher and Lewis 2008; Raisch et al. 2009) especially in inter-organisational settings.

The paper presents two complementary case studies of longitudinal NPD processes. We collected the data underpinning both cases prospectively. The first case is about developing new food processing technology, and the second about developing new technology for treating ballast water. Four main tensions are identified from each multi-phase case; strategy, standards, product/market/resource base, and project organisation. These are then related to four key paradoxes from the innovation literature; incremental-radical innovations, path dependence-path creation, convergence-divergence cycles (of learning), and evaluation criteria-actual outcomes respectively. As such, the research question we are addressing is *how do managers cope with the tensions underpinning innovation paradoxes when managing innovation processes*?

The paper proceeds as follows. First, we briefly outline the innovation theme within the IMP literature, before turning our attention to current debates in the organisation studies literature regarding paradox. We then present four key innovation paradoxes from our reading of the innovation literature. In section 4 we outline the case study research methodology, and in section five present the two cases. Section 6 discusses the main findings by relating how managers cope with the tensions over time to the key innovation paradoxes. In so doing we add to existing works about paradox in innovation settings (e.g. Ropo and Hunt 1995; Smith and Tushman 2005) and contribute to IMP by providing an analysis of how managers cope with tensions underpinning NPD processes in network settings.

2.0 Paradoxes within networked innovation processes

Innovation has always been central in the IMP approach (Mattson, 1978; Håkansson, 1989) and continues as a topical theme in numerous contexts. These include biotech (Ingemansson, 2009; Waluszewski et al, 2009; Shih 2009; Ingemansson, 2010), fish (Hoholm and Håkansson, 2012), construction (Dubois and Gadde, 2002; Bengtson 2003; Bengtson and Håkansson, 2008; Bygballe and Ingemansson, 2014) and health care (Wagrell and Waluszewski, 2009).

The basic assumption underpinning the myriad works is how relationships and networks are a central organising forms for innovation (Gemünden et al, 1996; Håkansson and Waluszewski, 2002a; Gressetvold, 2004; Holmen, et al, 2005). For example, La Rocca and Snehota (2014) discuss the necessity of developing relationships co-currently with an innovation when developing new ventures.

Research has emphasized how to interact with and manage supplier, and in particular customer, relationships when performing innovation. The extent of supplier involvement and organising of often competing suppliers in NPD projects influences networked innovation success (Andersen and Drejer, 2009; Pulles, Veldman and Schiele, 2014; Luzzini, Amann, Caniato, Essig and Ronchi, 2015). For both the individual user and the user firm (e.g. Rosenberg, 1982; Rothwell et al., 1974; Lundvall, 1988; Shaw, 1985; Lundgren, 1995; Håkansson, 1987; Håkansson and Waluszewski, 2002; 2007; von Hippel, 1988, 2007; Heikkinen, Mainela, Still and Tähtinen, 2007; Öberg, 2010 Story, O'Malley and Hart, 2011; Laage-Hellman, Lind, and Perna, 2014) key customers/user firms or 'lead users' are reported to play multiple roles in the design (e.g. idea generation, prototype testing, production) and implementation stages (e.g. commercialisation, developing uses) of innovation.

Hence in terms of the NPD process, both the development (Håkansson and Laage-Hellman 1984; Heikkinen and Tahtinen, 2006) and commercialization (Harrison and Waluszewski 2008; Waluszewski et al, 2009; Aarikka-Stenroos et al, 2014; Crespin-Mazet, Grenier, Goglio-Primard and Lombardo, 2014) phases of have been investigated. For example, Story et al (2011) argue that inter-organisational actors play different roles at different parts of an innovation process, supporting Bieman's (1991:172) study of the role of users in the development of medical devices, whereby the intensity of interaction between a manufacturer and users "varies dramatically depending on the stage of the product development process…" Further, Aarikka-Stenroos et al (2014) discuss how different actors play different roles in commercializing innovations, e.g. in performing the work involved in creating markets and facilitating diffusion.

The roles played by actors can also vary in terms of the formation and orchestration of an innovation network or networked innovation project (Perks, 2005; Perks and Jeffery, 2006; Heikkinen and Tahtinen, 2006; Nätti, Hurmelinna-Laukkanen, and Johnston, 2014; Nystrom, Leminen, Westerlund and Kortelainen, 2014; Goduscheit, 2014). For example, the capability to perform an orchestration or 'network webber' role in forming R&D networks (Heikkinen and Tahtinen, 2006) or living labs as an innovation network form (Nystrom et al, 2014), or the ongoing performance of such a role in service innovation (Nätti, et al, 2014) influence network organising and innovation success. A shared motivation behind the networked innovation effort is also central: what Öberg and Shih (2014) refer to as a 'convergent logic'.

Inter-organisational innovation viewed through a lens of interfaces in resource configurations is one way to uncover network interactions (Waluszewski, 2004a; Håkansson and Waluszewski, 2002a, 2007; Bengtson and Håkansson, 2008; Harrison and Waluszewski, 2008; Waluszewski, et al, 2009; Ostendoft, Mouzas and Chakrabarti, 2014; Purchase, Olaru and Denize, 2014; Crespin-Mazet et al, 2014). Thus, what is in focus is an interaction process where the *use* of a new product or economic resource is created in a user's context in interaction with a manufacturer (Håkansson, 1987; von Hippel, 1986). As the purpose of this paper is to address how managers cope with the tensions underpinning innovation paradoxes when managing innovation processes in network settings, we now outline the organisation studies literature which is concerned with paradox.

2.1. Paradoxes as contradictions in organisational life

The concept of paradox has been widely used in organisation and management studies as a way to capture dualities in organisational life in a whole range of topics (Lewis, 2000; Smith and Lewis, 2011). In addressing the question of what are social paradoxes (Poole and van de Ven 1989), a key term appears to be contradiction (e.g. Andriopoulos 2003; Bloodgood and Chae 2010; Calton and Payne 2003; de Witt and Meyer 2010; Dittrich et al. 2006; Eisenhardt 2000; Lewis 2000; Smith and Lewis 2011; Smith et al. 2010). That is, paradox is when 'polar opposite conditions can simultaneously exist...in the same thing' (Mick and Fournier 1998:124).

As paradoxes contain contradictory elements, it is essentially impossible to solve these; instead, they are an inherent part of modern business (Handy 1994; Cameron and Quinn 1988; Quinn 1988; Løwendahl and Revang 2004: Peters and Waterman 1982; Andriopoulos 2003; De Witt and Meyer 2010). It is this very inconsistency which distinguishes 'paradox' from the often related dilemmas, puzzles and trade-offs; 'at best, the problem-solver can find a workable reconciliation to temporarily cope with the unsolvable paradox' (De Witt and Meyer 2010:16). Lewis (2000: 764) cites Handy's (1994) understanding of managing as coping rather than control to emphasize this.

Van de Ven and Poole (1989) suggest that individuals/teams in organisations can resolve (via spatial separation, temporal separation or synthesis) or accept paradox. Acceptance, or perhaps less passively, engagement (Andriopoulos 2003; Beech et al. 2004), involves what Smith and Lewis (2011: 389) term 'working through' paradox. Lewis (2000: 764) posits three ways in which paradox can be managed; acceptance, confrontation and transcendence. The resolution strategies do 'not imply eliminating a tension but, rather, finding a means of meeting competing demands or considering divergent ideas simultaneously' (Smith and Lewis 2011:389). For example, in Smith, Binns and Tushman (2010) business models are posited as a way to manage multiple paradoxical strategies simultaneously. A similar logic underpins the current organizational ambidexterity debate (e.g. Raisch and Birkinshaw 2008).

The nature of paradox has been investigated in a wide variety of contexts. These include paradoxes of governance (e.g. Sundaramurthy and Lewis 2003), identity construction (e.g. Fiol 2002; Gotsi et al. 2010), sensemaking and change (e.g. Luscher and Lewis 2008), globalisation-localisation (O'Driscoll 2008), competition-collaboration (Calton and Payne 2003; Oliver 2004; Chen 2008), influence and control in business networks (see also Håkansson and Ford 2002) and revolution-evolution in strategic change (De Witt and Meyer 2010). Many of these paradox forms are contained within the four umbrella categories from Smith and Lewis (2011); learning, organizing, belonging, and performing. The focus in this paper is on the tensions underpinning forms of innovation paradoxes; contained broadly within the learning paradox category.

We now turn our attention to four established innovation paradoxes derived from the innovation literature; incremental-radical, path dependence-path creation, convergence-divergence, and evaluation criteria-actual outcomes. In so doing we are both relating to one of Lewis's (2000) classifications of paradox and adding depth to this.

2.2. The paradoxical nature of innovation processes

The organisation of innovation has essentially been studied through paradox lenses for decades. For example, Schumpeter (1942) introduced the distinction between incremental improvements and creative destruction. Moreover, process-based research of change efforts has long been requested by organization scholars (e.g. Tsoukas and Chia 2002; Van de Ven and Poole 2006; Hernes 2007). However, with a few exceptions (e.g. Van de Ven et al. 1999), process studies in innovation have put relatively low emphasis on how resistances, limitations and political processes may play out during such processes (Author 2011). For example, socio-material resistances (Nicolini 2011), or how controversial and chaotic 'choice' and 'strategy' become in the face of high uncertainty (Akrich et al. 2002a, b). We can begin to uncover process understandings by working from a paradox approach.

Paradox 1: Incremental-radical innovations

The Schumpeterian idea of creative destruction underlies the common notion of radical innovation, even if the notions radical and incremental are more often used in evaluations of novel technologies, than in relation to innovation on the industrial level (e.g. Van de Ven et al. 1999; Orlikowski 1993). A simple way of distinguishing these relative terms is based on the number of new elements to be (re-) combined, and hence the level of difference from established technologies, products and organizations (Ettlie et al. 1984; Zhou and Li 2012).

Incremental innovation typically consists of series of improvements and adaptations in products, processes or organizational practices over time, often triggered

by feedback from users (Shanklin and Ryans 1984). Radical innovation, however, typically involves a higher degree of novelty. Such innovations may therefore be more disruptive, and require larger changes in the practices of the user organisations. 'Breakthrough innovations' are more likely to stem from experts seeking to 'push' their solutions out into user settings of various kinds, even if this will also often include utilizing the organization's market knowledge (Shanklin and Ryans 1984; Zhou and Li 2012).

Paradox 2: Path dependence-path creation

The nature of innovation processes has been explained in very distinct ways; from evolutionary selection (making the success of innovation processes random from the individual actor's point of view), to rationalist models, such as stage-gate models (Cooper 1990, 2008) whereby the whole process can be planned and executed. However, innovation process outcomes are typically different from initial intentions (Van de Ven et al. 1999). This space 'in between' history and future can be captured in our second paradox.

Path dependence is a kind of historical determinism stemming from historical contingencies and accidental events, leading to a relatively rigid path that organizations and organizational fields follow (Davis 1985; Garud and Karnøe 2001). Lock-ins and dominant designs may emerge over time, putting significant limitations to subsequent development. These are based on an organization's current knowledge, technologies and organizing. Path dependence thus provides partial explanations to issues such as why more radical innovation processes tend to take long time. However, it should not only be seen as a barrier to innovation, but also producing the basis from which certain kinds of further developments are possible.

Garud and Karnøe (1997; 2001) critiqued the inherent determinism of the path dependence ideas in their conceptualization of path creation. They argued for the need to understand the role of agency in innovation and the shaping of new paths. 'Mindful deviation' explains how innovators systematically search for alternative interpretations and actions to find and realise new ideas. Innovation is thus based on actors' 'ability to span boundaries of relevance structures, translate objects and mobilise time as a resource' (Ibid., 2001:25).

In this way, the 'ability to create and exercise options' (Ibid., p7) becomes the basis for mobilizing development, as well as for flexible alteration, enhancing and changing outcomes of innovation processes over time. The paradox is then put to the centre: the tensions between the intentional and the historical, and the interaction between heterogeneous actors and resources over time, means that innovation processes are not random, nor fully governed, and while action seems to matter, uncertainty can never be ruled out completely (Kline and Rosenberg 1986; Pavitt 2005; McMullen and Shepherd 2006).

Paradox 3: Convergence-divergence cycles (of learning)

Departing from Anderson and Tushman's (1990) 'punctuated equilibrium model of cyclical change', Van de Ven et al. (1999) conceptualised innovation processes as learning processes, based on nonlinear cycles of "divergent and convergent behaviours that may repeat itself over time and reflect itself at different organisational levels" (Van de Ven et al. 1999:213). Divergence is equated to 'learning by discovery' (expanding); convergence to 'learning by testing' (narrowing) (Van de Ven et al. 1999:203). In this emergent process view, sensitivity to initial conditions as well as capabilities in managing complexity is seen as crucial for coping.

Also Kline and Rosenberg (1986:276) emphasized learning in their ground-breaking work, documenting the intertwining of, as well as tensions between, technology and economy. The more radical the innovation and the more related practices needing to change, the higher uncertainty, and hence the more need for learning. Hence, overplanning may inhibit an innovation process because of the tendency 'to underestimate the number of tasks that must be solved and hence also the time and costs' (Ibid., 298; Pavitt 2005).

Paradox 4: Evaluation criteria-actual outcomes

Van de Ven et al. (1999:42) identified how performance criteria, regarding input, process and outcome, changed over time. In response to unexpected events, managers will often 'search and redefine their innovation ideas and strategies'. Other researchers have included political aspects, emphasizing how evaluation principles and institutionalized rules are negotiated across boundaries. While borrowing evaluation criteria across boundaries may help identifying novel opportunities, this may also contribute to the (re-)constitution of power relations (Beunza and Stark 2004; Grenville-Howard and Carlile 2006). Together, sets of evaluation criteria shape frames of reference, providing direction to the process, while also often rendering innovators blind to alternative pathways (Garud and Rappa 1994; Garud and Ahlstrom 1997). Outsiders are thus needed to challenge the internal views and interpretations.

The problem with evaluation criteria is also linked to uncertainty because 'the usefulness of an idea can only be determined after the innovation process is completed and implemented' (Van de Ven et al. 1999:11). Hence, to enable continuing the process in the face of unexpected events, changes of evaluation criteria are to be expected. In sum, the coping with evaluation criteria and actual outcomes activates a need for the management of paradox, in which highly effective organisations are able to perform 'in contradictory ways to satisfy contradictory expectations" and "ambiguity in goals' (Ibid., p.12).

2.3 Micro foundations of coping with paradox within NPD processes

Above we highlight the importance of Van de Ven et al's (1999) substantial works. However, relatively little is said about how and why processes play out in the ways reported. In other words, there is a need for understanding the micro foundations of the tensions underpinning innovation paradoxes over time.

A focus on the micro foundations of managing, organising and strategising is common across the management discipline as scholars move their emphasis from a focus on nouns to verbs (e.g. organization to organizing). For example, there are studies of the micro foundations of resources, routines and capabilities (Salvato 2003; Teece 2007; Abell et al. 2008; Foss et al. 2011), such as absorptive capacity routines (Lewin et al. 2011) or those focused on the micro foundations of innovation systems (e.g. David and Rullani 2008). The strategy-as-practice approach developed at least in part because '…the process literature is still insufficiently sensitive to the micro' (Johnson et al. 2003:5; see also Whittington 1996, 2002, 2006, and Jarzabkowski et al. 2007).

Taking a micro lens to the study of paradox implies putting the tensions underpinning paradoxes, and those individuals involved in these, centre-stage. It suggests a focus on the practical coping or improvisation (Chia and Holt, 2006) of managers and employees within NPD processes. In particular, the very nature of doing something new means that disagreement and conflict is inherent and commonplace. We argue we are better able to investigate how 'at best, the problem-solver can find a workable reconciliation to temporarily cope with the unsolvable paradox' (De Witt and Meyer 2010:16).

Managers have to cope with processes changing when managing innovation prospectively; the interplays of plans, organisational politics and real-time events. Yet there are few studies which take a longitudinal perspective in paradox or closely related research in order to investigate how this varies over time, e.g. by phase (Luscher and Lewis 2008; Raisch et al. 2009; Andriopoulos and Lewis 2010). If managing paradox '...involves consistent inconsistency as managers frequently and dynamically shift decisions…' (Smith and Lewis 2011:392), adopting a micro lens facilitates looking at the dynamics involved in some depth.

3.0 Methods

The paper uses a multiple case study research methodology. Case studies embed an object in context, and allow depth, detail, and richness of data (Yin 2009; Easton 2010). For this paper a multiple case study methodology was deemed suitable for two main reasons. First, it allowed us to explore the micro foundations of coping with innovation paradoxes in context. Secondly, while sacrificing the benefits of depth from a single case study, a multiple case design allowed for several observations of an understudied phenomenon (Eisenhardt 1989).

The two cases chosen were selected for theoretical reasons as complementary; about the same phenomenon but in two different contexts (Eisenhardt 1991; Dubois and Gadde 2002) rather than as comparative and thus demonstrating variation on some aspect (Eisenhardt and Graeber 2007). Both were considered to be examples of highly politicized innovation processes, and therefore full of tensions for the managers and employees concerned. The cases have also been studied prospectively, which allows for a fuller appreciation of the challenges involved in managing innovation. Thus we have proceeded via an abductive theory building approach (Dubois and Gadde, 2002) in combining theoretical ideas and empirical observations.

The first case is about the agriculture cooperative Tine and its innovation strategy and project activities to develop new technology and business from biomarine resources. It also involves Bremnes Seashore, a family owned Norwegian fish farm. The case was investigated by one of the authors over a period of 3-4 years. Participant observations were conducted, including a period of four months full-time in the corporate headquarters, in addition to 35 semi structured interviews, from production personnel to corporate management, along with key participants from partnering organizations. This was supplemented with extensive project documents and electronic communications.

The second case is about Daro Marine, a Scandinavian maritime services company, and their efforts to develop a ballast water treatment technology (conducted by the other author). 50 semi structured interviews were undertaken prospectively over a two year period with the managers and employees directly involved from functions such as technical development and sales. The interviews were between 1½ to 2 hours in duration. The primary data has been supplemented by the inclusion of substantial secondary material, e.g. business cases and market reports.

The construction of the two case narratives required gaining sufficient 'under the skin' familiarity with each case, and then describing the events, actions, transitions and 'slices of narrative' within each via a series of discussions over time. In other words, the multiple data sources were combined to generate a basic chronology of events using the logic of longitudinal process research (Huber and Van de Ven 1995; Langley 2007).

We adopted theoretical periodisation in order to embed both cases in time and to facilitate contrasting the cases; periodisation requires a researcher to develop a series of phases that relate to a research object (e.g. Jessop 1990). We created a sequence of five standardised phases from both the cases. Of course there is some fluidity and overlap across the periods rather than each being entirely distinct (Norcliffe and Bartschat 1994). The five phases are; (i) idea, (ii) development, (iii) launch/sales, (iv) verification post market feedback, and (v) market return/re-launch respectively.

Next, we returned to the narratives in order to identify multiple types of tensions – and examples of these – within each case. We collapsed an initial rough categorisation of nine tensions, based on key events and transitions, into four more

robust categories which covered both cases. The four categories of tensions are; (i) strategy, (ii) standards, (iii) product, market and resource base, and (iv) project organisation. Overall, the cases are being used to build theory about the micro foundations of coping with innovation paradoxes in context; not to either test current theory or illustrate it (Bonoma 1985; Mitchell 1983; Eisenhardt and Graeber 2007).

4.0 Two complementary cases

4.1 Tine Biomarine

The Norwegian agriculture industry is highly industrialized, from farming through the production system to complex networks of distribution and marketing. The Norwegian fish industry, on the other hand, has a production system limited to slaughtering, cooling and transporting the fish efficiently to relevant markets. During the last decades some fish species, such as salmon, have been domesticated, and aquaculture has become dominant. This has opened up for industrialization similar to agriculture.

Between 2000 and 2005 the government established the so-called blue-green innovation policy, reorganized public R&D institutes, and aligned research funding to enable collaborative research and technology development, as well as encouraging commercialization. The idea was that the fish industry could benefit from tapping into a well-developed knowledge infrastructure, while agriculture could learn from the international experience of the fish industry.

Phase 1: Idea. At the time Tine had concerns about the emerging competition and the liberalization of the highly regulated dairy industry. Hence, an innovation strategy was prominent on the strategic agenda, and five innovation areas were identified that were included in the business strategy implemented in 2000 and confirmed in 2005.

One of the five innovation areas was biomarine innovation. Tine had been involved in a few R&D-projects exploring biomarine ingredients and raw materials. Some were already failing, particularly their participation in an investment fund specializing in seafood. Still, they found seafood and biomarine ingredients to represent opportunities in growing markets of functional foods and seafood. Moreover, one of the directors of the Tine board argued that 'public discourse on blue-green innovation is the strongest driver for these activities'. It was, however, controversial to mix the dairy cooperative's core activities with biomarine activities.

At the same time, a Tine researcher coincidently met a food science researcher from a biomarine research institute. The biomarine researcher had started developing a novel technology for curing fish and was filing a patent application. They started collaborating on researching the technology, adding the expertise and resources on proteins from Tine. Eventually, they managed to get the Research Council of Norway to fund the project. It was not straightforward to get acceptance in Tine R&D for such a

project, as ‘Tine was in a very early phase on their fish strategies, […] and so we simply fronted the ingredients side’ (project manager). The argument of exploring novel use of an excess resource, proteins from whey, helped in mobilizing support. The Neptun research project was thus established in collaboration between two research institutes and Tine.

The researchers faced numerous problems of making the technology work; while the experiment results were promising, the product was barely edible. The main problems stemmed from the quality standards in the fish industry. Supplies from several sources were of low and uneven quality on hygiene for the curing process to work well. Tensions were experienced when trying to negotiate and teach suppliers, and changes of suppliers did not provide much better results. They decided they had ‘to go in and take control, even in raw material supply and processing’ (Corporate Director).

In this early idea exploration phase, there were several ideas about what kind of product this could be, and for what kind of users: It could be a high-end speciality product, or a “copy” of similar meat based products for the mainstream market. While it would be easier to have access to distribution channels domestically, they wondered whether it would be necessary to go international with such a niche product. One or the other, the project team and their supporters in the respective organizations believed this to have a massive commercial potential, and the level of enthusiasm was high. In particular, the participants seemed to be very excited with the opportunity to explore such an interesting technology, and this excitement seemed to inspire the involved marketing professionals as well as business management despite the early stage.

Phase 2: Development. Gradually a few projects became almost synonymous with the biomarine innovation strategy, including the Neptun project, although it was established with few relations to the strategy. After a few years of research, Tine decided to buy the patent application. This marked a shift in the process, where Tine took clear responsibility for trying to commercialize the results of the Neptun project, and thereby formally relating the technology to their strategy. A product development project was organized (UmiNoKami or UNK) in parallel with the research project, and the UNK project took over the attention from the Neptun project.

During this period of developing the technology into a commercial product, micro-biological and supplier related challenges remained unresolved. Furthermore, some newly hired product developers suggested that the technology should be modified from using frozen to using fresh raw materials as input. This was strongly opposed by the original participants as it went against current knowledge, hence the new hires ‘did things on the side […] after the others had gone home’ (product developer). Neither was the issues related to what the product should be, and what markets to go for resolved. An ambiguous set of stories about huge international markets on the one hand, and

about high-end products used in advanced ways by gourmet chefs on the other, were told in plans, presentations and materials.

The UNK project was organized mainly as an intra-organizational project. Although the project was supposed to be about developing and commercializing seafood products, a heavy R&D bias remained for some time. Several people from a Life Sciences university were hired. One of them got a role as product developer in the UNK project. Tensions soon emerged between the original group from the Neptun project, and this new group with lots of experience from the fish industry and with a particular focus on raw material quality rather than on other ingredients.

Phase 3: Launch/sales. After a few years the overarching biomarine innovation strategy had started fading in attention and importance. The top management of Tine started becoming impatient with the major projects, and they started expressing the need for some evidence of having moved in the right direction. The UNK organization felt this pressure. The director for the business unit with responsibility for the project was ready to 'clean up the mess' in the biomarine project portfolio.

After having discussed the issue with a senior researcher among the new hires, the director decided to re-organize the project. They hired a marketer from the cheese division with a good reputation as the commercialization manager. In practice, he became the new project manager. After attending a few meetings with the relatively big group (10-12 participants), he became frustrated with the cacophony of voices in the meetings, and he did not feel they had much progress. He went to the unit director and got support for reorganizing the team again: 'All others were just cut off […] and we reduced R&D costs by two thirds' (commercialization manager).

The UNK project was radically downsized, as the commercialization manager only kept one person on the regular team, one of the new product developers. Hence, the team went from a highly and widely competent team of researchers and marketing professionals to a small and action oriented team, where much of the project history as well as the connection to the Neptun research project had been deleted. This change was called a 'coup' by the new team. Representatives for the 'old' team expressed disappointment that their experience were no longer required, and disagreed with how the project changed direction. Afterwards, the project was run in a much more pragmatic fashion. The product developer had, even before the re-organization, started experimenting with using a particular high quality fresh raw material, and eventually this made the technology for curing the fish stable.

Having been involved in developing the high quality raw material in a previous project, the product developer had good relationships to the fish farm, Bremnes. This enabled working closely with them, e.g. in teaching them the micro-biological production standards necessary. Nevertheless, it took months of training and adjusting routines before the product was stable in production. Again, the novel technologies, in

this case leading to high quality raw materials, ignited excitement and fascination in Tine.

The commercialization manager brought with him versions of the product to a number of meetings with different distribution actors; e.g. in the US. His philosophy was to meet potential customers and learn from their reactions: 'Every presentation is to be seen as a preparation for the next customer'. Any market and customer would be good, although some markets and distributors were clearly more attractive than others; large catering customers would mean significantly less adaptation of packaging, marketing and product adjustments, as compared to retail.

Even now, following the re-organizing of the team, and removing opposing interests, the product ambiguity remained. Gourmet chefs were hired to present the product in context; the quality requirements here suggested high-end segments. Still, the economic argumentation needed to legitimize the project for top management and other key stakeholders, resulted in efforts to relate the product to mainstream use, such as sandwich fillings, and to mainstream distribution channels, e.g. the major supermarket chains.

Phase 4: Verification post-market feedback. Over time the commercialization manager learned how hard it was to sell an innovative cured fish product that people had not seen before. In parallel, he and many of his potential customers were increasingly fascinated by the high quality raw material. He began to consider that it would be easier to sell a product based on fresh salmon loins.

The fish farm was against this idea, and within Tine it was necessary to build strong arguments and personal alliances before the project's product and marketing strategy could be changed. It was seen to threaten the considerable investments to make the curing technology work. However, the commercialization manager and the director of Tine's biomarine business unit had a good relationship to the top management, and had the opportunity to argue for the case of changing strategy.

The decision went in their favour, including the permission to change marketing strategy; from starting internationally to beginning in the domestic market. The new project strategy also changed the efforts from mainly marketing towards the restaurant/catering market to targeting consumers/retail. With a high-end salmon loin, they could relate much clearer than before to the fast growing sushi trend. Although the handling of the raw material and the production process had been improving, they still faced occasional slip ups, causing intense activity to identify the causes, and training the production workers make sure the routines were fully stable.

At this point, Tine had not been investing in any new biomarine project for a few years. The importance of the biomarine innovation strategy clearly seemed to have faded out; or perhaps top management wanted to have some evidence of value before

considering further expansion. A part of these considerations was whether the UNK concept would scale, and if not perhaps the UNK venture should be sold on.

Following the introduction of the high quality loin raw material, Tine started negotiating with the supplying fish farm. The two agreed to start a joint venture to ensure both parties' continued commitments.

Phase 5: Re-launch. With the new strategy in place, the commercialization manager and the product developer could re-orient the project. The new loin was introduced for test-sales in a few selected gourmet supermarkets. A large retail chain, Tine's long time customer, was immediately interested in the new product, and gradually increased their orders. It was still positioned as a high-end brand, but increasingly was made accessible for a mainstream segment of consumers in regular and discount supermarkets. After a year or so, hardly anyone talked about the cured product anymore, despite the significant amount of resources and time that had been invested. Still, the brand and the project were labelled a big commercial success, and the step-by-step introduction in the neighbouring markets of Sweden, Germany and France could start.

The collaboration between the project team in Tine and the fish farm involved some tensions from early in the project. The commercialization manager took a tough negotiation role with the fish farm management, while the product developer developed his collaborative relationship with production team leaders and personnel. The change of strategy from cured to loin increased the stress on the relationship. After several events where the commercialization manager found that he got products of uneven quality, the conflict peaked.

According to the fish farm management the commercialization manager 'acted as if he was the CEO of the company', instructing them in an intolerable way. Shortly after this the commercialization manager left his job, and the product developer took over. After another couple of years, Tine sold all their shares to the fish farm. Tine would continue taking care of marketing and distribution, while Bremnes took full ownership of the brand and production. An intense relationship with successful collaboration as well as difficult tensions was stabilized by introducing somewhat more distance.

4.2. Daro Marine

Ballast water is 'fresh or salt water, sometimes containing sediments, held in tanks and cargo holds of ships to increase stability and manoeuvrability during transit'[i1]. These

[1] www.pbs.org/strangedays/glossary/B.html. Other parts of the text in this section are taken from www.imo.org/conventions/mainframe.asp?topic_id=867 and www.dnv.com/industry/maritime/publicationsanddownloads/publications

sediments contain invasive species; the central reason for the recent development of ballast water treatment technology in the marine industry in response to the Ballast Water Management Convention 2004. The invasive species having a free ride in ballast water tanks in approximately 40,000 vessels globally explain the introduction of, for example, the European zebra mussel in the Great Lakes in Canada.

The International Maritime Organisation (IMO) agreed the Convention in London during February 2004. The Convention will be ratified into law 12 months after it has been signed by 30 states, representing 35% of the world merchant shipping tonnage (it remains unratified, 10 years on). The legislation creates basic demand; no vessel owner would voluntarily spend $500,000 to $5,000,000 per ship in order to comply.

*Phase 1 – Idea***.** Daro Marine is developing one of the technology initiatives. They have a strategic focus to develop a new business stream in the emerging market for environmental solutions. The existing core business of safety products is relatively well established. That is, 'we know all the actual and potential customers - there are no big surprises here'.

The decision and 'kick off' for the NPD process took place several years after the agreement of the Convention. Several existing competitors were beginning to develop technologies and there was movement towards ratification of the Convention. It was also bad timing due to the global financial crisis (lessening interest in environmental solutions and one reason why the Convention remains unratified). Nevertheless, market estimates of a $35 billion market encouraged an entrepreneurial stance: 'we knew the market would be there ...I expect it will be ratified by the end of 2010…'.

A prototype treatment system was obtained from a new supplier after a search process. It combined several treatment technologies, such as filtration, within one system. The intention was for it to be viable across all water types and water temperatures based on the quality standard embedded in the Convention at the time. This was thought to result in a large potential market penetration.

A testing process was put in place on a vessel within the Daro organisation. Part of this was attempts to retrofit a system on board the vessel when in dry dock. The learning led to ongoing modifications of the system, both at the supplier and in-house. For example, efforts were focused on optimising the design of the system regarding how the sub- technologies worked together and on understanding the scalability.

There is a three-step process for getting a system approved by IMO. The first two approval types awarded are 'in terms of the suitability of the safety of the crew, vessels and environment. But it does not cover if the product works as intended. For this, it is type approval'. Type approval is awarded by individual flag states. The new supplier was heavily involved in the process of gaining the necessary approvals. The

first two approval types were obtained in the idea phase, the type approval in the development phase (see below).

In the first year of the process a project plan was drawn up but 'we didn't keep it…I didn't know enough about what the product was about…there have been various versions of the template, and they have not been all that successful...'. That the 'process is not there, [we have] no common template' is magnified by the fact that the NPD team is split over multiple locations. The project manager attended an in-house course which provided 'clearer ideas regarding the starting point, roles…' and a new template was established as the process moved into the next phase.

Phase 2: Development. Innovation processes do not happen in a vacuum; within this phase the relevant division of Daro Marine merged within another division. The assumption that demand is 'there' remained, in that 'customers have to do it' (purchase a system) and hence that the market is put in place by legislators.

A working project plan was now in place. At the start of the phase decisions were made within R&D to take a step-by-step approach to product development. That is, to 'do one thing at once' and develop first a standard product which fits several applications and then different versions of this for smaller/larger vessels later (often potential customers have multiple vessel types in their fleets).

At the same time, the sales network intensified their existing market awareness activity around the new system. The purpose was to 'cultivate the market without a finished product… to build awareness of what we are selling even if it is not 100% finished... it takes a while to get the information into the market'. The new system is not a gap in a product line within an existing range. However, one consequence of early market awareness activity was that '…the information provided to the sales network has changed repeatedly as the product design has changed…Sales think it is finalised when it is not…'

A Customer Benefits Exercise was established. There was disagreement in terms of how to provide quotes; by emphasising the technical design or starting from customer needs and motivations. In other words 'what is the product offer...'. The structured process took place over several months.

For the existing ship yard customers, the new technology was related to existing plans for new builds (new ships); 'we have an idea of the output each year...it is big'. New customers, ship owners, would require a system to be retrofitted on existing vessels (up to 40,000 vessels worldwide). However, 'the owner market is more time consuming...there is a different buying set up and engineering requirements...'

Towards the end of the phase, Daro received type approval (the third approval), fulfilling the minimum requirements in terms of legislation. Efforts within the 'commercial' part of the NPD team moved towards an internal launch (to 'sell' the

product to the sales network), and to plan and start to execute a large-scale external launch.

At the same time, the relatively few people on the technical side continued their efforts to fix ongoing design and development issues in order that the product was ready to be handed over. This was partly an issue of working towards a second-layer of approvals (for industry 'class' societies) and a mentality of 'problem solving along the way'. Moreover, individual US states such as California and the US Coast Guard (USCG) were creating additional noise regarding separate requirements from that of IMO, but without a clear standard or testing protocol. This increased uncertainty for both the supply and customer sides. Nevertheless, the awaited ratification of the Convention was expected to trigger sales.

Phase 3: Launch, sales. Towards the end of the external launch process, efforts were underway towards 'where we think we can get sales quickly'. Target lists were already in place from the existing customer base, typically based on size of the fleet. A progression from building market awareness to 'getting as many orders as possible' is in essence a sales approach based on 'a machine gun... where does it hit the market'. What is implied here is that orders can be scaled up or aggregated into segments later. There were disagreements within the team as to the important segments and vessel types.

The new post-merger management team started to review the ongoing projects from within both of the previously separate divisions. On the one hand, there was the opportunity of the ongoing market size estimate for ballast water technology at $36 billion. However, at the same time sales 'are not getting any direction… we are in danger of being 'all things to all people'...what are the biggest segments where we have a product?' One outcome was a requirement to filter the existing 100-200 'serious enquiries' to approximately 50 whereby 'we can interact and have a real chance to get these...'.

The need to interact to get a sale also highlights an ongoing concern, the practicability of installing a new system on an existing vessel. That is, '...we have to actively help the customer... to make an initial assessment for installation'. However, the lack of technical sales knowledge presented both an immediate problem – 'how to help define the scope' - and an issue of how to accumulate operational experience over time. Moreover, the internal capability to handle increasing numbers of orders was a source of conflict. 'There are expectations regarding the level of orders we can get in reserve...these lead to expectations regarding deliveries and investment'. In other words, making sales implies a capability to be able to deliver orders, in order to avoid overselling.

Managerial attention turned to building the internal capability in order to scale up to meet existing orders and the expected jump in sales. The project team was re-organised in order to focus attention; to increase the numbers of people involved in

order to finalise the product, set up production, build the supply chain etc. In other words, 'we needed awareness of the project, and the opportunity...but also the challenges'.

This was supplemented by changing the roles for both project management and ownership. This included a 'dedicated senior position...'. A series of workshops was set up with the purpose of completing the project in 6-8 months. In the first of these, they 'started to create a team...it was fantastic, there were lots of fights...didn't understand each other...we make plans, we do it, we report back...people... are pulling in the same direction...'

One source of confusion was in terms of a 'lack of readiness'. It 'was beginning to sink in just how big the opportunity was'. After the external launch, the continuing 'doing something new under time pressure' led to reflections that 'it is huge and that was the mistake from the beginning…we knew it was a big market…but we had no awareness as to how to meet the market… we didn't know…'. To some extent the development and commercialisation of the technology has been run in the same way as if it was an incremental innovation within the existing product range.

The need to scale up was underpinned by recognition of the lack of scope reduction. It is one consequence of a 'need to iterate during the process, in terms of who to sell to and where to, this can change over time...'. The outcome was renewed focus on the 'core' product as several team members pushed for stabilising a 'mark one' of the new technology or 'let's go with what we have'.

Towards the end of this phase, several sub-processes collide as the Daro team begins to gain market feedback; the system fails to obtain the class approval certificate because it is not robust enough for operational conditions, efforts to install it on an internal customer vessel are unsuccessful, and there are increasing numbers of difficult questions from customers. The reaction underpins a disagreement across the senior managers within the team of 'sell, sell, sell versus test, test, test'.

Now 'the team became political again as the implications kicked in' a decision was required as to whether to continue or to close down the project. On the one hand was a view that 'this is an approved product but with lots of costs attached...we get dollar blind...we didn't know what we had'; on the other, 'don't close it down, we have commitments in the market...we think we can solve it'. Eventually deliveries are postponed.

Phase 4: Verification after market feedback. In the next phase Daro was required to verify the new product after receiving market feedback. Careful negotiations with customers by the sales team lead to various postponed deliveries and changed contract clauses. Sales were now primarily focused on the core business of safety although a limited quoting process was ongoing.

A suggestion was that the earlier NPD team had handled risk and maintained momentum in the innovation process via a 'problem solve as we go' mentality. However, there were also '...not enough resources from the beginning...' Nevertheless, 'there were too many blanks...we didn't know about the water environment, the pressure...we were starting to understand where we were in readiness and the impact on the project...'. A new scaled-down team was created. The focus was on re-engineering and re-testing the technology. Earlier tensions were now downplayed in the face of a clear need to respond to the market feedback. That is, '...the team works well...it is stable in the responsibilities...clear on roles...good at talking...' and there was one designated leader on a day-to-day basis.

A re-design and verification programme was planned and executed. In the first instance it involved the parts of the system which were involved in the failed tests and ideas for re-designed components from new team members. A challenge from the company management team was in place to address exactly what the product was able to do in normal ship operating conditions. The technology 'is not good enough for all the operational environmental issues'.

Over time, the re-design programme expanded in scope to incorporate the essential workings of the technology. The supplier of the system was involved in both the re-design and testing programmes. Daro also started to use external water testing labs in order to obtain third party verification. A realisation developed within the team that the IMO type approval process is somewhat disconnected from operational conditions. 'TA is dangerous...it is disconnected from an understanding of ballast practices...this is our learning internally'. For example, the awarding of a TA certificate is not a guarantee that a treatment solution is viable in all water conditions (fresh etc).

One response to the lack of understanding of the use of the new technology on both the supplier and customer sides is the efforts of the USCG to change their vessel permit regulations vis a vis ballast water management. The US requires more than the IMO TA process. This required Daro and their competitors to undertake verification testing in third-party water laboratories.

Phase 5: Market return/re-launch. In this phase the confusion over the validity of the TA process and the need for the emerging supply side to undertake further testing at water treatment laboratories to investigate the limitations of their systems continued. The speed at which the ballast water treatment system industry was developed at least in part explains why many of the current systems can be considered as prototypes. Any insufficient testing on the part of a supplier has not been helped by the TA process being 'full of holes'; systems will require further development in order to 'do what was intended'.

This is exacerbated by continuing difficulties in gaining operational experience to better understand ballasting practices. The Ballast Water Convention is still not

ratified, which means that ship owners can delay a decision. For example, the limited sales which are taking place are mainly for new builds at the yard; few systems are in use (because they do not need to be used). IMO has undergone a highly politicized process in which the implementation deadlines contained within the Convention, the TA process, and the treatment standard have been re-debated. The USCG has recently introduced a parallel approval process, with a more tightly specified testing protocol. This might become the new universal standard. For Daro, the continuing uncertainty makes the scaling up of production/organisation difficult, due to the classic problem of being too far ahead of demand. The emphasis is instead on the core business.

5.0 Analysis

In this section we discuss both cases in terms of the four tensions, before discussing how this underpins the four innovation paradoxes.

Tension 1: Strategy

In the Tine case, the coinciding of the emerging biomarine innovation strategy and the Neptun project happened largely by accident. Yet initially the Neptun project manager related carefully to the emerging idea of biomarine innovation when seeking support and resources for her project. Fortunately, Tine management needed examples of how their resources and competencies could be related to biomarine innovation, and the research council had a strong wish to support agro-marine collaboration projects. However, many people in Tine questioned this strategy, as it was seen to collide with the fundamental purpose of Tine to be a distribution channel for its owners (dairy farmers).

This mutual alignment of Neptun and corporate strategy continued through phase two. As other biomarine projects failed, Neptun increasingly became synonymous with the corporate strategy. The project management nevertheless struggled to influence Tine's management when they gradually saw the need to change their framework conditions, such as starting commercialization internationally or domestically. Tine bought the patent application, and this changed the project strategy, with a goal to speed up the time to market, compared to the research-based Neptun project. However, during phase three, the biomarine innovation strategy started fading, and the top management started becoming impatient with the lack of direction and progress. Researchers in the Neptun team were anxious that the project would be closed down, and made sure to present their prospects whenever possible to the management.

In phase four the strategy changed significantly. While Tine had by then stopped all investments in new biomarine projects, and the business press had criticised their biomarine ventures, the re-organized and downsized UNK project team made sure to keep their project 'under the radar', and moved on via a highly pragmatic marketing and sales strategy. When the learning from market actors showed strong enough evidence,

the project management was finally able to convince corporate management to shift project strategy more radically.

In phase five, they could 'go to market' with a new product, and start domestically. This led rapidly to success in a few test stores, and thereafter the domestic scaling of distribution worked well. Top management scepticism evaporated, as they could now use the project to defend their biomarine innovation strategy, and take credit for the success. Internationalization could start. However, the scale of the project was not big enough for Tine, hence the decision to sell their shares to the fish farm after a couple of years.

In the Daro case, the environmental focus is emerging in phase one, as the division establishes a new environmental business stream with ballast water treatment technology as a key product. As the financial crisis impacts on the shipping industry, this potentially alters the strategic underpinnings for environmental products (due to the high cost of a new system). However, demand is still assumed to be in place because 'legislation creates market need' and the company continues to take an entrepreneurial stance. Over time the environmental strategy becomes more and more dominant as ballast takes up increasing resources across the organisation.

In phase two, the strategy work of merging two divisions takes managerial attention from the governance of the ballast project. The core business is also dominant as the two divisions need to work out how to integrate their competencies. The reconciliation is that the ballast activity carries on, using the necessity of gaining type approval as the key scope/governance tool.

There is recognition of the current misalignment between perceptions of potential market size and a need to scaling up the organisation during phase three. The changes to the project structure and the increase in the numbers of people involved are attempts at matching the two. It is also a tension between being bottom up and top down in terms of building market awareness and starting to segment. This is reconciled by a new president, with a more conservative style, pushing in a 'top down' direction and starting to frame the new product-market in a more systematic way.

By phases four and five, the market feedback and continuing uncertainty regarding the type approval standard generates a perceived mismatch between focusing on the ballast project and the existing safety business stream/strategy. One way in which this plays out is in managerial discussions in which the conflict is between closing down the project and in continuing the re-design efforts. There are efforts to re-focus the core of the organisation onto safety while at the same time retaining the environment strategy in place.

Tension 2: Standards

In the biomarine project, the tensions between the fish and agriculture industries related to production standards were hard to resolve throughout all the phases of the project.

Different suppliers of fish were tested, and even with Bremnes, systematic training and frequent re-adjustments were needed throughout phases one to four.

In the end, this problem was fatal for the UNK commercialization manager's participation in the project. Although finding temporary stability in phase five, the production/hygiene standards problem was likely to reoccur due to time and/or price pressure. Fishermen and fisheries have through centuries institutionalized their practices for raw material processing. When Tine came in with industrialized technologies and practices, with a very different set of standards, the shaping of a new path was much harder than anticipated. In the end, several participants in the process emphasised, to their own surprise, that the most important innovation was not the products as such, but the introduction of hygiene/micro-biological standards in biomarine production.

In the ballast water technology project, the three-stage type approval process is a central attention-focusing and scope device in phases one and two. Daro continues with development and sales activities while the approvals are underway. Nevertheless, in phase 2 while gaining type approval means that the minimum legislation requirement has been met and the standard reached, uncertainty is generated by non-IMO actors threatening parallel standards. The project team monitors the debate while simultaneously continuing sales efforts based on the TA certificate and aiming for class approvals.

Later in phase three, there is a misalignment between the granted type approval and the failure to obtain class approval. This cannot be reconciled quickly and causes substantial internal debate. In phases 4 and 5, the type approval certificate is now a source of considerable uncertainty, and it calls into question just exactly what the product is able to do. Re-design activities and using external laboratories for additional verification testing is required for both Daro and their competitors. The standards issue remains unresolved; it can be speculated that the USCG standard will eventually become dominant.

Tension 3: Product, market, resource-base

In the Neptun project two incompatible visions were built in during the idea and development phases; 'an affordable mainstream product for everyday consumption' versus 'a high-end product for exclusive use'. These two stories were brought along with the project through the phases. During development, the choice of raw materials and of processing procedures were influenced by the need to keep costs low (mainstream product), while the challenges of making the technology work, as well as the use of gourmet chefs in the evaluation and marketing of the product suggested a high-end positioning.

Over time, the framework conditions for the Neptun project were increasingly felt as a straitjacket for the project participants, but they were not up for renegotiation. The project had to be fully reorganized and mobilize strong arguments before top

management could be convinced to change. Moreover, what the innovators 'promised' in their early business plan was, in retrospect, far too ambitious and ignorant of the technical and commercial challenges of the project.

When Bremnes' high quality raw materials were introduced, this added to the exclusivity of the product and at the same time resolved the technical challenges. It was not before the change to fresh loins that this tension could be fully resolved, by selling a very familiar and flexible product (fresh salmon loins), only lifting the quality and image into the high-end segment. It turned out that customers were willing to pay a significantly higher price for this, compared to regular salmon loins. The relationship between resource and market positioning is clear; the characteristics of the material resource and the competence it requires put clear restrictions on what is possible.

In the Daro case, the question of 'what is the product' remains open. In phase one, the intention is to source a multi-technology which is viable across all water types and temperatures. Yet in phase two team members decide on a step-by-step approach to develop various versions of the product sequentially. At the same time, the sales activity is to generate interest across the board. As selling efforts continue in phase three, the disjoint between sales and technical development continues. The bottom up 'getting as many orders as possible' sales approach is challenged by a more top-down understanding to focus on strategic customers. This is compounded by inevitable conflict within the team regarding the most interesting market segments. In phases four and five the issue of 'what is the product' (and 'does it do what was intended') comes to a head after receiving market feedback.

At the same time, the scaling up of the organisation to meet the orders sold is another source of conflict. In particular in phases three and four the increasing realisation that the team were 'doing something new under time pressure' resulted in various reflections that the work involved had been underestimated. When the current experience in the organisation is in the safety business stream, it is inevitable and understandable that a new project will be addressed in a similar way as when developing incremental improvements to the current product lines.

Tension 4: Project organisation

The Neptun project started out as a 'regular' R&D project, and Tine made sure to include marketing and IP experts. However, this expanded both the number of problems to be solved, as well as number of opportunities. All the excitement and enthusiasm in the Neptun team did not help the project move towards something that could be commercialized.

The subsequent radical downsizing was experienced as disappointing, but for those taking over it was seen as necessary to have progress in the project at all. The eventual inclusion of Bremnes as shareholder was a strategic move to try and ensure a successful project. Similarly, the exclusion of distributors from the initial processes of

development was done to avoid embarrassing themselves, even if this also meant that Tine missed important and valuable pieces of information.

We see similarities in the Daro case. In phase one there is not a common understanding of the activity sequence or the division of work into roles. This changes as the project manager starts to try and impose a clear structure. The team is rather small at this phase and is stable in terms of who is involved. The resulting working project plan is a key input into phase two. By phase three, the ongoing process momentum for both sales and technical development eventually results in misalignment. Here the tension is reflected in the increasing scope of the project (putting the production side in place) and the numbers of people involved. That is, 'roles and responsibilities have been clarified' but the magnitude of the task has changed again, i.e. 'the opportunity but also the challenges'.

As the need for re-design occurs after receiving market feedback, the team becomes increasingly paralysed by the extent of disagreement. This is dealt with by the team being disbanded (and a new team is established in the next phase). The new team first stabilises what has gone on before, and then later acts as a serious destabilisation mechanism as re-design and testing work needs to take place. By phases four and five, the internal disagreements remain but the core of the team has a clear goal and an understanding that more knowledge is required of how the product works in operational conditions.

6.0 Discussion: Relating the tensions to the paradoxes

In sum, this paper has explored the micro foundations of coping with tensions underpinning four key innovation paradoxes in NPD processes over time. We have used rich empirical material collected prospectively, which we argue is essential for developing a fuller understanding of the challenges involved when managers have to cope with processes changing when managing innovation prospectively; the interplays of plans, organisational politics and real-time events. Yet there are few studies which take a longitudinal perspective in paradox or related research in order to investigate how actions to manage vary over time, e.g. by phase (Luscher and Lewis, 2008; Raisch, et al, 2009; Andriopoulos and Lewis, 2010).

Table One (below) relates the four tensions identified in our case studies to the four paradoxes. We have linked every tension to the two paradoxes that are most relevant to the tension, although there are of course aspects of several paradoxes present in several of the tensions. As presented in the case studies, we see the shape of the tensions change over time and across the phases. In this section we discuss the main patterns as to how tensions relate to paradoxes.

Table One: Linking tensions to innovation paradoxes

Tension	**Paradoxes**
Strategy	Convergence-divergence Evaluation criteria-actual outcomes
Standards	Path dependence-creation Evaluation criteria-actual outcomes
Market, product, resource-base	Incremental-radical Path dependence-creation
Project organisation	Convergence-divergence Incremental-radical

Divergence is related to the exploration of knowledge internal to the project/process (Van de Ven et al, 1999; Hoholm and Olsen, 2012). We find that the exploration of alternative strategies contributed to divergence. In the **strategy related tensions** in our cases, we saw how multiple strategies were present simultaneously, hence producing divergence. What starts as necessary explorations may lead to challenging paradoxes later.

Convergence, then, is argued to be driven by the need for decisions and progress (Ibid.). It implies disregarding some of the complexity of the situation in order to enforce progress. Accordingly, when the projects in our study were seen to produce too much divergence, closing down the projects became a relevant consideration, and the actors had to put a lot of effort into 'saving', i.e. arguing and demonstrating the potential value of their projects. In the biomarine case, choice was a key driver for convergence. To make choices in the face of uncertainty sometimes implied that they had to cope with temporally irreversible decisions, and other times they had to cope with re-opening decisions when the complex consequences of their choices were revealed.

However, we also found that 'external' factors, such as legislation and customers, were sometimes related to convergence. However, in the ballast water case, legislation made the actors think less about the actual challenges related to the ships, as well as the incompleteness of the standards. Hence, they ran the risk of having the process re-opened to divergence. Another driver for convergence in this case was the fact that they worked with the same customer base when selling different products, pushing Daro into converging their product offers, which again led them to make under-estimations.

In both cases, several stakeholders were involved, making alignment of interests and creation of common meaning critical (Öberg and Shih, 2014), often done by

'opening the window' of the market opportunity. At the same time, involving multiple stakeholders allows for divergence, having different views, competences, resources and interests present. While identifying the 'universal' pattern of divergence/convergence, Van de Ven et al. (1999) did less in-depth analysis of the factors driving it, such as in our cases how entrepreneurialism, sales, and technologists' problem orientation were driving divergence, and legislation and decisions under uncertainty were driving convergence, although always under the risk of re-opening the process for divergence.

The **strategy tensions** also related to the paradox of evaluation criteria versus actual outcomes. Inter-organizational strategizing during innovation, whether consensual (Öberg and Shih, 2014), or controversial (Hoholm and Olsen, 2012), is likely to lead to common frameworks that will serve as evaluation criteria for some time. The politics of aligning interests in networks, converging the meaning of the project, and later assessments are likely to be made accordingly.

Any changes to framework conditions may therefore sometimes be difficult as they are stabilized or aligned across several actors. In the shipping case, again legislation was a central issue, leading to market size estimates via simple counting of vessels. In combination with the wish to be positive about being entrepreneurial, this led to enthusiastic market size estimates, which again required them to mobilize sufficient resources, or as was said by one of the actors, there is "gold at the end of the green market rainbow".

In the biomarine case, market estimates was made via what could be called the regular 'ritual' of market analysis: Counting the number of users (or here: consumers), and surveying their opinion about the new product. It is not very difficult to achieve good numbers this way, but it does not necessarily say anything about the actual behaviour of potential users when the innovation is made available to them. Nevertheless, the 'promises' made during project initiation and business planning regarding product development, market size and market strategy, are likely to be part of the subsequent framework conditions and evaluation criteria for the project.

Over-optimism in market estimates is often encountered in entrepreneurial settings, when uncertainty is disregarded in order to converge the meaning/vision of a project that can convince decision makers/stakeholders. In our cases this led to 'promises' (i.e. evaluation criteria) that were extremely difficult to fulfil. Moreover, market estimates are also network estimates: What is the potential with our network partners? As entrepreneurial activity needs to combine the development of innovations with developing relationships (La Rocca & Snehota, 2014), such estimations are not unproblematic.

While it may be a good thing to put pressure for achieving certain goals, such criteria were frequently experienced as rigidities hindering necessary adjustments or pivots. After all, strategy is about influencing, and evaluation criteria (Grenville-Howard, 2006; Van de Ven et al., 1999; Garud and Ahlstrom, 1997), whether

intentional or induced from outside actors, were used to frame and give direction to the process, as well as producing limitations as to what was possible when actual outcomes proved different from the anticipations built into the evaluation criteria. As Van de Ven et al. (1999) emphasised, use value can only be fully understood after developing the innovation.

The **tensions concerning standards**, related to the issues of path creation and of evaluation criteria, were mostly stemming from outside the projects. In the biomarine case, micro-biological measurement standards from another industry and industrial network, were employed to make improvements in the value chain. The introduction of different measurement standards, borrowed from agricultural industry, such as radically lowering the accepted bacteria counts in the raw material, allowed for changing the path. However, it was far from easy; a rigid control regime and intensive training were necessary, resembling how power relations may be constituted through borrowing standards across boundaries (Beunza and Stark, 2004; Grenville-Howard and Carlile, 2006). Standards can also be hard to cope with, as they may be 'moving targets'. In the biomarine case, the micro-biological standards were not given, rather pragmatically set according to what management though was possible.

In the ballast water case, standards had not been thought through from the user's point of view, hence producing unexpected consequences later. Once in use, the new standards were challenged by other actors, e.g. in terms of the evaluation of the technologies vis a vis water conditions, water temperatures, use-limitations of actual systems, etc. The limits to the legislator-induced standards could only be found through use.

This is not the same self-reinforcing cycle of technology evaluation criteria as described by Garud and Rappa (1994), although the actors encountered the similar effect of becoming blind to alternatives. By having to fix the standards to make progress in early phases, Daro had the surprise of the actual limitations by phase five, whereby they had to actively cope by going back to the test lab, as did all their competitors. Then, there was the parallel (superseding?) type approval from the US Coast Guard, which based on the same standard, used a different evaluation protocol, hence producing new rounds of development.

If we go even closer to the actual process, the assumption of Van de Ven et al. (1999) of increasing certainty of innovation processes over time could be challenged. Choices made during the process not only lead to learning, alignment and therefore increased certainty; they may also lead to rigidities, representing barriers to necessary change. To create a new path implicitly means building new interdependencies. Moreover, we saw how, while a resource during early exploration, the 'ambiguity of goals' (Van de Ven et al., 1999) became a curse later in the processes, limiting the capacity for action.

The **tensions of product, resources and markets** related particularly to the radical/incremental and the path dependence/creation paradoxes. As mentioned, the complexity, and hence 'radicalness', of the technologies in our case studies were significantly under-estimated, partly from lack of experience with the novel combinations of elements, and partly from the unpredictable consequences of interacting with others (Håkansson and Ford, 2002; Håkansson and Waluszewski, 2007; author, 2012). In the ballast water case, the development efforts grew steadily, mainly because they had not done this before. They did not realize this because they treated the project as similar to things they had more experience with; safety product innovations, where they have done a lot of incremental innovations.

Moreover, what is the product offer? In the biomarine case the ambiguity of high-end versus mainstream products and markets kept confusing the participants through phases one to four. In the ballast water case, this question was kept relatively open throughout the whole process. It was considered important to stay entrepreneurial, meaning to embrace all promising opportunities, and this was reinforced by the urge to sell hard, and get orders wherever they could, before having a ready product package. The sales strategy also was a driver for 'scope creep', with the product offer continuously changing to meet various customers' needs and requirements. Then, in phase four, market feedback led to a series of re-evaluations of the product offer ("does the product do what was intended?").

From this we see how interaction with customers may produce an increasing gap between what is sold and what can be made. Such tensions between product development and sales have been found in several studies (cf. Nelson and Winter, 1982). Interestingly, in the ballast water case, the company was not aware that they were moving towards a more radical innovation, as their starting point was to look at the innovation as an extension of their established product portfolio.

In Tine, the project started with technical fascination, acknowledging some of its radicalness, but still the project grew in complexity in unexpected ways. First, like many other network actors they gradually understood that they had to get involved in more of the value creation process in order to induce improvements and changes. Second, among customers, the cured product was experienced as too unfamiliar and it did not fit into any established market categories. Hence, Tine was forced both to simplify the technology (strip away several of the technical novelties) and adapt to the established distribution and consumption practices. This illustrates how, when adapting new products to users and user practices, the innovation often has to be made less radical; converge, simplify and remove elements to make it fit (Hoholm and Olsen, 2012).

It is relevant to ask whether Bremnes could have commercialized their technology on their own. Before entering the relationship with Tine, they tried and failed, as their distributors were not eager to pay a higher price for their raw materials. The path

dependence of the fish industry network locked Bremnes into a commodity oriented market structure, optimized to distribute volumes rather than qualities. But, as argued in path dependence theory (Davis, 1985), in the initiation of new paths serendipity tends to play a role. By connecting to an entirely different network, they could bypass the path dependence of the fish industry, and start creating a new path together with Tine.

This expands Garud and Karnøe's (2001) focus on 'mindful deviation', and "ability to span boundaries of relevance structures, translate objects, and mobilize time", as the deviation and the mobilization process was based on connecting to another network. As a consequence, this has opened up a new market category for fish in Norwegian and some other European food retail markets. Bremnes could start using the agricultural organisation and competence for product development, branding and distribution. From this, we would argue that more attention needs to be given to the interplay between organizational and industrial change during more radical innovation, than has been emphasised so far (Van de Ven et al., 1999; Orlikowski, 1993).

Last, the **tensions of project organization** were related mostly to the convergence/divergence and the incremental/radical paradoxes. As mentioned, the uncertainty did not always decrease over time. As a consequence, project teams were restructured several times, in terms of size, roles and who was in charge. There is also a need for innovation project organization to improve the team's ability to relate and interact across organizations, and to cope with interaction uncertainty. This is implicated in Van de Ven et al. (1999) and Orlikowski (1993), and has required elaboration.

We also need to consider the political aspect of divergence/convergence. In our cases, to restructure the team was used as a political coping device, for example in the ballast water case, when the team got overly political it was dismantled. Changes in size and who is in charge means that different things get emphasised, hence producing divergence.

Furthermore, the incremental/radical paradox was weaved in to this. When realizing the radicalness, Daro also realized the need to prepare and build the organization more than had been done, thereby changing the team quite dramatically. As was said, they were 'realizing the opportunity but also the challenges'. Retrospectively, what can be seen as a too small team, was – prospectively – thought to be right, but then swamped by a number of issues and uncertainties, arguably leading to more and more divergence.

The biomarine project organized as large and diverse team to explore the technology alongside seeking to learn about its market potential. As could be expected, this produced a high degree of divergence, and severe difficulties in making decisions and moving forward. Not before the new project management and their corporate supporters made a 'coup', and downsized the project team radically, could they catch

speed towards commercialization, and gradually remove unnecessary features of the product and its use.

Suggestions for further research

Lastly, using a case study research methodology means that we cannot generalise our findings to a broader population. However, we argue that the patterns we discuss here are of general interest, and would like to challenge others to work further and develop new insights into paradox. One issue is that studying innovation processes, which are inherently politicized by their very nature, are difficult to come by (and once access has been granted, it is a challenge to maintain this). However, studying such processes prospectively gives a fuller view of the challenges involved in coping with reconciling paradox over time.

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