

A cognitive and pragmatic account of innovation: domesticating the probiotic Gefilus in Finland

Nina Janasik

A cognitive and pragmatic account of innovation: domesticating the probiotic GEFILUS in Finland

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Abstract

The aim of this dissertation is to study the ways in which new products gain their distinct identity, or their individuation—i.e., the process of change from an ‘imitator’ to an ‘independent product’. Although this process occurs with regard to all innovations, it has not been problematized as a theme in its own right. The dissertation explores this topic through a case study of the probiotic Gefilus innovation in Finland during the period from 1987 to 1997. The research performed in this dissertation is qualitative. The dissertation provides a cognitive and pragmatic account of the ways in which new products gain their distinct identity among consumers. It thereby provides a complementary perspective on existing research on product identity formation.

Individuation forms a part of the larger process of domestication, or the active process of making an unfamiliar new object one’s own that the consumer is assumed to perform when consuming goods. Recently, consumer research has been enriched by socio-cognitive explorations from the tradition of science and technology studies (STS). The dissertation continues this line of socio-cognitive research by inquiring into the more specific ways in which both the intended and real a) object and b) image of such new and unfamiliar products are shaped during the process of individuation. The main analytical tool in this inquiry is the framework of conceptual blending. To this cognitive exploration, the dissertation also adds a pragmatic and organizational line of inquiry. In particular, it suggests that certain ways of organizing collaboration across knowledge borders are particularly well suited for addressing challenges related to the individuation of new products, and that such pragmatic and organizational aspects therefore also need to be taken into consideration.

The key finding of the dissertation is that the individuation process of the probiotic Gefilus innovation involves the introduction of hierarchy, i.e., a distinction between first-order and second-order imitation. At the first level, the Gefilus innovation imitated other products of the same kind, such as yoghurt and cultured buttermilk. At the second level, however, it imitated other products belonging to the category of functional foods, such as the cholesterol-lowering margarine Benecol. The case study shows that this introduction of hierarchy occurred as a response to an impossible situation of institutional contradiction or ‘torque’, and that it represents a creative, as opposed to destructive, way of exiting such situations. The case study also shows that the introduction of hierarchy forms a central part of the explanation of the unfolding of the Gefilus domestication process.

Keywords Probiotic innovation, domestication, individuation, cognition, organization, learning, conceptual blending

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Tekijä

Nina Janasik

Väitöskirjan nimi

Innovaation kognitiivinen ja pragmaattinen analyysi: probioottisen Gefilus-tuotteen kotiuttaminen Suomessa

Julkaisija Insinööritieteiden korkeakoulu**Yksikkö** Yhdyskunta- ja ympäristötekniikan laitos**Sarja** Aalto University publication series DOCTORAL DISSERTATIONS 52/2011**Tutkimusala** Tieteen- ja teknologiantutkimus, kuluttajatutkimus**Käsikirjoituksen pvm** 31.05.2010**Korjatun käsikirjoituksen pvm** 23.05.2011**Väitöspäivä** 08.07.2011**Kieli** Englanti☐ **Monografia**☒ **Yhdistelmäväitöskirja (yhteenveto-osa + erillisartikkelit)****Tiivistelmä**

Väitöskirjan päämääränä on tutkia tapoja, joilla uudet tuotteet saavuttavat omanlaisensa identiteetin eli uusien tuotteiden eriytymistä, joka on muutosprosessi 'matkijasta' 'itsenäiseen tuotteeseen'. Vaikka jokainen uusi tuote käy läpi tämän prosessin, sitä ei ole laajasti käsitelty omana itsenäisenä teemanaan. Väitöskirja tarkastelee eriytymisen teemaa tapaustutkimuksen kautta, joka on probioottisen Gefilus-innovaation kotiuttaminen Suomeen vuosina 1987-1997. Väitöskirjassa on käytetty kvalitatiivisia tutkimusmenetelmiä. Väitöskirjassa esitetään kognitiivinen ja pragmaattinen näkökulma siihen, miten uudet tuotteet saavuttavat itsenäisen identiteetin kuluttajien keskuudessa. Väitöskirja tarjoaa täten täydentävän näkökulman olemassaolevaan tutkimukseen tuoteidentiteettien muodostumisesta.

Eriytyminen muodostaa osan laajemmasta kotiuttamisen eli kesyttämisen prosessista. Viimeksi mainittu määritellään usein kuluttajan toimintana, jossa hän kuluttaessaan omaksuu vieraan tuotteen ja tekee siitä itselleen tutun. Viime aikoina kotiuttamistutkimusta on rikastuttanut sosiokognitiivinen lähestymistapa tieteen- ja teknologiatutkimuksen alueella. Väitöskirja jatkaa viimeksi mainitun tutkimustradition piirissä tehtyä työtä tarkastelemalla, miten tällaisten uusien ja vieraiden tuotteiden suunniteltu ja todellinen a) objekti ja b) idea muovautuvat eriytymisprosessin aikana. Tutkimuksen pääasiallinen analyttinen työkalu on alun perin kognitiivisen kielitieteen alueella kehitetty käsitteellisen sekoittumisen (engl. conceptual blending) viitekehys. Tähän kognitiiviseen tarkasteluun väitöskirja lisää myös pragmaattisen ja organisaationaalisen tarkastelulinjan. Väitöskirjassa ehdotetaan, että jotkut tavat organisoida yhteistyötä yli tiedollisten rajojen ovat erityisen sopivia vastaamaan uusien tuotteiden eriytymiseen liittyviin haasteisiin.

Väitöskirjan keskeinen löydös on, että probioottisen Gefilus-innovaation eriytymisprosessi sisältää hierarkian, ts. erottelun ensimmäisen ja toisen tason imitaation välillä. Ensimmäisellä tasolla Gefilus-tuote matki muita samantyyppisiä tuotteita kuten jugurttia ja piimää. Toisella tasolla se matki muita funktionaalisten elintarvikkeiden kategoriaan kuuluvia tuotteita kuten kolesterolia alentavaa Benecol-innovaatiota. Tapaustutkimus osoittaa, että kyseinen hierarkia ilmaantui vastineena mahdottomaan institutionaaliseen ristiriitaan, ja että se oli rakentava ulospääsy tämänkaltaisesta tilanteesta. Tapaustutkimus osoittaa myös, että hierarkian ilmaantuminen selittää keskeisesti Gefilus-kotiuttamisprosessin kehityksen luonnetta.

Avainsanat Probioottinen innovaatio, kotiuttaminen, eriytyminen, kognitio, organisaatio, oppiminen, käsitteellinen blending

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Contents

Acknowledgements	2
List of original publications	4
List of tables and figures	5
Glossary	6
1. Introduction	9
2. Data and methods	19
2.1 Empirical data	19
2.2 Methods	22
3. Theoretical resources for studying individuation	28
3.1 Consumer research	29
3.2 Science and technology studies (STS)	34
3.3 The conceptual blending framework	42
3.4 Knowledge networking: a pragmatic approach	46
3.5 Practices, people and communities	54
4. Empirical analysis of the Gefilus innovation process	62
4.1 Blending for individuation: conceptual integration networks	62
4.1.1 The object of the Gefilus innovation	63
4.1.2 The image of the Gefilus innovation	69
4.1.3 Summary	76
4.2 Organizing for individuation: knowledge networking	77
4.2.1 The object of knowledge networking	77
4.2.2 Individuation as problem-solving	69
4.2.3 Summary	76
5. Conclusions and discussion	83
5.1 The cognitive perspective	84
5.2 The pragmatic approach	89
5.3 Alternative methods	91
References	96
Appendix 1 Semi-structured interview schema for knowledge networking	109
Appendix 2 Guidelines for knowledge networking case studies	112

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For years, I have decorated my usually rather small office space with a postcard saying, “Happiness is not the goal; it is the path towards the goal”. Judged by this Aristotelian standard, although perhaps not always by others, I can confidently say that I have been very happy while writing this dissertation.

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List of original publications

- Paper I Bruun, H., Langlais, R., and Janasik, N. 2005. Knowledge networking: A conceptual framework and typology. VEST 18(3-4): 73-104.
- Paper II Langlais, R., Janasik, N., and Bruun, H. 2004. Managing Knowledge Network Processes in the Commercialization of Science: Two probiotica discovery processes in Finland and Sweden. Science Studies 17(1): 34-56.
- Paper III Janasik, N. Forthcoming. Learning to Match: User-producer integration and blending in the probiotic Gefilus innovation process. International Journal of Learning and Change. 17 pages.
- Paper IV Janasik, N., Honkela, T., and Bruun, H. 2009. Text Mining in Qualitative Research Application of an unsupervised learning method. Organizational Research Methods 12(3): 436-460.

Contributions of the author

Paper III is solely the work of the author. In **Paper IV**, the author was responsible for formulation of the argument, the theoretical review, the qualitative part of the analysis, and for the conclusions and implications. In **Paper II**, the author was responsible for the empirical analysis of one of the article's two cases, and for formulating the conclusions and implications. In **Paper I**, the author was a co-developer of the conceptual framework and provided, based on the work performed in Paper II, one of the article's three empirical case illustrations.

Nina Janasik's contribution to the co-authored articles verified by:

Tapio Luttinen
Professor

List of tables and figures

Table 1. An overview of the four original papers of the dissertation.

Table 2. Qualitative data sources used in the dissertation.

Table 3. Scenarios of use as envisioned by Konrad (2008).

Table 4. The characteristics of two knowledge frameworks (KF) that competed with each other within Valio, a large Finnish dairy company, in the late 1980s and early 1990s.

Table 5. Probiotic scenarios of use 1905-1996.

Table 6. Gefilus sales figures in comparison with sales figures for similar ‘first-level’ products (cultured buttermilk and milk).

Table 7. Gefilus cultured buttermilk in comparison with total sales for cultured buttermilk in Finland 1992-1997.

Table 8. The process of knowledge networking in the case of Gefilus.

Table 9. Mode of domestication vs. problem type.

Figure 1. Multiple perspectives on an object of inquiry from the point of view of theory-driven vs. data-driven approaches and qualitative vs. quantitative methods.

Figure 2a-c. The communicative structure of three modes of knowledge networking: modular, translational and pioneer knowledge networking.

Figure 3. A conceptual framework linking innovation management and NPD.

Figure 4. A network model of NPD.

Figure 5. The conceptual integration model.

Figure 6. The 1996 marketing campaign.

Figure 7. The ‘Bacteria to the Rescue’ blend.

Figure 8a-d. The product category vs. product situation in 1990.

Glossary

Accommodation: process in which the introduction of a new product into symbolic webs of meaning and material constellations of goods shakes those webs and constellations profoundly

Appropriation: the aspect of consumption in which socially located individuals accept enough of the relevance of the publicly defined meaning of some good to their own circumstances to buy and accept the new good into their domestic environment

Assimilation: process in which the introduction of a new product into symbolic webs of meaning and material constellations of goods merely substitutes another product without much change occurring in either the symbolic webs of meaning or the material constellations of goods

Blend: new conceptual structure in working memory produced by the process of blending conceptual and/or material elements from separate input spaces

Bottom-up qualitative research: qualitative research characterized by sensitivity to actual usage of terms and categories, as well as to actual practices

Conceptual blending: process of conceptual mapping and integration that by its proponents (Gilles Fauconnier and Mark Turner) is claimed to be *the* generic way of arriving at conceptual novelty

Conversion: aspect of consumption which reconnects the household into the public world of shared meanings; signals the importance of the need to legitimate one's participation in consumer culture in the display of competence and ownership

Commodification: the industrial and commercial processes that create both material and symbolic artifacts and turn them into commodities for sale in the formal market economy

Connectionism: set of approaches in the fields of artificial intelligence, cognitive psychology, cognitive science, neuroscience and philosophy of mind, that models mental or behavioral phenomena as the emergent process of interconnected networks of simple units

Domestication: the active process of making the unfamiliar one's own ('taming the wild') that the consumer is taken to perform when consuming goods

Double-loop learning (deutero-learning): second-order learning, or learning at a higher level of logic which gives a context for learning at the first level

Functional food: food that is satisfactorily demonstrated to affect beneficially one or more target functions in the body, beyond adequate nutritional effects, in a way that is relevant to either improved state of health and well-being and/or reduction of risk of disease

Generic space: the space, in the framework of conceptual blending, that contains the conceptual structure that two or more input spaces to the process of blending have in common

Ill-defined problem: a complex problem that does not supply all the information required for the solution of the problem, and that has unspecific criteria for knowing when it is solved

Incorporation: aspect of consumption which refers to the process of the new product finding its place in a pattern of domestic use in domestic time

Incremental innovation: a new product, service, or technology that modifies an existing one in a process of gradual development

Individuation: name given to processes whereby the undifferentiated tends to become individual

Input space: bounded conceptual space in working memory with elements that function as input to the creative process of generating new conceptual structures

Knowledge networking: pragmatic approach developed within organization studies to capture the challenges arising from collaboration across knowledge-related boundaries; describes ways in which bodies of knowledge are interconnected

Lactobacillus: a gram-positive rod-shaped bacterium that produces lactic acid, especially in milk

Modular knowledge networking: knowledge networking mode that organizes learning and knowledge generation through two levels: Level 1 consisting of separate and independent modules of learning and knowledge generation, and Level 2 consisting of an integrating function

Objectification: aspect of the process of appropriation, in which a new product is made to fit in the pre-existing culture

Pioneering knowledge networking: knowledge networking mode based on the participants transcending their own knowledge frameworks, generating and integrating knowledge through direct communication across framework boundaries without any mediators

Probiotic: a live microbial food or feed supplement which beneficially affects the host animal by improving its intestinal microbial balance

Radical innovation: a new product, service, or technology that completely replaces an existing one often in a process of rapid upheaval

Scenario of use: the conceptual or fictive scenarios as imagined by designers, users or other actors involved in the development, production and diffusion of a new socio-technical system

Self-Organizing Map: a type of artificial neural network that is trained using unsupervised learning to produce a low-dimensional, discretized representation of the input space of the training samples, called a map

Singularization: process in which individuals make goods unique, special and non-tradeable by tying them to their own specific classifications

Structural mapping: a mapping of knowledge from one domain (the base) into another (the target) which conveys that a system of relations which holds among the base objects also holds among the target object

Top-down qualitative research: qualitative research characterized by use of pre-fixed categories and concepts in approaching the field

Translational knowledge networking: knowledge networking mode that has a standardized, mediating code that translates the language of particular knowledge frameworks into a language that can be understood by all

Unsupervised learning: paradigm in machine learning and statistical data analysis in which the system is given a collection of inputs and it creates a model of these without external supervision; may give rise to novel model constructions autonomously emerging from the data

Well-defined problem: situation in which the initial problem is clearly stated, the appropriate operators are easy to identify, and criteria for regarding the problems as solved are unambiguous

1. Introduction

Ever since the publication of Douglas and Isherwood's classic *The World of Goods: Toward an anthropology of consumption* in 1979, consumer researchers have taken for granted the thought that commodities form a system of meaning in which the parts get their meaning only from the whole. Douglas and Isherwood write: 'The goods are both the hardware and the software, so to speak, of an information system whose principal concern is to monitor its own performance' (1979: 49). When new products enter such socially knitted webs of meaning, they have to somehow 'fit' into them in order to be intelligible. This fitting process can take a number of shapes. Pantzar (1993, 1995), for instance, suggests that there are 'possibly two almost completely different ways in which innovations enter into everyday life: accommodation vs. assimilation' (1995: 21). In assimilation, a new product merely substitutes another product without much change occurring in either the symbolic webs of meaning or the material constellations of goods. This was the case, for example, when margarine substituted butter as the main form of spread for Finns during the last century (Pantzar 1995). In contrast to this mode of entry, in the process of accommodation 'the old interactive systems of commodities are shaken profoundly' (1995: 21). A paradigmatic example of this second mode of entry is the introduction of electric light in the US during the 19th century (e.g., Bazerman 1999; Hargadon and Douglas 2001; see also Veryzer 1998a, 1998b).

The aim of this dissertation is to study the ways in which new products gain their distinct identity, or their *individuation*—i.e., the process of change from an 'imitator' to an 'independent product' (Pantzar 1995). Although this process occurs with regard to all innovations, independently of their degree of radicality, it has not been problematized as a theme in its own right. The dissertation explores this topic through a case study of the probiotic GEFILUS innovation in Finland during the period from 1987 to 1997. The research performed in this dissertation is qualitative, i.e., it is based on interviews and document analysis. The dissertation provides a cognitive and pragmatic account of the ways in which new products gain their distinct identity among consumers. It thereby provides a complementary perspective on existing research on product identity formation.

Interestingly, then, both the 'incremental' innovation of margarine and the 'radical' innovation of electric light seem to involve essentially the same tradeoff between similarity and difference. For margarine: 'Through the substitution process margarine changed from being an imitator to being an "independent" product that is associated today with radically different imagery from that of butter'

(Pantzar 1995: 22). For electric light: ‘for its initial success, Edison’s system of electric lighting depended on the concrete details of its design to invoke the public’s familiarity with the technical artifacts and social structures of the existing gas and water utilities, telegraphy, and arc lighting. Although this familiarity provided the public with the means for quickly understanding the value of his new system and how to interact with it, Edison’s system of lighting ultimately was able to displace many of those established institutions and become itself the model for successive ones’ (Hargadon and Douglas 2001: 476). The *domestication* (Silverstone and Haddon 1996; Lie and Sørensen 1996; Pantzar 1993, 1995) or ‘taming’ of a new product into an existing system of cultural meanings would thus appear to always involve some kind of *tradeoff or balance between similarity* or recognition of familiar traits on the one hand, *and difference* or the perception of unfamiliarity, on the other. Institutional analysts Hargadon and Douglas (2001: 478) have phrased the core of the issue succinctly:

Purely novel actions and ideas cannot register because no established logics exist to describe them. Instead, such innovations fail to be adopted because they go largely unnoticed and unvalued. This presents a dilemma. Without invoking existing understandings, innovations may never be understood and adopted in the first place. Yet by hewing closely to existing institutions, innovators risk losing the valued details, representing the innovation’s true novelty, that ultimately change those institutions. Success, then, requires entrepreneurs to locate their ideas within the set of understandings and patterns of action that constitute the institutional environment in order to gain initial acceptance, yet somehow retain the inherent differences in the new technology that ultimately will be needed to change those institutions.

The dilemma is well known also in consumer research (e.g., Douglas and Isherwood 1979; Miller 1987; Leiss, Klein and Jally 1986; Pantzar 1993, Niva 2006, 2008) and in science and technology studies (e.g., Star and Griesemer 1989; Akrich 1992a, 1995; Callon 1991; Carlson 1992; Latour 1992; Konrad 2008). The fact that all comprehension of novelty some way or the other goes via the already familiar is also known in anthropology, where, for instance, Powers and Powers (1984) have described how a peach was first described as a ‘hairy apple’ among the Oglala people. However, although the general form of the dilemma is well conceptualized, and there are a multitude of empirical studies touching upon the dilemma in some form or the other (e.g., Akrich 1992a; Hyysalo 2006, 2010; Konrad 2008; Lehenkari 2003), the *process* of what I will here coin ‘*individuation*’ of products—i.e., the process of change from ‘*imitator*’ to ‘*independent product*’—that seems to be involved in *all* innovation, has not been explicitly addressed as a theme to be

problematized in its own right. Explicitly addressing this topic and exploring it through a case study of domestication of the probiotic Gefilus innovation in Finland during the time period from 1987 to 1997 is the main task of the current dissertation.

The terms *domestication* and *appropriation* are often used interchangeably to denote the active process of making the familiar one's own that the consumer is assumed to perform when consuming goods (Silverstone and Haddon 1996, Pantzar 1996; Niva 2006, 2008). Researchers within this tradition emphasize that domestication involves 'taming the wild'—and often both exciting and frightening—and bringing it to the 'cultivated' sphere of existing meanings (e.g., Silverstone and Haddon 1996; Pantzar 1995). Domestication usually takes place of objects or *artifacts*. However, recently Shove and Pantzar (2005: 45) have argued that such analyses of the ways in which things are acquired, appropriated and used 'routinely fail to capture the extent of what is involved', and that the unit of domestication therefore should be not only the material object in itself, but the whole practice of using that particular object. This practice involves the 'active integration of materials, meanings and forms of competence' (2005: 45) and analyses of processes of domestication should accordingly pay attention to all of these elements. Whereas domestication is an established term, *individuation*, understood as a process that is part of what is involved in making objects (and images and techniques) familiar, is a term that I have introduced myself in order to capture the way in which a product (and image and technique) moves via imitation of something already familiar to acquire a distinct product (image, technique) identity of its own. In light of the view presented by Shove and Pantzar (2005), then, *all* components of a practice need to go through this kind of individuation process as part of the overall process of domestication.

In their article, Shove and Pantzar (2005) analyze the ways in which Nordic walking, a form of 'speed' walking with two sticks, was successfully domesticated in Finland but has to date failed to integrate into the UK context. They thus compare a success and a failure. In this dissertation, I will study the domestication process of Gefilus from the point of view of individuation. This process is particularly appropriate for studying the issue because of the problems that the producer, the Finnish dairy company Valio, encountered along the way: first, they failed miserably in 1990, and then they succeeded beyond expectations in 1996. Here, then, we have both failure and success in one and the same process. The Gefilus innovation process started in 1985, when a new strain of *Lactobacilli* was discovered by Dr. Sherwood Gorbach and Dr. Barry Goldin in Boston (Gorbach 1996). A lactobacillus is any long, slender, rod-shaped, anaerobic bacterium of the genus *Lactobacillus* that produces large amounts of lactic acid in the fermentation of carbohydrates,

especially in milk. Gorbach had been searching for years for a *Lactobacillus* strain that would attach itself to the human intestine. The new strain, named *Lactobacillus rhamnosus* GG (hereafter: LGG) was finally found to be promising. A US patent application was filed in 1985 and granted in 1987. Meanwhile, in Helsinki, Finland, Valio was searching for scientific advances. The R&D director Kari Salminen soon learned of LGG and contacted Gorbach and Goldin. By January 1987 the company had negotiated a licensing agreement with these scientists. In 1990, the first products – a whey drink and a natural set-type¹ yoghurt – were launched in Finland, under the Gefilus® trademark.² However, these products had little initial success and in 1996, after a series of product changes, another attempt was made. On this occasion it was a success.

In principle, there is nothing peculiarly different with the Gefilus innovation as compared to other ‘functional food’ innovations³. Being a ‘hybrid’ (Lehenkari 2003) between food and medicine, it faced the same kind of individuation challenge as all other unfamiliar products during processes of domestication. Also, as was to be expected, the domestication process (reported in Paper II and III) exhibits ‘organizing processes with elements of assimilation and accommodation’ (Pantzar 1995: 21). However, from the point of view of individuation the Gefilus domestication process does show some peculiar patterns that have not been observed in the literature on the domestication of innovations, particularly in consumer research and in science and technology studies (STS), the two main audiences of this dissertation.⁴ More specifically, the domestication process exhibits four distinct phases: 1) 1990 – The Gefilus product is introduced in a form that is so different from all other products that almost nobody knows what it is all about (too different; market failure). 2) 1992 – The Gefilus product is re-introduced in a form that is so much like other products that only some people manage to see how it is different from those other products (too similar; only partial success). 3) 1995 – The Gefilus product is re-introduced in a form that is even more similar to already known products (too similar; very limited success). 4) 1996 – The Gefilus product is re-introduced in a form that is almost identical to another Finnish ‘functional food’ product, the cholesterol-lowering margarine Benecol by the Raisio food company, that has been successfully

¹ Set-type yoghurt is produced when the yoghurt is fermented directly in the cup and not in e.g. containers. The yoghurt is solid. It contrasts with stirred-type yoghurt.

² Gefilus® and LGG® are both trademarks registered to Valio Ltd.

³ An often quoted definition of functional food is the following: ‘A food can be regarded as functional if it is satisfactorily demonstrated to affect beneficially one or more target functions in the body, beyond adequate nutritional effects, in a way that is relevant to either improved state of health and well-being and/or reduction of risk of disease. A functional food must remain food and it must demonstrate its effects in amounts that can normally be expected to be consumed in the diet: it is not a pill or a capsule, but part of the normal food pattern.’ (Diplock et al. 1999)

⁴ Another literature of relevance for these issues is the literature on institutions and institutional change, of which the above quoted Hargadon and Douglas (2001) are an exemplification. I will, however, only briefly touch upon this.

introduced to the Finnish market the year before (balance between similarity and difference; market breakthrough). What is happening here?

Already from this brief description, it seems probable that from the point of view of individuation, some kind of process of active variation of product characteristics has taken place with regard to achieving the required balance between similarity and difference. However, it was not a 'straight' process of learning to finding the 'right' mode of entry (for example, realizing that the Gefilus product could not, due to its nature as a 'hybrid' between food and medicine, be domesticated by assimilative strategies only, but that more elements of accommodation are needed; and then learning to proceed this way, whatever that would have meant in practice). What we have here instead is a strange *mimetic* or *mirror-like twist*: In the fourth phase, the Gefilus innovators, who have been trying for five long years to solve the individuation problem on their own, see that the *Benecol* innovators apparently know how to do things with this new 'functional' kind of food product, and modify both their own product and their marketing strategies to the image of *Benecol*. In other words, they make their own product and marketing strategy *fully similar* to that of another product that is *different in the same way*. Also, in order to ensure that this mimetic twist is recognized widely, they deliberately violate marketing regulations for foods by illegitimately claiming that Gefilus 'cured' some illnesses related to antibiotics use, conforming only when the resulting hassle with authorities has secured consumer interest.

It seems clear that part of what this learning process involved has to do with the Gefilus innovators' ability to perceive, recognize and exploit *levels of logic* when it comes to solving the individuation dilemma. That is, when the success of *Benecol* on the Finnish market was a fact (for a description of the process of creating credibility for *Benecol* as part of this success, see Lehenkari 2003), the innovation network behind Gefilus learned to utilize central features of that process to their own benefit. Instead of just progressing with solving the individuation challenge at the first level (i.e., finding a suitable tradeoff between similarity and difference in relation to already existing dairy products on the Finnish market), they took advantage of the second level of similarities and differences provided to them by *Benecol* (i.e., reshaping their own product so that it imitated central traits of that other new functional food product). In doing so, they created a new product and image-creating strategies for the product that drew on similarities and differences *at both levels*. This kind of second-order learning has been called 'double-loop learning' or 'deutero-learning', first by Bateson (1972) and later, in an organizational context, by Argyris and Schön (1974; see also Argyris 1977). The learning here is 'double' both with respect to the product or the *object* which

was to be domesticated (i.e., learning to find a food substrate for the LGG bacterium that would be as ‘similar to’ the butter used in the Benecol innovation as possible) and with respect to the creation of the *image* of the object thus modified (i.e., taking the deliberate risk of offending the authorities by going too far in arguing that the product was ‘different’ from other products, thereby ensuring enough visibility and recognition).

To my knowledge, previous research has not attended to these processes of double imitation before. In this dissertation, I will inquire into the ways in which the object and the image of the Gefilus product innovation were shaped means of such learning. I will approach this issue by means of two analytical tools: the framework of *conceptual blending* as it has been developed by Fauconnier and Turner (2002; see Paper III), and the framework of *knowledge networking (KN)* as it has been developed by Bruun, Langlais and Janasik (see Papers I, II and IV). Both of these are approaches address knowledge structures involved in human thinking and action. Blending is claimed by its proponents to be *the* generic process of arriving at any conceptual novelty in the individual human mind, and the KN approach claims to have found *the* structures of human collaboration across knowledge boundaries. Leaving these grand claims aside, it can be concluded that both of these knowledge and meaning centered approaches are very promising for studying the process of learning to find a suitable tradeoff in existing worlds of meaning. As we will see in later sections, the blending approach provides us with nothing short of a *cognitive mechanism through which the tradeoff between similarity and difference is achieved* at both the *first and second order* level of logic with regard to both the *object and image* of innovation. The KN approach, again, shows us *how collaboration across epistemic boundaries is best organized* when the aim is to find a ‘perfect’ tradeoff.

Against this background, the main research question of this work can now be formulated as follows: *RQ: How do new products individuate from ‘imitators’ to ‘independent’ products answering to and involving distinct new needs and related imageries?* This question can be broken down into five sub-questions, the answering of which enables us to provide an answer to the main question. First, I will ask, (1) *How has individuation been addressed in consumer research and in science and technology studies?* I answer this question through a review of these two literatures. This review points to the significance of knowledge—its generation and integration—for the process of individuation. Second, I ask, (2): *How to conceptualize knowledge in order to better understand its role in the individuation processes?* I answer this question by providing an account of the frameworks of conceptual blending and KN. Third, I ask, (3) *How do individuation processes*

unfold from the point of view of such knowledge structures? Here, I show that product individuation involves knowledge processes that until now have escaped researchers' attention. Fourth, I ask, (4) *How to make the resulting improved understanding of individuation actually do some work for innovation processes?*, and lastly I inquire, (5) *How are knowledge structures in individuation processes best studied?*. Working through these five questions enables me to answer the main research question. An overview of the four original articles of the dissertation is presented below.

Paper I – KN: A conceptual framework and typology

KN is important for organizations in providing resources for learning and the generation of new knowledge; it refers to processes of interaction across epistemically defined boundaries between individuals, groups, or units. As such, it is an integral aspect of interdisciplinary collaboration. Building on a review and empirical work, my co-workers and I distinguish three modes of KN: modular, translational and pioneer. Managing the opportunities and challenges inherent in each form of KN demands attention and can produce positive results for organizational performance, increasing efficiency, creativity, or both; disregarding them can turn KN into the opposite of the original intention—*disadvantage*—because of the high costs generated by failure. In this first article, my co-workers and I also propose an outline of a research agenda for additional understanding of structures and dynamics of KN in a variety of contexts.

Paper II –Managing Knowledge Network Processes in the Commercialization of Science: Two probiotica discovery processes in Finland and Sweden

To learn more about the formation, transformation and interaction of KN, my co-workers and I studied two processes of commercialization of scientific knowledge. Both involved a *Lactobacillus* strain – *Lp299v*, in Sweden, and LGG, in Finland – and two different companies. The first, a small science company, was established expressly to commercialize *Lp299v*, while the other, a large dairy company, sought to develop new functional food products from LGG. Both were successful, but differed in KN in the research, commercialization and stabilization phases. For *Lp299v*, pioneer KN dominated and commercialization unfolded more smoothly than for LGG, where modular networking prevailed. This indicates that, in science-based innovation, the balance between pioneer and modular modes of KN must be considered, and that there is a relation between modes, and the structure of the problems. The second article indicates that new questions are raised about the challenges that various kinds and sizes of companies experience in different stages of innovation.

Paper III Learning to Match: User-producer integration and blending in the probiotic *Gefilus* innovation process

KN provides us with an epistemic perspective on innovation processes. However, this perspective is not sufficient to opening up the change dynamics of the object of innovation as it is shaped in the interaction between users and producers. The third article provides resources for this in the form of the framework of conceptual blending. The notions of user involvement and user orientation have become popular catchphrases in innovation research and practice. Central in this research are the ideas that knowledge about users leads to better design, and that the interests of users and producers need to be aligned. In another field of research, scholars have long recognized the significance of metaphors for integrative pursuits. However, to date these two literatures have not been combined into an integrated framework. Producing such a framework for understanding the process of interest alignment is the main task of this paper. Illustrating the framework with a recent probiotic innovation process, the paper argues that *learning to match* type of boundary – syntactic, semantic, pragmatic – faced between users and producers with type of capability is crucial for bringing about successful user-producer integration. The paper also argues that *learning to blend* forms a central part of the semantic capability.

Paper IV Text Mining in Qualitative Research: Application of an unsupervised learning method

The study of knowledge structures such as those involved in KN and conceptual blending is challenging for a number of reasons. The fourth article provides an introduction to and a demonstration of the Self-Organizing Map (SOM) method for organizational researchers interested in the use of qualitative data in general and in the study of knowledge structures in particular. The SOM is a versatile quantitative method very commonly used across many disciplines to analyze large data sets. The outcome of the SOM analysis is a map in which entities are positioned according to similarity. My co-workers and I argue that text mining using the SOM is particularly effective in improving inference quality within qualitative research. SOM creates multiple well-grounded perspectives on the data and thus improves the quality of the concepts and categories used in the analysis. The improvement applies also to knowledge structures.

Table 1. An overview of the four original papers of the dissertation.

The four original articles and the argument that follows from them relate to the five research questions in the following way. The *first* research question—how individuation has been addressed in previous research—is a distinct research question that draws upon, yet is not exclusively

confined to, the themes and problems addressed in the four original articles. The *second* research question—how to conceptualize knowledge in order to better understand its role in individuation processes—is addressed in all four original articles: articles I and II address the topic of KN, while articles III and IV address the topic of cognitive frames and mechanisms. The *third* research question—how do individuation processes unfold from the point of view of such knowledge structures—is addressed theoretically in articles I and III, and empirically in articles II and III. Reflecting the synthetic first research question, the *fourth* research question—how to make the resulting improved understanding of individuation actually do some work for innovation processes—is addressed towards the end of this summary. Finally, the *fifth* and last research question—how are knowledge structures in individuation processes best studied—is addressed in article IV.

For some readers, this set of articles may still appear heterogenous. However, there is a clear continuity as well as logic between the four articles of the dissertation, which also reflects the personal learning journey of the author during the process of writing the dissertation. The first and second articles address knowledge structures involved in human thinking and action at the level of the *collective*. In doing so, they link to previous research on practice in organizations, in particular to previous research on how innovation processes should be organized and managed (e.g., Brown and Duguid 1991; Dougherty 1992; Boland and Tenkasi 1995; Carlile 2002). The third and fourth articles, in turn, reflect the author's growing insight that such collective-level structures have no life in themselves, but must be enacted over and over again by human agents who are more than knowledge producers. Such structures are enacted by *individuals*, who, in addition to possessing and enacting highly specific cognitive frames, are partaking in various kinds of *practices* (Bruun, Langlais and Janasik 2002).

The term 'practice' is associated with the idea of human agency, understood as the human capacity for intentional action (Bruun et al. 2003; Giddens 1986), and it refers to the structured contexts within which intentional action is performed as well as interpreted by the agent (Bruun et al. 2003; Cook and Brown 1999). The notion of practice thus essentially designates involvement in some task or activity (Miettinen 1998) relatively independently of coherence in behavior (Bruun et al. 2003). Although closely related (see, e.g., Wenger 2002; Bruun et al. 2003), the notion of practice is thus not identical with the notions designating the kind of collective knowledge structures outlined mainly in the pragmatic approach. The two notions should also not be seen as mutually exclusive:

the epistemically oriented and the practice oriented approaches are best viewed as *supplements*, i.e., as focusing on different sides of one and the same situation (Bruun et al. 2003).

The rest of the summary is structured as follows. In the next section, I present the empirical data that the work in this dissertation is based on, and discuss the methodology used in analyzing the data. In section 3, I discuss the topic of individuation in relation to the two literatures of consumer research and science and technology studies (STS). The theoretical review then continues in the cognitive approach explored next. In this theoretical section, I also present a pragmatic approach developed by my co-workers and myself for the organization of individuation work. This so-called KN approach complements the cognitive perspective and together they provide the basis for the empirical analysis performed in section 4. I conclude, in section 5, with a summary and discussion of the central results of the dissertation.

2. Data and methods

The main development of the innovation under study in this dissertation took place in the Finnish dairy company Valio Ltd, established in 1905. The company is the largest milk processor with a net turnover of 1,8 billion euros (company homepage). Valio Ltd is owned by 22 dairy cooperatives, which are communities of milk producers that collect or process milk. For a dairy company, the firm has an unusually strong basis in R&D. This emphasis on R&D activities can be traced back to the heritage of A.I. Virtanen (1895-1973), to date the only Finnish scientist awarded the Nobel Prize (in 1945). Valio is the market leader in all key dairy products in Finland. Based on its development work with the probiotic Gefilus innovation starting towards the end of the 1980s, the company also presents itself as ‘a world class pioneer as the developer of functional foods’ (company homepage). Today, the two functional product brands of Valio are LGG® products (sold under the Valio Gefilus® and Valio Kidius Gefilus® brand) and Evolus®. The LGG® products are targeted towards the well-being of the gut, while the Evolus® Double Effect products helps to both control blood pressure and lower blood cholesterol (company home page). In this dissertation, I will, for the sake of clarity, use the term ‘Gefilus’ to refer to all *products* produced by Valio that contain the probiotic *bacterium Lactobacillus GG* (for which the abbreviation ‘LGG’ is reserved).

2.1 Empirical data

The empirical data presented in this dissertation were collected years 2003-2010, and fall into two main categories: 1. Thematic interviews with people who had been directly involved in inventing and developing the Gefilus innovation and 2. Documentary data, or ‘texts’ in the sense of Silverman (2004). I will address each data category in turn.

1. Interviews. Thematic interviews were performed, in three distinct rounds, with people who had played a central role in the development of the Gefilus innovation. The first round of interviews was conducted in 2003 and resulted in n=15. A second, complementary round of interviews was conducted in 2004-2005 and resulted in n=6. Finally, complementary interviews were conducted, when judged necessary, in 2004-2010 and counted n=4. In all, the interviews numbered n=25. The semi-structured interviews were all conducted confidentially. Some interviews (especially those of the first round) were transcribed fully, while others (especially from the second and third rounds) were transcribed only selectively. The decision was based on a consideration of the centrality of the interview for the topic under study in Papers II and III. The interview subjects were collected

following the snowballing method (Silverman 2004), and consisted of the discoverers of the LGG bacterium at Tufts in Boston (n=2), scientists from Finnish universities conducting research on the bacterium (n=3), company R&D senior and other managers (n=5), former CEOs (n=1), other senior managers (n=1), other R&D personnel (n=3), marketers (n=5), company economic personnel (n=1), company lawyers (n=1), other functional food researchers (n=1), functional food regulators (n=1), and company personnel involved in international operations (n=1). The interviews were conducted in Finnish (22), Swedish (1) and English (2), and their average length was 90 minutes.

2. Documentary data. The documentary data falls into two categories: A. Advertising material, mostly but not exclusively visual, and B. other textual documentary data (Silverman 2004). A. The visual data consisted of a comprehensive set of Gefilus advertising material produced by and for the company, as well as other advertising material related to Gefilus. During the spring of 2003, I was allowed to copy and scan a full archive folder of Gefilus marketing material from the period 1990-2004. This resulted in a complete copy of the folder as well as in 112 scanned jpg-files. The folder also comprised a comprehensive and systematic—and constantly updated—summary, written by marketing personnel, of all marketing measures taken by the marketing department during the time period under study. In addition to this data, I was allowed access, in 2009, to three company internal marketing research reports (1996, 1997, and 1998) as well as one email summary and four scanned pages of the results of such a company internal marketing research report (1995). These were named, in consecutive order, as follows:

- 1) *Gefilus tuotteiden tunnettuus*. Lokakuu 1995. Valio Oy. (The Familiarity of Gefilus Products. October 1995. Valio Ltd).
- 2) *Gefilus tuotteiden tunnettuus ja käyttö*. Maaliskuu 1996. Marketing Radar. (The Familiarity and Use of Gefilus Products. March 1996. Marketing Radar).
- 3) *Gefilus tuotteiden tunnettuus ja käyttö*. Seuranta 1996-1997. (The Familiarity and Use of Gefilus Products. Follow-up 1996-1997. Marketing Radar).
- 4) *Gefilus-tuotteiden seurantatutkimus 1996-1998*. Huhtikuu 1998. Marketing Radar. (Follow-up Research on Gefilus Products 1996-1998. April 1998. Marketing Radar).

B. The textual documentary data was gathered in the period 2003-2010 and consisted of a) Valio yearly reports from the period 1985-2001, and b) Valio brochures and magazines on functional foods and especially Gefilus. The most important of the all in all 30 brochures and magazines were the following: 1. *LGG News* 1998. Published twice a year by Valio Ltd. 2. *LGG Action* 1999-2002.

Published twice a year by Valio Ltd. 3. *LGG Summatim. Lactobacillus GG and its health effects*. 2002 (2nd amended edition), Maija Saxelin, company researcher. The LGG Summatim is a book that covers all research that to that date has been done on the LGG bacterial strain. In 2009, this material was complemented with c) one full archival folder of articles on Gefilus provided to me by the Valio company. In addition, during the years 2003-2004 I gathered d) 5 full archival folders of general documents on functional foods and probiotics, as well as e) books and articles on the history and development of probiotics. In addition, I collected data from the internet on functional foods and probiotics, among these Elie Metchnikoff's classic *The Prolongation of Life* (1907/1908), which I selectively read and analyzed as part of the revision of Paper III.

Interviews (oral)	Documents (texts)
Discoverers of the LGG bacterium (2), scientists from Finnish universities conducting research on the bacterium (3), company R&D senior and other managers (5), former CEOs (1), other senior managers (1), other R&D personnel (3), marketers (5), company economic personnel (1), company lawyers (1), other functional food researchers (1), functional food regulators (1), and company personnel involved in international operations (1)	Comprehensive set of Gefilus advertising material (1 archive folder, 112 jpg-files), summary of marketing measures (1), company internal marketing research reports (4), Valio yearly reports 1985-2001 (16), Valio brochures and magazines (30), archive folder of Gefilus articles (1), archival folders of general documents on functional foods and probiotics (5), books, articles and internet pages on the development of probiotics (ca. 30)

Table 2. Qualitative data sources used in the dissertation.

2.2 Methods

The qualitative research theorist and practitioner Silverman (2004: 35-37) has brought forth the view that whenever possible, the sensibilities of qualitative research should be combined with the increased stringency that reference to numbers can, at best, provide. I share Silverman's view, and will shortly return to my own take on the relationship between qualitative and quantitative research as my co-workers and I have presented this in Paper IV. First, however, I address the qualitative part of the juxtaposition. As Silverman (2004: 38) writes, people doing qualitative research, such as myself in the work presented in Papers II and III of this dissertation, at best share 'a set of preferences'. In other words, what today justifiably counts as qualitative research is so varied that no uniform definition can be provided. Silverman (2004: 38) characterizes these preferences of qualitative researchers as follows: '1. A preference for qualitative data – understood simply as the analysis of words and images rather than numbers. 2. A preference for naturally occurring data – observation rather than experiment, unstructured versus structured interviews. 3. A preference for meaning rather than behavior – attempting to document the world from the point of view of the people studied. 4. A rejection of natural science as a model. 5. A preference for inductive, hypothesis-generating research rather than hypothesis testing.' These five preferences are beyond any doubt visible also in the work presented in Papers II and III of the current dissertation.

According to Silverman (2004: 3), in addition to the five preferences of people doing qualitative research also presents six 'critical notions' that all qualitative researchers in one way or the other need to address. These are: 1. *Models* – overall frameworks for looking at reality (e.g., behavioralism, feminism). 2. *Concepts* – ideas deriving from given models (e.g., stimulus-response, oppression). 3. *Theory* – a set of concepts used to define and/or explain some phenomenon. 4. *Hypothesis* – a testable proposition. 5. *Methodology* – a general approach to studying research topics. 6. *Method* – a specific research technique. In this dissertation, the *model* is provided by the loosely defined approach of *socio-cognitive research*, i.e. an approach in which socio-cognitive processes are taken to be a complex and dynamic combination of coupled individual cognitive processes (Honkela et al. 2009). The central *concepts* of this model are those associated with the frameworks of conceptual blending (Paper III) and KN (Paper II) as briefly characterized in the introduction. The *theories* derived from the model and the concepts are readily discernible in Papers II and III as well as in sections 4 and 5 of this summary.

The notions of *methodology* and *method*, however, need to be somewhat expanded upon in the context of this section. In line with the definition of methodology above, I would say that the methodological approach taken in this dissertation is *qualitative*, as characterized by the five preferences above, but that this methodological approach has *two different modes or orientations*, which both are reflected in the papers of this dissertation. These modes can be called *top-down* versus *bottom-up*. In order to get a sense of what these modes or orientations mean, it is useful to look at Silverman's (2004: 84-86) discussion of the anthropologist Moerman's (1974) research on the Lue people in Thailand. The aim of Moerman was to elicit from these people what 'being a Lue' (the name of the tribe) meant to them, and he set about accomplishing this task by asking native informants questions such as 'How do you recognize a member of your tribe?' Very quickly, however, Moerman came to recognize that approaching the issue in this way only resulted in an inventory of 'tribe traits', i.e., a list of traits that could always be accused of having left something of importance out. Furthermore, such lists are always retrospective—once one has decided that the Lue are a tribe, it is not difficult to 'discover' a list that supports the case (Silverman 2004: 85). Such reflections led Moerman to abandon the approach of asking 'Who are the Lue' (presupposing the category of a 'tribe') in favor of inquiring, by means of observation, how and why the identification of 'Lue' is preferred in everyday situations (Silverman 2004: 84).

As I have discussed in Paper IV, the first attempt by Moerman can be characterized as *top-down qualitative research*. In qualitative research of such orientation, the researcher starts out with some preconceived category, and based on this approaches his or her empirical context of study (see the rightmost column in Figure 1 below). Of the papers in this dissertation, Paper II was conducted under influence of such top-down thinking. In contrast, *bottom-up qualitative research* is characterized by the kind of sensitivity to actual usage of terms and categories, as well as of actual practices, shown by the second research attempt by Moerman (see the leftmost column in Figure 1 below). Of the papers in this dissertation, Paper III moves significantly closer to this latter perspective (although it can be argued that it does still retain some of the characteristics of top-down qualitative research; see the introduction to Paper III). Finally, Paper IV of this dissertation explicitly thematizes these two modes or orientations of qualitative research, and also relates them to a *quantitative* method (the Self-Organizing Map) that can offer support and complementary perspectives to both kinds of qualitative research. Indeed, one of the rationales for writing Paper IV was to explicitly thematize and discuss these two modes of conducting qualitative research. As the succession of papers in this dissertation shows, I have, during the work on this dissertation, made a move from top-down modes of doing qualitative research towards more bottom-up ones.

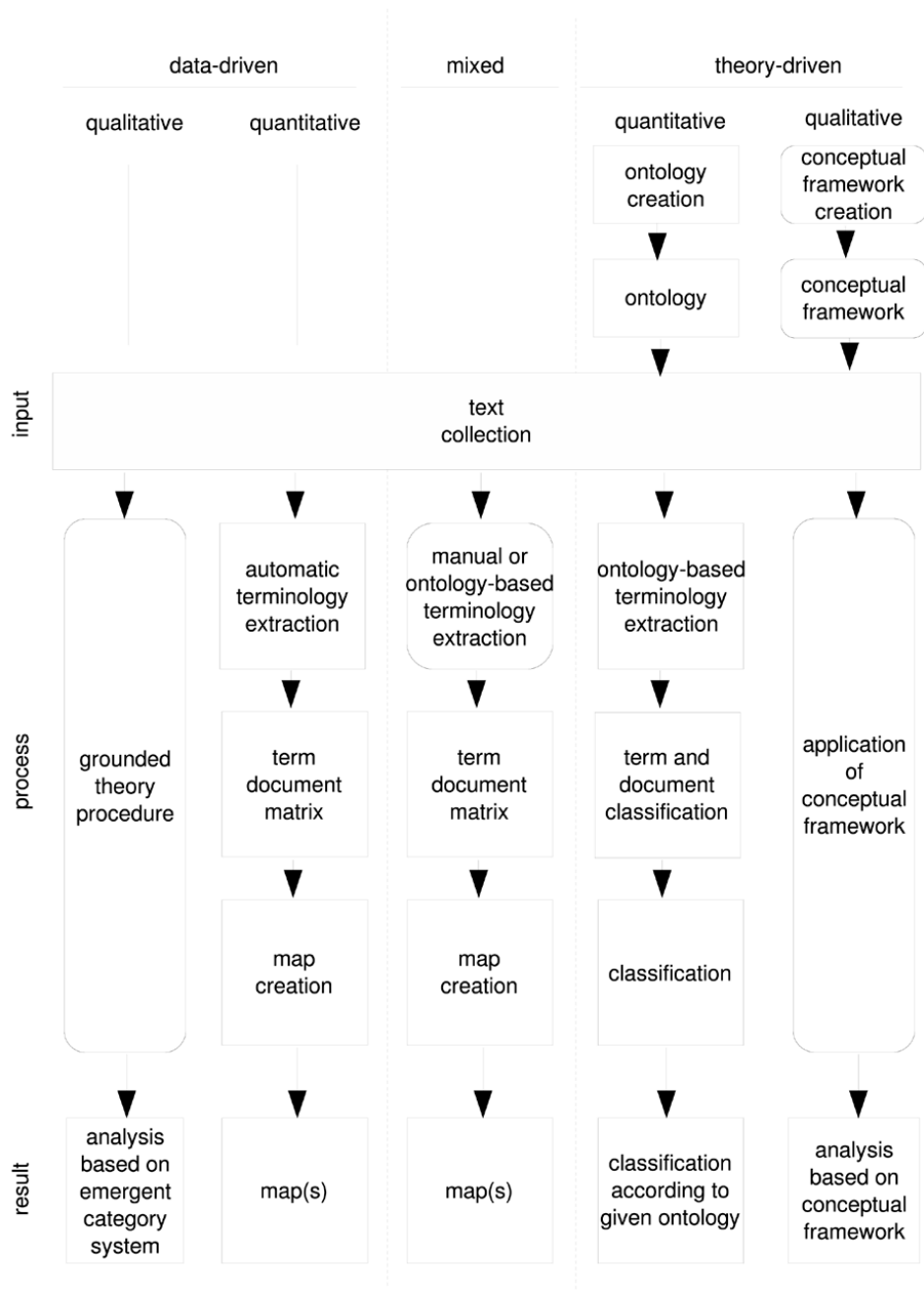


Figure 1. Multiple perspectives (vertical columns) on an object of inquiry from the point of view of theory-driven vs. data-driven approaches and qualitative vs. quantitative methods.

Despite these differences in methodological orientation, however, the specific *methods* that I used in Papers II and III were the same, i.e., 1. analyzing texts and documents and 2. interviews. Of the four methods that Silverman (2004: 12) lists as typical for qualitative research of whatever mode or orientation—i.e., observation, analyzing texts and documents, interviews, and recording and transcribing—I thus only used two. This choice was, however, not as much as a result of my own preferences as dictated by necessity; despite several attempts, I was not able to negotiate access to the company's R&D department in order to enable using also the methods of observation and (video) recording and transcribing.

The research performed for this dissertation can be divided into three distinct phases or stages. 1. Model and concept building (2002-2005). 2. Theory and hypothesis construction (2004-2010). 3. Methodological reflection and partial change in methods used (2006-2009). The first phase of the research resulted in Paper I, the second phase in Papers II and III, and the third, shorter phase in Paper IV. As can be seen from the above, the phases partially overlap chronologically. Next, I will address the specific methods used for each of the papers produced for this dissertation.

Paper I was initiated in 2002 with the explicit intent of producing a conceptual framework for the study of the integration and coordination of knowledge in innovation processes. It was based on a method that I have come to coin 'theoretical induction' (as opposed to the analytical induction propagated by, e.g., Silverman 2004). The main procedure of this method is to read through a number of empirical case studies in the secondary literature searching for commonalities in the descriptions of the ways in which collaboration across knowledge borders was organized in them. Such a process of theoretical induction resulted in the typology of possible ways of organizing collaboration across knowledge borders reported in Paper I. This first paper does not include any original empirical work except in the form of illustrations from ongoing empirical research on the topic, as this had approached the publication phase in 2004 (Paper II).

The conclusions and results of Paper II, however, are based on original empirical research into the Gefilus innovation process, in Finland, on the one hand, and the ProViva innovation process, in Sweden, on the other. For this comparative study, I performed, in 2003, 15 semi-structured interviews. My colleague Richard Langlais in Sweden did the same. The interviews were at this stage selectively transcribed according to the principles of what Silverman (2004) calls *constructionism* (as opposed to other possible versions of approaching interview data such as positivism, emotionalism and ethnomethodology). More specifically, I was searching for

memberships in as well as the knowledge contents and methodological tools of the categories of 'knowledge frameworks' (KFs) as my co-authors and I had defined this category in Paper I. This procedure falls within the parameters of top-down qualitative research as described above.

For Paper II, I also collected and analyzed documentary material or 'texts' (Silverman 2004). Silverman (2004: 112) lists four distinct ways in which researchers have analyzed how texts represent reality: 1. Content analysis 2. Analysis of narrative structures 3. Ethnography and 4. Ethnomethodology as this has been conducted by the Chicago school anthropologist Sacks. Of these four ways to analyze reality representation, the one that comes closest to my procedure in the analysis produced for Paper II is ethnomethodology. However, my way of approaching my collection of texts (i.e., searching for ways in which knowledge production and integration was organized with respect to the Gefilus innovation) was at this stage still very much informed by the top-down orientation evident in the work of Moerman described above. Therefore, although the aim of identifying category memberships (in this case, in 'KFs') is the same in the case of ethnomethodology and in my procedure, the latter is still so much informed by top-down reasoning that the methodological affinity is at most an issue of family resemblance.

The work performed for Paper III shows, however, more recognition of the bottom-up orientation. For Paper III, I conducted 10 additional interviews during the years 2004-2010. I also returned to some of the interviews of the first round of interviews with the explicit intent of searching for emergent categories rather than evidence for pre-defined ones. This time, I was searching for ways in which the interviewees had conceived of the potential future users and uses of the Gefilus innovation ('scenarios of use'), and I analyzed the increased interview sample with the intent of finding and categorizing such potential future uses. The same search also guided my analysis of the increased collection of texts (this now comprised also of the company internal marketing research reports on the actual usage of the innovation). Most importantly, for Paper III I also changed the way in which I conducted the analysis of the empirical data. Whereas the analysis had, in Paper II, mainly been an issue of applying the conceptual framework developed in Paper I, I now, in Paper III, consciously used the framework of conceptual blending to produce an analysis that is fully analogical to the 'category membership identification' approach as described by Silverman (2004). Indeed, I suggest that this framework be seen as a full-fledged alternative to the latter (see Paper III and section 4 in this dissertation).

The more specific ways in which the conceptual framework of KN was applied to the Gefilus case are exemplified in the two appendices of this dissertation. Having chosen two cases to study for a common research project—Gefilus in Finland, to be studied by me, and ProViva in Sweden, to be studied by my colleague and advisor Richard Langlais—the latter was responsible for creating a semi-structured interview schema for KN (see Appendix 1). The first round of case interviews was performed based on this schema. When the interviews as well as other related data was collected, we proceeded to analyzing them based on the guidelines for KN case studies developed by my colleague and advisor Henrik Bruun (see Appendix 2).

The criteria used for determining what kind of knowledge structure we encountered were based on researcher judgment on similarities and differences along the three criteria for knowledge structures established in Paper I: 1) the object of knowledge; 2) the methods used for learning and generating knowledge; and 3) the self-understanding of the knowledge producer. Having analyzed the knowledge structures thus defined over time in the two innovation processes, we proceeded to writing the article that was to become Paper II of this dissertation. This procedure is thus also what lies behind the two major visualizations of the KN process that will, together with exact terminological specifications, be presented later in the summary.

As for conceptual blending, I followed the established methodology within cognitive linguistics for analyzing marketing material as blends (see, e.g., Fauconnier 2001; Fauconnier and Turner 2002; Coscarelli 2007). The marketing visualization presented later in the summary is representative for the last stage of the commodification phase of the domestication process, and the visualization picturing its conceptual structure shows in detail how the blend functions as an attempt to bridge the cognitive frames of users and producers (see Paper III).

The work in Paper IV is based on a pilot study on knowledge integration in a small Finnish coffee firm (Janasik 2003). For this study, I performed eight interviews (not included in the data section above), which were in Paper IV treated as ‘texts’ and analyzed, first, by means of the top-down qualitative research described in relation to Paper II, and then by means of the quantitative unsupervised learning method of the Self-Organizing Map (SOM). The SOM is an unsupervised learning method that originally stems from artificial neural network research. Currently, it is commonly used as a method for statistical visualization and data analysis (Kaski, Kangas and Kohonen 1998; Oja, Kaski and Kohonen 2003; Pöllä, Honkela and Kohonen 2009). Paper IV argues that both top-down and bottom-up qualitative research might benefit considerably from

taking into account also quantitative methods, particularly the SOM. This is because the SOM significantly improves the quality of the inferences drawn in such research by improving the quality of the concepts and categories used in the analysis. Within both theory driven and data driven qualitative research, the quality of inferences crucially depends on the adequacy of the terms or categories used. If the chosen terms or categories do not reflect something of importance in the data under study, it is not likely that inferences drawn from the data using those terms are going to be of any major value either (see Paper IV). The work in this paper thus both corroborates and develops further Silverman's (2004: 37) contention that 'there is no reason why qualitative researchers should not, where appropriate, use quantitative measures'.

3. Theoretical resources for studying individuation

In this section, I begin by addressing the first research question, i.e., the question of how the theme of individuation has been addressed in consumer research and in science and technology studies. According to Pantzar (1995), the main literatures in which relationships between humans and things (goods and commodities) are discussed are: 1) The 'biography of things' perspective as represented by consumer researchers, anthropologists and sociologists, 2) The social construction of technology perspective as represented by sociologists of science and technology such as, e.g., Bijker (1995), 3) The Actor-Network Theory as built by Callon (1991) and Latour (1992), and 4) The ecology of goods approach as represented by, e.g., Pantzar (1995). In accordance with ordinary usage, I take, however, the second and third to form one category, that of science and technology studies or STS. I then move over to the second research question, i.e., the question of how to conceptualize knowledge in order to better understand its role in the individuation processes. Drawing on the research reported in Paper I, II, and III, and on previous research, I suggest both a new cognitive and a new pragmatic way of approaching the issue of individuation. The aim of the *cognitive* account is to show the knowledge-related building blocks and integration mechanisms of knowledge in individuation processes. The aim of the *pragmatic* account is more hands-on: Given that this is the material to be integrated, how do you best organize the actions of people to achieve this end? I argue that understanding how products move from imitators to 'independent' products—i.e., how they individuate—requires attention to both aspects separately as well as to how they interact in the process of making innovations familiar to specific target groups.

3.1 Consumer research and the 'biography of things' approach

In recent times, the perspective of 'biographies of things' has emerged within consumer research as an approach aiming to describe and understand the ways in which different commodities or goods become integrated into our daily lives (Pantzar 1995; Kopytoff 1986; Miller 1987; Carrier 1995; Silverstone and Haddon 1996). This perspective seeks to understand the ways in which meanings attached to specific goods are transformed from anonymous commodities with objective exchange values to personal possessions significant for various kinds of identity projects (Pantzar 1995; Niva 2006, 2008). The unit of analysis are microprocesses, since they focus on individual commodities and households, and authors within this approach usually represent the disciplines of anthropology, sociology, and consumer research (Pantzar 1995; Niva 2006, 2008). The major concepts of this perspective are 'domestication', 'appropriation', 'objectification', and 'incorporation' (Pantzar 1995; Kopytoff 1986; Miller 1987; Silverstone and Haddon 1996; Niva 2006, 2008). Within this research tradition, it is believed that modernization (industrialization, urbanization and rationalization) has led to a distancing of consumption from production, which translates into the produced goods being always in some sense 'alien' to us (Miller 1987; Niva 2006, 2008).

Consumption thus becomes the work in which the alien is made familiar, equivalent to socially organized practices of the 'appropriation' of objects (Miller 1987; Sassatelli 2007; Niva 2006; 2008). For all new products presented to some specific consumer group, then, the challenge is to go through a process of becoming understood, accepted, and integrated into the myriad of practices making up ordinary, everyday life. Within consumer research, the process of making the unfamiliar familiar has been addressed by, e.g., Douglas and Isherwood (1979), Miller (1987; 1997), McCracken (1988), Gronow and Warde (2001), Appadurai (1986), Kopytoff (1986), Pantzar (1995) and Niva (2006; 2008).

Many of the researchers in this tradition have a background in anthropology, and they thus share the anthropologist's appreciation of 'the strange'. This is well exemplified by the work of Douglas and Isherwood (1979), which started a new era in consumer research. In explicit counterposition to the rationalistic thinking of economists up until then, Douglas and Isherwood (1979: 41) argued that human consumption of goods or commodities is fundamentally a sensemaking process: 'If it is said that the essential function of language is its capacity for poetry, we shall assume that the essential function of consumption is its capacity to make sense. Forget the idea of consumer irrationality. Forget that commodities are good for eating, clothing, and shelter; forget their usefulness and try

instead the idea that commodities are good for thinking; treat them as a nonverbal medium for the human creative faculty.’ For Douglas and Isherwood, consumption goods are thus not merely ‘messages’ (e.g., someone bragging with some new gadget): ‘they constitute the very system itself’ (49). Indeed, treating goods as both ‘the hardware and the software of an information system whose principal concern is to monitor its own performance’ (49) leads to the obliteration of Cartesianism, or the distinction between physical and psychological experience: ‘Goods that minister to physical needs—food or drink—are no less carriers of meaning than ballet or poetry’ (49). For Douglas and Isherwood, then, consumption is an active process through which all social categories are being continually defined: ‘Consumption uses goods to make firm and visible a particular set of judgements in the fluid process of classifying persons and events.’ (45) Thus, when discussing consumer behavior, instead of making reference to the rational choices of the solitary economic individual, Douglas and Isherwood speak of ‘metaphorical understanding’ of ‘meanings’, a process through which people classify, compare and order their worlds (see also Niva 2006).

These conceptualizations based on meaning and categorizations have become part of the fundamental presuppositions that consumer researchers share in their analyses of consumption (Niva 2006). For instance, in his work McCracken (1988) follows this basic conceptualization of consumption as sensemaking and in stressing the consumer as a cognitively active agent constantly classifying and reclassifying rather than as a solitary rational ‘decision-maker’ (Niva 2006, 2008). Also Kopytoff (1986) and Appadurai (1986) share the basic suppositions of consumption as sensemaking. According to Kopytoff, there is a tension between the two logics of economics and culture, however. In what he calls ‘commodification’, goods are brought out to be exchanged, and they have both use value and exchange value (the logic of economics). In ‘singularization’, the opposite process of commodification, individuals make goods unique, special and non-tradeable by tying them to their own specific classifications (the logic of culture; Kopytoff 1986; Niva 2006). Appadurai (1986) stresses the links between goods and knowledge: on the one hand, goods embody aesthetic, technical and social knowledge, on the other, using them requires knowledge. As production and consumption move at further distance from each other, both knowledge bodies fragment and become partial and contradictory (Appadurai 1986; Niva 2006, 2008).

For Miller (1987, 1997), the pioneer of material culture research, the work that the consumer does in singularizing a specific good is a form of appropriation of it, during which process the good in question is decoupled from its abstract and strange (objectified) existence and made into familiar, ‘inalienable’ cultural material (see also Niva 2006). Appropriation is a process of making a good

‘one’s own’ by attaching one’s own emotions and aspirations to it. For Miller (1987), goods are at one and the same time physical and tied to human action, and symbolic, i.e., means for making distinctions and identifications, for expressing emotions and world views (Niva 2006, 2008). In addition to paying attention to specific processes of appropriating objects, Miller also pays attention to the structural conditions of making a good one’s own. The culture in which an individual lives provides this individual with the tools (values, ideals and principles) by means of which goods can be evaluated. Cultures are seldom monolithic, however, which means that different circumstances provide different tools and resources for appropriating objects (Miller 1987; Niva 2006).

More recent consumer research (e.g., Miller 1995; Lury 1996; Lupton and Noble 2002) as well as many within the field of technology research (e.g., Woolgar 1991; Akrich 1992b; Callon 1991; Mackay and Gillespie 1992; Lie and Sørensen 1996; Oudshoorn, Rommes and Stienstra 2004; Geels 2005) have observed that in bridging the gap between production and consumption attention needs to be paid both to the ways in which meanings are built and inscribed into objects, and the ways in which they are appropriated by consumers in their everyday life (Niva 2006; 2006). Within this newer discussion, the terms appropriation and domestication are often used interchangeably to denote the active process of making the unfamiliar one’s own that the consumer performs when consuming goods (Niva 2006, 2008). Researchers within this tradition emphasize that domestication involves ‘taming the wild’ and bringing it to the ‘cultivated’ sphere of existing meanings (e.g., Silverstone and Haddon 1996; Pantzar 1995, 1996, 2000; Niva 2006, 2008). They often also emphasize the fragmentary character of appropriation (Niva 2006).

Elzinga (1998) conceives of culture as a particular resource in the domestication of technology, since technology is domesticated via the use of metaphors and images, and Powers and Powers (1984) describe how new goods are domesticated via a process of ‘metaphorical expansion’ (e.g., the example of the peach that was first described as a ‘hairy apple’). This same mechanism of what might be called ‘domestication by means of a tradeoff between similarity and difference’ has been observed also by Hargadon and Douglas (2001), who describe how Edison skillfully played with similarities and differences in domesticating electricity, and by Pantzar (1995), who describes how margarine in Finland was domesticated by consumers perceiving it to be similar to butter.

Before moving over to the theme of the comparison of similarities and differences in the domestication of new goods, in the next section, it is worthwhile to recount the basic elements in the oft-cited three-stage model of domestication provided by Silverstone and Haddon (1996).

According to them, ‘domestication’ is a process in which ‘new technologies and services, by definition to a significant degree unfamiliar ... are brought (or not) under control by and on behalf of domestic users. In their ownership and their appropriation into the culture of family or household and into the routines of everyday life, they are at the same time, cultivated. They become familiar, but they also develop and change.’ (Silverstone and Haddon 1996: 60) From the consumption point of view, this process has three dimensions. The first is that of ‘*commodification*’ in which, as a result of activities of industrial designers, public policy-makers, regulators, and market-makers, specific claims for function and for an identity of a new product or service are made ... Commodification refers to the industrial and commercial processes that create both material and symbolic artifacts and turn them into commodities for sale in the formal market economy’ (1996: 62).

The second dimension of consumption is ‘*appropriation*’ in which socially located individuals (individuals distinguished by class, age, gender, ethnicity, and as members of families or households) accept ‘enough of the relevance of the publicly defined meaning of something to their own circumstances to buy and then accept the new object or product into their domestic environment’ (1996: 64). This process of appropriation has two aspects. The first aspect is ‘*objectivation*’, in which the new product is made (also literally) to fit in the pre-existing culture. The second aspect is ‘*incorporation*’, which refers to the process of the new product finding its place in a ‘pattern of domestic use in domestic time’ (1996: 64). The third and final dimension is ‘*conversion*’, ‘which reconnects the household into the public world of shared meanings and the claims and counterclaims of status and belonging ... it signals the importance of the need to legitimate one’s participation in consumer culture in the display of competence, and ownership’ (1996: 65). From the point of view of this model, the research conducted in this dissertation focuses predominantly, although not exclusively, on the commodification phase of the domestication process, and on individuation as part of the commodification aspect of domestication.

Throughout this literature, there is heavy emphasis on the ‘cognitive work’ (Douglas and Isherwood 1979) that the consumer performs when interacting with the world of goods. The consumer is viewed as incessantly busy with classifying and categorizing (Niva 2008). Although not explicitly stated, the essence of this ongoing cognitive work is the discernment and recognition of similarities and differences. One place in which the cognitive work of consumers has been addressed is the research on user-producer interactions (e.g., von Hippel 1988, 2005; Hyysalo 2010; Heiskanen et al. 2010; Heiskanen 2005; Hyysalo, Johnson and Heiskanen 2007). A central tenet in this flourishing

line of research is the idea that increased knowledge about users leads to better design (Hyysalo 2010; Heiskanen et al. 2010; Heiskanen 2005; Hanna et al. 1995). Reflecting this contention, a plethora of methods or ‘tools’ for user involvement has seen the light of day (Hyysalo 2010; Heiskanen and Repo 2007). In addition to the conventional methods of concept testing and usability (Heiskanen and Repo 2007), some of these are: field studies, participatory design, contextual design, user participation, designer visits to homes or workplaces, ethnographic observation and joint workshops (e.g., Heiskanen and Repo 2007; Heiskanen et al. 2007).

However, as has been pointed out in this literature, “the ‘user’ is a complex idea” (Hyysalo 2010: 20; see also Woolgar 1991). On the one hand, the user can be understood as referring to a category used by engineers and developers to designate those who may eventually use their systems. On the other hand, it can also refer to a range of other individuals and institutions, who develop relations with some specific technology over time. There are also many different kinds of users, and they can have various degrees of participation in the creative process. (Hyysalo 2010) To complicate things further, a vision of ‘the user’ or ‘the use’ of some new product or technology held by the designers of it may not at all resemble the views or representations of that particular product or technology held by its real, flesh-and-blood users. Furthermore, more often than not, before some particular product or technology stabilizes into a specific shape, there are usually many rounds of trial, error and much reciprocal frustration in which the views of the designers or producers and the views of the real users or consumers clash, conflict and at best adapt (see, e.g., Hyysalo 2004).

Despite this complexity, however, there is also a rather stable agreement in this literature that in order for an innovative product or technology to succeed, the interests and needs of producers or designers and users need to be aligned (see, e.g., Heiskanen et al. 2010; Heiskanen et al. 2007; Hyysalo 2004; Hanna et al. 1995). As has recently been pointed out (Heiskanen et al. 2010: 498), however, adequately addressing the question of how such processes of alignment take place requires that the analytical focus is shifted from the mechanistic application of the methods or tools of user involvement to the more exact ways in which such tools *mediate* the interaction of users and producers. Often used methods are: 1) Explicit requirement-gathering techniques, such as market or customer research 2) involvement of some users as hired in-firm experts or participants in consumer panels and user groups 3) designers’ own experiences 4) product developers’ professional background and 5) cultural maturation (since technologies build on media and technology genres that are assumed to be familiar to users; Hyysalo 2010).

Another point of agreement in this literature is that, more often than not, the first mediating method—that of explicit requirement-gathering techniques—is not in itself sufficient to produce the desired alignment between user and producer perspectives (see, e.g., Hyysalo 2010; Heiskanen et al. 2010; Hyysalo, Johnson and Heiskanen 2007). However, as has been pointed out by Heiskanen and Repo (2007: 169), in *some* cases, it can be: “In some product groups, early users have similar skills and preferences to the designers of the product. Thus companies with limited resources may actually find personal experience a cost-effective source of user information.”

Later in this section, I will argue that the Gefilus innovation is an example of an innovation that, from the point of view of user-producer alignment and mediating methods, succeeded against all odds, and that part of the reason was the application of a very specific kind of mediating method or tool—that of conceptual blending. Here, however, I will conclude this brief overview of consumer research with the observation that despite the thorough recognition of the cognitive work performed by users or consumers, there is little or no reference in literature to the more specific cognitive structures involved in this work at either the individual or the collective level. In order to develop tools with which to approach this active interpretative work of the consumer—and also of the ‘other’ of the consumer, the producer—it is necessary to go to literatures where such structures and processes have been addressed. A good place to start looking for such explicit work is science and technology studies (STS), in particular its recent developments towards a more ‘socio-cognitive’ perspective.

3.2 Science and technology studies (STS)

How do two of the central currents in science and technology studies—Social Construction of Technology and Actor-Network Theory—and their multifarious descendents address the individuation challenge, i.e. the requirement to solve the individuation dilemma in a satisfactory enough way? The answer is perhaps clearer for the first current, which argues for the ‘interpretative flexibility’ of scientific findings and technological inventions (Bijker, Hughes and Pinch 1987; Pinch and Bijker 1987; MacKenzie 1999). The notion suggests that technology design is an open process outcome of which depends on the social circumstances of development: Artefacts are essentially the product of intergroup negotiations comprising ‘relevant social groups’ (Bijker et al. 1987; Klein and Kleinman 2002). In the original formulation of the SCOT approach, a relevant social group demarcated as ‘all members of a certain social group’ that ‘share the same sets of meanings attached to a specific artefact’ (Pinch and Bijker 1987: 30). For short, relevant social

groups are the embodiments of specific interpretations (Klein and Kleinman 2002). Those groups may have widely diverging interpretations of some specific artifact (e.g., the bicycle), and the design process continues until the artifact no longer poses a problem for any social group. This is called ‘closure’ or ‘stabilization’ (Bijker et al. 1987; Pinch and Bijker 1987). The end of negotiations can be reached by two mechanisms. The first mechanism is ‘rhetorical closure’, whereby a declaration is made that no problem exists anymore and that the design process can end. The second mechanism is ‘closure by redefinition’, whereby unresolved problems are redefined in a way that no longer pose any problems to any social group (Klein and Kleinman 2002).

Since its original conceptualization, however, the SCOT approach has encountered numerous criticisms, also from its own original developers (e.g., Pinch 1996). The bulk of the criticism is directed towards the notion of ‘relevant social group’, which is perceived to be too simplistic in view of the structural and power-related intricacies of modern society. To answer some of this criticism, Bijker (1995) developed the notion of ‘technological frame’, which refers to the ‘shared cognitive frame that defines a relevant social group and constitutes members’ common interpretation of an artifact (Klein and Kleinman 2002). The notion comes close to the Kuhnian ‘paradigm’, since it includes goals, problems, theories, heuristics, and prototypical artefacts that shape all group members’ activities: ‘Within a technological frame not everything is possible anymore (the structure and tradition aspect), but the remaining possibilities are relatively clearly and readily available to all members of the relevant social group (the actor and innovation aspect)’ (Bijker 1995: 192). Needless to say, this notion too has received criticisms and suggestions for improvement (for a review, see, e.g., Hyysalo 2006). For our purposes, however, it is important to note that this foundational perspective, in contrast to consumer research, makes *explicit* reference to collective-level knowledge structures (here ‘technological frame’), and that it thus provides us with a tool for starting to open up the content and workings of such structures in the processes of ‘meaning shaping’ discussed also within the anthropologically oriented consumer research.

Within the work of another anthropologist with colleagues—Latour, with Callon and Law—meanings co-exist seamlessly with material structure in what this approach coins ‘actor networks’ (e.g., Callon 1999; Latour 1992, 2005; Law 1999; Callon and Law 1982): ‘The actor network is reducible neither to an actor, alone, nor a network. Like a network, it is comprised of a series of heterogeneous elements, animate and inanimate, that have been linked to one another for a certain period of time’ (Callon 1999). The focus of this approach is on how such networks either become stabilized or disappear. Since the approach recognizes primarily the notion of ‘force’ in such

processes of formation and extinction (Miettinen 1999), the negotiations referred to in SCOT become ones of 'translation' and 'transformation': 'By translation we understand all the negotiations ... acts of persuasion thanks to which an actor or force takes ... authority to speak or act on behalf of another actor or force' (Callon and Latour 1981: 279). It thus becomes central to establish and maintain 'the balance of forces irrespective of the nature and origins of these forces' (Callon 1980: 209) via a process of 'transformation' in which forces become involved 'as if they were identical' (Callon and Law 1982). By making reference to the notion of force, it was possible to treat all entities, human and non-human alike, as being 'on a par' (Miettinen 1999).

However, there is more to the processes of translation and transformation than this. As eloquently explicated by the fictive professor Norbert in *Aramis, or the Love of Technology* by Latour (1996), in order for any technological dream to gain reality, it has to be opened up to the social game of mutual interest and strategy definition by means of interpretations, or, for short, to the process of negotiation. Interpretation occurs mainly through the 'narrative scenarizations' put forward by the actors (Latour 1996). These scenarizations (e.g., the narrative scenarization or vision of margarine as by far preferable to butter) are thus the starting point for the process of translation, through which transformation of other actors' interests takes place. In translation, what is in fact different (e.g., margarine) is treated as if it was the same (i.e., butter) in a successive series of moves (e.g., marketing campaigns), and if the receiver of the translatory message (e.g., Finnish consumers) accepts these moves (i.e., starts buying margarine instead of butter), that translation has been successful and the actors in question enrolled (Callon and Law 1982). The process of trying to capture and win the interest of other actors by means of translation and transformation is called 'interessement' (Callon and Law 1982; Callon 1999). To me, this process seems to be one more way of articulating the individuation dilemma, albeit in a form that, for its own purposes, tries to do away with all references to human agency. In comparison with SCOT, which says that the relevant social groups, with their respective technological frames, negotiate different meanings until these become sufficiently similar (or the whole problem is reframed), it is, paradoxically, also richer, since it aims to open up the more specific ways in which such meaning negotiations occur.

How, more precisely, do narrative scenarizations or visions (e.g., of margarine replacing butter) move over to the sphere of material structure (i.e., a package of *Oivariini* as it is known in Finland), once they have managed to capture enough interest of enough actors? Another actor-network theorist's, Akrich's (1992a), answer is via the notion of 'scripts', or 'socio-technical scenarios'. The concept of socio-technical scenario or script was developed within science and

technology studies as an analytical tool for comparing designers' conceptions of technology, technology design, and actual user behaviour (e.g., Akrich 1992a, 1992b, 1995; Callon 1991; Latour 1992; Woolgar 1991), and has since been used widely (e.g., Landström 2006; Oudshoorn et al. 2004; Gjöen and Hård 2002; Konrad 2008). Akrich defines the notion of script or scenario as the end product of the work of inscribing a 'vision of, or prediction about, the world in the technical content of some new object' (1992a: 208). A script comprises assumption of motives and competencies of the users; it also describes a space where the program of the action is supposed to take place (Konrad 2008). The socio-technical scenario or script is negotiated between the different actors participating in some innovation process and it is eventually 'inscribed' into the technical artifact (Konrad 2008). According to Konrad (2008: 6), the notion of script has two advantages as a tool for analyzing use-related conceptions of designers and other involved actors, compared to related concepts such as, e.g., 'user representations':

Firstly, the concept of roles and roletakers, e.g., user roles and user groups, supposed to occupy these roles, allows the differentiation of use- and user-related assumptions. This distinction is important because designers may have rather elaborate conceptions of how a technology will be used, yet only diffuse ideas of who will be the users. In addition, a specific role may be associated with different actor groups, or a specific group of actors may be associated with different roles. Secondly, it is a broader concept taking into account more elements than conceptions of future user groups.

However, according to Konrad (2008: 7-8), this concept, although better than many alternatives, shows three critical shortcomings: 'a) the designers' representations resulting from the final shape of a socio-technical system are insufficiently differentiated; b) the generation and c) the co-evolutionary dynamics of scenarios are not sufficiently considered'. Most importantly for our purposes, however, Akrich makes no clear distinction between a script or scenario as 'dreamed up by those who conceive' a new system [i.e., the 'narrative scenarization' described by Latour] and a script or scenario as the 'end product' of "inscribing" this vision of (or prediction about) the world in the technical content of the new object' (Akrich 1992a: 208). In contrast to Akrich, Konrad (2008) refers to scenarios squarely as 'the conceptual or fictive scenarios *as imagined* by designers, users or other actors involved in the development, production and diffusion of a new socio-technical system' (Konrad 2008: 4; italics added). She builds on the thinking of Schutz (cited in Konrad 2008), for whom all our knowledge is structured according to 'types'. What is considered to be the 'typical' characteristics of some object depends on an agent's system of relevance, i.e., on the

interests, purpose and background of the agent. Innovation developers too, have assumptions regarding typical uses and users, and these ‘type repertoires’ constrain what kinds of use models and prospected contexts they articulate into scenarios of use.

Scenario change occurs when developers run into problematic situations, e.g., appropriation processes involving real users (Konrad 2008). The new (changed) types can be modifications of existing types (e.g., when small changes are made to a use model comprising suppliers and buyers), differentiations into sub-types, such as different kinds of buyers, or a new type that emerges as a synthesis of multiple types; for example, introducing the use model of a service provider. A ‘type-based’ scenario is thus ‘a projection of a network of interrelated typified roles or positions and role-takers, partly occupied by human actors and partly by technical elements’ (Konrad 2008: 6). Such a scenario includes: 1) *use models* or typified conceptions of one or more user roles; 2) *user models* or the expected role-takers; 3) *the objects of use*, which describe the anticipated functionalities of the technical or socio-technical system as it presents itself to the user; 4) an *operating, distribution and maintenance* model defining what must be done to keep the system working; and 5) *the prospected context* or a typified conception of complementary artifacts, infrastructures, associated activities and the spatial surroundings in which the scenario will take place (see Table 3). Konrad proposes that different pathways open up depending on the dynamics of the change of the elements of the scenarios of use involved in the process of interactive social learning and redefinition. If one element changes slowly, process of convergence can be expected. If both the designer and user sides are in flux, opening processes of variance are likely. (Konrad 2008: 22)

Use model	Typified conception of one or more user roles. May be associated with different submodels of use, i.e. different typified ways of using, e.g., different types of buyers in an electronic marketplace with different interests and competencies.
User model	Assumptions about the expected role-takers. Parallel to the submodels of use, differentiated submodels of users may be conceived.
The object of use	Anticipated functionalities of the technical or socio-technical system as it presents itself to the users.
Operating, distribution and maintenance model	An operating scenario defines what must be done to keep the system working, e.g., actualising contents, and who is supposed to assume these tasks. The maintenance scenario describes role-takers and the roles of those who control the system and restore functions in case of breakdown.
The prospected context	Typified conception of complementary artefacts, infrastructures, associated activities and the spatial surroundings, where the scenario is supposed to take place.

Table 3. Scenarios of use as envisioned by Konrad (2008).

Of the work in science and technology studies cited here, Konrad's comes closest to explicitly opening up the microprocesses at play in what I have called processes of individuation. In Konrad's model, convergence or similarity of the elements described by the scenario of use can be expected if one element (e.g., the user model of margarine as consumed primarily by health-aware middle-aged women) changes slowly, whereas differentiation or difference can be expected when the elements are in flux (e.g., the ten use models presented by Edison for the phonograph; see Millard 2005). Konrad also makes explicit reference to both the individual-level (i.e., type repertoires) and collective-level (i.e., scenarios as part of societal-level expectations) knowledge structures guiding these processes of convergence and differentiation. She also takes into consideration how these two levels interact in actual processes of interplay between scenarios of use, actual artifacts and patterns of use: 'Dynamics on a societal level contributed to the scenario evolution as well. Scenarios presented as highly promising in the societal discourse on e-commerce—scenarios that were part of the actual e-commerce agenda—were taken up by the local actors. Partly this resulted in rather radical re-orientations of the guiding scenarios' (2008: 21).

However, Konrad does not relate the two processes of convergence and stabilization at these two levels to the issue of individuation, i.e., to how a product (e.g., the interactive television or the electronic marketplace) *moves from* being an 'imitator' *to* being an 'independent product'. Mainly this is because she only inquired into the early phases of these two innovations. Konrad's work on type-based scenarios speaks to both the SCOT approach, in that a 'particular variety of scenarios produced by different actors and actor groups can be regarded as a specific form of interpretative flexibility of technology' (2008: 7), and to the ANT approach, in that it provides patterns with predictive force for when to expect stabilization and when differentiation.

The last research from the field of science and technology studies that contains tools necessary for understanding the solution to the individuation dilemma of the Gefilus innovation is by Bowker and Star, especially their work on the 'naturalization' of categories and classifications (1999). Like many of the other researchers cited from both consumer research and STS, Star and Bowker share the anthropologists' understanding of the interplay between familiarity and unfamiliarity in the naturalization of both people and commodities. According to them, however, 'familiarity is a fairly sloppy word ... a better way to describe the trajectory of an object in a community is one of naturalization' (1999: 299). For them, naturalization means 'stripping away the contingencies of an object's creation and its situated nature. A naturalized object has lost its anthropological strangeness' (1999: 299). It is not predetermined whether an object will ever become naturalized in

one or many ‘communities of practice’ (Lave and Wenger 1991); this is decided by the unfolding of ‘practice-activity’ (1999: 299). As a paradigmatic example of an object that has been so naturalized is the light switch: ‘People don’t think twice about their nature, only about whether or not they can find them when needed’ (1999: 299). The end point of the trajectory of naturalization of objects is thus ‘transparency’, while the endpoint of membership in a community of practice is ‘complete legitimacy’ (1999: 301). Although these two trajectories are inseparable in practice, for analytical purposes, it is possible to think of ‘two trajectories traveling in tandem’ (1999: 300).

The trajectories of both people and objects can, however, get severely twisted or ‘torqued’ if these have to be made to fit in too rigorous categorization systems (1999: 184). One of the saddest cases of too rigid categorizations can be found in the South Africa of apartheid, where the trajectories of innumerable lives were torqued to the point of becoming unlivable. Many, however, found release from their impossible situation by means of skillful negotiation. For instance, Bowker and Star (1999) cite the case of children whose both parents carried white identification cards but who themselves were dark-skinned. For these kinds of ‘borderline’ children, there were buffer schools that admitted as pupils ‘slightly colored’ children. However, these schools could not admit in too many such pupils, since they would then face the risk of sanctions from the Population Board. The solution to this impossible situation was a kind of ‘double loop learning’ (Bateson 1972), in which the Principal would let some children in, reject some out of hand, and finally reject some on the basis of the school already being ‘full’. In the last case, there was the possibility of appealing to the board of the school committee’s decisions, and the appeals were often successful: ‘Thus, there was a delicate invisible negotiation between parents and school principals-school committees. If no real reason was given for rejection, there would have been no grounds for appeal to the board’ (1999: 215). What these parents learned, then, was to find a good solution for their borderline child by learning to play the game not only at the *primary* level of ‘appearances’ (rejection because of school being full), but also at the *secondary* level of the ‘real situation’ (if there is a rejection based on the school being full, appeal is often successful). Thus, one way out of trajectory-threatening torques is that of ‘double loop learning’ or ‘deutero-learning’ as described by Bateson (1972).

The issue of concealment—of deliberately creating and exploiting a gap between the level of the overtly viewable and the level of hidden conceptual and material structure—is central also in Hargadon and Douglas’ (2001) answer, from the point of view of institutional theory, to the individuation dilemma. Drawing upon a historical analysis of Edison’s light bulb and on Eccles, Nohria and Berkley’s (1994) notion of ‘robust action’ as actions that are ‘effective in the conditions

of a relatively short run’ and that ‘remain adaptive in the face of uncertain and evolving conditions in the long run’ (2001: 479), Hargadon and Douglas (2001: 488) present ‘robust design’ as a means of successfully handling the tradeoff between similarity and difference:

An innovation’s design is robust when its arrangements of concrete details cues schemas and scripts that are immediately effective in the short term, by invoking preexisting understandings, but that do not constrain us to discover new ways to interact with the new ideas as our understandings evolve. So the challenge for developers of an innovation lies in pursuing robust designs—in deciding which details to present as new, which to present as old, and which to hide from view altogether.

From the point of view of robust design as the central means of overcoming the individuation dilemma, Edison’s genius lay not so much in the technical superiority of his work—on the contrary, in the beginning it was far from clear that his innovation even was technically superior—but in his goal ‘to effect *exact imitation* of all done by gas so as to to replace lighting by gas with lighting by electricity’ (Basalla 1988: 48; italics added). Although outside of the scope of this dissertation, it would be interesting to ask how this dilemma, facing as it does margarine and electricity infrastructure alike, relates to the notions of ‘boundary objects’ and especially ‘boundary infrastructures’ as analyzed by Bowker and Star (1999). Boundary objects are objects that ‘have different meanings in different social worlds but their structure is common enough to more than one world to make them recognizable, a means of translation’ (1999: 297). Presumably, the tradeoff between similarity and difference is present also in these kinds of translations.⁵

In sum, my review of the literatures of consumer research and STS from the point of view of the individuation dilemma reveals that 1) the individuation dilemma is both known and partially addressed in both literatures; but that 2) the specifics of this dilemma are not explicitly thematized nor empirically analyzed in any one current or work. The two literatures reviewed do, however, yield a number of useful analytical tools for understanding what happened in the individuation process of Gefilus. The five most important are: a) *domestication*, which refers to the way in which a new and unfamiliar object or commodity becomes familiar to a specific audience, b) *technological frame*, which refers to the interpretations that different social groups make about an object or commodity in making it familiar to a particular audience, c) *scenario of use*, which refers to the

⁵ Strategies of concealment have been studied also within the rhetorics of science, where, e.g., Ceccarelli (2001) has identified the two strategies of ‘interdisciplinary chiasmus’ and ‘polysemantic textual constructions’ as being particularly good at effecting translations across knowledge perspectives.

visions of how the object is to be used by people embodying specific technological frames, d) *type repertoire*, which refers to the contents of the individual cognitive frames of people creating scenarios of use for new goods, and finally e) *torque*, which refers to a serious twist in the process of making the new object familiar or natural to an audience.

Of these five concepts, I will use three—*domestication*, *scenario of use*, and *torque*—as given background notions in the empirical analysis of the Gefilus individuation process (in section 4 of this summary). I will return to the notion of technological frame later in this section. Also, at this point I wish to take the opportunity to clarify that these five notions, and the literatures and perspectives that they are embedded in, were chosen on the basis of how well they contribute to the theory underlying the empirical analysis in the next section. Now, however, it is time to take a closer look at the framework of conceptual blending.

3.3 *The conceptual blending framework*

In order to understand the argument, however, it is necessary to begin by looking at the basics of the conceptual blending framework Fauconnier and Turner (2002). This framework can be seen to continue a centuries-long debate on the nature of ‘cognitive frames’, or the structures in our minds that organize the way we perceive and interpret the world. Within science and technology studies, the issue of cognitive frames has recently been addressed by Konrad (2008), who makes reference to the thinking of Alfred Schutz (see Paper III). Schutz’s thinking aligns well with prototype theory in cognitive science (e.g., Rosch 1983). Prototype theory is a mode of graded categorisation whereby some members of a category are more central than others. Today, there are a number of graded categorisation approaches similar to prototype theory. Recent examples are adaptive and emergentist views about conceptual modeling as proposed by Gärdenfors (2000), Kohonen (2001), Honkela et al. (2008) and Li, Farkas, and MacWhinney (2004; see also Zadeh 1965). Within cognitive science today, the most elaborate work on concept formation processes is conceptual blending developed by Fauconnier and Turner. Building on graded categorisation approaches, they attempt to explain the ‘hidden’ cognitive mechanisms that explain how new concepts and categories are *formed*. Thus, in addition to giving the contents of cognitive frames, the framework conceptual blending shows how those cognitive frames *change* (Fauconnier and Turner 2002).

Conceptual blending claims to account for the workings of human creative mind (Fauconnier and Turner 1998; Fauconnier 2001). The approach explains how it is possible that something new can emerge from previously unconnected knowledge structures by showing how new emergent structure selectively arises from previously unconnected ‘input spaces’. A classical example of the cognitive process of conceptual blending is the game of trashcan basketball played all over the world by bored children and office workers (see Figure 5). In this game, children invent a challenge in which you have to throw a crumpled-up sheet of paper into a wastepaper basket. One category, or input space, from which this game draws resources is partial knowledge of basketball; another category or input space is the situation of trash disposal with paper and wastepaper basket etc.

What happens when the children start playing this game is that, based on structural similarity, elements from one input space start to become mapped onto the other input space: A ball in one input space now relates to a crumpled paper, a basketball basket to a wastepaper basket, and players to children. These partial mappings then project onto yet another space, that of the blend: In the new game, some properties are projected from the ‘basketball’ input, some from the ‘trash disposal’ input. Some properties (such as throwing a projectile into a receptacle) are shared by the two inputs, thereby creating a generic space containing that which the inputs have in common.

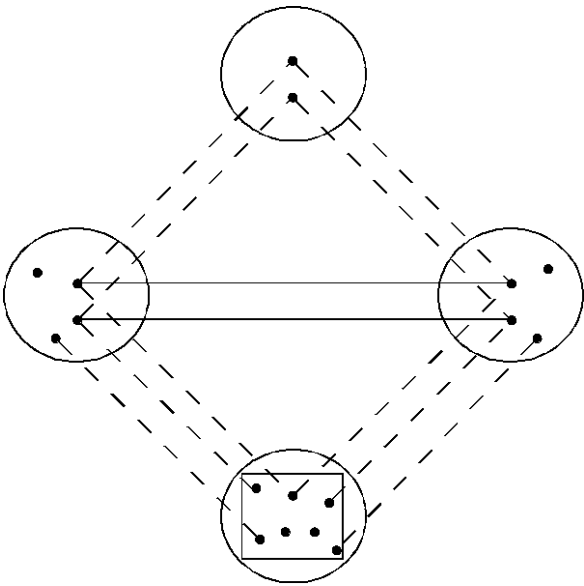


Figure 5. The conceptual integration model. The mental spaces are represented by circles, the elements by dots. The non-dotted lines represent cross-space mappings between elements in the

input spaces (ball-crumpled paper, players-children), the dotted lines represent projections to the generic space on the one hand, and the blended space on the other (adapted from Fauconnier and Turner 1998; see also Coulson and Oakley 2000).

Blends also typically *compress* conceptual material. For instance, in the Sámi blend ‘mosquito is not heard in heaven’ (see Hukkinen 2008), the concept of humans (that are not heard by authorities deciding on the issues of the Sámi people) are compressed into the image of a tiny mosquito. Finally, since the blend of trashcan basketball involves two *different organizing frames* (i.e., a game and waste disposal), this conceptual integration network is characterized as a *double-scope network* (Fauconnier and Turner 1998; Fauconnier 2001). Conceptual integration networks come in many forms and shapes depending on, e.g., whether the input spaces share the same organizing frame or not. Furthermore, the fact that this example comes from *practices* (basketball, waste disposal) is important; practices of various kinds are the *sine qua non* of conceptual blending. This is reflected in the work of Hutchins relating to ‘material anchors’ of conceptual blends. According to Hutchins (2005), we externalize much of our cognitive work onto external props, which function as material anchors for conceptual blends combining conceptual and material structure. A similar argument has recently been made by Slingerland (2008: 209): “From analog and digital gauges to money and tombs, and to the very graphemes that make up written language [...], physical objects and other concrete symbols in our environment serve as ‘material anchors’ that reify blends and make them available to be used as inputs in further blend construction”.

Conceptual blends, then, can be seen to be an extension of the Schutzian idea of types and type repertoires. Like types, blends capture ‘the mind’s conceptual content’. However, although the theory of types does contain a model for how concepts or types *change* (the new types can be modifications of existing types, differentiations into sub-types, or a new type that emerges as a synthesis of multiple types), it does not go as far in showing the actual *processes* through which such transformations take place. Furthermore, although Konrad does state that types ‘may be specific for individual actors, small actor groups or they may be part of the social repertoires of larger communities of actors, e.g., within a technological field’ (2008: 7), she does not characterize the nature of the knowledge structures in which they purportedly form the content. This nature, however, has been the almost exclusive focus of researchers working within the field of organizational cognition (e.g., Walsh 1995; Meindl, Stubbart and Porac 1996). These researchers have taken keen interest in knowledge structures because of their double function as both central action enabler (since such structures transform complex problems into tractable ones) and action

constrainer (since they may blind, e.g., strategy makers to central changes in their environment). (Walsh 1995).

Two traditions have shaped the study of organizational cognition: decision making theory, which draws on the information processing paradigm, and the interpretive and intersubjective perspective, which opposes many of the presuppositions of the previous tradition (Meindl et al. 1996; Eden and Spender 1998). Both traditions share, however, an understanding of the basic organizing structure that represents the information worlds of managers and thereby facilitates their cognitive and other activities. Within organizational cognition research, this organizing structure has been coined ‘knowledge structure’ (Shank and Abelson 1977; Walsh 1995; Eden and Spender 1998). A knowledge structure is ‘a mental template that individuals impose on an information environment to give it form and meaning’ (Walsh 1995: 281). It thus refers to the cognitive structure underlying top-down and theory-driven (as opposed to bottom-up and data-driven) information processing, and it comes very close to the notion of ‘schema’ (e.g., Abelson and Black 1986). The mental template is called knowledge structure because it ‘represents organized knowledge about a given concept or type of stimulus’ (Fiske and Taylor 1984, quoted in Walsh 1995). The mental template or knowledge structure consists of organized knowledge about a specific information domain, which makes it important to draw a distinction between the *content* and the *structure* of an individual’s knowledge structure (Walsh 1995; Meindl et al. 1996). A knowledge structure is built on an individual’s past experience in an information environment, and it orders that environment in a way that enables interpretation and action (Walsh 1995; Eden and Spender 1998). Knowledge structures are specific to various information domains (Walsh 1995).

However conceptualized, the knowledge structures discussed by Walsh (1995) can all be said to refer to cognitive frames of sorts. Here, I take the notion of cognitive frame to refer to any kind of top-down knowledge structure for information processing that guides human action, and consider the *content* of those cognitive frames and scripts to consist of conceptual structure the closer nature and working principles of which has been described by proponents of conceptual blending.⁶ Next, I

⁶ In discussing the more specific nature of structures guiding knowledge and action, I have only made reference to the ‘top-down information processing’ paradigm, thereby ignoring its opposite, that of the ‘bottom-up pattern recognition’ paradigm currently challenging the mainstream top-down approach (see, e.g., Gärdenfors 2000). Space does not allow me to go deeper into this second approach and its very different accompanying epistemology, and the various kinds of methods that they employ in their respective inquiries. Suffice it therefore to state that it is by no means self-evident that concepts and their changes are best characterized with the aid of any kind of notion of a frame, and that there are many conceptualizations of these phenomena that fundamentally challenge many of the presuppositions taken for granted by the predominant Western tradition.

will move from the individual level to the level of collectivities and show how the notion of technological frame provides the starting point of the *pragmatic* account of individuation in Paper I of this dissertation, i.e., that of KN.

3.4 Knowledge networking: a pragmatic approach

The perception of similarities and differences, and designing objects that reflect certain kinds of similarities and differences rather than other, is fundamentally an issue of knowledge, meaning and understanding. For short, it is an issue of symbolic representation. People do not perceive similarities and differences in a vacuum, as it were, but only against the background of some pre-understanding provided to them by their ‘cognitive frames’ or ‘schemas’. Cognitive frames are the lenses through which we, as individuals, make sense of the world; they are, *a fortiori*, thus also the devices through which we are able to make sense of the world of goods. However, individuals’ perception of similarity and difference is not only shaped by their individual cognitive frames. Within the social studies of science and technology, terms abound that make a reference to some kind of collective-level knowledge structure that directs and guides the perceptions and judgments of innovators and consumers alike (some examples are ‘technological frame’, ‘epistemic culture’, ‘technological paradigm’, ‘social group’, ‘practice-bound imaginary’, and ‘thought world’; the list could be made longer). Thus, KFs emanating from our various knowledge inhabitations—in disciplines, in professions, in hobbies—also shape our perception of the world and of our own action in it (see Papers I and III).

Within consumer research and science and technology studies, a number of terms have been suggested for such collective knowledge structures, starting from Fleck’s (1935) ‘thought worlds’ via Kuhn’s (1962) ‘paradigm’ over to Bijker’s (1995) ‘technological frame’ and Knorr-Cetina’s (1999) ‘epistemic culture’. Knowledge has also been a keen area of interest within the field of organizational cognition (e.g., Walsh 1995; Meindl et al. 1996), innovation research (e.g., Tidd, Bessant and Pavitt 2001; Carlile 2002; von Hippel 1988; Dougherty 1992; Miettinen, Lehenkari, Hasu and Hyvönen 1999), economics (e.g., Nonaka and Takeuchi 1995; Davenport and Prusak 1998; Murray 2001), organizational studies (Brown and Duguid 1991; Boland and Tenkasi 1995; Hargadon and Sutton 1997) and social scientists researching interdisciplinarity (e.g., Klein 1990, 1996; Boden 1999). Within the international relations and environmental governance literature there is also the notion of ‘epistemic community’ (e.g., Haas 1989, 1992; Thomas 1997).

Despite this upsurge of interest in knowledge and its significance for the unfolding of innovations, however, few authors in any of the research streams mentioned above have attended *specifically* to what might be called the *epistemic* aspect of interaction in innovation processes, i.e., to aspects of such collaborative endeavors that have to do *specifically* with the impact of there being significant differences between the *bodies* of knowledge that are made to encounter each other (see Paper I). For instance, the approach of ‘knowledge management’ as created by Nonaka with colleagues starts out promisingly with the aim of addressing questions of ‘What is knowledge in organizations and how can it be shared’, but then, despite all claims to the contrary (see, e.g., Nonaka and Takeuchi 1995), ends up treating knowledge-sharing as mainly an issue of access to information (e.g., Hansen 1999; Cross, Parker, Prusak and Borghatti 2001; Gold, Malthora and Segars 2001). The innovation literature similarly tends to black-box knowledge structures and processes in favor of institutional and technological mechanisms (e.g., Tidd et al. 2001).

Some authors within these fields do break this pattern (e.g., Nonaka and Takeuchi 1995, Iansiti 1998; Miettinen et al. 1999; Cuzmano 2000; D’Adderio 2001; Grant 2001; Murray 2001; Dougherty 1992; Boland and Tenkasi 1995). However, even the research that goes comparatively deep into knowledge structures and their significance for innovation processes, such as, e.g., Miettinen et al. (1999), tend to remain content with looking at the activities of the knowledge-bearing agents (e.g., the ‘perspective making’ and ‘perspective taking’ of Boland and Tenkasi 1995) rather than at the characteristics of the actual knowledge itself, as well as with the observation that knowledge in innovation processes is often ‘complementary’ (e.g., Miettinen et al. 1999).

Although this is both important and true, leaving the issue at this point fails to address both the more specific character and composition of knowledge perspectives and the multitude of problems that can arise due to the significant differences between them. The main aim of the conceptual framework of *KN* as presented in Paper I is precisely to provide analytical categories and tools for analyzing problems that arise from difference in knowledge perspectives. *KN* refers to processes of interaction across knowledge-related defined boundaries between individuals, groups, or units. It is the activity of forming and maintaining an epistemically heterogeneous social structure—i.e., the *knowledge network*—as part of some trajectory of learning and knowledge generation. The networking thus links knowledge actors having different knowledge perspectives to each other, and to a particular focus and shared effort (see Paper I).

The starting point for the conceptual framework of KN is the notion of *knowledge framework (KF)*, which refers to socially constructed frameworks of perception and reflection. Such frameworks can in some cases be the result of the particularities of the specific task at hand and the context for action. Often, however, they are the result of a broader systematization of thinking within specific fields. In the latter case, my co-authors and I have preferred to speak of *knowledge regimes (KR)* rather than KFs. The notion of KR refers to a system of practices, norms and rules through which a certain KF is consolidated and reproduced (see Paper I). KRs generate *scripts for behavior*, or paradigmatic exemplars or prototypes for how actions should be performed (Nooteboom 2001). Some scripts for behavior are fundamental, regulating the basic mode of learning and the type of knowledge that is sought, and cannot be changed without altering the regime. Others are more open for change, at least in the long term. These include the culture and organization of knowledge creation as well as the basic concepts, methodologies and theories that are used. On the most dynamic level, there are specific methods, techniques and instruments, as well as concepts and theories, that are outside of the epistemological core of the regime, and therefore relatively easy to change (see Paper I).

The definition of KN as learning and knowledge production by interaction across epistemically defined boundaries immediately raises questions about the nature of such boundaries and about the means with which they can be identified. To address this issue, the KN approach proposes a set of parameters or criteria for the specification of a KR. Common for all KRs is that the KFs that they consolidate and reproduce fulfill three criteria of identification: they 1) define a certain domain of objects and relations as the object of knowledge; 2) promote a distinct methodology (including methods and instruments) for learning and knowledge generation; and 3) embrace a particular interpretation of why learning and knowledge generation is important, and of the role that the knowledge-generating agents are supposed to play (see Paper I). Furthermore, it is important to note that not all KFs are taken to be scientific or academic. The object domain and the methodology include, for instance, various types of knowledge (e.g., know-what, know-why, know-who and how) as well as various modes of learning (e.g., learning by doing, learning by interacting, learning by searching, and learning by simulating (see Paper I).

Concrete examples of KFs as they have been studied in Papers I and II are the two KFs at play in the Gefilus innovation process (see Table 4). As the company developed its first Gefilus product, various epistemic boundaries had to be crossed, including disciplinary boundaries in research and cognitive and organizational boundaries in innovation. More specifically, a *new way of thinking*

about the business of food developed within the company, eventually forming a process of internal networking (identifiable as the Gefilus network on the basis of the three parameters described above) that promoted a scientific basis for product development.

Despite initial resistance from the rest of the company (at times, however, the issue was more of a lack of understanding than about active resistance), which was still working within the confines of an old, traditional KF, the Gefilus network gradually gained foothold and consolidated into what can be characterized as an independent KR. At Valio, the hardest part in the introduction of the new way of thinking was to align the use and practice of leading edge science with the more down-to-earth approach that characterized much of the work done in the company at the time. In order to understand the new way of thinking, the people within the traditional mode had to extend *the very notion of food* to include aspects that had previously belonged squarely to the sphere of drugs, such as, e.g., the credibility of the science behind the new ingredient. More specifically, it would seem that this *difficulty in extending the object of knowledge* was the focal point of the communicative challenges between the two KFs (see Papers I, II and III; see also Table 4).

	THE GEFILUS KF	THE TRADITIONAL KF
OBJECT OF KNOWLEDGE	<ul style="list-style-type: none"> - Microbes, especially Lactobacilli; other milk ingredients (proteins, lipids etc.); specialized milk processing technology; trends in scientific research; trends in health-related behavior - Research and development in industrial and academic contexts 	<ul style="list-style-type: none"> - Traditional dairy products; the processing, developing, marketing and selling of bulk dairy products - Changes in consumer preferences; changes in market trends - Logistics (own advanced distribution network)
METHODOLOGY FOR LEARNING AND KNOWLEDGE GENERATION	<ul style="list-style-type: none"> - Methods: visioning, planning; scanning research journals, magazines and internet fora; conducting scientific research; attending scientific conferences; collaborating with spear-head research 	<ul style="list-style-type: none"> - Methods: collaborating with applied research units on improvement of process technology; organizing product tastings; surveying, analyzing and forecasting consumer and market changes

	units - Instruments: research laboratories within and outside the firm; the company's technology licensing business unit; latest ICT technology	- Instruments: milk processing technology; employee's taste organs; surveying and forecasting devices; latest ICT technology; devices for logistic analysis
EPISTEMIC SELF-UNDERSTANDING	- Purpose: bringing forth radically new innovations with high added value - Measures of success: successful completion of expensive and long-term research and development projects - Image: dynamic, commercially informed scientist	- Purpose: to produce high-quality bulk dairy products; to act as guarantor and developer of the livelihood of milk producers - Measures of success: growth in short-term sales figures - Image: reliable producer of high-quality dairy products

Table 4. The characteristics of two KFs that competed with each other within Valio, a large Finnish dairy company, in the late 1980s and early 1990s. (Reprinted from Paper I.)

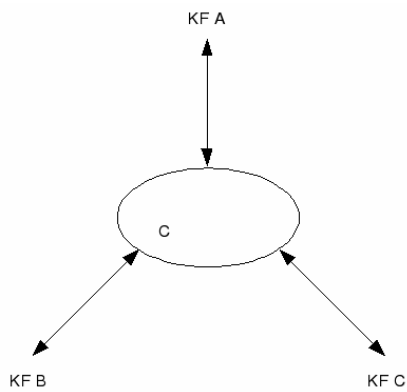
The term *KF* thus refers to a certain way of learning and knowledge generation that becomes consolidated and reproduced by a *KR* or a system of individuals, organizations, institutions, intellectual and material resources, practices and values. There are several possible forms for such knowledge structures to interrelate in concrete collaborative efforts, each associated with problems that are specific to them. One form that such linking of knowledge actors with differing KFs can have is that of *modular KN* (MKN). This is the simplest kind of KN and it organizes learning and knowledge generation through two levels. Level 1 consists of separate and independent modules of learning and knowledge generation, and Level 2 of an integrating function (see Figure 2a).

MKN is common in industrial manufacturing and in innovation. However, it can be found anywhere where knowledge generation is organized through component production and integration. For instance, multidisciplinary scientific projects are often implemented as MKN, with each disciplinary representative focusing on his own field of expertise and a project coordinator combining the knowledge produced as project reports, anthologies or seminars. What makes such products modular is that the focus is on combining KFs, not on effecting direct communication between them. Metaphorically, it leaves each framework as a black box, but seeks to combine the various black boxes. Academic MKN can be explorative in the sense that it combines perspectives

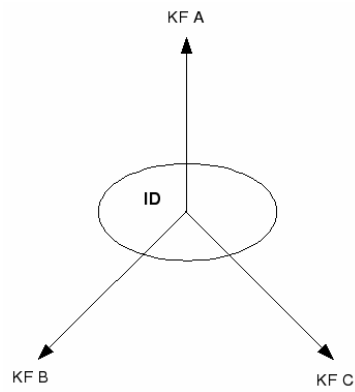
in new ways, and thereby provokes in its audiences a broader or otherwise different grasp of the problem at hand than is customary. However, the scope of exploration is usually limited due to the restricted degree of interaction between frameworks (see Paper I).

In contrast, *pioneering KN* (PKN) is based on the participants transcending their own KFs, generating and integrating knowledge through direct communication across framework boundaries without any mediators (see Figure 2c). Such lack of initial common ground often occurs among new cooperation partners. Where MKN sought to *combine*, PKN seeks to *explore* and *synthesize*. PKN can be found, for instance, in contemporary attempts to integrate computer science with bioscience, or bioinformatics. In comparison with MKN it is, however, a more risky endeavor, since it 1) requires a high degree of methodological self-awareness and self-reflection (this is because there are no fixed rules for how to solve the knowledge-related problems that are bound to arise); 2) requires a certain disposition and certain competencies, such as openness for new impressions, fearlessness in the face of the unknown, and the ability to codify and communicate one's own perspective to the others; and 3) requires the effective bridging of social and cultural differences between KFs (see Paper I).

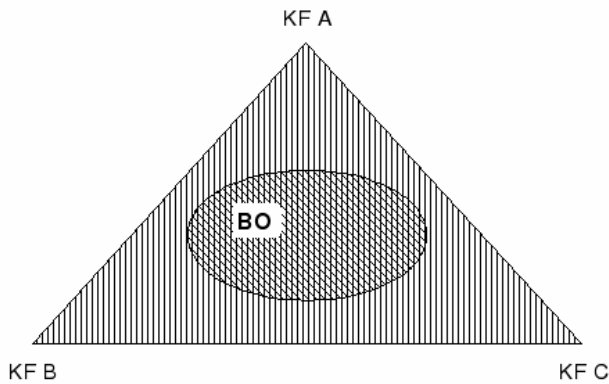
The third form of KN, *translational KN* (TKN) can be regarded as a hybrid between MKN and PKN. With MKN, it shares the division into Level 1 and Level 2. However, where MKN has the coordinator, TKN has a standardized, mediating code that translates the language of particular KFs into a language that can be understood by all (see Figure 2b). TKN can be found, for instance, in industrial design, which requires intense interaction between different functions. Examples of standardized, mediating codes, or, with a more general term, *interfacing devices*, are Delphi questionnaires, laboratory protocols, and standardized scientific ontologies (see Paper I). With PKN, TKN shares the challenge of effecting a more direct communication across framework-related borders. However, whereas engaging in PKN is greatly challenging to its participants, for TKN the challenge is mainly to design interfacing devices that work well and to manage and organize their use (so-called interface management). The main challenge for managers of TKN is to stimulate effective communication between the global (Level 2) and local (Level 1) levels (see Figure 2; see also Paper I).



a. Modular KN



b. Translational KN



c. Pioneering KN

Figure 2a-c. The communicative structure of three modes of KN: modular, translational and pioneer KN. (Reprinted from Paper I.) Key: KR=Knowledge regime; C=Coordinator; KF=Knowledge Framework; ID=Interfacing Device; BO=Boundary object.

Again, a concrete example of a process of KN is provided by the Gefilus case study (see Table 8). The Gefilus innovation process started with processes of *pioneer* KN, which eventually led to the discovery of the LGG bacterium, the future main ingredient in the Gefilus products. However, in the Finnish dairy company Valio, *modular* KN took over for nearly a half-decade. The pattern was to persist until the mid-90s, when there was a last effort to make the product succeed nationally. In this last and successful attempt, pioneering KN was again utilized (see Table 8). It is highly

noteworthy that this KN process completely lacks the *translational* mode. I will return to the intricacies of the Gefilus KN dynamics in section 4.2 below.

The KN approach as it has been presented here is still very much in its beginning, and therefore still in need of elaboration. However, it is possible to discern a *correlation* between the *structure of problems and challenges encountered* and *KN modes*. More specifically, it seems well-advised to respond to *ill-structured* problems (i.e., problems that addresses complex issues and thus cannot easily be described in a concise, complete manner) with *pioneering* KN, and to *well-structured* problems (i.e., problems that have a clearly defined starting point, a finite set of operators, and a clear goal) with either *modular* or *translational* KN (see Paper II; see also Bruun and Sierla 2008). However, other problem characteristics may have an influence on the choice of mode of KN, and it is also possible that a certain form of KN might affect the ways in which problems are defined (Bruun and Sierla 2008).

This correlation between problem type and KN mode has been developed further in Bruun and Sierla (2008). Bruun and Sierla start from Newell and Simon's (1972) classic conceptualization of problem solving in terms of 'problem space', which is defined as the field of possible states that a specific problem yields (2008). Problem solving consists in the transition from an initial problem state to a goal state, and this is achieved by identifying and using different kinds of operators, e.g., tools and techniques (Bruun and Sierla 2008). In this view, *well-defined* problems are situations in which the initial problem is clearly stated, the appropriate operators are easy to identify, and criteria for regarding the problems as solved are unambiguous (2008). In contrast, *ill-defined* problems are more complex, do not supply all the information required for the solution of the problem, and have less specific criteria for knowing when the problem is solved (Simon 1962). However, since its conception this view of problem solving has encountered many difficulties. One central problem with this view is that it regards problem solving to be deductive in nature (i.e., that problem solving is a matter of following rules) and that it does not consider the broader context within the activity of problem solving occurs (Bruun and Sierla 2008).

In view of these problems, a contrasting view of problem solving that is based on 'optimization modeling' has developed. It regards particular facts and circumstances as *constraints* upon new facts (i.e., the problem definition and the proposed solutions to the problem). Contextual (Dreyfus 1972; Suchman 1987) and connectionist (Bechtel and Abrahamsen 1991) approaches to problem solving can be seen to fall within this category (Bruun and Sierla 2008). Here, the outcome of

proposals is projected onto a ‘fitness landscape’ in which different problem definitions and solutions can be evaluated for how well they fit particular constraints (2008). In this landscape, hills represent increases in fit, while valleys represent decreases in fit. In complex landscapes, there are many hills and valleys of varying height and depth (2008). The landscape does not remain constant, but may change during the problem solving process, and there is no general role for optimization in the definition of problems and the search for solutions. Optimization can range from very narrow search to extensive exploration, depending on a number of factors (Bruun and Sierla 2008).

Why have I chosen the label ‘pragmatic’ for this rather intricate KN approach? The main reason for this is choice is that in contrast to many other ways of addressing knowledge issues in the literatures referred to above, this approach gives concrete and specific advice on how to *organize* collaboration processes based on *knowledge-related* structures and not, say, on issues of a more social character, such as position in social or informational hierarchies. Basically, what the approach is saying is that ‘if you aim for *this* kind of integration of knowledge, *then* you are well advised to choose *that* mode of organizing your activities’. The KN approach has been used in, for instance, the study of knowledge integration in functional food innovation processes (Paper II in this dissertation), the study of the integration of knowledge in contemporary biomedical research, more specifically the functional genomics approach and the bioinformatics approach in such biomedical research (Bruun 2006), and the study of distributed cognition in the development of automation technologies for agriculture (Bruun and Sierla 2008).

It is my view that this approach can form a good pragmatic complement to more cognitively oriented studies of, e.g., individuation processes. Before turning to this, however, a critical question needs to be answered: Where, in this account, are all *the people* who generate and integrate knowledge? Furthermore, where are all the myriads of concrete details and doings that usually go into new product development? This is our next topic.

3.5 Practices, people and communities

During the intricate process of developing new products, few would think about their activities in terms of KRs and KFs (Bruun et al. 2003; Trott 2002). What matters from the point of view of an individual’s everyday activity is the *practice* in which one is engaged. Indeed, within new product development literature, the starting point has long been various kinds of notions that relate to the world of practical, hands-on doing. Trott (2002) warns about the risks of abstracting too much away

from the world of enmeshed practitioners and highlights the challenges involved in establishing *cross-functional teams*. The seminal papers of Brown and Duguid (1991) and the work of Wenger (e.g., 2002) create and adopt the notion of *communities of practice* as the baseline for thinking about knowledge dynamics in product development work. Boland and Tenkasi (1995) take the analysis one step further and speak explicitly of *communities of knowing*. Where in all this practice-related thinking does the pragmatic approach fit in? Are we to think of it as an attempt to *replace* existing, by now well-established practice-based ‘perspective makings’ (Boland and Tenkasi 1995) or as an attempt to *supplement* them by structurally more fine-grained analyses?

As will become evident in the following, my own take in the issue leans more towards supplementation than towards replacement. I also believe that there is much to be learned—*both ways*—from juxtaposing these two perspectives or styles of thinking. In order to see how, it is useful to start with the kind of ‘basic template’ for new product development processes sketched by Trott (2002). Trott begins by noting that to many people, new products are the outputs of the innovation process, where the new product development (NDP) process is the subprocess of innovation: “Managing innovation concerns the conditions that have to be in place to ensure that the organization as a whole is given to develop new products. The actual development of new products is the process of transforming business opportunities into tangible products” (2002: 200; see Figure 3). In recent decades, the organizational activities of a company undertaking actual processes of new product development have been represented by numerous different models, of which Trott (2002: 214) lists the following: 1. Departmental stage models 2. Activity-stage models and concurrent engineering 3. Cross-functional models (teams) 4. Decision-stage models 5. Conversion-process models 6. Response models and 7. Network models.

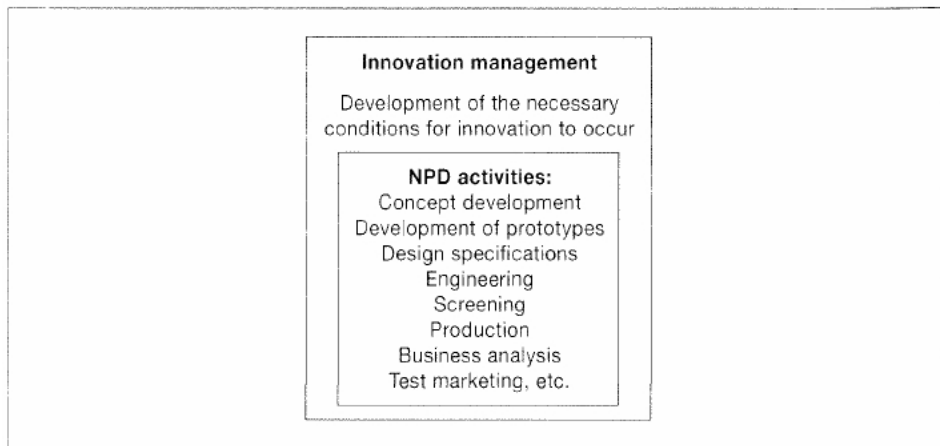


Figure 3. A conceptual framework linking innovation management and NPD (reprinted from Trott 2001).

Of the models, the last or the network model represents the most recent thinking on the subject (Trott 2002: 218; see Figure 4). According to this model, knowledge is accumulated from a variety of different inputs, such as marketing, R&D and manufacturing, and it builds up gradually over time as the project progresses from initial idea (technological breakthrough or market opportunity) through development (2002: 219). This view of the process forms the basis of network models, which accordingly emphasize that external linkages coupled with internal activities contribute to successful product development (Trott 2002; Nonaka and Takeuchi 1995). Thus, the accurate metaphor for the process of NPD understood as a process of knowledge accumulation that requires input from a variety of sources is that of “a snowball gaining in size as it rolls down a snow-covered mountain” (Trott 2002: 219).

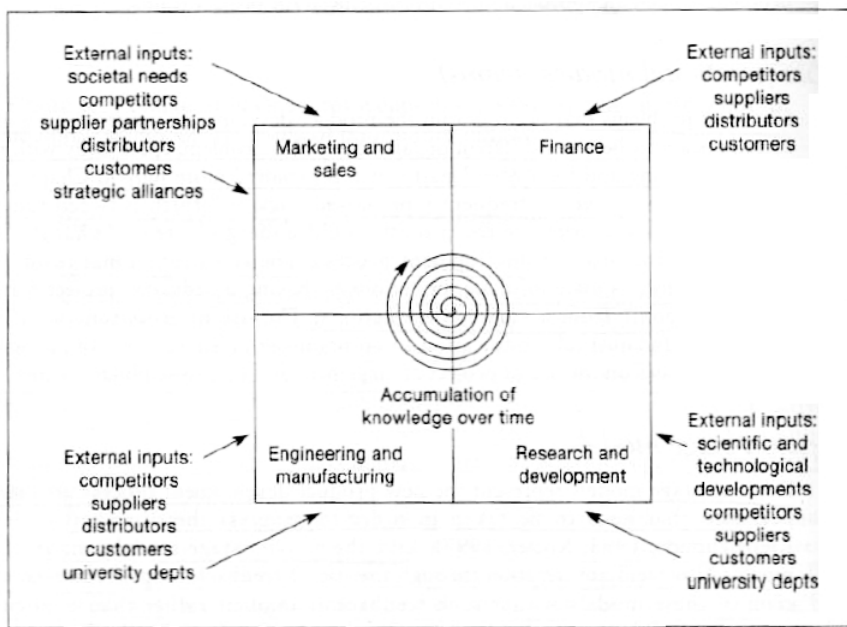


Figure 4. A network model of NPD (reprinted from Trott 2001).

However, it is possible to approach this basic process of NPD as knowledge accumulation from two quite distinct perspectives. On the one hand, it can be approached from the ‘structuralist’ point of view of knowledge structures such as KRs and KFs, as I have done above. On the other hand, it can be approached from the ‘practice-oriented’ point of view of knowledge practices or knowledge work, such as cross-functional teams (Dougherty 1992; Trott 2002; Hauptman and Hiriji 1999; Olson et al. 1995; Sethi, Smith and Park 2001), communities of practice (Brown and Duguid 1991; Wenger 2002), communities of knowing (Boland and Tenkasi 1995) and technology brokering (Hargadon and Sutton 1997). Whereas the former approach emphasizes the need to look more specifically at the structural characteristics of different bodies of knowledge, the latter tends to be highly critical towards attempts to design work or organizations without regard for the actual work performed by the organization (for an excellent example, see Barley and Kunda 2001). Indeed, the case could even be made that the approach that I have here presented as ‘pragmatic’ falls prey to exactly the kind of abstract distancing from real world work and knowledge processes that leads the whole field of organization studies astray in misleading and distancing abstractions (Barley and Kunda 2001: 77).

Doing so, however, would be to throw the baby out with the bathwater. The pragmatic approach as I have represented it here has not been the result of armchair reasoning. Instead, it is the result of process of induction and abstraction *from existing descriptions of collaborative work processes* found in organizational studies with the intent of producing a new category or tool for understanding processes of knowledge integration that can then be applied as a guiding instrument when approaching new empirically rich cases. Indeed, this way to proceed comes very close to the one exemplified by Lave and Wenger's (1990) concept of learning as 'legitimate peripheral action':

Lave and Wenger (1990), with their concept of legitimate peripheral participation (LPP), provide one of the most versatile accounts of this constructive view of learning. LPP, it must quickly be asserted, is not a method of education. It is an analytical category or tool for understanding learning across different methods, different historical periods, and different social and physical environments. It attempts to account for learning, not teaching or instruction. Thus this approach escapes problems that arise through examinations of learning from pedagogy's viewpoint. It makes the conditions of learning, rather than just abstract subject matter, central to understanding what is learned. (Brown and Duguid 1991: 48)

To make the analogy explicit: The notion of learning as 'legitimate peripheral participation' [KN] is, in its capacity of being an analytical category or tool for understanding learning [knowledge integration], of course, an inductive abstraction from specific "different methods, different historical periods, and different social and physical environments". However, neither it nor the notion of KN are based on contestable armchair reasoning. Both the notions of LPP and the notion of KN are making the *conditions of learning* [knowledge integration] central to understanding what is learned. In the case of *learning*, the notion of LPP draws attention to the need of learners to become 'insiders' in communities of practice by first participating in its workings at the margins. In the case of *knowledge integration*, the notion of KN draws attention to the need of knowledge integrators to attend to problems related to the different ways in which bodies of knowledge can be related (modular, translational, pioneering). It is very difficult—indeed, next to impossible—to see why the first kind of inductive abstraction process in order to find a new "analytical category or tool" should be legitimate and the second not.

Against this background, it is perhaps easier to see why the 'structuralist' notions of KR and KF, and the 'practice-oriented' notions of community of practice and community of knowing, are not 'on a par' when it comes to picking out the phenomena going into the NPD "knowledge accumulation spiral", as it were (see Figure 4). In line with their status of inductively abstracted

analytical categories or tools, the ‘structuralist’ notions of KR and KF are used to pick out similarities and differences in *the collective knowledge structures* observed in some specific empirically rich case. These collective knowledge structures form only an *aspect* of the phenomena characterized by the infinitely richer notions of communities of practice and communities of knowing, which both pick out *collectives of people doing and knowing things*: indeed, communities of practice are *defined* as being comprised of “practitioners who do roughly similar work” (Barley and Kunda: 2001: 87), while a community of knowing is “a community of specialized knowledge workers” (Boland and Tenkasi 1995: 351).

Perhaps a metaphor could help in making this relationship between structures of knowledge, on the one hand, and structures of people *possessing* and *enacting* those structures in their working life, on the other, even clearer. If and when we create a representation of the KN processes taking place in some community of practice by, e.g., studying its communication in some of the fora for discussion and reflection described by Boland and Tenkasi (1995), this representation would function as an *avenue into* that community of practice. It would *not* describe that community of practice ‘in itself’, as it were, with all its myriad of practices and work processes incessantly going on, but would *give us an indication of* the kind of community of practice living its life over there (for a similar argument on ‘thought worlds’ as indicative of communities of knowing, see Boland and Tenkasi 1995). It is also worth noticing that exactly the same kind of distinction between *knowledge structures and contents*, on the one hand, and *doings and knowings* on the other, can be made at the level of the individual; only there the input going into the NPD accumulation spiral is, on the ‘structuralist’ side, conceptual blends, and on the practice-based side, specific “technology brokerings” and various “routines” for information search and storage (Hargadon and Sutton 1997).

Thus, although the four articles included in the dissertation focus mainly on the structural aspects of collaboration across knowledge borders, it is my view that a fully adequate understanding of innovation processes requires paying close attention to *both* the—collective and individual level—knowledge structures *and* the actual use and creation of knowledge as part of action (Bruun et al. 2003; Wenger 2002; Miettinen et al. 1999). The two approaches should thus not be seen as mutually exclusive, but as supplements that focus on different sides of one and the same situation (Bruun et al. 2003). The former allows us to understand the specifically knowledge-related conditions that prevail within a community of practice, conditions that are independent of individuals in the sense that they can remain the same despite the turnover of people (Bruun et al. 2003; Varela et al. 1999). The latter, again, reminds us that the structures described by the ‘structuralist’ approach have no life

in themselves, but must be enacted over and over again by human agents who are so much more than knowledge producers (Bruun et al. 2003; Bruun and Langlais 2002).

Characterizing the two approaches as complementary calls, however, for a discussion of the senses in which they enrich each other. What complements what, and how? Moving from the practice-based approach towards the ‘structuralist’ one, the obvious answer is that the former provides for *agency*, while the latter provides for *structure* (Giddens 1986). Importantly, however, the former also provides for *context*, an important aspect that the ‘structuralist’ approach tends to leave too ‘thin’ in specific analyses (Geertz 1973). This is a tendency that despite measures of correction have left their mark also in the analyses found in the current dissertation. For researchers within the ‘structuralist’ tradition, learning from the more ethnographically, institutionally, and interactionalistically oriented line of research might thus be worthwhile. Also moving in the other direction, from structure to practice, there are many opportunities for complementary learning. At the level of the collective, we know, for example, that many of the problems encountered in cross-functional teams stem from differences in KFs and the KRs underlying them. Not even the most thorough and far reaching of practice-based approaches (a case in point is Boland and Tenkasi 1995) can address those problems, since they do not move from the level of doings and knowings into the actual contents and structures of those doings and knowings. An enticing avenue for thought is also opened by the following quote from Hargadon and Sutton’s (1997) article on organizational routines for what they call “technology brokering” or “cross-fertilization” for sustained and renewed innovation: “There may be alternative ways of organizing for technology brokering that reflect different environments and different strategies and result in different sets of internal routines” (Hargadon and Sutton 1997: 747). Maybe the analytical category or tool of KN and the way it was created can provide some guidance as to how such alternative ways can be explored and ordered?

Such exploration along guidelines created by the ‘structuralist’ approach can also be envisaged for the individual level. As Hargadon and Sutton confess,

“Our effort to blend network and memory perspectives suggest that network theory might be developed further by devoting more attention to the transformation and combination of ideas and resources as they flow through network actors. The transformation and combination described in this paper occurs predominantly through individual actions within, and not between, such actors. ... But this perspective treats network actors largely as conduits that pass along unchanged ideas and resources to others. Little

attention is devoted to if, how, or why those ideas and resources are transformed and combined into new solutions for other actors and subgroups” (1997: 744-745).

To me, this looks like a direct call for socio-cognitive mechanisms such as those represented by Schutz’ theory of types, or the framework of conceptual blending as I have represented it here. Is it, for instance, thinkable that the ‘retrieval’ processes designers acting as technology brokers must be able to perform—“To recognize the potential value of a product’s technological components, the designers must abstract them from their specific, past implementation before adapting them to meet the needs of the current problem” (Hargadon and Sutton 1997: 738)—always has to involve moving through what blending theory calls the *generic* space in order to be productive (see Figure 7)? And that opening up “if, how, and why” ideas and resources are transformed and combined into new solutions thus is well advised to pay due attention also to the offerings of ‘structuralist’ approaches? These questions will have to be left for the future. The time, however, has come to move over to a cognitively oriented study of a specific individuation process, that of the probiotic *Gefilus*.

4. Empirical analysis of the Gefilus innovation process

4.1 Blending for individuation: conceptual integration networks

In their recent work, Shove and Pantzar (2005) have been using the notion of practice as involving the active integration of materials, meanings and forms of competence: 'More abstractly, we work with the notion that innovations in practice depend upon the active integration of elements, some new, some already well-established, that together constitute what we might think of as innovations-in-waiting or prototypes' (2005: 48). However, innovations in practice are not simply determined by these elements: 'What really matters is the way in which constitutive elements fit together' (2005: 61).

These observations are highly relevant also for the innovation under study in this dissertation, that of Gefilus products containing the LGG probiotic bacterium. The bacterium itself was discovered by Dr. Gorbach and Dr. Goldin in 1985, licensed by the Finnish dairy company Valio in 1987, and integrated into the first products and presented to Finnish consumers in 1990. Market breakthrough did not take place until 1996, however, when the Gefilus brand was re-introduced under the auspices of a major marketing campaign highlighting that the 'Bacteria to the Rescue' had at this point in time been introduced into milk (see Figure 6).

Naturally, this process did not unfold in a vacuum. In the last years of the previous millennium the competitive situation changed drastically in the food industry: the simultaneous occurrence of deregulation, increased international competition, shifting trends in consumer markets, and appearance of several new technologies created new working conditions for the food sector (Lagnevik et al. 2003). In particular, it created the need to shift from the production of commodity products to production and marketing of high-value-added products, where whether this value was high or not was to be determined by the consumer (Lagnevik et al. 2003; Niva and Jauho 1999). One such central new value was—together with organic food, ecological and ethical values, and the internationalization of food culture—health (Falk 1996; Lagnevik et al. 2003; Niva and Jauho 1999). Whereas the discussions around food in the 1970s centered around fat, salt and other 'unhealthy' ingredients, and in the 1980s were focused around various kinds of 'light' products, the major trend of the 1990s was 'positive healthy eating' and sustaining and promoting health by means of nutrition (Niva and Jauho 1999; Lagnevik et al. 2003).

Developing the Gefilus innovation was, then, a relatively early attempt at producing such a ‘high-value-added’ product. However, the difficulties it encountered especially in the beginning clearly reflects the ways in which it was—and is—not self-evident that the increases in health awareness channel into demand for health-enhancing or functional foods (Niva and Jauho 1999). Although there are few empirical studies on especially Finnish consumer reception of functional foods from the 1990s, the ones that do exist highlight the discrepancies between the optimistic belief in health trends by producers and retailers, on the one hand, and the much more reserved stance of the interviewed consumers, on the other (Niva and Jauho 1999). The studies especially emphasize the fact that such new ‘targeted’ foods need to find their place in relation to already existing views of health and healthy eating, views that despite some strong shared commonalities such as ‘versatility’ and ‘moderation’ still harbor a multitude of different claims and counterclaims made by various kinds of experts (Lagnevik et al. 2003; Niva and Jauho 1999; Beck 1992; Giddens 1991).

In this section, I will focus strictly on the first two of the elements mentioned by Shove and Pantzar—those of the *object* and the *image*. I will approach individuation from the point of view of conceptual blending, which means that I here begin to address the third research question of the dissertation, (i.e., how do individuation processes unfold from the point of view of knowledge structures?). My argument will be that with respect to both object and image, the Gefilus innovators performed a *second-order imitation* involving *double-loop learning* as an important element, and that this to a significant extent explains the unfolding of this particular innovation process.

4.1.1 The object of the Gefilus innovation

Previous studies of individuation processes (e.g., Pantzar 1995; Hargadon and Douglas 2001) have pointed out that the object of innovation undergoes a mimetic process that eventually results in the new object forming a distinct identity of its own. This process usually proceeds at one level only, i.e., the object imitates and eventually individuates from a similar object from the same product category. For Gefilus, the case is more complicated. Not only did the Gefilus innovators proceed at the first, ordinary level of similar products, they also finally learned to imitate a product at a *second* level of logic, that of functional foods. In doing so, they created a new object that drew on similarities and differences at *both* levels.

In Paper III, I have argued that conceptual blending can be a powerful cognitive tool for aligning the cognitive frames of users and producers. I have also shown how the object of innovation transforms as a result of repeated attempts at such alignment between the user-producer frames. In this section, I wish to expand on this argument and argue that conceptual blending is the central cognitive mechanism through which the tradeoff between similarity and difference is achieved at both the first and second order levels of logic with regard to the object of innovation.

As we remember from the previous section, Konrad (2008: 4) defined ‘scenarios of use’ as ‘the conceptual or fictive scenarios *as imagined* by designers, users or other actors involved in the development, production and diffusion of a new socio-technical system’ (italics added). She also argued that imagined use models and imagined prospected contexts of use are ‘type-based’, i.e., that they take form based on what kinds of ‘type repertoires’ the designers harbor. However, although she recognizes the significance of ‘type characteristics’ for the formation of use models and contexts of use, they are strangely absent when it comes to the element of the *object* of innovation. Thus, in Konrad’s work there is no explicit reference to the *imagined* or *projected* object.

Blending, however, trades precisely in such projected objects. Indeed, the main question within this perspective is how, more precisely, such projected objects are formed. Furthermore, since this approach is inherently process-based, it also shows the actual processes constitutive of such imagined or projected objects. In other words, it shows how the actual link between the old (type, prototype) and the new (type, prototype) takes place. Thus, a significant part of the process of forming a new *actual* object involves cognitive processes of comparison of similarities and differences with *other actual* objects reifying, as ‘material anchors’, preceding conceptual blends (Hutchins 2005; Slingerland 2008). This cognitive process eventually results in a *new blend* or *projected* object that can then again be materially ‘reified’ or ‘entrenched’ into an actual object. Thus, based on the above reasoning, more attention needs to be paid to the ways in which not only the *projected use models* and *contexts of use*, but also the *imagined or projected objects*, partake in the interplay between actual artifacts, practices, and scenarios of use.

Table 5 below provides a first and preliminary guideline of how such an integration of the projected objected and existing ways of thinking about scenarios of use might look like for the Gefilus innovation. Table 5 is, however, based only on projected objects as parts of scenarios of use that eventually were entrenched into actual artifacts. Although beyond the scope of this summary, a fully adequate representation would divide the ‘object’ row into projected and actual objects in a

way that represents also projected objects that for one reason or the other never materialized. For instance, in the early 1990s, there existed the projected object of a ‘total’ health product that would contain not only probiotic bacteria but also a number of other ingredients such as calcium; and the latter half of the 1990s witnessed the brief lifespan of the projected object of probiotic ice-cream. Explicitly including *the projected object* as an *analytical sub-category* would allow asking the question of *on what grounds* some blends move on towards processes of entrenchment and anchoring, while others fade quietly into oblivion (see Nagai, Taura and Mugai 2008).

At an even more general level, opening up the question of the imagined or projected object enables researchers within science and technology studies to address the central question of opening versus closure, stabilization versus diversification (e.g. Bijker, Hughes and Pinch 1987; Callon 1991; Akrich 1992a, 1992b, 1995; Konrad 2008). In dialogue with the social construction of technology and actor-network theory, Konrad (2008: 22) proposed that different pathways open up depending on the dynamics of the change of the elements of the scenarios of use involved in the process of interactive social learning and redefinition. If one element changes slowly, we can expect a process of convergence. If both the designer and user sides are in flux, opening processes of variance are likely. The analysis in Paper III and elaborated here suggests that processes of conceptual blending might be involved in *both* opening *and* closure: in *opening*, because blending explains the fine mechanism of how new ideas and categories are *formed*; and in *closure*, because the blending approach shows how such *projected* objects are eventually reified into *actual* ones.

Moreover, the analysis in Paper III shows that although the Gefilus innovators never succeeded in opening the new product category of *functional foods*, they nevertheless eventually managed to open its sub-category of *probiotics*, by means of the last and successful marketing blend of ‘Bacteria to the Rescue’ (see Figures 6 and 7 in section 4.1.2. on the image of Gefilus). Ironically, closure seems here to be represented by multinational companies (e.g., Danone) that have managed to successfully penetrate the domestic market with probiotic products of their own.

From the point of view of individuation, the four actual Gefilus objects presented to Finnish consumers in the period 1990-1996 (see Table 5), represent four distinct attempts at solving the fundamental dilemma of a tradeoff between similarity and difference. This dilemma is faced by every new object (and image, and technique; Shove and Pantzar 2005) of innovation when it is presented to new consumer audiences in the process of domestication.

The first new actual object, the strange ‘fermented milk product’ (see Paper III) was simply *too different*—at the level of *first-order* imitation, it tried to imitate *yoghurt*, just as *margarine* had attempted to imitate *butter*, but failed. Next, the search for a bulk product next resulted in Gefilus cultured buttermilk, which from the point of view of individuation represents a case of *partial success at first-order imitation* that was limited to a rather small user segment, that of women drinking cultured buttermilk. The next attempt at first-order imitation, re-introducing the Gefilus yoghurt, however, met with very limited success (see Paper III). Meanwhile, whereas the developers of Benecol were witnessing a huge demand for their product at this time—many grocery stores sold out within no time—the developers of Gefilus are still waiting for the big moment. Only one year later, however, also their product will be firmly anchored in the consumption practices of Finnish consumers. To paraphrase Bateson (1972), what was the difference that made a difference?

	19 05	1985	1990	1992-94	1995	1996
1. Use model	Fermented milk products for enhancing gut well-being and longevity	Some kind of dairy products for enhancing the well-being of the gut	A fermented milk product and whey drinks to enhance the well-being of the gut	Cultured buttermilk and whey drinks to enhance the well-being of the gut in ways specified by scientific research	In addition to those previously outlined, included the enhancement of the well-being of children	Progression of specific use models that started with the use model of enhancing the well-being of children
2. User model	Fellow co-Parisians	As many users as possible throughout the world	Finnish consumers with an interest in keeping up and enhancing their gut health	Finnish consumers with associated gut health problems	Finnish consumers, children included, with associated gut ailments	A number of user groups that would be enrolled according to the 'starting with the parents' mobilisation plan devised together with the ad bureau
3. Objects of use (projected)	Lactobacillus bulgaricus-containing cultured buttermilk for enhancing gut well-being and longevity	LGG-containing dairy product of some kind for this kind of enhancement of well-being	LGG-containing set type fermented milk product and the whey drink	LGG-containing cultured buttermilk and whey drinks	LGG-containing cultured buttermilk, whey drinks and yoghurt	LGG-containing milk, and cultured buttermilk, and whey drinks, and yoghurt
4. Infrastructure	Metchnikoff's laboratory facilities	Somewhere in the world	The facilities provided by the dairy cooperative company Valio	Valio Ltd	Valio Ltd	Valio Ltd
5. Context	Early 20th century Paris, France	Yet to be specified	Finland	Finland	Finland, European Union	Finland, European Union

Table 5. Probiotic scenarios of use 1905-1996.

From the point of view of historical research methods, it is always dangerous to use counterfactual reasoning (see, e.g., Kragh 1987). Thus, there is no way of knowing how the Gefilus individuation process would have unfolded without Benecol as one central element. Maybe the narrative would still have included milk as its primary-level imitation target (see, e.g., Menrad 2003). However, the Benecol innovation and its breakthrough was a historical fact in 1995, and it meant that the Gefilus innovation process, from the point of view of conceptual blending, at that point had *one more input space*. Furthermore, it was not just *any* input space; it was an input space that, from the point of view of individuation, introduced *hierarchy* into the process. At the *first-order* level, the anchoring of LGG into milk thus producing Gefilus milk imitated, and intended to substitute, ordinary or ‘conventional’ (Menrad 2003) milk in much the same way that margarine was intended to substitute butter. However, at the *second-order* level, anchoring the LGG strain in this way also imitated *butter*, more specifically *cholesterol-lowering* butter as developed by the Benecol innovators. Butter is a bulk product with a large user segment, and so indeed is milk.

That this second-order imitation was highly successful is shown by the sales figures for this time. Gefilus milk became a ‘locomotive’ for other products, and pulled with it especially the cultured buttermilk (see Tables 6 and 7). In the following years, these figures steadily increased at the same proportions. Marketing research showed that the ‘total familiarity’ of Gefilus products rose from the low figures of 1995 to the remarkable 83% in 1996, 88% in February 1997 and 89% in March 1997 (Marketing Radar 1997). In addition, although the campaign was addressed to parents, studies on consumption conducted for the company showed that the group that hooked on to Gefilus was ‘the mother/adult woman of the family’ user category (Marketing Radar 1997).

Year	Cultured butter milk	Gefilus cultured b. m.	Milk	Gefilus milk
1992	90,3	2,37	842,1	0
1993	88,8	2,99	829,6	0
1994	86,5	3,04	808,6	0
1995	83,7	3,17	743,6	0
1996	86,4	8,63	738,9	2,74
1997	86	12,19	724,7	3,62

Table 6. Gefilus sales figures in comparison with sales figures for similar ‘first-level’ products (cultured buttermilk and milk).

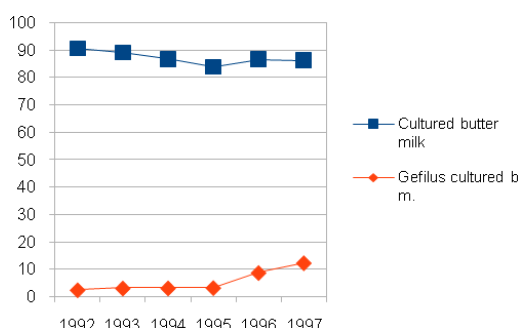


Table 7. Gefilus cultured buttermilk in comparison with total sales for cultured buttermilk in Finland 1992-1997.

Thus, from the point of view of individuation, although the probiotic Gefilus was the *first* functional food innovation ever to be presented to Finnish consumers, the innovation was now *redomesticated*, by means of both first- and second-order imitation, to a Finnish audience which by now had been familiarized to the product category of functional foods with its by that time prototypical representative, the Benecol cholesterol-lowering margarine.⁷

4.1.2 The image of the Gefilus innovation

When it comes to creating the new product's *image*, it was clear from the start that the emphasis would be on promoting physical well-being and health, which had become trendy in the West during the 1980s (interviews 3, 14). Judging from the advertisements from the time period 1990-1997, the more specific ways in which the Gefilus innovation was to accomplish this was, however, not altogether easy to communicate to the Finnish audience. In this sub-section, I will look at the creation of the Gefilus product's image from the point of view of conceptual blending. First, I will inquire into the specific *health claims* made with regard of the new product. Then, I will analyze the *visual and verbal imagery* used in the advertisement campaigns. I will argue that just as in the case of the *object*, also the *image* involved both making use of the cognitive process of conceptual blending and the actors' learning to recognize and exploit logical levels.

⁷ To my knowledge, the literature of conceptual blending does not as of yet contain guidelines for dealing with issues of hierarchy such as the one presented here. I have therefore chosen to restrict the visualization of the blending processes only to the first order of logic. There seems to be room for further development of the approach itself here.

Regulatory constraints: food and medicine as exclusionary categories

In 1990, when the first Gefilus product was introduced to Finnish consumers, those consumers as well as the food producers and food regulators were accustomed to think in terms of a rigid distinction between *food*, on the one hand, and *medicine*, on the other (interviews 1-4, 25). Finnish jurisdiction clearly separated these two categories, and this was reflected in the kinds of claims of efficacy that were allowed to be made concerning the new kind of product (see, e.g., Lehenkari 2003 and Menrad 2003). During the whole period of 1990-1995, the advertisement material does not make reference to the specific kind of 'hybrid' category that the Gefilus product was an instantiation of (company marketing material). It was not until the introduction of Benecol on the Finnish market in 1995 that the term 'functional foods' was beginning to be applied to foods of this kind (Lehenkari 2003; interviews 1-4, 24). However, even the introduction of this 'hybrid' product category did not bring with it any changes in the *regulation* of food and medicinal products (interviews 1-4, 24). Regulatory changes reflecting this real-world change were not to take place until much later (interviews 4, 24). During the whole of the period under study, it was not allowed, for food products, to make *any* kind of reference to curing disease. The Benecol instantiation of the category of functional foods did not encounter any particular difficulties with this rigid way of dividing up the world⁸. The Gefilus instantiation, however, was to face a genuinely Catch 22 situation.

Health claims and imageries in 1990 – 1995

When the LGG bacterial strain had been introduced to Valio and successfully integrated into the first food substrate, the issue of what name⁹ the new product should have naturally came to the fore (interviews 3, 11). According to actors involved in the naming process, the choice of 'Gefilus' was due to two circumstances: 1) The actors wished to somehow establish the link between the 'GG' of the two discoverers, i.e., Gorbach and Goldin; and 2) they wished to establish, already at the level

⁸ This is because the food authorities did not consider claims concerning 'vital functions' to be in conflict with the regulatory demands (see, e.g., Lehenkari 2003).

⁹ As has been emphasized by Bowker and Star (1999) and later by Pantzar (2000), the act of *naming* is highly significant in shaping the image of an innovation, especially in the context of its early stages. History provides us with many examples of this. Naming was highly central in, for instance, defining a need for the already referred-to phonograph or record-player (Siefert 1995; Pantzar 2000). In the 1950s, Finns spoke of the computer using such terms as 'intelligent machine', 'brain-machine', 'electron brain', 'electrical brain' and 'artificial brain'. The mobile phone has also been given many kinds of labels. Some of them referred directly to radio waves: everyman's radio and the two-way radio. The portability of the phone was an important aspect: the walkie-talkie, the car-phone, the mobile phone. Also the fact that it fits in the hand has given rise to expressions: the hand-held phone, 'handy' (Pantzar 2000).

of the product name, a link to the Acidophilus products that had preceded it in the 1980s, and whose heir Gefilus, from the point of view of the company, essentially could be seen to be (interviews 3, 11). Thus, also here we see the tradeoff between similarity and difference at play. On the one hand, there was the need to connect the product to products already familiar to Finnish consumers. On the other, there was the need to highlight the distinctiveness of the new product so that it at the same time also contrasted with those familiar products.¹⁰

What, more precisely, did this distinctiveness consist of? In the center of this question are the specific *health claims* that were printed on products covers and presented to potential consumers in marketing campaigns. Starting with the first advertising campaign, the proposed distinctiveness of the product was that it ‘brought with it a new way of taking care of one’s well-being’: ‘in producing these products, the unique lactic acid bacterial strain of *Lactobacillus GG* has been used; several domestic and foreign research studies have shown that this strain has beneficial gut-friendly effects’ (marketing material from 1990). In 1991, it was added to this that ‘when hurriedness and stress disrupt your stomach, the good-willed GG bacteria can make you feel more at equilibrium’, and that those friendly GG bacteria ‘protect a sensitively reacting gut, e.g., when using antibiotics’ and that they ‘lessen and ease the too usual gut problems during tourist trips’. In 1992, it was claimed that regular use of Gefilus products helps increase the ‘natural immunity of the gut’ (1992 marketing material). The claims stayed essentially the same until 1995, when the message was compressed into three main points: ‘Gefilus – established as effective by research’ – ‘balances’, ‘increases the natural immunity of the stomach’, and ‘works against harmful bacteria’. In addition, there was the slogan ‘Gefilus takes care of the well-being of your gut’ (1995 marketing material).

These health claims did not go against official regulations and thus did not institute any action from food regulators. Nor did the authorities have anything to object to in the visual and verbal imagery used by the producers of the Gefilus innovation (see Paper III). The first 1990 marketing campaign’s ‘Good Feeling Comes’ is slightly naughty in that some double meanings can be read into the ‘coming’ element, but this was so subtle that it did not cause any action either. The 1992 marketing campaign, which made reference to at the time highly popular oriental and African dancing, were likewise non-offending, as was the 1995 incarnation of safety: a girl merrily communicating with her benevolent old close male. Nor did the slogan ‘Velvet for the Belly, Velvet

¹⁰ Indeed, from this point of view it is somewhat strange that the Gefilus marketing material does not make any reference whatsoever to Acidophilus products. Interviewee 24 has strong opinions on this issue, pointing to the challenges remaining for Finnish marketing as opposed to the marketing measures of multinational food companies.

for Life!’ that accompanied the 1992 marketing campaign give any reason for governmental action. The 1995 marketing campaign was rather small and proceeded in even safer tracks, the main message in the 1995 campaign being ‘Studied, Safe Balancer’. The downside of this caution was, however, that the product category remained relatively unknown (for exact numbers of this unfamiliarity, see Paper III). This unfamiliarity was even further underscored by the major breakthrough of the Benecol cholesterol-lowering ‘functional food’ margarine in 1995.

Health claims and imageries in 1996

As we have seen, in 1996 a final attempt at effecting market breakthrough on the Finnish market was made in the form of the ‘Bacteria to the Rescue’ marketing campaign (see Figure 6 and Figure 7, in which the exact structure of this *marketing blend* is represented). As I have argued in Paper III, *learning to blend* is one of the main skills companies need to master along the ‘semantic dimension’ of communication across the user-producer interface (the other ones being syntactic or related to basic common understandings, and pragmatic, or related to interests; see also Carlile 2004). In Paper III, I have also described, in detail, how this particular learning process unfolded.

The aim of the campaign was to ‘rebrand’ the whole Gefilus trademark in light of the changed situation (i.e., Benecol; interview 4). For this campaign, the health claims were revised (interviewee 4 remembers long and detailed discussions between R&D and marketing on how they were to be formulated) and they finally took the shape of four distinct claims: 1) ‘Gefilus increases the immunity of the stomach and the gut against harmful bacteria’; 2) ‘it helps in sudden disorders of the stomach’; 3) ‘it is an efficient aid in preventing and curing, among other things, diarrhoea’; and 4) ‘it protects the stomach from irritation caused by the use of antibiotics’ (1996 material). These specific claims were not in circulation for long, however. After the initial launch of the Gefilus milk, in connection with which these particular claims were made public, the Finnish food regulators forced the company to withdraw them and replace them with the following three claims: 1) Gefilus ‘increases the natural immunity of the stomach and the gut’; 2) it ‘increases the formation of antibodies against harmful microbes’; and 3) it ‘balances the functioning of the stomach’ (1996 marketing material).



Figure 6. The 1996 marketing campaign.

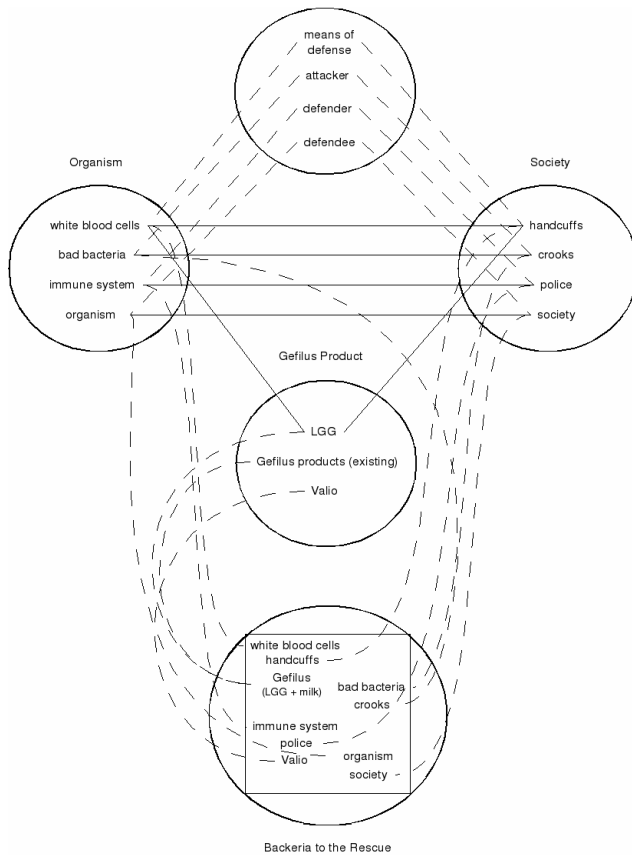


Figure 7. The 'Bacteria to the Rescue' blend.

The reasons for this withdrawal and change was the intense reaction of the main food authority at the time (Elintarvikevirasto or The National Food Administration, NFA) forbidding any kind of reference to *curing disease* in marketing food products. The reaction was debated in the national press (e.g., the newspaper Helsingin Sanomat 13.3.1996), and eventually resulted in an official communication from the authority explicitly stating that it wishes to keep the categories of food and medicine completely separated from each other. Indeed, this communication went so far in its puristic aspirations that it stated that it is forbidden, in communicating with consumers, to make any reference to results of scientific research, *even if these results have been proven to be scientifically valid* (NFA Communication 10/1996). The rationale behind this was that the consumer needs to be ‘protected’ from ‘misleading’ information (HS 13.3.1996; NFA Communication 10/1996). The guidelines were also codified in the 1997 formal regulation system *Lääke- ja terveystväättämien valvontaopas* (*The surveillance guide to medicinal and health claims*). In 1996, however, the situation resulted in intense communication between the company and the food authorities (interviewee 14 speaks about ‘running back and forth’) resulting in the compromise that the company was allowed to proceed with its specific way of metaphorically expressing the main effect of the product—‘Bacteria to the Rescue’—but that it was not allowed, in any further campaigns, to go beyond existing regulatory borders, not even in the case of Gefilus capsules sold at pharmacies that were developed later on (interviews 4, 24).

Image-wise, however, the ‘Bacteria to the Rescue’ slogan can be considered a hit. Skillfully playing with cultural meanings, this conceptual blend implicitly refers to the ongoing discussion about the dangers of the ‘Killer Bacterium’, i.e., bacteria (often *Streptococcus A*) resistant to antibiotics that had begun to spread alarmingly in Western Europe in the beginning of the 1990s (e.g., Huovinen 1996), and contrasts itself with this bug as well as others bugs. The reference to rescuing or ‘saving’ is evident also in the image of the gloria, which adds a religious dimension to the blend (see Figure 6). In addition to tapping into the much discussed public fear, however, the metaphor also brilliantly compresses the main effect—*helping you with stomach trouble of even dangerous kinds*—of the new product, thus in effect constituting a kind of *hidden health claim*. Thus, not only is the blend a *compressed second-level name* for the new product with the *first-order name* of ‘Gefilus’; it is also a metaphorical shorthand for the distinct *effect* of the functional food product, i.e., it expresses in a compressed form that which makes it *different* from both other related products (i.e., ordinary milk) and *similar to products that are different in the same way* (i.e., the cholesterol-lowering Benecol).

We can now begin to explicitly characterize the rather cunning ways in which Valio made its way around the Catch 22 posed to it by the rigid ‘either-food-or-medicine’ categorization. At the end of 1995, this impossible situation contained the following elements: 1) The new product category of functional food, as well as its instantiation Benecol, has become familiar to Finnish consumers. 2) The Gefilus innovators at Valio have since long had a product which falls into this category and which has a distinct health effect of its own. 3) The Gefilus innovators need to make it clear to Finnish consumers through efficient marketing that they have such a product. 4) In this marketing, they are not allowed to make any direct reference to this distinct health effect. So, 5) in order to reach their goals, they *have to* do what they *cannot* do. If they do, they will get punished. If they do not, they will fail. This situation is very much akin to both the concept of ‘double bind’ as described by Bateson (1972) and to the concept of ‘torque’ as characterized by Bowker and Star (1999). If we are to believe Bateson (1972) and Bateson (2005), there are two major ways in which one can respond to such impossible situations. One is to fall into deep lethargy and even pathology, which in a company context at a minimum translates into a failure. Another is to rise above the dilemma in a way that creates a *hierarchy* between the first-order level at which the action lock-in occurs, and a second-order level at which the lock-in is constructively addressed.

It can be fairly confidently concluded that in its response to this first-level lock-in, the company managed to choose the constructive ‘double-loop’ learning path, and that this solution had two main components. The first was the act of making health claims that the company *knew* that would receive public repercussions, i.e., the four 1996 health claims reported above. The constructive learning element came from the fact that this punishment (i.e., the demand to withdraw all flawed packages and all flawed marketing material) and the public debate that ensued *only stimulated* demand for Gefilus products, which in 1997 began to diversify, for example to fruit drinks, capsules and cheese. Suggestions for new foods in which LGG could be added ‘rained in’ (interview 14). The second component is the ‘Bacteria to the Rescue’ slogan, which metaphorically compresses the main health claim. Since this was allowed, it too can be seen as a partial second-order victory. Although this way of proceeding undoubtedly, from the point of view of the company, represents a constructive way of resolving this potentially very damaging situation, in the broader picture it nevertheless represents only a tactical, not strategic, victory—both at the level of national and EU legislation, the categories remained intact for years to come (Menrad 2003; Niva 2006, 2008).

4.1.3 Summary

To summarize, the Gefilus innovators were able to both perceive, recognize and exploit levels of logic when it comes to solving the individuation dilemma. That is, when the success of Benecol on the Finnish market was a fact, the innovation network behind Gefilus learned to utilize central features of that process to their own benefit. Instead of just progressing with solving the individuation problem at the first level (i.e., finding a suitable tradeoff between similarity and difference in relation to already existing conventional dairy food products on the Finnish market), they took advantage of the second level of similarities and differences provided to them by Benecol. In doing so, they created a new object and image-creating strategies for the object that drew on similarities and differences at both levels. The learning here was ‘double’ both with respect to the *object* which was to be domesticated (i.e., learning to find a food substrate for the LGG bacterium that would be as ‘similar to’ the butter used in the Benecol innovation as possible) and with respect to the creation of the *image* of the object thus modified (i.e., taking the deliberate risk of offending the authorities by going too far in arguing that the product was ‘different’ from other products, thereby ensuring enough visibility and recognition).

This rendering of the Gefilus innovation thus somewhat complicates the in itself plausible view of Shove and Pantzar (2005) that it is not just the specific elements of some practice (materials, image, and techniques) that matter, but also the ways in which they are integrated—or, as I would say, blended—into a new totality or whole. First, this analysis introduces *conceptual blending as the central mechanism of shaping the object and image of innovation* in a way that eventually resolves the individuation dilemma in a satisfactory way in relation to some audience: New and yet new blends are tried out until one that makes the tradeoff between similarity and difference is found. Second, this analysis introduces the issue of *levels of logic* or *hierarchy* into the discussion of the ways in which individuation processes unfold. Pantzar (1995) describes how the process of individuation unfolds at only one level, as it were; margarine imitates butter both materially and symbolically and gradually begins to take on a material and symbolic life of its own. This analysis describes how the process of individuation unfolds at not only *one* level, but at *two*: Gefilus first imitates a number of other products (yoghurt, cultured buttermilk), and then, when this first-order imitation process fails, imitates both milk (at the first level) and the cholesterol-lowering Benecol margarine (at the second order), the latter effecting success. For innovations that have become

‘stuck’ at the first-order individuation challenge, then, second-order imitation can represent a constructive way to move forward with the process of ‘blending for individuation’.

4.2 Organizing for individuation: knowledge networking

In the previous section, I provided a *cognitive* account of individuation in terms of conceptual blending. I now turn to the *pragmatic* aspect of individuation processes as described in section 3, and ask whether there are any kind of linkages between the ways in which the object and image of the Gefilus innovation took shape and the way in which collaboration was organized across knowledge borders during this period. In other words, do the unsuccessful versus successful shapings of the Gefilus object and image go hand in hand with specific ways of organizing collective work activities in modular, translational and pioneering knowledge networks? Furthermore, even if this was shown to be the case, what are we to make of such correlations? In this section, I thus continue exploring the third research question (i.e., how do individuation processes unfold from the point of view of such knowledge structures?). Based on the qualitative work performed in this dissertation (especially Papers II and III), it is not possible to draw any far-reaching conclusions as to the validity of such possible correlations (see section 5.3). However, despite these undoubtedly justified waivers, some of the phenomena that seem to go together in the unfolding of this process just seem to be ‘too neat’ to be a mere coincidence. I therefore present them, aware, however, of the possible pitfalls of correlations only (see also Cozby 2004).

4.2.1 The object of knowledge networking

In Paper II, my co-authors and I have suggested that there is a correlation between the structure of problems and challenges encountered and KN modes (see also section 4.3 above). More specifically, in this paper we suggested that it seems well-advised to respond to *ill-structured* problems (i.e., problems that addresses complex issues and thus cannot easily be described in a concise, complete manner) with *pioneering* KN, and to *well-structured* problems (i.e., problems that have a clearly defined starting point, a finite set of operators, and a clear goal) with either *modular* or *translational* KN (see Paper II; see also Bruun and Sierla 2008). Paper II also introduced the notion of *transepistemic challenge*, i.e., problems that occur when attempting to transcend one’s own KF, and identified the difficulty of extending the *notion of food* as one of the most central transepistemic challenges in the Gefilus KN process (see Tables 4 and 9). Thus, this difficulty of

extending the object of knowledge was at the heart of the communicative challenges between the two KFs (see Papers I, II and III; see also Table 4).

KR 1	TC 1	Action	Mode of KN	Result
Multidisciplinary research on the intestinal effects of diet in relation to cancer (Lab in Tufts, New England Medical Center, Boston)	Do Lactobacilli have any beneficial effects on human health? Can this be verified?	Collaboration with other researchers who were studying the survival characteristics of various <i>Lactobacillus</i> strains, toxogenic <i>E. coli</i> , and viral diseases	Pioneer	Formation of knowledge regime 2 The desired LGG strain was identified; clear indications of health effects
KR 2	TC 2			
Multidisciplinary research on the characteristics of the LGG strain (Labs in Tufts, New England Medical Center, Boston)	How can the LGG discovery be commercialized?	Search for a suitable partner	Modular	
KR 3	TC 3			
Valio: traditional dairy company with investments in R&D and a probiotic ideology	Is there a scientific basis for probiotic dairy products?	Negotiations with both Finnish and foreign scientists; Gorbach & Goldin contacted	Modular (with KR 2)	Valio gets global rights to the LGG strain (1987)
KR 4	TC 4			
The <i>Gefilus</i> knowledge regime; making a scientifically-justifiable health-promoting product (Valio)	How can experts, consumers and the skeptics in Valio be convinced of the feasibility of the new LGG-based product concept?	Collaboration with researchers in Finland & abroad; across department boundaries at Valio	Modular organization of research (on bacterium; production, health effects) From 1994, pioneer networking in Valio; licensing squad (1994), with marketing (1996)	The launch of the first <i>Gefilus</i> products (1990); scientific evidence of the beneficial effects of LGG (1990-1992); international sub-licensing agreements
KR 5	TC 5			
The traditional knowledge regime: the processing, developing,	How can high-quality dairy products be produced and	Applied research on process technology; product tasting; analyze and forecast	Modular (departmental responsibilities)	Broad, high-quality commodity product

marketing and selling of commodity dairy products (Valio)	distributed efficiently? How can sales figures be improved?	market changes; develop distribution network. Resistance to KR 4		sortiment; financial returns for the national milk producers
KR 6	TC 6			
The Gefilus knowledge regime plus marketing department (Valio)	Marketing strategies: How to communicate to consumers?	Development of novel marketing strategies	Pioneer	Commercial success with <i>Gefilus</i> products (1996 onwards)

Table 8. The process of KN in the case of Gefilus. KR=knowledge regime, TC=transepistemic challenge, KN=knowledge networking.

In Paper III, I continued addressing the transepistemic challenge posed by the object of knowledge by inquiring into the ways in which it is formed in the interplay between intended use, artefacts and use practices. Here, I have continued my inquiry into the ways in which objects are formed by connecting the scenario model of Konrad (2008) with the framework of conceptual blending. These two interconnected streams of analysis—the cognitive and the pragmatic—give rise to the question of how, more specifically, they are related. In other words, is there a deeper relationship between the ways in which the *pragmatic* organization for knowledge integration and the *cognitive* shaping of the object unfolded? If so, is this related to how the process of interest in dissertation—i.e., that of *individuation*—unfolded?

4.2.2 Individuation as problem-solving

As we recall from the introduction, new products can make their way into specific material and symbolic systems of goods in two different ways: They can either be 1) *assimilated* into existing systems of goods in a way that does not much change that existing order, or they can be 2) *accommodated* into those systems in a way that may severely upset existing systemic interconnection between goods (Pantzar 1995). In the theoretical section, I also presented the distinction between well- and ill-defined problems, and briefly described the view of problem-solving as based on ‘optimization modeling’ (see also Bruun and Sierla 2008).

Now, from the point of view of this alternative approach to problem-solving, individuation can be viewed as a *process of finding a local optimum in symbolic and material space* (i.e., the tradeoff described by Hargadon and Douglas 2001). From the *pragmatic* perspective, reaching this optimum

involved, first, a process of *unsuccessful modular* KN, and then, a *successful* episode of *pioneering* KN (Paper I and II). From the *cognitive* perspective, reaching the local optimum required, first, a process of *unsuccessful first-order* imitation, and then, a *successful second-order* imitation (Paper III and this summary). That the results of these two inquiries are interrelated becomes clear when we juxtapose Table 8 with Table 5: The *modular* mode correlates squarely with the three *unsuccessful* attempts at integrating the LGG bacterial strain into food substrates, while the *pioneering* mode correlates with the *successful* one.

Furthermore, from the point of view of problem-solving as optimization modeling, the notion of *transepistemic challenge* can be re-interpreted as a problem, well- or ill-defined, in the process of finding a tradeoff between similiarity and difference, that is in one way or the other related to difficulties in communicating across knowledge borders (Paper II). The transepistemic challenge of the object, and also of the image, posed in the Gefilus domestication process were, at first, treated as if they were an issue of *assimilation*, i.e., by means of first-order imitation. Only when it became clear that this mode of entry did not work did the Gefilus innovators switch over to modes of operation more in line with *accommodation*, in this case, e.g., second-order imitation. My suggestion is thus that there is a correspondence between the *assimilation mode of domestication*, *well-defined problems*, and *modular KN*, on the one hand, and the *accommodation mode of domestication*, *ill-defined problems*, and *pioneering KN*, on the other (see Table 9). Furthermore, for situations in which the *first* kind of correspondence applies, the individuation challenge can be solved by taking recourse to similarities and differences at *one level only*, while situations where the *second* kind of correspondence occurs, much can be gained by learning to recognize and exploit similarities at *different levels of logic*.

Mode of domestication	Problem type	
	Well-defined	Ill-defined
Assimilation	Modular KN	Translational KN(or hybrid)
Accommodation	Translational KN (or hybrid)	Pioneering KN

Table 9. Mode of domestication vs. problem type.

4.2.3 Summary

In this sub-section I have made the following three claims: 1) I have suggested that there is a correspondence between the assimilation mode of domestication, well-defined problems, and modular KN, on the one hand, and the accommodation mode of domestication, ill-defined problems, and pioneering KN, on the other (see Table 9). Furthermore, for situations in which the first kind of correspondence applies, the individuation challenge can be solved by taking recourse to similarities and differences at one level only, while situations where the second kind of correspondence occurs, much can be gained by learning to recognize and exploit similarities at different levels of logic. 2) I have proposed that *transepistemic challenges in individuation processes* can be viewed as a *special class of (often ill-defined) problems that are related to difficulties in communicating across different knowledge perspectives*. 3) Finally, I have suggested that the *Gefilus* individuation challenge comes closer to being an *ill-defined* problem than to being a well-defined one (there are certainly individuation challenges that are more complex than the one under study).

Note, however, that these claims are about *correlations* or *co-occurrences* between classes of phenomena, and as such subject to all the liabilities that go along with such non-experimental methods, not least the problem of cause and effect and the third variable problem (see, e.g., Cozby 2004). In other words, based on this research one cannot make claims as to which comes first and causally effects what, and it might also be that these correlations are explained by some third factor (confounding variable) not addressed in this dissertation (Cozby 2004). Despite these concerns, however, I think it can be fairly safe to conclude that some forms of organizing collaboration across knowledge boundaries—and in particular the pioneering KN mode—are more conducive for complex blends such as the ones discussed in section 4. This conclusion is also supported by research that has used the pragmatic KN approach. For instance, Hukkinen (2008) describes how collaboration in a pioneering mode produced highly innovation policy recommendations in the form of blends for reindeer management in Lapland.

Before moving to the conclusion, it is worthwhile to consider more precisely *why* certain forms of KN correspond to certain forms of problems and problem-solving. Since an exhaustive answer to this question would merit an article of its own, I will here only indicate the direction in which I think it is fruitful to search for an answer. In his 1998 article, Paul Nightingale has presented a complementary ‘Cognitive model of innovation’, in which he proposes that innovation, in contrast

to scientific exploration, progresses from a known, desired end result to find the starting conditions that will eventually produce it (1998: 705). This ‘direction problem’ of technology, he suggests, is overcome by following “tacitly understood technological traditions based on embodied and embedded conceptions of similarity”; these technological traditions “provide a mechanism that guides innovation and allow problems that are initially nebulous and very general to resolved to specific problems and resolved” (1998: 705).

Thus, Nightingale suggests that people working within a specific technological tradition, when confronted with a specific problem, only ‘see’ solutions that are similar to previous solutions in that specific technological tradition. Now, suppose that these people working within a given technological tradition confront an ill-defined (according to all kinds of definitions) problem that they cannot find a previous ‘similar’ solution to. If they were to organize their *search for relevant similarities* in a *modular* way, this search would be coordinated by some kind of coordinating device that would juxtapose different knowledge domains. In all probability, this way of proceeding could provide *some* ideas on how to get further with the problem. However, if they were to organize their search for such possible solution similarities in a *pioneering* way, with its open-flowing discussion and communication, the probability is much higher that they will eventually see similarities that are not trivial and that might help them solve their particular problem.

Indeed, this is reflected in the emphasis on analogy of the flourishing literature scientific and technological creativity; here, analogy is *the* mechanism for recognizing deep, as opposed to trivial, similarities, and it is also the starting point for the process of conceptual blending (see, e.g., Hargadon and Sutton 1997; Fauconnier and Turner 2002; Hukkinen 2008). Thus, from this perspective the answer to “the why question” is that “because organizing the search for similar solutions in a pioneering rather than modular (or translational) way significantly increases the probability that a relevant and fruitful similarity will eventually be found”.

5. Conclusions and discussion

My theme in this dissertation has been the domestication of new products, and I have made reference to two different modes in which domestication can occur: a) assimilation and b) accommodation (Pantzar 1995). The modes can be found, under different descriptions, in all of these literatures (for instance, under characterizations such as ‘incremental’ vs. ‘disruptive’ or ‘radical’ technologies; see, e.g., Tidd et al. 2001; Veryzer 1998a, 1998b). In these literatures, that which is taken to be domesticated is usually the object or material of innovation. However, as Shove and Pantzar (2005) argue, that which is domesticated can also be broadened to practices, understood as composites of the elements of object, image, and technique. I have focused specifically on the process of *individuation*—the process of becoming a distinct product via initial imitation of similar existing products—as part of the overall process of domestication.

The main lesson to be learnt from my work is that individuation processes can occur not only at *one* level but at *two*, and that this can be of explanatory value for the unfolding of *some* innovation processes, especially those fraught with difficulty at the level of first-order individuation. Empirically, I have opened up this process of double individuation of the Gefilus object and image by means of the analytical tools of conceptual blending and KN. By doing so, I have also developed further existing cognitive and pragmatic perspectives.

It is time to summarize and discuss the conclusions reached in this dissertation, and the value of these contributions in relation to already performed work in the selected fields. I begin by addressing the *cognitive* perspective, centered around the analytical tool of *conceptual blending*, discussing both theoretical developments and empirical results. Then, I address the *pragmatic* perspective, which centers around the analytical tool of *KN*, and discuss the theoretical and empirical implications of this. This addresses the fourth research question of this dissertation (i.e. how to make the resulting improved understanding of individuation actually do some work for innovation processes?). I then present, based on the work performed in Paper IV, an alternative method for the study of knowledge structures. This addresses the fifth research question of this dissertation (i.e., how are knowledge structures in individuation processes best studied?).

5.1 The cognitive perspective

The concept of ‘socio-technical scenario’ or ‘script’ was developed within science and technology studies as an analytical tool for comparing designers’ conceptions of technology, technology design, and actual user behaviour (e.g., Akrich 1992a, 1992b, 1995; Callon 1991; Latour 1992) and has since been used extensively in both consumer research and STS (e.g., Landström 2006; Oudshoorn et al. 2004; Gjören and Hård 2002; Konrad 2008). Akrich defined the notion of script or scenario as the end product of the work of inscribing a ‘vision of, or prediction about, the world in the technical content of some new object’ (1992a: 208), while Konrad (2008) referred to scenarios as ‘the conceptual or fictive scenarios *as imagined* by designers, users or other actors involved in the development, production and diffusion of a new socio-technical system’ (Konrad 2008: 4; italics added). Building on the thinking of Schutz, for whom all of our knowledge is structured according to ‘types’, she proposes that scenarios of use consist of five interrelated elements (see Table 3), and that different pathways open up depending on the dynamics of the change of the elements of the scenarios of use involved in the process of interactive social learning and redefinition. If one element changes slowly, we can expect a process of convergence. If both the designer and user sides are in flux, opening processes of variance are likely (Konrad 2008: 22). As we have seen, however, Konrad does not make a distinction between *actual* and *projected* objects, and therefore does not address the more specific ways in which objects are *imagined* before entering the *actual* dynamics of scenarios of use, artifacts, and use practices.

This, however, is precisely what the blending approach proposes to do. Building on graded categorization approaches of, e.g., Rosch (1983), the proponents of conceptual blending (Fauconnier and Turner) attempt to explain the ‘hidden’ cognitive mechanisms that explain how new concepts and categories that enter into the real dynamics are *formed*. One central added value of using conceptual blending is, then, that we can get at and characterize not only the *actual*, but also the *projected* objects of innovations. Furthermore, I argue that the approach of conceptual blending is a very suitable analytical tool for characterizing, in greater detail, the interrelations between the elements of practice as this notion is conceptualized by Shove and Pantzar (2005), i.e., materials or ‘stuff’, images, and techniques. Innovations in practice, they claim, are not simply determined by the elements constituting it; ‘What really matters is the way in which constitutive elements fit together’ (2005: 61). The conceptual blending approach is, I think, unique in its capacities to characterize such ‘fittings’, especially when taking into account that conceptual blends

typically consist of both material and symbolic structure (see, e.g., the analyses presented by Hutchins 2005). Although but one way in which the relationship between material and symbolic structure has been conceptualized (for other related approaches, see, e.g., Latour 2005; Haraway 1997, and Barad 2007), the strength of this approach lies in the very specific ways in which it can show how the various elements of the 'blended space' of, e.g., the Gefilus milk, or the practice of Nordic walking (Shove and Pantzar 2005), are integrated into a new and unique whole.

The main results of the empirical investigation into the Gefilus individuation process from the point of view of conceptual blending are the following: 1) Conceptual blending is the mechanism through which both object and image are shaped so that they reach the tradeoff or 'local optimum' of similarity and difference in relation to some specific audience. From this point on, both material and symbolic structure can, and incessantly do, then continue to diversify with mainly the boundaries of human imagination as a constraint. 2) Mainly and for the most part, this individuation by blending occurs at one level only, as in the case of margarine (Pantzar 1995). However, in the case of Gefilus, the formation of both the object and the image took place not only at *one*, but *two* levels: the first-order level of similar food products (e.g., yoghurt, cultured buttermilk, milk) and the second-order level of similar functional food products (e.g., cholesterol-lowering butter). This double individuation occurred only after insuperable difficulties had arisen at the first level, together with the fact that the second level category had been introduced to the specific audience by external (from the point of view of the company) means.

Thus, the Gefilus innovators failed to introduce the new *product category of functional foods* by themselves, but when that category had been introduced by the Benecol innovators, the Gefilus innovators managed to introduce both the *probiotic sub-category* and a *probiotic product* by blending for individuation at two levels instead of only one (see Figure 8a-d).

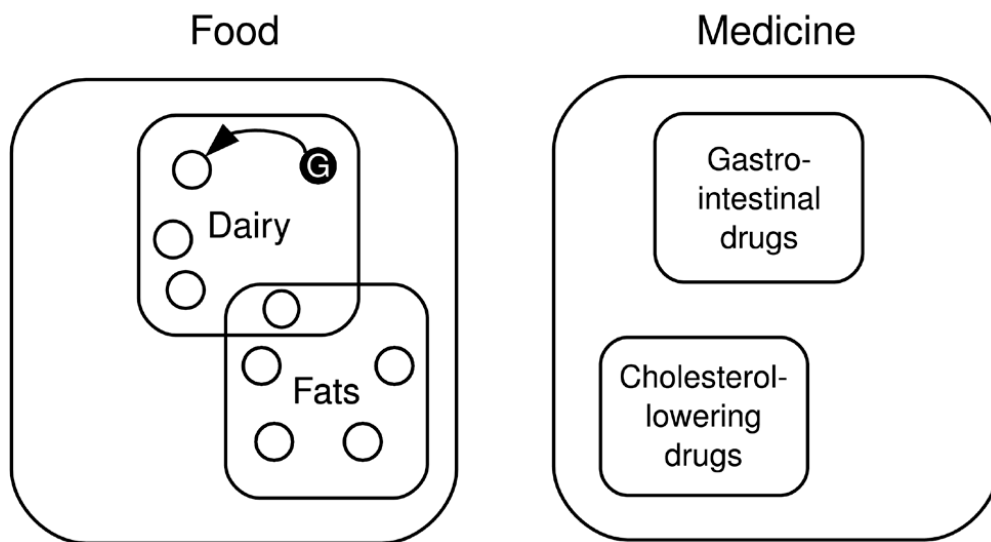


Figure 8a. The product category vs. product situation in 1990. The Gefilus set-type yoghurt is introduced (black point) into a context that strictly separates food from medicine, and it mainly imitates yoghurt (the black arrow).

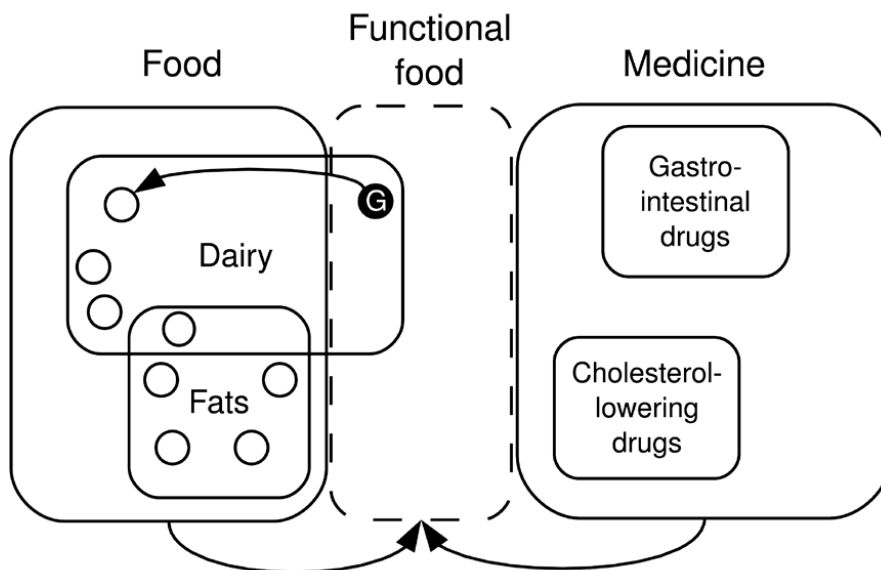


Figure 8b. The product category vs. product situation in 1990-1995. Valio tries to communicate the existence of a new product category (the dotted lines), to which the Gefilus product belongs, to Finnish consumers, but fails.

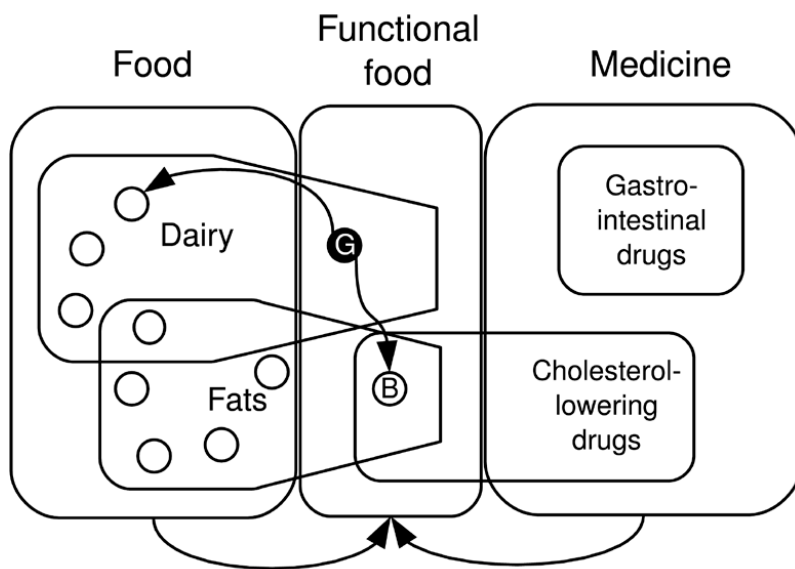


Figure 8c. The product category vs. product situation in 1995, after Benecol (B) has entered the Finnish market, establishing the product category of functional foods (non-dotted square in the middle). Gefilus (G) is now imitating not only first-level dairy products (arrow from G to the left), but also second-level Benecol (B; arrow from B to G), aiming for the same position as Benecol.

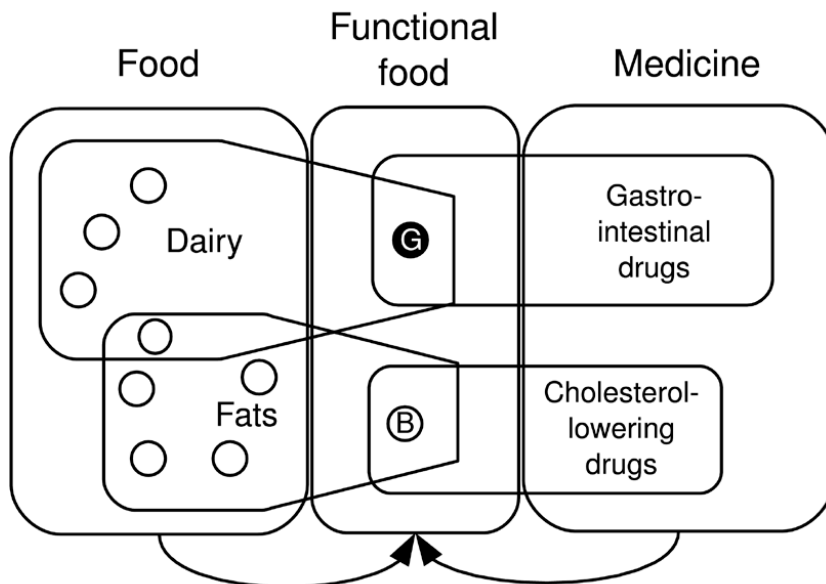


Figure 8d. The product category vs. product situation in 1996. The Gefilus product (G) has managed to make its situation symmetrical with Benecol (B): both products are instantiations of the hybrid product category of functional foods and recognized as such by Finnish consumers.

From the point of view of this double individuation process, the empirical research on reasons behind consumers' functional food choices (Urala and Lähteenmäki 2003) stands out as highly interesting. Urala and Lähteenmäki (2003) analyzed, with the aid of the so-called laddering interview method, the reasons that consumers give for either choosing or not choosing functional foods in different product categories (yoghurt, spread, juice, carbonated soft drinks, sweets and ice cream). The results of this research indicate that respondents did *not* see functional foods as one homogenous group over different product categories. Instead, they seemed to perceive functional products as a member of the general product category such as yoghurt or spread and only secondarily as a functional food (Urala and Lähteenmäki 2003: 148). Also, choosing a functional food in one product category did not necessarily correlate with choosing functional foods in other product categories. The highest correlations between the choice frequencies were between functional probiotic yoghurts and functional cholesterol-lowering spreads (2003: 151). Thus, it is not only the *producers* of functional foods such as Gefilus and Benecol that were, as late as 2003, faced with the issue of levels, i.e., with the tension between inclusion in the first-level category of conventional foods and simultaneous inclusion in the second-level category of functional foods; it was, and continues to be, also the situation faced by the *consumers* (see also Niva 2008).

One final observation is necessary before closing this sub-section: It has *not* been my task to open up the issue of why the Benecol innovation network succeeded to domesticate a new *product category*, while the Gefilus innovation network failed to do this (although this would be highly interesting). My task has only been to explore and explain how, *despite* the failure in domesticating the *product category* in 1990-1995, the Gefilus innovation network *still* managed to succeed at domesticating the *probiotic* Gefilus *product* in 1996. For *this* question, I offer the 'learning-to-imitate-at-two-levels' argument.

This kind of research is, however, highly pertinent in view of the many challenges that have been identified for the development and marketing of functional food products, such as 1) the costs of product development and marketing (exceed the costs for conventional food products by far); 2) the broad knowledge base needed (i.e., medical and marketing) for this kind of endeavor; 3) the need for highly visible information and communication activities to consumers and opinion leaders (such as, e.g., doctors and nutritional advisers; this is regarded as crucial); 4) the current regulatory situation separating food from medicine; and 5) the price premia for this type of food compared with conventional foods (Menrad 2003). Note also the recent observation that the general success factors for the marketing of food are valid for functional foods as well (Menrad 2003).

Since the unfolding of the Gefilus process from introduction (1990) to breakthrough (1996), much research has also been performed on consumer appropriation of functional foods worldwide (for a summary, see Niva 2008). In general, the main pattern of ambivalence—of simultaneous appreciation and suspicion—identified by Niva and Jauho in 1999 seems to be prevalent also towards the end of the first decade of the new millennium (Niva 2008). Although from a market research perspective functional food products have become differentiated and commercialized for different target groups, from the perspective of everyday appropriation the phenomenon is more complex: age, gender, education and health-related views and practices do not predict straightforward the incorporation of functional foods in the everyday diet (Niva 2008: 58). Furthermore, consumers report a multitude of reasons for using functional food products, the motive of enhancing health being only one among many others (Niva 2008).

Taken together, these challenges explain part of why the functional food segment is characterized by a relatively high number of product failures (Menrad 2003). They also highlight why the issue of user-producer integration is still highly relevant for companies aiming to bring forth new functional food innovations. Learning to work with and exploit levels could thus be potentially very helpful in this promising yet challenging field, especially for small and medium-sized companies for whom future strategies have been judged as rather limited (Menrad 2003; Mark-Herbert 2004).

5.2 The pragmatic approach

As we have seen, there is a plethora of concepts attempting to capture more or less the same as the notion of 'KF', such as, e.g., 'thought worlds' (Fleck 1935; Dougherty 1992), 'paradigm' (Kuhn 1962), 'technological frame' (Bijker 1995) and 'epistemic culture' (Knorr-Cetina 1999). The novelty of the KN approach lies not so much in bringing forth this concept as in 1) the way it advises attempts at collaboration across knowledge from a distinctly knowledge-related, as opposed to, e.g., social or economic, point of view, and 2) the presentation of the three KN modes (i.e., modular, translational, and pioneering). It is my judgment that this pragmatic approach, and the ways in which it connects to more cognitive ones, is still in need of further reworking in order to be fully satisfactory.

However, there is true novelty in the introduction of the three KN modes. Although the literature on interdisciplinary collaboration, on which this theoretical development is based, is ripe with distinctions between different forms of interdisciplinary collaboration (for an extensive review, see,

e.g., Bruun 2000 and Klein 1996), there has previously been few attempts at discerning the epistemic organization (a kind of fundamental ‘least common denominator’ as far as knowledge structure is concerned) in various kinds of collaborations across epistemic boundaries.

The most significant contribution of this approach is the possibility of identifying challenges that emanate from specific kinds of ways of organizing collaboration from the point of view of knowledge. In other words, it is possible to identify certain kinds of challenges that go together with *all* collaborations that are organized in a modular way, independently of the specific empirical context in which the collaboration occurs.

For theories of management and organization, the distinction between different types of KN poses a range of general research questions, such as: What problems are typical for each form of collaboration? What kinds of solutions are there for those problems? When is one kind of KN more efficient than others? What factors determine the choice of collaborative form? What problems are posed by the transformation from one type of KN to another? Are certain transformations—for instance, from modular to pioneering—more difficult than others? Can the different types be intermixed in a way that overcomes the problem of eventual contradiction between the modes? And so on (see Paper I).

The main results of the empirical investigation into the Gefilus individuation process from the point of view of KN are the following: 1) There appears to be a correspondence between the *assimilation* mode of domestication, *well-defined* problems, and *modular* KN, on the one hand, and the *accommodation* mode of domestication, *ill-defined* problems, and *pioneering* KN, on the other (see Table 9). Furthermore, for situations in which the *first* kind of correspondence applies, the individuation challenge can be solved by taking recourse to similarities and differences at *one* level only, while situations where the *second* kind of correspondence occurs, much can be gained by learning to recognize and exploit similarities at *higher* levels of logic. 2) *Transepistemic challenges in individuation processes* can be viewed as a *special class of (often ill-defined) problems* that are related to difficulties in communicating across different knowledge perspectives. 3) The *Gefilus* individuation challenge comes closer to being an *ill-defined* problem than to being a well-defined one (although there are certainly individuation challenges that are even more complex than the one under study; for an illustrative example, see Höyssä and Hyysalo 2009 on a radical diagnostics innovation). These conclusions can be viewed as hypotheses generated by the empirical case study, and they all call for more research of both qualitative and quantitative kind for their corroboration (e.g., Yin 2003).

In order to be fully credible, these hypotheses need, in the future, to be linked to broader conceptual, theoretical and empirical discussions in science and technology as well as innovation studies. Is there, for instance, a relation between the degree of innovativeness (i.e., radical and discontinuous or disruptive vs. incremental) and the two correlations identified in this work so, that incremental innovation is linked to the first correlation, while radical and/or disruptive innovation is linked to the second? Furthermore, how does the distinction between technological radicality (i.e., a product is/is not radically different from earlier technologies) vs. market disruptiveness (i.e., a product does/does not involve significant changes in consumer patterns) relate to the two correlations (see Veryzer 1998a, 1998b; Sandberg 2008)? Can there, for instance, be situations where work with some technology proceeds best in a modular or translational mode, while marketing activities need to be organized in a pioneering manner? Or the other way around? How do the two correlations map onto the distinction between product, process and service innovations? Are there any differences and/or similarities? If so, which? Do the developmental trends towards virtual collaborations and global networking (e.g., Tidd et al. 2001) influence the ways in which the two correlations play out? And so on.

5.3 *Alternative methods*

In the section on methods, I ended by describing the work performed in Paper IV of this dissertation. In particular, I defended Silverman's (2004: 37) view that 'there is no reason why qualitative researchers should not, where appropriate, use quantitative measures'. For both qualitative and quantitative research alike, however, issues of the *credibility* of the performed research—i.e., its reliability, validity and generalizability—rise to the fore. *Reliability* refers to 'the degree of consistency with which instances are assigned to the same category by different observers or by the same observer on different occasions' (Hammersley 1992, quoted in Silverman 2004: 225). In relation to the qualitative research methods of texts and interviews, reliability essentially means a) categorizing texts in a standardized way, i.e., so that any researcher would categorize in the same way; b) tape-recording all face-to-face interviews, carefully transcribing these tapes according to the needs of reliable analysis (i.e., not handing the task over to an audio-typist); and c) presenting long extracts of data in the research report (Silverman 2004: 226-230). The papers in this dissertation fully meet all these criteria except the one of presenting extracts; it can be argued that both Paper II and III quote interviews sparsely. This, however, is mainly due to the restrictions of the number of words that are allowed in the journals in which the articles are published.

A second aspect of the credibility of research is that of *validity*, by which is meant ‘truth: interpreted as the extent to which an account accurately represents the social phenomena to which it refers’ (Hammersley 1992, quoted in Silverman 2004: 232). Two forms of validation that are often quoted as suitable for qualitative research are *triangulation* (Denzin 1970) and *respondent validation* (Bloor 1978). Silverman (2004: 234-235), however, argues that there is no external point of view from which to adjudicate between the accounts produced the different methods used in such a procedure, and that these therefore ignore the context-bound and skilful character of social interaction. Many problems also inhere with the method of respondent validation (Silverman 2004: 235-236). Based on these critiques, Silverman (2004; see pp. 236-237) proposes instead a set of five more appropriate methods for validating studies based predominantly on qualitative data: 1. Analytic induction 2. The constant comparison method 3. Deviant-case analysis 4. Comprehensive data treatment and 5. Using appropriate tabulations. From the point of view of these five methods of validation, it can be argued that, although not below critical values in any of the articles of the current dissertation, the validity of the papers does increase the further we move onward from the theoretical induction performed in Paper I to the more bottom-up-oriented work of Paper III. This beyond doubt reflects the general methodological development of the current dissertation.

Finally, the third and last aspect of the credibility of qualitative research is that of *generalizability*. Hammersley (1992, quoted in Silverman 2004: 249) suggests that the representativeness of a single case such as the one presented in this dissertation can be increased by three methods: 1. Obtaining information about relevant aspects of the population of cases (in this case, innovation processes) and comparing the case to them 2. Using survey research on a random sample of cases and 3. Coordinating several (ethnographical) studies. For pragmatic reasons, an author of a dissertation is more often than not confined to the first method. However, given this restriction, there are, according to Silverman (2004: 255) some ways in which the generalizability of qualitative research can be increased: 1. Combining qualitative research with quantitative measures of populations 2. Purposive sampling guided by time and resources and 3. Theoretical sampling. The only difference between to two latter applies when the ‘purpose’ behind ‘purposive’ sampling is not theoretically defined (Silverman 2004). In the last case, the aim is to generalize in relation to ‘*theoretical* propositions rather than to *populations* or universes’ (Seale 1988, quoted in Silverman 2004: 251). In the work performed in this dissertation, I *only* make claims to generalize to theoretical propositions, the closer nature of which can be found in the four included articles and in this summary.

The methods section describes what I did in fact do with the interviews and texts that I performed and gathered during this research. Before closing on methodology, I would like to briefly indicate, based on the reasoning and exemplifications of Paper IV, what *could* have been done, by way of *quantitative* analysis, also to this material, had there been the time and opportunity. First, I could have done the same kind of qualitative and quantitative analysis of the Gefilus interview material in search of ‘KFs’ as I did with the pilot case interviews. Second, I could have related the conceptual blending framework to the SOM and asked in which the latter could have been helpful in the search for ‘cognitive frames’. I will discuss each of these in turn.

In Paper IV, my co-authors and I argued that both top-down and bottom-up qualitative research might benefit considerably from taking into account also quantitative methods, particularly the SOM. More specifically, my co-authors and I argued that a) for a qualitative researcher of a *bottom-up* orientation, the categorization produced by the quantitative research method of the SOM can be of utility in both *exploratory* (i.e., looking for higher-order analytic categories) and *confirmatory* (i.e., testing the adequacy of such analytic higher-order categories) investigations; and that b) for a researcher of a *top-down* orientation, the categorization produced by the SOM can be of utility mainly in *confirmatory* investigations (i.e., testing the adequacy of theory-based categories, such as, par excellence, ‘KF’).

Thus, had the 25 interviews of the Gefilus case been subjected to the same kind of procedure that the eight interviews of the coffee firm case, a researcher of a *bottom-up* orientation could have used the SOM as an aid both in actually performing the kind of abstraction work usually associated with such ‘grounded’ (Silverman 2004; see also Clarke 2005) approaches and in checking that these abstractions are adequate. In contrast, a researcher of a *top-down* orientation could have used the concept maps produced by the SOM to check the adequacy of the analytic categories used (for details on the SOM procedure, see Paper IV). Based on these considerations, this dissertation suggests that combining quantitative methods of the kind represented by the SOM with qualitative methods as described by Silverman is a good way of increasing both the reliability, validity and generalizability of qualitative research (see also Castellani, Castellani and Spray 2003).

Could the quantitative SOM method be helpful also in the study of cognitive frames and their contents? This is a highly intricate question (for a negative answer on this question, see, e.g., Huff 1994). However, in my view it is possible to view the concept maps produced by the SOM as *markers* for the existence of underlying ‘deep structures’ (cognitive frames, schemas, blends) of

individuals. Thus, although the concept maps produced by the SOM would not be able to characterize the *exact nature* of such deep-level cognitive structures, their specific outlook would nevertheless, due to the unique way in which the elements in the map are linked to the input data, indicate *something* of the underlying cognitive organization (for details of the argument that the SOM can be seen to approximate the contents of cognitive frames, see Paper IV).

Here, I would also like to briefly address the issue of rival explanations (e.g., Yin 2003; Rossi and Freeman 1982). Might not, for instance, the continued exposure of the Finnish population to health-promoting foods have enhanced the consumers' receptivity to the novel Gefilus products, thus turning Valio's clever new blend into only a contributive factor and not, as has been suggested here, the main explanation? There can be no doubt that contextual changes, most importantly the introduction of Benecol in 1995 but also general cultural maturation (e.g., Hyysalo 2010; Haddon 2004), were important for the eventual success of Gefilus. Indeed, the whole argument of this dissertation builds on the premise that this contextual change was critical for the outcome of the process. Also, the case description in Paper III shows how contextual factors, such as the economic depression of the early 1990s and the restructuring of the company to meet the demands of the upcoming EU membership, influenced the ways in which the process unfolded.

However, I would not go so far as to making the claim that the rival explanation of cultural maturation rules out the company-level double-loop learning process as main explanatory factor. First, the interviews systematically highlight the 1996 activities as the single most influential factor when it comes to accounting for why the Gefilus project was not simply ended. Second, given the low levels of familiarity with Gefilus products in 1995, as exemplified by the company marketing research data, it is very doubtful that the Finnish consumers would have made the product 'their own' without some kind of significant marketing measure. Thus, instead of viewing these two explanations as rival, I would rather view them as being complementary in the same way that is reflected in the following quote from an article on technological change as approached with a cognitive, as opposed to economic and organizational, lens: "Thus frames matter, not distinctively, but as an essential part of this self-reinforcing system." (Kaplan and Tripsas 2008: 800)

The main aim of this dissertation has been to provide a cognitive and pragmatic account of innovation processes that can complement existing research. I started by asking the following research question, *RQ: How do new products individuate from 'imitators' to 'independent' products answering to and involving distinct new needs and related imageries?* In searching for an answer to

this main question, I broke it down to five sub-questions, the first of which was (1) *How has individuation been addressed in consumer research and in science and technology studies?* The theory review in section 2 showed that although the two reviewed literatures do contain an awareness of the individuation challenge, it has not addressed it explicitly as a theme of its own. The review also pointed to the significance of knowledge for the process of individuation. Next, I asked, (2): *How to conceptualize knowledge in order to better understand its role in the individuation processes?* For this, I provided the notions of conceptual blend (for individual-level knowledge structures) and KFs (for collective-level knowledge structures).

My third question then was, (3) *How do individuation processes unfold from the point of view of such knowledge structures?* From the cognitive perspective, my answer was that it unfolds via a process of imitation at not only one, but two levels of logic, involving multiple reshapings of the object of innovation by means of blending. From the pragmatic perspective, my answer was that it unfolds via either modular KN (in case of simpler, one-level imitations) or pioneering KN (in case of complex imitations at multiple levels of logic).

Having come thus far, I inquired, (4) *How to make the resulting improved understanding of individuation actually do some work for innovation processes?* I answered this question by pointing to the general challenges faced by food producers aiming for the introduction of functional foods, and by suggesting that the identified process of double imitation might function as an example for especially smaller actors in the field. Lastly, I asked, (5) *How are knowledge structures in individuation processes best studied?* This turned out to be a challenging yet rewarding question, since the answer showed that knowledge structures in individuation processes can be studied by means of both qualitative and certain kinds of quantitative methods. Time constraints, however, did not allow me to perform the kind of quantitative analysis of the Gefilus data that I did on the pilot study on knowledge integration in another food-related business context (see section 5.3).

Going through these five sub-questions allowed me to formulate an answer to the main research question of *how new products individuate from ‘imitators’ to ‘independent’ products answering to and involving distinct new needs and related imageries*. The dissertation suggests that the answer is, *in cases of encountering torques or double binds, as was the case in the Gefilus innovation process, they individuate via successful double-loop learning*. The main contributions of this dissertation in relation to existing knowledge on individuation processes can thus be summarized as follows:

1. The *cognitive* account. The dissertation contributes to the hitherto exclusive focus by previous consumer and STS research on first-order imitation by showing that the process of individuation can, in challenging circumstances, include individuation at multiple levels of logic. Without this new knowledge, the unfolding of the Gefilus innovation cannot be satisfactorily explained. The dissertation also shows that the process of conceptual blending forms a central mechanism of shaping the object of innovation so that it eventually fits its targeted cultural context.

2. The *pragmatic* account. The dissertation furthermore contributes to the above two fields by suggesting that the observations of a correlation between KN mode and problem structure is of relevance also for the domestication, and related individuation, of innovations. In simpler cases (i.e., involving only first-order imitation), collaboration across knowledge borders in such processes can well be organized in a modular fashion. However, in more complex cases (i.e., involving second-order imitation), pioneering or translational modes are more suitable.

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Appendix 1

Semi-structured interview schema for knowledge networking (originally developed by R. Langlais)

1. The company

What scientific fields would you say are present in the scientific work of the company?

Has that changed with time?

How has it changed?

Who are the key persons embodying the fields?

How would you describe the challenges of the scientific work?

In the earliest days of the company, what were your main considerations/concerns, in proceeding with the scientific work?

What were the opportunities?

What were the challenges?

Was anything considered a problem?

2. The inter-firm collaboration

Was there any need to go outside of the company, for example to establish any intentional collaboration outside the company?

Were there many different kinds of collaboration?

Which kinds?

Was there any problem with the collaboration?

What did you need to consider when deliberating on entering it?

How did you organise it, formally or informally etc.?

How did it take place?

Has the nature of the collaboration changed with time?

Has that been satisfactory?

3. The process

When you were organizing the scientific work, and you considered these different fields that were necessary, how would you say it went, when scientists from different fields were working together on one goal/project/target/product?

Did you feel it necessary to do anything about that?

In other words, was it necessary to do anything to change it in some way, to assist it, modify it, and so on?

Who took the first initiatives?

Who was enrolled? When?

What was and is being done? By whom?

How do you describe that?

What are the challenges and the advantages of that?

Were there any major twists and turns on the way?

Of what kind?

Did you face any specific obstacles?

Are you succeeding?

Regarding the scientific work, has the company ever engaged consultants in order to assist in organizing the work?

How did that proceed?

Regarding the scientific work, has the company ever organized, or sent any of its employees, on any courses? (This could include the non-scientific staff, whom the company felt should get some instruction in the content of the research, or for managers, in knowledge management, or for scientists, in thinking entrepreneurially, etc.)

Have the scientific staff spent any time on sabbaticals, working in other laboratories, for developing new skills, etc.?

Have the scientific staff had any intense, in-house training with experts in the selected future core technologies?

Have the scientific staff taken any part-time coursework (in other words, while on the company's payroll) in topics related to those technologies or disciplines?

Have the scientific staff been put through any cross-training within R&D?

Have any of the scientific staff been put in any kind of apprenticeship relationship to newly-hired scientists with important tacit knowledge in the selected future core technologies?

4. The outcomes

Would you say the work has been successful?

In which respects?

In which respects not?

5. The location (this in all evidence varies according to case)

The company is located in xxx. Does xxx have any significance for it?

For the same reason, does the xxx have any relevance?

How much mobility is represented by your scientific staff? Do the staff tend to stay on with the company, or are they moving around to different jobs within the xxx area? Are the ones you hire of this category?

6. The future

What kinds of issues are facing you now as you look ahead at new innovations and further development?

How do you think you might approach those?

Do you feel confident about the prospects?

Appendix 2

Guidelines for knowledge networking case studies (originally developed by H. Bruun)

Structure of analysis (not to be mixed with structure of article)

1. Description of the company history

- Origin, foundation
- General development (owners, technologies, markets)
- Economic figures through time: turnover, revenues
- Innovative activity through time: patents, key innovations

2. Analysis of how the company has organised knowledge production (within a specified field, such as R&D)

- Core competencies and their distribution in:
- In-house units
- Inter-organisational networks

3. In-depth analysis of two or three knowledge production processes

- Short description of the main elements of the process (When did it start? What kind of knowledge was produced? What was the importance of this knowledge for the company?)
- Description of key knowledge regime/regimes (How does it understand the world? What methodologies/techniques/instruments are used? How is the epistemic subject understood? Focus should here be on the aspects that differ from the regime characteristics of collaborators)
- Collaboration across knowledge regime boundaries: knowledge networks
- Why was such collaboration needed (in terms of the cognitive or technological requirements of the knowledge production)?
- What was the dominant form of the network (Architectural/Translational/Pioneering: Combination? Changing?)
- How was the network managed/organised?
- Was collaboration successful? (what criteria should be used to determine this?)
- What knowledge-related problems occurred?
- How were these problems solved?
- What problems could not be solved?

4. Integrative capability: discussion on the basis of the previous analysis

- What can be said about the (knowledge) integrative capability of the company?
- Is there a development in these competencies?
- Are there specific needs for the future: lessons learnt from the case study?

Some general comments

- The point of the project is to see how the knowledge-related aspects interact with social and institutional aspects. It is therefore important that both are well described: What knowledge is produced? What is the cognitive challenge in the knowledge integration? What is the social structure within which knowledge is produced (regimes, networks)?
- Another point of the project is to investigate how knowledge is integrated and whether there were problems in the way in which this happened. This means that knowledge integration must be thematized and that its characteristics and performance must be analysed.
- A distinction should be made between inter-organisational networks and knowledge networks. Collaboration between organisations can occur within the framework of one and the same knowledge regime (for instance company chemists collaborating with university chemists). It is therefore important that any claims about there being a knowledge network is justified: that one shows that there is collaboration between different competencies.
- Case studies can vary in emphasis: some can be more focused on the analysis of knowledge production processes (3), and others more on integrative capability (4).

Remember that the project has a double ambition:

1. To increase our understanding for processes of transepistemic knowledge production: What kinds of transepistemic production are there? How do they differ? Etc.
2. To develop recommendations to companies (or other units/organisations) that want to produce knowledge transepistemically. How should they organise/manage such a process? What difficulties can they expect to face in particular cases of transepistemic knowledge production? How can the integrative capability of a company be increased? Etc.

The general hypothesis behind the project is that the two are interconnected: good answers to the second set of questions must be based on the answers to the first set.



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