The contrary forces of innovation
A conceptual model for studying networked innovation processes

Competitive paper

Special track: Time and process in business network research

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1. Introduction:

Innovation processes represent a particular challenge to industrial network theory, given its emergence from a focus on explaining why businesses tend to be much more intertwined in stable collaborative networks than what can reasonably be associated with the fundamental assumptions underlying the general equilibrium market theory of mainstream of economics. Given this emphasis on relative interrelatedness, interdependency and stability, observed radical changes and innovations must, however, also be properly accounted for. To do so, a particular concept of "friction" has been introduced which identifies controversy between the forces of whatever has been put in place and the forces of whatever movements, changes and efforts that somehow interacts with such an established order (Håkansson & Waluszewski 2001). On the other hand, Actor-Network Theory which more genuinely is an analytical theory to deal with and to explain "emerging phenomena" like innovations, by some has been pulled into the world of industrial network analysis, with the ambition to combine the two approaches in order to better explain the industrial network to change/innovation relationship (Mattson, 2003; Araujo, 2007; Brekke, 2009; Hoholm, 2009).

This paper is based on a research project that has explored this route by conducting a highly detailed case study of an industrial food-product innovation project called "Salma", related to the Norwegian dairy company Tine SA and the fish farm Bremnes Seashore. The observations have been analyzed in the perspective of both industrial network and actor-network theory, with a particular ambition to enhance our understanding of the innovation phenomenon in the context of industrial networks. The study has also pulled from a variety of other studies of innovation processes.

Based on this study, we suggest that the most crucial "frictions" or "controversies" that we observe along the innovation process can be productively analyzed as a dynamic interplay between two different kinds of processes that are typical to emerging innovation projects. "Friction" or "controversy" relates to the re-appearing confrontations between the outcomes of these two. One of these processes has to do with the efforts to mobilize resources, activities and actors by means of including these into particular framings which represent visions about rewarding future states and arguments that are there to convince others to make commitments

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to the project. The other process is the process of actual learning by those working to materialize the project, which evolves through a combination of discoveries, positive and negative feedbacks and creative propositions about the true state of the market and of what represents the most promising routes for the project to advance. New framings are created, different actors and resources are being interacted and new arguments are being produced to pull the innovation project in alternative directions. Over time, these two processes typically emerge into different paths where after they confront one another over new battles for resources, activities and actors' commitments to the framing of the future process. The outcome to such a controversy depends on the abilities of each of the two sides to mobilize substances and arguments. Hence, to turn around an already established framing of committed resources, activities and actors typically involves both efforts to undermine the rival by means of undermining, rejecting or deconstructing some of its core assumptions, propositions or constructs, and efforts to overthrow it by means of mobilizing more convincing and substantial alternatives.

We argue that structuring the analysis into this kind of bipolar process model, leads to a more extended, realistic and precise understanding of how networked innovation processes evolve, as well as of the mechanisms that characterize the relationship between relatively stabilized interacted business networks and the innovation/change phenomena we observe. It provides a better understanding of the mechanisms involved in the "friction" phenomenon pointed at by others, and it also enhances our understanding of the controversies that are core to the divergence-convergence pattern of innovation processes found by van de Ven et al (1999). Finally, we argue that interaction of mobilizing and explorative processes provides an interesting alternative approach to, or expansion of, the "path creation through mindful deviation" argument presented by Garud and Karnøe (2001).

2. Knowledge gap and research questions

Over the years, a substantial body of research has demonstrated how most of what we perceive of as competitive markets are dominated by interacted networks of business organizations that seem to form relatively stable structures over time. Acknowledging that this is a dominant characteristic of the world, we still need to understand processes of change, innovation, growth, decline etc. To understand relatively stable, interacted business networks does not explain how relationships and networks come about in the first place, how they may change, dissolve or evolve over time, or how entirely new or different networks may establish themselves in between all those who are already there.

How then, is interaction conceived of within the 'interaction approach'? First, sometimes actors do not seem to have a choice; due to their social and material embeddedness in relationships, interactions are necessary to survive or to get anything done at all. Still, when one has a choice, interaction might be sought out for different reasons, including problem solving, learning, innovation, efficiency or cost reductions (Ritter & Ford, 2004). Ford et al. (2003:7-8) have employed 'networking' as a synonym to interaction in business networks, claiming that all companies are networking, which means "suggesting, requesting, requiring, performing and adapting activities, simultaneously". Networks are, however, often considered to be quite stable and difficult to change. The reason for this is said to be the result "of complex interactions, adaptations and investments within and between the companies over time" (Håkansson & Ford, 2002:133). That is; the observed stability is presumably the outcome of lasting investment and stabilizing processes.

This perspective on industrial networks points at a 'process perspective' on business practice which pulls the importance of time into the analysis. Johanson and Mattson (1987) elaborated interaction into two categories, namely exchange and adaptation. In order to capture the dynamic (interactional) side of these categories, time needs to be included as a factor (Medlin, 2002; Dubois & Araujo, 2004; Ritter & Ford, 2004), because there seems to be a difference where *exchanges* that happens in the present, and *adaptations* that are being "planned in the present, exist as changes to resource ties and activity links in the future" (Medlin, 2002:7). Both concepts are closely related to past experience, present interaction context and future expectations. Altogether, this resembles a research perspective investigating "the social creation of reality through interaction" over time (Medlin 2002:4).

Some authors have put resources (Waluszewski, 2004; Håkansson & Waluszewski, 2001), and more specifically, knowledge, (Araujo, 2003; Håkansson & Waluszewski, 2007) at the centre of their analyses of inter-organisational interaction. In such interaction possibilities for new solutions are created, and old resource combinations are confronted with new alternatives, which produce variation (Waluszewski 2004:146). In their inquiry into the question of why and how technological systems often hold a certain stability that makes them difficult to change, Håkansson & Waluszewski (2001) oppose the notion of 'inertia'. Instead they launch the concept of *'friction'*. They observed how resources often seemed to be 'cemented' upon each other, and therefore are hard to change or replace, and yet resource combinations with a seemingly unlimited stability, sometimes suddenly dissolved. Friction is defined as a relational concept, describing a force directed towards each of the two interacting bodies. It is furthermore a time-related construct, as friction is thought of as having different effects at different times. And it is transformational, in that friction not only leads to movement, but also to some kind of transformation of the interacting bodies. Friction also connects historical and contemporary processes in being a reaction to one or more of them, and is thereby neither leading to random nor deterministic change processes. Based on these aspects, friction is viewed as being an 'active force' in resource interaction, causing changes in existing resource combinations, somehow with a strong tendency to favour existing (i.e. historical) values (Håkansson & Waluszewski, 2001b:2).

With regard to the effects, it is argued that forces directed towards one resource will also affect all of the other resources with which the focal resource interacts. Hence, effects are never merely local; they distribute through friction across interfaces to other resources - transforming them too. One reason for the observed *stabilisation* effects, they argue, is that friction connects the present with the past, thereby defending earlier results and solutions. This is a process of bringing historical entities together as well as of integrating new interfaces with existing interfaces in emerging interrelated networks (ibid:15). On the other hand, friction also produces *de-stabilisation* effects. Through friction, simultaneous processes are connected, allowing the same interface to be activated in several change processes. In this way, friction can also sometimes enforce change (ibid:17).

Waluszewski (2004), Håkansson & Waluszewski (2001), Leek et al. (2003), Medlin (2002) and Dubois & Araujo (2004), all call for developing theoretical 'tools' to better analyze the dynamic aspects of networks. Mattsson (2003:16) suggests that Actor-Network Theory (ANT) could enrich and complement the industrial network approach by explicating how human and non-human actors are related, how social phenomena are 'performed' in emerging and heterogeneous networks, by offering a more precise methodology for studying dynamics. He also suggests that ANT could benefit from the accumulated knowledge of the IMP approach when turning their eyes towards economic and market phenomena. Araujo (1998) made an

early argument for merging some of the insights of ANT with insights from the industrial network approach. He advocated a network view of organisation, defined as "a set of interlocking and shifting relations with porous and fluid boundaries[3]" (Araujo, 1998:317), where sociotechnical networks should be the units of analysis. So, innovation[4] processes are found *between* the social and the material, and in the relating/associating of events over time. They are "implicated in everyday of collective practices" and in the "interactional practices that relate the organisation to other actors" (Araujo, 1998:317). This ordering process is about shaping recursive patterns, and when interconnecting multiple such orderings, a complexity emerges that seems to privilege incremental over radical change. This is similar to the argument of Håkansson and Waluszewski (2001) that, in industrial networks, innovation/change needs to be closely adapted to the existing features of implicated networks in order to be acceptable and doable, hence implying a 'conservative' logic.

Actor-network theory and the study of emergence

The particular strand of science and technology studies (STS) called ANT has sought to describe and understand the rise, continuity and fall of socio-material networks, in viewing them as relational, heterogeneous and emergent. According to ANT, the social is unstable and unpredictable, as any actor can and often will resist the exercise of power by others. The actors that are able to enrol other actors in their network by selling their discourse and making the other actors dependent upon their knowledge and discourse/mode of ordering, will succeed in building their network, at least for a while. This is fundamentally a relational and process perspective, viewing the world in constant flux and hence putting stability – and stabilisation – under scrutiny. This makes this perspective a good starting point for studying innovation processes over time – implying a "radical" logic of established networks (actor-networks).

In applying the semiotic principles of relationality to all kinds of materials, ANT holds that "entities take their form and acquire their attributes as a result of their relations with other entities" (Law 1999:2), thus taking a non-essentialist standpoint. Law further emphasises the uncertainty and reversibility of entities resulting from this 'material relationality'. The dualisms of agency and structure in social theory are challenged by Latour (1999a), who argues that the social is not constituted by agents and structure at all; rather, it is a 'circulating entity'. To sum up ANT's ontology, it views reality as relational, and as a consequence, reality is also multiple. Actors must renegotiate positions and roles, mediate between expectations from different networks, and relate to truths in one network that are irrelevant in another. Law (1994) make use of the Goffmanian term of 'performativity' to explain how reality is both real and produced at the same time, and hence different in different performative settings.

Latour has in several of his studies of knowledge production and innovation (e.g. 1988, 1996) shown that transfer or diffusion of knowledge is never just that, knowledge is never just 'flowing' or 'diffusing' through the system. Instead, he argues that the object (e.g. knowledge or an innovation) is always changing on its way. Further, he argues, it is not moving ('flowing') by itself; it is always up to the individual actor to decide whether s/he should pass it on or not, in what way and in what form. Latour's (1988; 1999) concept of *networks* is one

[3] See Mørk & Hoholm (2008) for a review and discussion of boundary crossing and boundary organising practices, drawing in particular on the contributions of Orlikowski (2002), Hernes (2004) and Barrett et al. (2007).

[4] Similarly, Brown & Duguid (1991) argued that learning should be viewed as the bridge between working and innovating.

that emphasises 'work' more than 'net'. He argues that networks should be understood as processes of translation, association, deformation and transformation. This is because:

> the spread in time and space of anything – claims, orders, artefacts, goods – is in the hands of people; each of these people may act in many different ways, letting the token drop, or modifying it, or deflecting it, or betraying it, or adding to it, or appropriating it. (Latour, 1988:267)

This implies that networks are *less predictable* than might be believed. The possibility of controlling networks in time and space becomes highly questionable, because power might not be a cause, but "the consequence of an intense activity of enrolling, convincing and enlisting" (ibid). Law (1992) adds that network ordering is also a matter of the uncertain process of *overcoming resistance* – an argument with similar associations as Haakanssons & Waluszewski's *"friction"* argument.

Latour suggests the term 'translation' as more appropriate than 'diffusion' for explaining processes of knowledge transfer, creation and change. Translation, then, is defined by Law as "the process or the work of making two things that are not the same, equivalent" (1999:8). E.g., texts are often constructed as combinations of other texts, taking on the role of representing the other facts, figures, numbers, definitions, descriptions, etc. Thus, in reality, the ability to gather, simplify and represent an increasing number of materials in one, is what makes knowledge mobile and influential. This is 'translation', i.e. to speak *for* and represent someone else, and to simplify and delete complex, effortful and often controversial processes.

In his work towards fleshing out pathways to a process perspective in organisation studies, Hernes (2007) sums up some of the contributions from Latour's works that are considered useful for studying innovation processes. First, no social order can endure over time except via socio-material relations (Hernes, 2007:72). Second, these heterogeneous networks are kept together in and via recursive patterns that are repeated in time and space. Third, this means that entities (actors, resources, innovations, etc) are the outcomes of their relations. While Hernes (2007) portrays actor-network theory and process studies, as perspectives that emphasise 'choice', 'play', 'experimentation', which allow "for choices to be made while remaining open to the possibility that the outcomes will not be as expected" (ibid:76), he does not put as much emphasis on how actors get themselves in the position to do the experimentation and have choices in the 'first place'. In a negative sense, this means that little is said about the resistances and limitations that actors experience when trying to order things into (new) patterns, whether such resistances come from materials and (interacting) practices (Mørk et al., 2006), politics of expertise (Mørk et al., forthcoming) or interaction in wider networks (Hoholm & Mørk, 2009).

Taken together, we see industrial network theory and ANT as fundamentally congruent theories in their similar foundation in a relational, emergent, process view perception of the world. They have emerged with a focus on different phenomena and different academic opponents, and they have developed a different set of vocabulary and operational analytical constructs that aims at explaining things observed. However, we see no paradigmatic obstacles to combining the two in search for a combinatory gains. The challenges are merely pragmatic and related to the particular research objectives at hand. So, this is what we have tried to explore.

Innovation management and process studies

Innovation process studies have been conducted in a variety of research camps across the management sciences. Kline and Rosenberg (1986) researched the intertwining of technology

and economy in innovation processes. They claimed that economists had black-boxed the process of technical transformation, while technologists often failed to take the 'external forces of the marketplace' into consideration. Innovation, from this perspective, is a complex and uncertain process, and an "exercise in the management and reduction of uncertainty" (ibid:276). Von Hippel (1988) a few years later, became the major proponent for considering the market – in the shape of users/lead-users – as internal to the innovation process, granting full interactivity also to the 'users' influencing the innovation and its fate by using, modifying and/or rejecting it.

According to Pavitt, only two aspects of the innovation process are generic; "coordinating and integrating specialised knowledge, and learning under conditions of uncertainty" (Pavitt, 2005:109). The risk of failure in innovation processes will increase "with the number of practices and competencies that need to be changed" (Pavitt, 2005:105). Such 'radical' innovation processes are equated with processes of learning, where 'overplanning' may distort the process because the future cannot, by definition, be fully known. Innovation typically consists of contingent processes, stemming from interaction between science, technology and markets, thereby representing high levels of uncertainty. Hence the 'management of uncertainty' is one of the crucial tasks for participants in such processes.

The longitudinal comparative study of innovation in the MIRP-study (Minnesota Innovation Research Project), reported in Van de Ven et al. (1999), has become an obligatory point of passage for anyone studying innovation processes. Their main thesis is that the common pattern of all innovation processes "is a nonlinear cycle 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). Linear stage models as well as random models are disputed; instead, they argue for innovation as 'emergent process' based on nonlinear dynamics, in which sensitivity to initial conditions and the ability to manage complexity are viewed as being crucial for success. Again, learning is viewed as a central aspect of the process, where 'learning by discovery' is understood as "an expanding and diverging process", and learning by testing as "a narrowing and converging process" (ibid:203). Their data demonstrate how a given innovation path typically diverts into multiple paths of exploration directed towards different perceptions of economic opportunity. Over time – and in particular as a result of resource constraints and interaction by resource controllers, most of these paths were typically expelled in order to converge the process through a narrow trouble shouting funnel with specific targets to reach. As such, this indicates a dynamic relationship between explorative and directive, mobilizing processes where the dynamics is typically triggered by infusions of money into the process. At the same time, they argue that this dynamic is also a reoccurring pattern through out the entire innovation process, which implies that there must be more to be said about the mechanisms involved in generating this dynamic pattern.

In their study, they also found that managers' performance criteria shifted over time, both in relation to outcome, process and input, and in line with the changing needs of the innovation process and the unexpected events that occurred. Such changes "triggered innovation managers and entrepreneurs to search and redefine their innovation ideas and strategies" (Van de Ven et al., 1999:42). Hence, the controversies observed obviously had to do with fighting over alternative framings, orders of meaning and direction for where the innovation should be directed. Beunza and Stark (2004) and Grenville-Howard and Carlile (2006) confirm this argument, although from a more political point of view, showing how the negotiation of evaluation criteria is fundamentally a political process through which power relations are changed and re-constituted over time. In order to succeed with innovation, there is a need to

acquire power via coalition building. Coalitions, or networks, tend to grow over time, resulting in complex networks "engaging in a series of transactions necessary to move the innovation forwards" (Van de Ven et al., 1999:50). This networking process is non-linear, characterised by "numerous bargaining, commitment, and execution events" of the inter-organisational relationships. After some time, the networking may reach a point of "self-organising criticality", "wherein the relevant unit of analysis becomes the web and not the dyad".

A distinction is made, by Garud and Rappa (1994:344), between two different cyclical processes: One in which "evaluation routines designed to judge specific artifacts begin reinforcing researchers' beliefs", and another of institutionalisation, in which developing a "common set of evaluation routines that can be applied to all technological paths". Garud and Rappa observed how beliefs were externalised by creating routines, which in turn were used to evaluate the technology in a self-reinforcing circle. However, the influence went both ways, as the technical artefacts also had severe impact on what kinds of evaluation routines could be employed. On the 'positive' side of technologists' blinkers, Garud and Karnøe (2001) have investigated the role of (and space for) agency in shaping new industrial practice, or, in other words, shaping new technical paths. They argue that 'mindful deviation' is a central characteristic of how entrepreneurs contribute to 'path creation' and thus towards implementing new ideas in the economy. However, none of this really explains how and why controversies and frictions emerge over time, or how and why particular pathways get chosen before others. Hence, it is still unclear from these approaches how we may enhance our understanding of how stability and change are related in innovation processes.

Research questions

Sensitivity towards conflict and controversy is strongly present in ANT (Latour, 1987; 1996), which explicitly advises the researcher to trace controversies, since this is where the 'black-boxes' are destabilising, hence enabling an observation of how 'new' socio-technical networks come about. Law (1992) describes the building of networks as 'overcoming resistance' and, similarly, Pickering (1995:22) describes the production of (scientific) practice as "a dialectic of resistance and accommodation". 'Friction' in the industrial network approach points to the resistances and influences that necessarily follow from any attempt at changing resource constellations. Further, the political aspects of innovating are explicitly stated both by Pavitt (2005) and Van de Ven et al. (1999).

In order to identify a suitable case, we elaborated from Van de Ven et al.'s (1999) definition of a 'generic innovation journey', emphasising innovation processes that are purposeful for developing a novel idea, yet constitute substantial uncertainty regarding the market, technology and organisation. Furthermore, they emphasise processes that include a collective effort over time that requires greater resources than those possessed by the people who undertook the efforts (Van de Ven et al., 1999:22). Tine BA, an agro-food cooperative with its core business in the dairy sector, turned out to have a combination of new corporate innovation strategies, a R&D department and a number of interesting ongoing innovation projects crossing the industrial boundaries between the agricultural and biomarine industries, hence departing from the traditional resource- and activity base of the company.

It is impossible to explain what happens in innovation processes in individual, deterministic or linear ways. These are highly interactive processes, involving a number of both human and non-human elements, where the outcome – on almost any parameter – is not given at the outset. Hence, we posed research questions that could help us capture at least some of these

aspects. These questions also started out with the premise that 'new' knowledge never is created out of the blue. It will always be derived from something that already exists – hence we might say that it is the *association* that is new: Ideas of how to (re-)combine, translate or transform existing knowledge into something new. Hence, the research questions we pursued were the following:

- *How do innovation processes evolve over time?*
- *How is knowledge translated, transformed and combined in processes of innovation?*
- *What are the contrary forces (frictions) of innovation processes?*

Beginning with acknowledging the presence of controversies in innovation, we wanted to understand more about what dynamics produce and fuel the inherent tensions of innovation processes. What are they, how do they influence the process, and how are the conflicts settled?

'Knowledge' is here understood and studied in a particular way: Knowledge is only analyzed in terms of how it is materialised in technologies and work practices. Thus, the focus is on *knowing*, or the doing of knowledge. It is a performative construct inseparable from the historical, social and technological setting in which it is embedded (Law, 1994; Araujo, 1998; Gherardi et al., 1998; 2002). Industrial innovation refers to the process of developing, producing and commercialising new objects through re-combining, transforming and translating knowledge and technology. Hence, innovation is about the whole process, from the inception of an idea until its eventual implementation/commercialisation (or failure).

Methodology

The case study was part of one of the authors' PhD-project, and was conducted for the most part as real-time ethnography, observing the actual processes as they happened. We have therefore been able to reconstruct the innovation process without some of the well-known methodological problems of post-hoc rationalization and 'closure' of the story by the involved actors. In addition it was necessary to trace parts of the process back in time via document analysis and interviews, because it turned out that certain historical events became important to the subsequent process. In addition to spending several months as participant observer in Tine BA, 35 formal semi-structured and open-ended interviews were conducted (including both main organizations and a set of partnering actors), and all available project documentation was examined. Ethnographic fieldnotes were written during participant observation, and all interviews were taped and transcribed. The analysis was a circular process, moving back and forth between literature and empirical data. The model presented and discussed in this paper was constructed as an outcome of this process, and then used to interpret the case and draw out implications for innovation process research and practice (Hoholm, 2009).

3. The Salma case

A Norwegian agricultural cooperative, Tine, and its counterparts in the agricultural and biomarine industries. It is an ethnographic case study of the organising of innovation processes, meaning the development and commercialisation of hybrid technologies and products between aquaculture and agriculture. What we are describing is the emergence of a possibility: The possibility of industrialising fish, and several (very early) attempts at doing so. Within this setting, we have studied a particular attempt at developing and commercialising new products from fish, a set of processes that started out with ideas of fermentation of fish (making 'salami' of fish) on the one hand, and new technologies for

processing fresh salmon on the other. In other words, it was an attempt at utilising knowledge and resources from one area within another: Erik Slinde, a creative scientist tried to use an agricultural technology, fermentation, to help industrialise the in Norway abundant raw material resource, fish. Tine BA, an agricultural cooperative, sought new opportunities for business in the biomarine area, based on their established knowledge and technologies of industrial production and marketing of dairy products. In addition Bremnes Seashore, a fish farm, looked for ways to create more economic value from its new technologies for processing salmon of supreme quality.

The product that during this process came to be named 'SALMA Cured' was in the most basic sense a combination of fish as raw material and fermentation as technology. Though it has many other uses, fermentation technology is normally used for making salami out of meat, and it is exactly this traditional salami recipe that served as the starting point for the project. Therefore, it has informally come to be called a salami, or sausage, among the project participants, and 'fish salami' will also be used in this thesis when referring to the more general idea of this invention, rather than to its various specific appearances and names throughout the project. However, in the end, the product that the consumer could find in an increasing number of restaurants and supermarkets was very different: 'SALMA Fresh', loins of salmon of high-end quality. Still, the story behind this product is a lot more complex than the neatly designed transparent package of high-end salmon would suggest. It is a socio-material drama consisting of several partly overlapping episodes[5], in which the actors struggled to cope with a set of challenging questions: How do you develop, realise and commercialise a food product that no one has heard of before? A product that falls entirely between established categories, both as it is perceived by consumers, and as it is organised in supermarkets and restaurants. Further, how do you make processing technologies work when they are applied to a new material?

Together with the research group from the University of Life Sciences, Bremnes Seashore had between 1993 and 2004 invested around 40 million NOK in developing technologies for slaughtering and processing of salmon, however, without any economic rewards within their established market system. Hence, they searched for partners that could help them commercialise and economise on the new knowledge. Then Tine arrived at the scene, representing an opportunity to escape the limitations of the fish industry, and to obtain a share of agricultural competence and infrastructure for product development.

Staging

With previous experience from 'both sides', having worked as a scientist and director of research both at the Food Research Institute and at the Institute of Marine Research, Slinde wanted to encourage the product development of fish:

> Let's take some food technologies, and then apply them to fish, using fish as raw material, and using food processes, and one of the processes that I know really well is production of salami. I thought to myself, ok, we can make a salami out of fish. (Erik Slinde, Institute for Marine Research)

From this experimental recombination of technologies and materials, based on Slinde's expertise, the idea of making salami out of fish, preferably from salmon, was tested. It soon became clear that the fat content in salmon would be a main technical challenge, and therefore a mix of red and white fish was seen as necessary. In addition, white fish, such as saithe, was

[5] For the complete case study, see Hoholm (2009).

much cheaper than salmon. This is an early version of the fish salami. On the one hand, applying technology from ordinary and mundane Norwegian salami, and on the other hand, it was thought of as a competitor and substitute for exclusive products like smoked salmon and 'speke-lax'. This 'double identity' was also present in the object's technical and economic challenges. First, there was a challenge in stabilising fatty acids. Second, there was a challenge of market segmentation, whether aiming towards the exclusive 'gourmet' segments or a larger market of 'everyday products'. And third, it was a matter of cutting costs, for example by blending salmon with saithe.

The first experiments did not go very well. Yet, even though he thought of the experiment as a failure, Slinde still brought the results back to his fellows at ForInnova (the University of Bergen's Technology Transfer Office) and the Norwegian Research Council:

> And then I went back home, and came with these nice packages, right, a little like 'dress up the bride'. And these guys ate it, and said it tasted delicious. So, I thought that, if three economists are sitting here telling that this is good stuff, then I am sure I can make it better" (Erik Slinde, Institute for Marine Research)

Slinde's interpretation of the situation, even in hindsight, was ambiguous. On the one hand, the first experiments failed, and he was really heading home without positive results. Still, just to be able to show *something*, he 'dressed up' the fish salami and let the businessmen have a taste. One of the Research Council representatives later told that he thought the product tasted "awful", but that they thought it was a fascinating project, and some of them had a good relationship to Slinde. Thus, it was decided to continue with further experiments, and start developing a business plan for the project.

While the fish sector is transforming towards cultivation instead of catch, industrialisation of processing, product development and marketing has not yet been followed. This is what the corporate management at Tine identified as an opportunity:

> We started talking about entering business development in the fish sector. And then we analyzed, where do we have something to build upon? Do we have resources that can be of importance in new areas? And we have a rather unique situation, as the only food company in Norway with a large R&D department. (Hanne Refsholt, CEO, Tine)

A very rational and strategic process was depicted, from the realisation of the external threat of international competition within their established areas (dairy products), to a systematic search and evaluation of opportunities, before making choices based on expected synergies with their own R&D capabilities and their unique value chain. The implementation of this strategy can be viewed as a broad trial and error exploration of a new field for the involved participants. Two main routes were tested, the financial and the industrial, of which the former had a short career because of some unfortunate failed investments. A set of very different biomarine industrial projects was established, with the shared idea to build and exploit industrial synergies with Tine's existing business; knowledge, technology, distribution and marketing. A common coordinating organisation, Tine Biomarin, was established in order to ensure access to the relevant in-house resources at Tine, and to facilitate interaction between the different projects, they were organised under a common organisation.

Mobilizing

After having proved to himself that the technology would be feasible, Slinde filed a patent application. At Tine, they did not necessarily think of this as a product for them at the time, this was more a way of developing business from selling whey as an ingredient to other industrial actors, in addition to expanding their knowledge on their own technologies and

surplus ingredients. Along with a technology transfer office, ForInnova, Slinde started presenting his invention at national and international food fairs. Due to the ongoing collaboration on the Neptun project, a reason for contacting the corporate management at Tine was already in place, and a first meeting was arranged. In the beginning, even though they were somewhat interested, Tine did not make any decisions. Slinde's other option was to sell the patent internationally, for instance to a Japanese actor visiting Bergen at the time. He expressed interest, and considered the price, a price significantly higher than what TINE had been offered, to be rather low. Within a few days after being confronted with this competitor, Tine had decided to buy the technology. The act of buying the patent represented a shift in focus and organisation, by forming a new project, Umi No Kami, aimed specifically at the technical and conceptual product development of this 'sea salami' into a commercial product. Nevertheless, the connection between these projects was maintained during the two first years of Umi No Kami, pooling the resource base for both projects.

This indicates that the mobilisation for buying the patent went through alliance building with central actors in Tine's business development activities, and through producing arguments according to corporate rituals (e.g. market share). The motive for initiating these projects seems ambiguous. On the one hand, the reason for doing Neptun, and relating it to Slinde's patent application, was the opportunity to exploit more of Tine's surplus of whey in an industrialised fish product probably produced by someone else. In this sense, the project looked similar to other projects related to Tine Ingredients' business area – selling various ingredients from milk, and thus often participating in R&D activities to enhance understanding of how to use these raw materials in different settings. But on the other hand, Nordvi revealed also an early hope for taking over the whole thing. Hence, the process of convincing the organisation to get involved with the fish sausage, and to buy the patent, began already with the establishment of Neptun. In part, they started an intentional process of presenting and arguing for this as a golden opportunity. In addition, it seems as if the object itself had some kind of ability to gather interest and enthusiasm at Tine on its own.

Whereas Neptun involved mostly researchers and technologists, Umi No Kami had to involve scientists, technologists and people with expertise on marketing and design. In addition, it was more strictly tied in with the corporate innovation strategy, hence also involving the management when setting or changing the direction of the project. From the start, the project included people with expertice on internationalization, marketing, research and product development. In addition 'external' experts on packaging, R&D, and sausage making were associated with the project. All in all a group with a broad set of competences was represented. The purpose was ambitious:

> The purpose is to develop a series of fish products that take part in creating a whole new category of fermented and dried fish products in the food trade, that are profitable, and that the consumer wants. The product is to be sold both in Norway and internationally.
> (Status report, Umi No Kami 2003-06-20, Tine R&D)

When confronted with the 'hairy' goals in the early strategy notes, one of the marketers could explain more about the dilemma of early phase innovation:

> Clearly, the dilemma when it comes to big investments, right, is costs, then you have to show expectations of great profit. But the question is, when you go for/pursue a radical innovation, like this, what kind of expectations should you have? Should you think from a seven-year perspective, or from a three-year perspective, as the management at the time demanded? (Hilde Torvanger, Tine R&D/marketing)

They knew the project would take time and money, and to legitimate this use of resources, expectations of great profit had to be demonstrated. Prosperous stories of the future had to be

made, which were partially grounded in the product and their limited knowledge of its potential markets, but mainly based on the expected level of ambition within the company.

Exploration

To sum up the main aspects of technology development, four intertwined technical and biological problems had to be solved before managing to produce the fish salami with the expected biological and nutritional quality and avoiding troublesome mould attacks. Hygiene was the main and overarching issue at play. Routines had to be sharpened, cleaning had to be done with extra care, and all of the other issues were more or less related to these two. Second, there was a bakery laboratory next door, hence there were more spores from yeast and mould in the air that caused trouble for the curing of fish. Third, the new technology – the drying facility – had to be adjusted to work optimally in relation to moisture. Last, the supply of – especially white – fish was a big problem. Several suppliers were tested, and they worked with some of them over time to make them improve their microbiological quality, without success. This quest for getting the technology to work led the technical project participants through a long exploration process. In the research-based project prior to Umi No Kami, Neptun, they produced knowledge on the use of milk proteins to stabilise fatty acids.

There was a limit to how much fat could be stabilised in such a product, a limit that made it difficult to use only salmon (with its high and variable content of fat, 10-30%) in the recipe. A number of different material and technological issues were investigated to enhance this stabilisation process. Different combinations of fat content and blends of saithe and salmon were tested, together with tests of other white fish species than saithe. Moreover, transferring the technology and procedures from the practice of making salami of meat, they used frozen raw materials to enhance the drying process.

The competing idea, of using only salmon – or at least as much salmon as possible, remained an option. To enable management of the problem of fat content in a pure salmon product, near-infrared spectroscopy (NIR) was launched as a possible tool for helping sort out the fish with least content of fat. Lars Petter Swensen, who had been working with this technology at the University of Life Sciences, was hired as consultant. In this way, they could maximise the use of salmon in the recipe. Control of fat percentage in the fish improved from the near-infrared-method, but then only the best parts of the fish could be used. This was also different from making salami out of meat, where trimmings are a common resource in the recipe.

After two to three years of research, the product developers could be quite specific about the transfer of meat technologies to fish. While the bacteria culture worked in the same way with fish, and the following pH and drying processes too, the process of binding fat was a lot more complex on fish. They had to strictly control the fat content, add proteins to encapsulate and stabilise the fatty acids, and use fresh premium raw materials instead of frozen trimmings. In total, these were significant changes for adapting the original technology to the new raw material, making the product both more expensive and more challenging to produce.

With the formalisation of the Umi No Kami project, it got fresh resources for exploring and sketching a product concept by seeking knowledge of consumers and their reactions to this product. The first sketch of a marketing plan reflected on why people would purchase and re-purchase the product. “Curiosity and health” was mentioned as the main triggers for customers, again linking Umi No Kami’s content of omega 3 to the growing health trends within food (‘Strategy document 2’, UNK, 2002-06-04). However, at this point the marketing plan contained no references to concrete market analyses, and looked more like an expression

of the project group's own speculations and reflections. Early market studies identified "the areas in which such a product could work", particularly the fermentation traditions in Spain, Italy, Germany and the fish traditions in Asia, especially Japan and Korea. These were also identified as markets with buying power. However, then "South-Europe was early put aside, as Norwegian fermented sausages not are comparable to the Spanish". In realising how the success of new fermented products in this region would probably be closely connected to very local and culturally significant actors, they chose to go for Nordic markets on the European continent instead, in addition to Asian markets.

"I haven't heard from them in weeks. We delivered good results on the adaptations of the product; it works excellent on pizza now. I think they just have lost interest". Øyvind Kiland, commercialisation manager of Salma, told about the last developments of marketing the 'salmon salami'. He was talking about a multinational restaurant corporation, with famous brands in their portfolio. After the first meeting with this company, Salma had to go back to the laboratory. In order to bake well in a pizza oven, it needed less drying, probably no smoking, and could possibly accept lower quality standards; in other words, it could become a product that was easier, faster and thus cheaper to make. The process of adjusting and testing a 'pizza version' of Salma in the lab went well. However, when returning to the company with good news, nothing happened. They had probably lost interest in the product, or they lacked faith in Tine's ability to deliver on their demands, or their contact person had got a new job. Who knows? The prospect of what had been considered an 'ultimate customer' had met its end

Then Tine's German agent caught interest and wanted to test it in German hypermarkets. They soon had the initial, unsliced, package for sale in KaDeWe, Berlin's huge and prestigious demonstration store for food products.

> We tested it in KaDeWe in Berlin, and we had promotion women to present it and give out tasters, and in a few days we sold 10 cartons, 100 salamis. What we saw was that without tasting and with very little knowledge among consumers, and a high price, it was very difficult. However, when people got to taste, most liked it. (Detlef Martens, DM-Nor)

Several lessons were learned in this preliminary market test. First, customers needed knowledge about the product – what it was, how to use it, its benefits compared to alternatives, etc. This had to be inscribed on the packages and presentation materials. Second, slicing and decreasing the size would clearly be beneficial. In preparing for presentation to the relevant retail chains, the design and packaging for the German market was developed, and sizes were decided: Small packages (50 grams) to reduce unit prices, ending up with a price of approximately 2.50 Euro to end consumers. Armoured with presentation materials, a suitable package, and a novel and branded product, Martens could go to the retail chains with the product. Salma was ready for test sales in 90 German 'hypermarkets'. Although not catastrophic, the sales of the 'Lax Salami' did not go particularly well, not even after adjusting the packaging information and trying a second round. It was soon realised that Salma, in this form, had little chances of commercial success in German hypermarkets. Thus, one by one, Salma's potential partners and associates for marketing and distribution either did not connect at all, or failed to fulfil the promises of the partnership.

Interaction and confrontation

What were important for the direction of the project were its initial intentions, forming what we could call 'framework conditions', stemming partly from management discussions and decisions on buying and formalising the project, and partly from the patent application itself –

its recipe and prescriptions for making this 'fermented fish product'. Both the technical work and the marketing work seem to have been conditioned by these initial intentions, limiting and shaping the potential pathways ('opportunities') explored by the project team:

> One of the premises that was very important, was that we had to use white fish, in a mix with red fish. It was a technological challenge, and a visual challenge, as it had a grey colour. And the product was difficult to make. And then, when we started developing a communication platform and name, we talked a lot about 'Sea Salami', and all such 'Salmon'-things, right, but this was out of the question, as we would then be limited exclusively to salmon, and we could not do that. (Hilde Torvanger, Tine R&D/marketing)

Although she had expressed sympathy with these framework conditions when discussing the marketing strategy, Torvanger described how this also limited their work. What for a period of time seemed rigidly stable, however, was later radically changed in the shift from Umi No Kami to Salma:

> And then we had a challenge that we really did not understand along the way, but that we have seen very clearly afterwards, that the framework conditions from the corporate management changed a lot during the process. (Hilde Torvanger, Tine R&D/marketing)

So, at the time, these preconditions were experienced as being very stable and restrictive, while later in the process, for some specific reasons, they could suddenly be changed. The introduction of a new relationship (between Tine and Bremnes Seashore via some newly hired researchers) and a new raw material (pre-rigor salmon) to the process changed the 'rules of the game', making raw material supply the pivotal criteria for partner evaluation.

The process of re-organising the Umi No Kami project came out of changes in the corporate management at Tine, and in the management and merger of Tine Biomarin with another business unit. Swensen called this a 'coup' of the Umi No Kami project, to create more momentum towards commercialisation. The shift represented a radical break with Umi No Kami as it had been originally organised and conceived of. The result was a project changing from being clearly R&D based on a commercial venture with ambitions to commercialise a brand concept.

Gunnar Hovland was hired as new director for Tine Biomarin at a point when Tine had invested a great deal in blue-green activities but without getting anything back. Although having a long-term perspective on these investments, it was time to start demonstrating some commercial potential. Around the same time, Swensen and the other researchers from the University of Life Sciences were hired by Tine R&D, and they soon found some common interests. Hovland interpreted his mission as being one **of "cleaning up the mess",** i.e., structuring and organising the activities more efficiently, and evaluating what to do next. With backing as well as pressure from the top management, Hovland now needed to prove the commercial value of the biomarine strategy before being able to expand.

In not knowing exactly what would happen, the project group feared Hovland's scepticism to the whole project; that he would chose to close it down as part of his task to restructure Tine's biomarine activities:

> I don't know if they were uncertain about whether they should close down the project or not, but that's how I experienced it. After awhile, they prioritised the project, and they made the decision to only use salmon. From my point of view, there were not very clear indications that pre-rigor was so much better. But it was promoted as if it had very big advantages. (Berit Nordvi, researcher , Tine R&D)

Hovland was introduced to the pre-rigor salmon, which triggered enthusiasm and new hopes for the Umi No Kami project, and it was decided to remove white fish from the recipe,

something the earlier project group had not been allowed to do by corporate management. The framework conditions had changed:

> It was from the top management, the framework conditions were changed so that when they took over the projects, they did not start from scratch, but they suddenly had a totally different set of conditions. Thus, they went for a new conceptualisation process, right, as they then only had salmon, they looked towards different markets. (Hilde Torvanger, Tine R&D/marketing)

How come the corporate management and board of Tine accepted these rather radical changes in an already expensive and so-far unprofitable project? How could they accept changing the framework conditions for the project? They went from a blended white and red fish recipe to pure salmon, from doing domestic marketing prior to international marketing to then launching internationally first, and eventually from organising everything internally at Tine (R&D) to spinning the project out in a joint venture with Bremnes Seashore. In addition to changes in the top management and the business unit management, a part of the explanation came from the emerging impatience from the owners and the top management towards the biomarine projects. This was not said very explicitly in public, but there were some signs of increasing pressure for commercial results, for producing some success stories to support the biomarine strategy, and for damming up for all above-the-line expenditures

Jan Ove Tryggestad, a membed of Tine's board of directors, could confirm my impression of 'the coup', and of impatience with the management regarding the Umi No Kami project. The impatience and uncertainty about the continuation of Umi No Kami had certainly become an issue in the top management at Tine. They were uncertain about whether and how the project should be pursued further. Hence, the shift was seen as a 'necessary change'. The board was impatient and frustrated over lack of progress. When the emerging new constellation gained strength, the story was effectively shaped on behalf of pre-rigor salmon as crucial for the quality and concept of the fish salami.

A second shift, following from the first, came after failing to sell the fish salami to various business customers (see above). Clearly disappointed by the lack of commercial progress, the owners at Bremnes gave a rough critique of the marketing and sales efforts of Tine Ingredients. A main reason for partnering with Tine had been the hope to get better prices on high volumes of their fish, and it took more time than expected to get there.

Visiting various marketing arenas, Kiland was continuously making sense of the project through meetings with customers, colleagues and partners. Sometimes he was almost doubtful about the potential for selling the sausage at all: "But think about it, would the sausage have been the product you would have started with?", and other times negotiating and doing sales presentations of the sausage to various actors from different countries. In his customer presentations he talked first about the superior pre-rigor salmon filets as a prerequisite for the salami, and thereafter presenting the salami. He felt that this worked betst, and he had a feeling that the raw material, the pre-rigor salmon filets, could be easier to market and sell.

The full story of this transition and the subsequent quite successful marketing of Salma Fresh will not be told here. To be very brief, the story – from a Tine perspective – is about an entire turnaround of the market strategy (again). The fresh loin, Salma Fresh, was first presented at local fishmongers in Oslo, but they were not at all interested in selling vacuum packed fish loins. Then Kiland brought his delicate packages of salmon loins to a high-end supermarket, Jakob's, and their fresh produce manager immediately caught interest. Within a couple of weeks they were ready for an introduction campaign in the store, which gave great sales at good prices for the new product. Jakob's was associated with Norway's larges retail chain,

Norgesgruppen, which also became very interested. Tine, as the dominant supplier of dairy products for almost a century, had close relationships to this retail corporation. Soon a roll-out plan was launched, first of launching Salma Fresh in another two supermarkets, Centra, before getting it out in a larger number of their 'Ultra' and 'Meny' supermarkets. At the same time, several gourmet chefs had found this to be a great raw material for their cooking, which ended up not only helping Tine with making marketing materials, but also putting Salma Fresh on their menus and serving as charismatic ambassadors for Salma. Suddenly, Salma was moving rapidly towards a great commercial success story. Now, the salami is never mentioned as part of the concept anymore, at least not in public. The crooked path towards this success story, whether on the Bremnes or on the Tine side is carefully deleted.

4. Analytical model

We suggest that innovation processes may fruitfully be conceptualised as a dual process: First, as a process of mobilising actor-networks, or getting the rights, alliances, space, time and resources to innovate, and second, of knowledge exploration in formulating and testing propositions about reality, which also means interacting because reality (people and things) often 'speaks back' (see figure 1). Thus, we get a bipolar model, in which the particular dynamics between the two poles of a concrete innovation process become a central part of explaining that case.

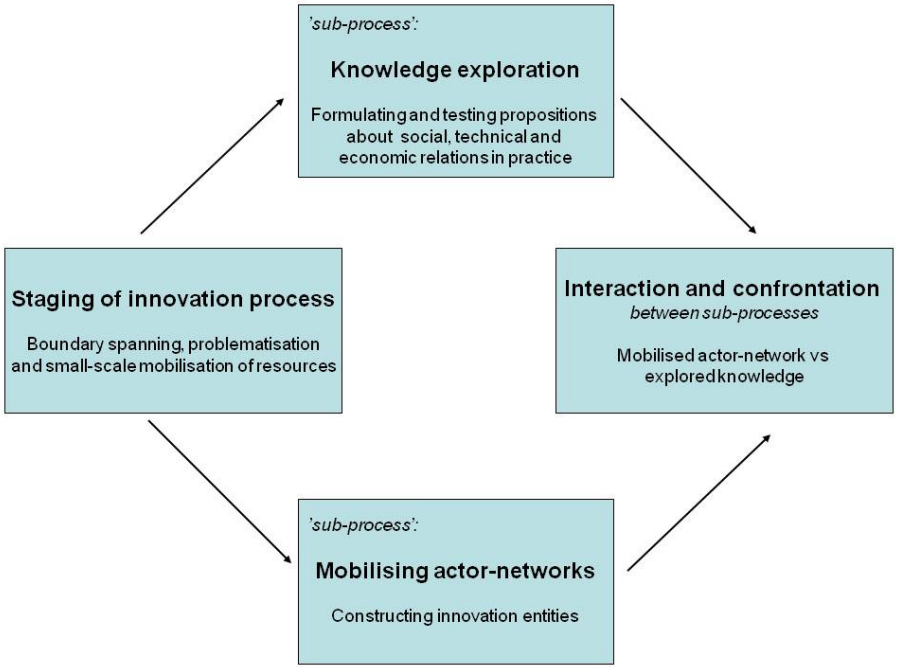

Figure 1: An interactive process model of how to study innovation processes as interaction in time between processes of mobilisation and exploration in a 'single' (although interconnected and heterogeneous) innovation process.

This dual process happens within a *network of interconnected processes*, which create resistances and constraints, as well as enablers for innovation in certain directions rather than others. It is clear from our empirical research that the processes of mobilisation and exploration are neither completely separate, nor completely intertwined. How and when these sub-processes interact, and the implication of this, seem to be important questions for understanding innovation processes. Sometimes these 'sub-processes' of the larger innovation process draw on each other. At other times they do not interact at all, and sometimes they come to confront each other – with potentially serious implications for the future of the innovation. From this model we get two different perspectives on the time (and timing) of

innovation processes: First, the time of a particular innovation process and its 'program of action' (strategy, interests, and the reach of its relationships). Second, the heterogeneity of time frames present in the larger network, related to all sorts of interacting processes (and their strategies, interests, and relationships), and to which the particular innovation process will have to connect in order to move towards realization. Thus, it becomes very clear how complex it may be to realize and stabilize innovations in (or even worse; across) industrial networks.

(Modellen under bør vel heller med I den empiriske framstillingen??)

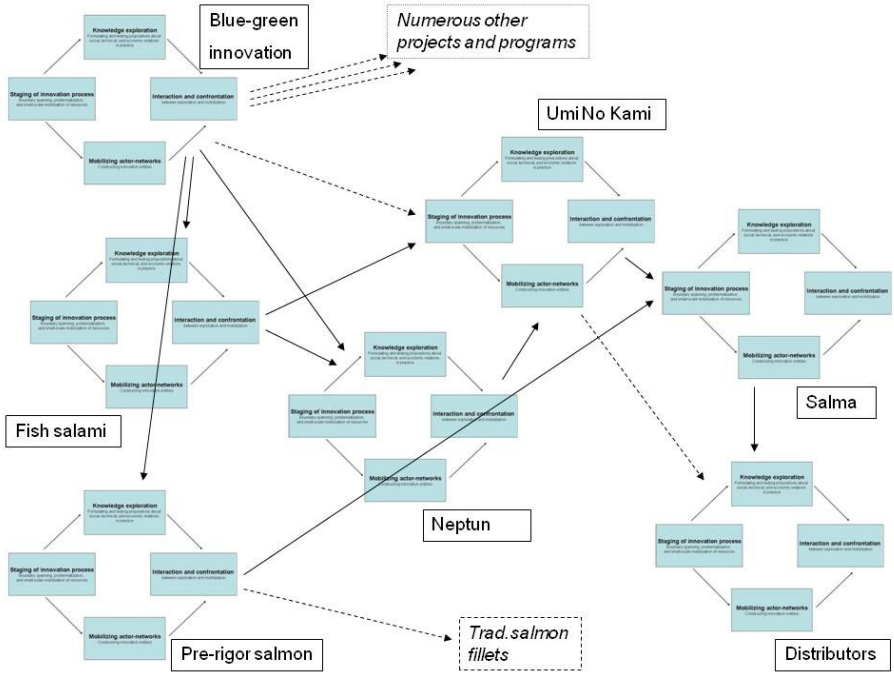

Figure 2: Innovation processes, situated in networks of interconnected processes.

The framework we suggest here did not come *before* the fieldwork; rather, it is an outcome of the combination of process-based theory and observations in the field, of recording and trying to discriminate between what kind of activities and 'sub-processes' are happening in practice, and pairing that with the logic of a relationalist and process view. Second, we will pull out some theoretical implications, suggesting how the study may contribute to and complement, theories of innovation processes.

Still, can a productive distinction be made between these two processes of mobilising actor-networks and knowledge exploration? Is not knowledge exploration also a matter of negotiating socio-material relations (as in mobilisation)? What then is the difference? Several of these activities, although analytically separable, are in reality interacting with each other. Mobilisation activities may have more or less immediate influence on the exploration, and vice versa. However, it takes different tools – skills, strategies and resources – to (1) recruit and mobilise elements, and (2) make them fit and hold together. The first, or 'mobilising actor-networks', typically consists of political activities/processes of (re-)presenting, convincing, forcing and negotiating. The second, or 'knowledge exploration', consists of knowledge generation. This involves the exploring and stabilising of relations between elements, such as ideas, materials, technologies and procedures; formulating propositions and testing them in practice. There are also differences in outcomes: Exploration/knowledge

generation tends to increase uncertainty, while mobilisation/power tends (if successful) to reduce uncertainty. Paradoxically, as the exploration process tends to produce multiplicity, ambiguity and thus choice, it demands, at some points, interaction with the mobilisation process.

When we use the terms 'process' and 'sub-process', we do not mean to say that there is an objective 'whole' that may be divided in distinctive parts. This is, as with most conceptual models and analytic frameworks, rather a matter of delimiting cases, research objects and research questions. What we call sub-processes in our case study may well have been parts of other processes too, serving other interests, and in fact this is part of our argument. The interconnecting (or embedding) of different processes with different time frames and different interests, is a crucial challenge during innovation processes. The model is depicting aspects of innovation *processes.* It is not referring to particular entities or actors but rather to kinds of activities and processes and their logics.

5. Interpretation of case and model:

Staging of innovation processes

The initiation of innovation processes, is what we call 'staging'. Something happens somewhere; someone asks a question, problematises something or incidentally discovers something. In the case study, we saw how new techno-scientific ideas emerged from curious experts (technologists, scientists, managers, etc) spanning the boundaries of their knowledge, facilitating interaction between actors and elements from different epistemic and/or industrial fields. An idea comes out of the meeting between different perspectives, different realities, different knowledge and experience. Often it is technologists seeking to supplement technologies for re-combination or seeking potential use for their inventions. Other times, it is marketers or customers that formulate a demand for a solution to a problem, or managers that seek to renew their organisation. What all such situations have in common for starting a process of realisation, is that the idea has to be brought to attention; creating interests and mobilising a minimum of time, space and resources. Sometimes it is necessary to stick with the initial question for a while before finding an opportunity to do something with it, that is, stage a process of exploration and mobilise resources (Spinosa et al., 1997). To cultivate the ability to formulate questions beyond the present knowledge domain and industrial path takes capacity for 'mindful deviation' (Garud & Karnøe, 2001).

Mobilising actor-networks

After formulating the question, putting it on the stage and creating some interest in it, the problem immediately arises of how to mobilise the time, space, actors and resources needed to start the exploration and realisation of the innovation. In the case, the professor partly had to show that there was something to explore there, through initial experiments and convincing presentations of the premature materialisation of the idea. Further, he had to enrol actors with money and expertise to participate in the further development, in this case by exploiting established relationships to people within funding bodies, a technology transfer office and at his present and previous research institutes. However, this was not a one time operation. Throughout the processes in this case study, the innovators repeatedly had to mobilise renewed support and more resources from their allies, and/or to find new partners. We also saw how a number of arguments were used, and how several actors were appointed as representatives for the project – or rather for the *potential* of the project. This is a pragmatic process; making the most of what you have when using it in convincing and negotiating to expand the actor-network and the access to resources. More or less coherent *chains of arguments* have to be constructed to mobilise time, resources and decisions. In addition, there

is the work of enrolling and aligning a set of actors and resources into an 'actor-network', making them represent and support the project, and keeping them interested over time, while doing the exploration work.

The immature object has to be taken through several translations; from idea, to prototype, to research application, to patent application, to product, to use and exchange, etc. This is partly depending on mobilisation; the construction of meaning and the mobilisation of chains of arguments: A technical recombination is possible – someone might be interested in using it in his/her practice – thus it could be exchanged for money.

Knowledge exploration

Exploration, on the other hand, is about testing whether these ideas and propositions hold in reality; is (or can we make) this technically feasible? Does it (or can we make it) fit within the distributor's product categories? Does it (or can we make it) fit within the using practices of consumers? How much are they willing to (or can we make them) pay for it?

When you actually have succeeded in mobilising some resources and convincing some people to give the idea a try, then you have to make it work in practice. This process of knowledge exploration[6], of 'making things work', involves a process of formulating and re-formulating propositions about the (potential) 'reality' of the innovation, and then testing it out in practice. It is a two step process: First, of creatively imagining potential social and technical relations, and then testing in practice if – and in what way – such relations are possible. An analogy to this process would be that of the scientific method, of formulating a research question, or a hypothesis, and doing practical empirical experiments to see if the answer to the question can be found, or if the hypothesis may stand the test. This is not a one-way street of an actor seeking to impose its his/her will on another, but rather an interactive, or, we could say negotiated, process. When testing a relationship between elements, e.g., between fish and fermentation culture, or between salmon products and users, the innovator enters her own picture, so to speak, and becomes involved with – and a part of – the object. Thus, not only is the innovator testing a relationship between elements, but the innovator herself experiences how the elements 'speak back', i.e. accepting some relations while rejecting others. Moreover, this testing of – and making of – relationships changes the innovation, often in unpredictable ways. Thus, although equipping the innovator with some creativity and agency, innovation as recombination of resources and restructuring of activity patterns is not a matter of unlimited agency of the heroic entrepreneur. The proposed relationships between technical, social and economic elements have to be tested and negotiated, and then reformulated and renegotiated, often several times between the involved parties. An unavoidable aspect of exploration is uncertainty. Precisely because exploration starts out with imagination, and because the objects being explored 'speak back' and bring in their own preferences, it is not possible to be sure whether – or how – the imagined recombination of elements could work. Knowledge exploration produces development risk, as there always will be uncertainties present, and in the case of more radical re-combinations, the number of such uncertainties causes indefinite development risk. This part of the innovation process is about developing 'chains of propositions' – from testing whether a technology is feasible, to testing whether such a product will find (paying) users and hence produce economic value.

[6] This term does not refer to James March' (1991) conceptual dichotomy of "exploration of new possibilities" and "exploitation of old certainties" related to organisational learning.

Interaction and confrontation of sub-processes

However, as mentioned previously, processes of mobilisation of actor-networks and knowledge exploration are not fully separable. Sometimes (but definitely not always) 'chains of power/arguments' (mobilisation) and 'chains of propositions' (exploration) interact with each other; borrowing elements from each other, or confronting each other's aims and outcomes. This does not happen continuously. After mobilising a set of actors and resources, and starting the exploration for shorter or longer periods, there may be no or little interaction with the mobilisation process and the original idea and intention. Parts of it may be involved in formulating and testing various propositions, while other parts are not. Yet, then, when resources run out and new resources have to be mobilised, for example, or when allies in the actor-network start getting impatient or are disappointed, the exploration process may be confronted for its lack of progress, its departure from the original vision or its need for reorienting towards enrolling other and different actors and resources. Such confrontations between the mobilized idea network and the actual exploration/realization process will often threaten the whole project, and if it is allowed to continue it is likely to change direction due to the renegotiations needed.

Discoveries and knowledge generated in the exploration process may challenge the mobilised actor-network to rethink and change their ideas, interests and participation, both allowing and supporting the project in exploring new directions and propositions. The ways in which such interactions and confrontations come about and what they lead to should be of particular interest to industrial/interactive innovation, as this would reveal some of the generative and limiting dynamics of innovation processes; where new meanings are negotiated, choices have to be made and new courses of action pointed out.

6. Theoretical implications

By constructing and amplifying the distinction between mobilisation and exploration in a bipolar model, we explain some of the micro-dynamics of innovation processes from an angle that, to the best of our knowledge, has not yet been sufficiently described in the literature.

First, during (sub-) processes of *mobilisation*, actor-networks are recruited and committed to things with which they are initially unfamiliar: An idea, a prospect or a prototype of something that may or may not become feasible and useable. Yet, to enable mobilisation, a degree of certainty has to be presumed. Second, during (sub-)processes of *knowledge exploration*, the aim is to create knowledge – to explore the object and its potentials – and therefore change is unavoidable. Moreover, this process of generating knowledge tends to multiply (alternatives of) the object, and hence increase rather than decrease the uncertainty/complexity – or development risk – of the project. Mobilisation and exploration are contrary forces in this model, and sometimes it appears almost like the innovation process is at war with itself. Whereas mobilisation is directed towards aligning interests and reducing risk, exploration is directed towards formulating and testing propositions about reality. While mobilisation seeks to converge, exploration frequently leads to divergence of the innovation. Finally, the *interaction* between mobilisation and exploration processes on the one hand, and between different actor-networks/organising processes on the other, often leads to controversies and compromises that may set the project off in new directions.

The presence of a number of uncertainties – 'nobody knows' problems – frequently produces high development risk in innovation projects. Although being experts in their respective fields, we argue that innovators' lack of knowledge pertains to the connection and translation of knowledge and technology between settings. Putting knowledge, and the lack thereof, at

the centre of attention, the framework suggests that innovators have to produce two different kinds of knowledge: First, a chain of arguments suited for convincing, mobilising, maintaining and removing (parts of) actor-networks and their resources. Second, they need to produce testable propositions about reality, e.g. of how to make the technology work and what users having interest in such a product. Innovation processes are propositional at their core. The original idea is a proposition about the potential that stems from a new combination of elements. This idea needs some resources to get started, and then the idea needs to be explored in practice – testing whether and how the proposition may hold. This will normally happen by breaking the original idea into a series of new and 'smaller' propositions; as the innovation is opened up and investigated, it is revealed as a more or less complex set of problems, all having many different solutions *in potentia*. However, in order to enrol allies, it is necessary to make the idea and concept converge on a number of aspects, and this will often create a 'lock-in' for the for the subsequent process – at least for a period of time.

In this article we argue that power to mobilise elements and decisions for innovation is produced by constructing a (more or less coherent) chain of arguments. In other words, mobilisation of actor-networks is based on a relational logic of 'power production', i.e., of carefully building (or connecting to) networks of human and non-human elements with interests in realising the innovation. Hence, constructing an actor-network around a new idea is an exercise in creative connecting of actors, networks, resources and ideas. In this sense, this part of the process is more or less ignorant towards 'truth'; rather, it is about producing power effects, i.e., mobilising actors and resources on behalf of the innovation, and translating their interests into a common project. Still, if and when an actor-network is mobilised, the elements employed in the chain of arguments may produce frames and evaluation principles that define the room for action in the project. Hence, temporal lock-ins may be enforced that can not easily be broken out of in the subsequent parts of the innovation process.

We will argue for the *exploitation of uncertainty* in interaction between (potential) allies in efforts to stage and mobilise resources for innovation. The existence of knowledge 'fields' and 'practices', as well as 'frames of reference', means that different actors have different experiences and expertise related to the characteristics (and potential) of the elements recombined into a new idea. Moreover, different actors are situated within different sets of relationships. However, few – if any – know what it takes to relate previously unrelated elements to each other. We argue that there are three aspects of the relationship between lack of knowledge and the mobilisation of actors and resources for realising innovative ideas (the building of actor-networks) that need to be explicated: First, asymmetrical knowledge and experience may be used during interaction to exploit the other. In the process of building arguments to convince others on behalf of an innovation, presumptive competent actors are mobilised to represent the innovation as something worth pursuing. Second, manipulation based on asymmetrical knowledge consists of mobilising apparent authority. Hence, if more 'radical' ideas will be impossible to evaluate in objective terms, those with more experience with (some of) the elements involved might be able to exploit actors with less or other types of experience. Choices regarding innovative ideas always have to be made based on limited knowledge.

Uncertainty, or the lack of knowledge, in innovation is a problem calling for 'exploration'; an active learning process. Exploration is the process of actually testing and developing the innovation. Such exploration processes are typically about imagining and formulating testable solutions, e.g., in the form of theories or propositions for problems of a technical, social and/or economic character, and then testing these solutions in practice. The exploration

process, of knowledge generation through proposing, testing, interacting and adapting (aspects of) the innovation, is supposed to move asymptotically towards solid knowledge. The paradox is that while the aim of exploration processes is to produce knowledge, they (almost) always produce complexity; multiplicity, ambiguity, choice. Even if sometimes the knowledge generating process succeeds in providing clear and singular answers, most of the time the object and its complex of (potential) relations in this case study expanded during exploration. I argue that this partly has to do with the innovation, at least in its early phases, being unstable within several dimensions, and that its stabilisation requires exploration of a number of interconnected issues. In addition, when experts start investigating an idea, making it into an 'epistemic object' (Knorr Cetina, 2001), it opens up and becomes a complex of interesting problems and opportunities. Paradoxically, in industrial settings exploration is a process aiming for expanding and generalising the concept, often involving hypotheses about appropriation and economies of scale. The innovation has to be brought towards stabilisation as a general concept and thus possible to scale up. This presupposes that the concept is tested in practice, that it shows that it holds. From this I suggest some theoretical implications of the knowledge exploration (sub-)process.

A main point in our analytic scheme is that processes of mobilisation and exploration not always interact. Sometimes they are not coupled at all, and when they do interact, tensions, confrontations and conflicts are often produced. We suggest that the reason for this is that the exploration process, of generating knowledge, challenges the mobilisation process that is already established, and creates a dynamic that may either strengthen the emerging path, or undermine and destroy it, or even lead to the establishment of new path creation processes entirely. Often, learning leads to departing from the original idea, which may create a mismatch to the extent that a battle for the future direction is unavoidable. Therefore, interaction avoidance seems to be a common challenge of innovation processes, basically stemming from the need to handle and reduce the divergent and expanding aspect of exploration. We argue that actors tend to avoid interacting with others during exploration processes because of the risk of being influenced. Moreover, that the battles that innovators take are only the ones they think they can win. We also saw in the case study that after a successful mobilisation, the resulting framework is kept tight until new confrontations and reconfigurations enforce or enable renegotiation either of the framework conditions or of the actual innovation.

Not only are (sub-)processes of innovation (sometimes) interacting, the innovation process is also interacting with a number of other actor-networks in a network of interconnected processes, thereby considerably increasing the complexity and uncertainty. We suggest that, from a process perspective, path dependence is better seen as relatively slower processes, maintained via carefully and often long-term assembled and intertwined networks of heterogeneous elements. Movement in such embedded networks create friction, which is a creative and destructive force, privileging continuations and incremental changes of the existing practice. This view of path dependence explains some of the slowness and some of the unexpected outcomes of innovation processes: (1) why innovation processes tend to take significantly more time than expected, and (2) why 'successful' innovations often are realised as incremental changes or additions to the existing set of relations.

Further, building the innovation into commercial relations is likely to de-stabilise it and produce new phases of development, of mobilisation and exploration. Hence, finding or creating *use* for the innovation in other actor-networks means that the innovation needs renegotiation. As mentioned previously, confrontations between mobilisation and exploration

are often destructive, thus actors seek to avoid involving themselves in more relations than necessary, and simplifications of networks might be necessary. And, while sometimes necessary, this reluctance to interact may again lead to sub-optimal mobilisation or exploration. When partially stabilised innovations (and their internal propositions about users) are tested with potential users, new propositions and adaptations of the established will arise, and thus lead to new development phases and new selection processes. In order to minimise such challenges, and thereby reducing development costs, businesses are forced into radical simplification of the innovation and its network, and adaptation to what already exists.

7. Conclusions

In sum, we maintain that this study have contributed to our understanding of industrial innovation processes by challenging and complementing perspectives of punctuated learning (Van de Ven et al., 1999), path creation (Garud & Karnøe, 2001), market making (Kjellberg & Helgesson, 2007 a,b; Araujo, 2007) and user-producer interaction (Håkansson & Waluszewski, 2007; Oudshoorn & Pinch, 2008). The analytic model and subsequent theorising is consistent with the methodology of actor-network theory, while also drawing on the insights of the mentioned perspectives. However, it differs from many actor-network theory accounts and conceptions in its attempt at handling industrial innovation, rather than science and technology development. It also differs from the related emerging sociology of finance (Callon, 1999; Knorr Cetina & Preda, 2004) in dealing with 'less pure' settings. I have emphasised the controversies of innovation; both within the process itself, and between the innovation process and its related network of interconnected processes.

There has been a call for studies of innovation processes in organisation and management research for the last 25 years, and yet our understanding of innovation processes is still limited. Although researchers like Kline and Rosenberg (1986) and Van de Ven et al. (1999) have pioneered the field through empirically and analytically rigorous studies, the topic is still far from illuminated in all its complexity. Similarly there has been recent calls for process studies of organisation (e.g. Tsoukas & Chia, 2002; Van de Ven & Poole, 2005), even though researchers like Weick (1979) radically challenged the field with his process based view 30 years ago. We suggest that ethnographic and comparative ethnographic case studies represent a great potential for contributing to these fields of research.

First, we suggest that there is a need for testing and tuning process based models, like the one presented in this thesis, in more settings. It could be tested in studies of innovation processes on more 'strategic levels' of organisations, such as the overall development of innovation strategy in the Tine corporation. Another route would be to use the model for research within various other industries, enabling testing the relevance of the model as well as comparison of innovation processes across industries. Furthermore, the relevance of the model in settings of (1) service innovation, and (2) entrepreneurship has not been discussed in this thesis, and we would be curious about the differences that would appear if this was done.

Second, we think that the insights produced from the analysis of the case study in this thesis are not exhaustive. At this level of detail in the empirical descriptions, more could be gained than I have been able to do in this project. In particular, I suggest that it would be interesting to identify more of the various strategies used for coping with the controversy and interaction (1) between the mobilising of actor-networks and the exploration of knowledge, and (2) between the innovation process and the network of interconnected processes in which it is situated.

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