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**INNOVATION STRATEGIES IN THE EMERGING
NUTRACEUTICAL AND FUNCTIONAL FOOD INDUSTRY**

Submission to area 6: Food Culture: Tradition, Innovation and Trust

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1. Problem Statement and Objectives of the Paper

Since the early 90s the sector of nutraceuticals and functional foods (NFF-sector) emerges at the boundaries of the pharmaceutical and food industries (Childs et al., 2000). With annual growth rates of 10%, this product segment is an attractive target for actors of different industries. Hence, next to the food industry one can observe the agribusiness, the specialty chemicals as well as biotech and the pharmaceutical industry striving for innovations and rents from this emerging market. Accordingly, tendencies of industry convergence can be observed in trends for the application of the same technologies, similar regulatory requirements for meeting science-based product approval, and for substitute products in food and in pharmaceutical markets (Heuskel, 1999). For example, the cholesterol-lowering technologies (for example, sterols) are applied across industry boundaries. The growing market for phytosterol-enriched margarines targeting the reduction of coronary heart disease risk factors (CVD), especially LDL-cholesterol, is marketed by the pharmaceutical (Johnson & Johnson's Benecol[®]-Margarine) and by the food industry (Unilever: Becel Pro-Active[®]-Margarine). Even though the pharmaceutical industry has traditionally focussed on curing, and the food industry on nurturing, the trend towards prevention is witnessed in both sectors, leading to substitute products produced by both formerly distinct industries. The process of convergence is also nurtured by the trend of regulatory convergence with respect to product approval due to costly pharmaceutical-like clinical studies increasingly required for nutraceuticals and functional foods. Even if there are slow developments on an international scale to harmonize, or to better, establish legislation, regulation remains an undefined area, where NFF products, perceived as "border-line products" are difficult to classify. Thus, the evolving regulation triggers additional challenges for players along the value chain reaching from crop development to food retail (Cloutier and Saives, 2002).

Innovation strategies - defined by Clark and Wheelwright (1993) as a plan for technology and product/market-combination - are not the same for nutraceuticals and functional foods as compared to conventional innovations in the food industry. Why is that? First of all, most innovations in nutraceuticals require high investments, which significantly exceed average R&D-spending in the food industry (Menrad, 2003). Secondly, innovations in the NFF-sector require different competences owned in different industries and thereby are way more complex as conventional food innovation (Bröring et al. 2006). According to Gilbert (1994) the innovation strategy a firm pursues is influenced by the resources a firm possesses, industry in which a firm competes as well as its past history and present strategy. This leads to the question of which innovation strategy companies striving for the NFF-sector are employing. Are there different approaches to innovation? In how far does the industry background determine the chosen innovation strategy? An exploration of the particular innovation strategy chosen for successful new product development in the NFF-sector is at the centre of this study.

Given the fact that the segment of nutraceuticals and functional foods offers a huge potential for innovation, but considerable investment along with a high degree of complexity this paper seeks to shed some light on the successful innovation strategies different actors pursue. The aim is to contribute to the understanding of how innovations can be pursued in a dynamic area of convergence and how the different actors in the particular case of nutraceuticals and functional foods respond in terms of their innovation strategy. Thereby this paper strives to enhance the management research rooted in the resource-based view (*e.g.* Penrose, 1959; Barney, 2001) with respect to innovation management in convergence. Beyond that the study at hand seeks to foster successful innovation management from a practical perspective by laying down different innovation strategies. Thus, by analyzing different industry cases of convergence, the paper strives to derive managerial implications regarding the development of innovation strategies and their implementation. Next to providing practical implications for innovation management in the functional food sector, this paper seeks to contribute to management research by linking the relatively unexplored context of industry convergence to the development of innovation strategies.

The remainder of this paper is organized as follows. In section two, general implications of convergence for innovation management are detailed as well as existing literature on innovation strategy building is reflected. This literature review provides an overview of present research on innovation and industry convergence in order to understand the particularities of industry convergence in general and with respect to the development of innovation strategies. Subsequently, section three looks at the nutraceuticals and functional foods segment which emerges between the food and the pharmaceutical industry and presents an example of industry convergence. In section four follows a description of the sample, the chosen research method and analysis. Section five presents the empirical part by a description and comparison of different case studies. The empirical findings and a typology of different innovation strategies are discussed in section six. Finally, section seven derives conclusions and highlights implications for theory and practise.

2. Implications of Convergence for Innovation Management

2.1 Innovation management in industry convergence

Industry convergence presents a particular context for innovation and technology management and the development of innovation strategies in particular. Firms who find themselves in converging industries face new competitors producing substitute products for the same new inter-industry segment arising on the boundaries of formerly disparate industries (Bröring et al., 2006). Successful innovation requires organizations to combine

many critical knowledge areas. These necessary areas of knowledge and competencies are traditionally owned in different industries. That these needed knowledge and competence sources are industry specific (Fai and von Tunzelmann, 2001) can be explained by the fact, that they are cumulative and path-dependent, since they develop over time following specific paths (Diericks and Cool, 1989; Teece et al., 1997; Greener, 2002). Hence, it seems that no player – notwithstanding of which industry affiliation he originates – possesses all capabilities needed for innovating successfully in times of convergence. The question here is how companies have to design their innovation strategies in order to cope with particularities of converging industries. So, what are these particularities in detail? As the preceding discussion indicated there are many dynamic characteristics of industry convergence influencing innovation. To summarize, these can be classified as illustrated in the following table.

Table 1: Industry convergence as a special situation for innovation

Convergence of Technologies	Convergence of Markets	Regulation and Standards
<ul style="list-style-type: none"> ▪ application of new technologies across industry boundaries ▪ fusion of existing technologies owned in different industries to form a common one 	<ul style="list-style-type: none"> ▪ demand structures converge ▪ substitute products arise from another industry 	<ul style="list-style-type: none"> ▪ missing industry standards ▪ regulation for the new “converged” sector is only about to emerge
new areas of technological knowledge become relevant for innovation	new areas of market knowledge become relevant for innovation	legal uncertainty in defining the options for innovation

An important characteristic in analysing industry convergence and its impact for innovation and technology management is the similarity of the previously separate industry sectors. This can be seen in the extent to which the two converging sectors have been alike in terms of their competence basis prior to convergence. Being theoretically anchored in the RBV this paper looks at differences between the two converging sectors as differences in resources and competences. The greater the difference between the two industries in terms of competences and experiences, hence, the greater the industry-specific development path differs, the more obvious are the problems firms have in realizing their opportunities in an emerging inter-industry segment (Bröring et al. 2006a). This raises the question of how firms can successfully develop innovation strategies and secondly how firms implement these.

2.2. Developing innovation strategies and the particularities of convergence

A sound innovation strategy is key for the successful commercialization of innovations (Afuah, 2002; Tschirky, 2003) – it is especially relevant in times of environmental change

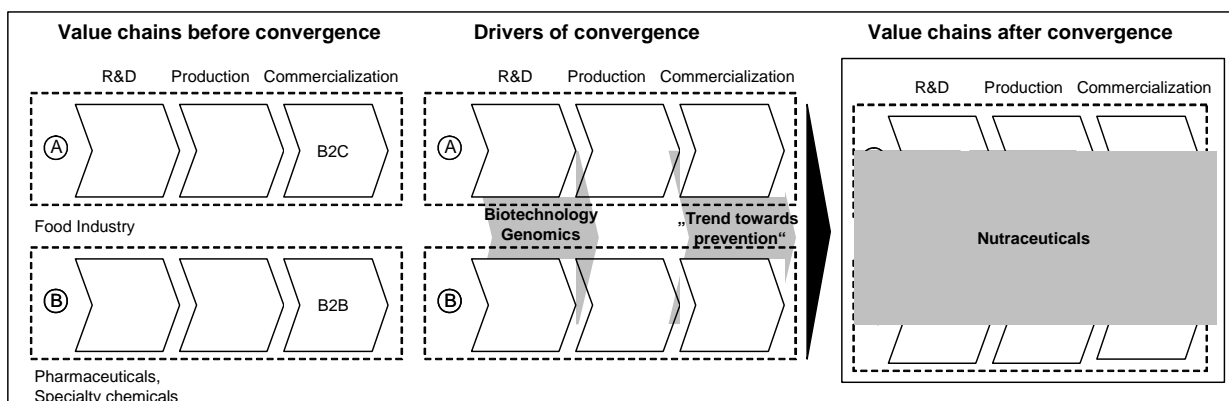
(Sanchez, 1996) such as convergence. As discussed beforehand in converging industries firms face changing technological and market developments. New areas of knowledge may become relevant for engaging in innovation. Concerning regulation and industry standards, Day and Schoemaker (2000) state that there are different rules in new industries, since neither industry standards, nor a regulation has yet emerged. Following the classification of Sanchez (1996), this paper understands inter-industry segments arising from convergence as evolving markets. Evolving markets can be characterized with a higher degree of uncertainty. Uncertainty is due to two reasons. First of all, the evolving market itself is far from clear preferences and defined technological designs. Secondly, firms involved in this market may struggle since they lack the needed competences and are sometimes also insecure about which competences to develop, because the specific competences and resources cannot be identified with precisions. Firms are insecure about their positioning in an emerging value chain. One reason for the inability to either identify opportunities resulting from industry convergence or understanding the required competence and knowledge basis can be seen in limited absorptive capacity (Bröring et al. 2006). Cohen and Levinthal's (1990) construct absorptive capacity is defined as "*the ability of a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends*" (Cohen and Levinthal, 1990: 128). Absorptive capacity only evolves over time and is path dependent. The reasoning for path dependency originates from the influence of past activities on future ones, because cognitive processes are cumulative, idiosyncratic as past and accumulated experiences determine the capability of a firm to absorb the external knowledge needed for idea generation. For example, firms that build a distinct technological competence are more likely to build on existing resources (compare e.g. Dosi, 1982; Dierickx and Cool, 1989; Helfat, 1994). In case of industry convergence which is based on both, convergence of technologies as well as on markets, firms face knowledge, capability and resource gaps. This calls for a constant scanning of the firm's immediate and neighbouring environments (Lei, 2000) in order not to be overrun by trends of convergence, but to actively shape and influence them (Bröring, 2005). Hence, as argued beforehand, firms confronted with trends of convergence may have to adapt their innovation strategy. In this context a firm's innovation strategy needs not only to account for the *plan for market and technology* (Clark and Wheelwright, 1993) but it also needs to take into consideration the organizational implications in order to realize the innovation strategy (Sauber and Tschirky, 2004).

3. Nutraceuticals and Functional Food – a sector between food and pharma

3.1 General Introduction into the Sector

The term „nutraceutical“ illustrates a growing together of the food and the pharmaceutical industry. This segment is developing since the beginning of the 90's at the border of these two industries (Bröring, 2005). It integrates different technologies and consumer trends but does not lead to a phasing out of the two formerly distinct industries. For instance, the progress of the biotechnology plays a special role for the development of bioactive substances. Furthermore „nutrigenomics“ as the connection of nutritional sciences and genomics represents a new area with huge potential for innovation. Here, scientific knowledge from the fields of genomics, crop science and genetic engineering as well as modern medicine is combined with the goal to develop nutritional products medical prevention and treatment. This form of complementary technological integration is accompanied by the convergence of product functions (*e.g.* food and prevention). The driver for market-related output-side convergence can be seen in a growing health trend, which provides for constantly growing sales of hybrid products like cholesterol-lowering foods. Thus, the emerging nutraceuticals and functional foods segment offers room for a variety of products. These reach from the simple enrichment of food with functional ingredients up to products of the personalized nutrition based on scientific knowledge of genomics.

Figure 1: Convergence of Nutrition and Pharmaceuticals: Nutraceuticals



Therefore, the emerging value chain between is an attractive target for players of food (*e.g.* Unilever, Nestlé) and pharmaceutical or chemical (*e.g.* Novartis, Abbot Labs, DSM, BASF) industry origin. Hence, the rising consumption of health promoting food products has triggered **players of different industries** to develop innovation strategies for the rising NFF-sector. The involved industries are encompassing (a) the food industry, (b) the pharmaceutical industry, (c) “functional ingredient” manufacturers of the specialty chemical sector, and (d)

multinational raw material suppliers or agribusiness conglomerates.¹ The motivations to develop innovations for the NFF-sector differ among industry players.

(a) The food industry

Food companies, whose margins have suffered a lot due to aggressive price wars and increasing power of retail, perceive the NFF-segment as a new option for growth in the mature food market. In the mid 90s several large multinationals (*e.g.* Nestlé, Danone, Unilever, Kellogg, Quaker Oats, Procter&Gamble) have started to introduce functional food products. Nestlé's LC1 probiotic yoghurt can be seen as a pioneer on the European market. On a global scale the Japanese firm Yakult with its equally named probiotic drink has developed the segment of functional foods. Yakult has introduced its fermented milk drink in 1991 (Heasman and Mellentin, 2001). Food companies such as for instance Unilever seem to benefit from existing brand loyalty and awareness of customers. This enhances the adoption and diffusion process of functional food innovations, which are often introduced in line extensions from existing strong brands.

(b) The pharmaceutical industry

Supplements have become an important side business of pharmaceutical companies. They are commonly handled under the consumer health care divisions of the pharmaceutical players (*e.g.* Glaxo Smith Kline, Novartis, Abbot Laboratories, Wyeth, Bayer). The motivation of the pharmaceutical industry to develop innovations for this hybrid segment are shorter development times and lower product development costs compared to pharmaceutical products. Thus, it seems favourable to use the intense experience in clinical trials for substantiating a health benefit of certain food products. Pharmaceutical firms have not only launched drug-like supplements, but also functional foods including cereal bars, cereals and beverages (Menrad, 2003). These so called "fast moving consumer goods" produced by science-driven pharmaceutical companies have not always been successful. For example, the product range "AVIVA" of Novartis Consumer Health introduced in 1999 flopped and has been withdrawn in 2001. In contrast to the consumer driven food companies, Novartis - a traditionally science-driven company - could not benefit from any existing brand loyalty (Biester, 2001). Thus, one explanation of the unexpectedly low sales can be seen in missing consumer marketing competencies, since the product range of different functional foods such

¹ In contrast to the four different industry players identified here, Menrad (2003) follows a slightly different approach. He distinguishes: multinational food companies with a broad product range, pharmaceutical and/or dietary products producing companies, national "category leaders", SMEs of the food industry, retail companies and suppliers of "functional ingredients". See Menrad (2003), p. 184.

as muesli, cereal bars, etc. has been managed by the existing OTC-function, which had no prior experience in marketing of “fast moving consumer goods”.

(c) The specialty chemicals industry

Ingredient manufacturers (*e.g.* Degussa, DSM, BASF, ICI, Danisco, Chr. Hansen) play a significant role in the emergence of the NFF-sector. Almost all large suppliers have launched innovations targeting this growing segment. This technology-driven industry group is especially important for SMEs of the food industry, which lack any technological know-how (Menrad, 2003). It seems that in an increasing number of cases these industrial product manufacturers try to move upstream in the value chain, which originates in the attempt to increase margins and decrease risks of commoditization (Abratt and van Altena-Lombard, 1993). Specialty chemical firms try to develop consumer awareness regarding their ingredients in order to let their ingredient brands appear on the end product (ingredient branding) (Hilliam, 2000). Some go even further and try to become manufacturers of end-consumer products (*e.g.* DSM is about to launch its sport drink PetoPro[®]). The direct B2C-activities are often undertaken in collaborations with food companies (DSM has chosen Haleko, a consumer goods manufacturer of sport drinks, as a collaboration partner).

(d) The agribusiness

The raw material processing and trading agribusiness (*e.g.* Archers Daniels Midland, Cargill, Monsanto, Cerestar) has become increasingly interested in this new segment which allows for higher margins than conventional commodities as for instance soy beans. The agribusiness has established itself as a supplier of functional ingredients, which are extracted from raw materials (*e.g.* phyto-estrogens from soy). Depending on how the public acceptance of genetically modified foods will develop over time, this industry player may possibly look at a wide-spanning potential for innovation grounded in the field of agricultural biotechnology. Some of the players have entered into R&D alliances with certain partners. An example here is Monsanto and GNC (General Nutrition Company) to produce a product line based on DHA (a polyunsaturated fatty acid (PUFA)) (Law, 1998).

Despite the fact that there are different industry groups increasingly interested in the NFF-sector, this study divides the actors into those with strong technology competencies and those with strong consumer market competencies. This leads to two major groups: the technology-driven chemical (specialty chemical) as well as the pharmaceutical industry and on the other hand the food industry, which is market-driven and less research intense. Alternatively, one

can label the pharmaceutical/chemical industry as a “high-tech” sector and the food industry as a “low-tech” sector. Hence, the NFF-sector emerges on the boundaries of two industry sectors, which differ strongly regarding their resources and competencies. In contrast to the science-driven pharmaceutical and chemical sector, the food sector has a much longer history in end-consumer marketing. Consequently, it has a good consumer insight on the end-consumer side, but also a well established relationship management with retailers on operational, tactical as well as on strategic levels (Harmsen and Jensen, 2004).

Table 2: Competence differences of actors in the NFF-Sector²

		Industry Background	
		Food/Nutrition ³	Pharma/Speciality chemicals
Technological Competencies	R&D-intensity	<ul style="list-style-type: none"> Low (< 1% of sales) 	<ul style="list-style-type: none"> High (>14% Pharma/ >4% Chemicals)
	R&D-cycles	<ul style="list-style-type: none"> short (1-3 years) 	<ul style="list-style-type: none"> Long (10 up to 20 years (in pharma))
	IP-strategies	<ul style="list-style-type: none"> Trademarks, consumer brands 	<ul style="list-style-type: none"> Patents (preferably on the product/compound)
	New Technologies	<ul style="list-style-type: none"> Traditionally external sourcing, no own development skills 	<ul style="list-style-type: none"> Foster internal development of technologies
Market Competencies	Market Insights	<ul style="list-style-type: none"> Consumer market (B2C) 	<ul style="list-style-type: none"> Industrial Clients (B2B)
	Access to Distribution Channels	<ul style="list-style-type: none"> Mass – Market Distribution via Retail Chains 	<ul style="list-style-type: none"> B2B Wholesalers, Pharmacies, Nutritional Speciality Stores
	Communication	<ul style="list-style-type: none"> End-consumer – oriented 	<ul style="list-style-type: none"> Science, industrial partner – oriented
Regulatory Competencies	Regulatory Approval Processes	<ul style="list-style-type: none"> Little or no skills 	<ul style="list-style-type: none"> Own regulatory approval business functions
	Familiarity with Safety/Efficacy Testing	<ul style="list-style-type: none"> No experience in clinical product evaluation 	<ul style="list-style-type: none"> Long-term experiences with clinical trials Via CROs (Contract Research Organizations) or own facilities
	Monitoring of the emerging Regulation	<ul style="list-style-type: none"> Limited access to changes in regulation via industry associations 	<ul style="list-style-type: none"> To some degree active in developing standards (biomarkers) relevant for health claims

As indicated in Table 2, the two industry groups: the R&D-intense pharmaceutical and chemical companies and the consumer-market oriented food-industry differ in many points regarding technological, market as well as regulatory capabilities. These primary observations can be complemented with secondary data arguing that participation in the NFF-Sector is a

² Bröring (2004), p. 5. Regarding R&D intensity, the OCED (1999), p. 106 offers a useful classification on industries. It uses the overall technological intensity (OTI) which consists of the direct R&D intensity (reflecting the development of technology) and the indirect R&D intensity (reflecting the use of technology). Based on a comparison of the measure OTI, the OECD classifies the pharmaceutical (including speciality chemicals) industry as high-tech (with an OTI of 11,35) and the food industry as low-tech (with an OTI of 0,73).

³ For a detailed discussion on the innovation system of the German food industry see also Menrad (2004). This indicates that the food industry employs only 0,4% of all the employees in R&D, compared to 2,4% in all industries in Germany.

multi-discipline endeavour requiring competencies of different industries (Childs, 2000). With regard to specialty chemical firms Abratt and van Altena-Lombard (1993) further find that these often lack marketing and publicity efforts, a competence which is considerably stronger in the fast moving consumer goods sector.

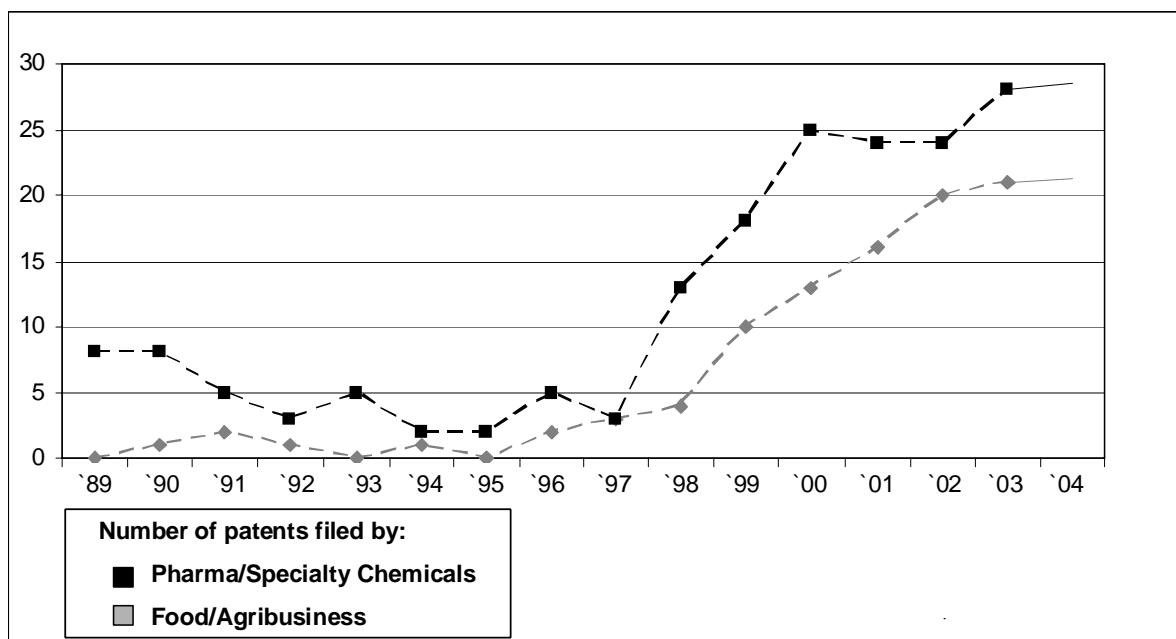
Even though the market for nutraceuticals and functional foods offers many options for additional growth, flop rates remain high and only a few products can claim to be top sellers (Scholl and Müller, 2004). The reason can be seen in the fact that no player – neither the food nor the pharmaceutical/chemical firms – possesses the required competencies in a market where both, strong R&D and strong consumer product marketing competencies are required. Due to differences in resource profiles and path-dependent development the food industry lacks the technological understanding, whereas the pharmaceutical industry suffers from a missing market competence.

3.2. Technology context of the Nutraceuticals and Functional Foods sector

With over 1000 scientific papers published each year new health properties of existing or new ingredients and raw materials have become a major concern of food scientists, pharmacists, chemists and medical doctors (Heasmann and Mellentin, 2001). Technology development of functional foods and bioactive ingredients has grown to be increasingly important also in terms of public funding. This is reflected by the fact that this area of research has developed to be a substantial part with increasing relevance in the 4th, 5th and the current 6th Framework Programme of the European Union.⁴ Trends indicating the development of technological convergence can be observed in patent data. In preparation of this study such a patent analysis has been undertaken for the ingredient “phytosterol”. As discussed above, phytosterol inhibits the absorption of LDL-cholesterol, a risk factor for many cardiovascular diseases. The ingredient is part of an increasing number of functional foods and nutraceuticals. One product example is the cholesterol-lowering margarine Becel pro-active by the food multinational Unilever.

⁴ Since 1995 there is a distinct programme called FUFOSSE standing for Functional Food Science in Europe. This EC-Programme is managed by ILSI Europe (International Life Science Institute Europe). See www.ilsis.org. One example of the EU funded research programmes under the 5th Framework Programme is the European Communities, specific RTD programme "Quality of life and Management of Living Resources", Key Action 1 "Food, Nutrition and Health" . See www.cordis.lu.

Figure 2 : Patent analysis of phytosterols (1989-2004)⁵



By using the databank Sci-Finder™ a patent search has been undertaken for the last 15 years. The output generated more than 300 patents, which have been classified by the industry affiliation of the filing organization. Figure 2 illustrates, that patent activity of both sectors has increased largely over the time period chosen. From 1989 until the end of the 90s, there has been only little patenting activity of the technology-driven sectors and almost none of the food sector. This indicates that R&D related to phytosterols has increased since the end of the 90s. Pharmaceutical and specialty chemical companies filed most patents. Nevertheless, food companies such as Unilever have become increasingly active in patenting as well. In this case convergence has been triggered by the application of new technological knowledge across different industries.

These examples indicate that new product development in the emergent NFF-sector is based on technologies which are applied in various industries and trigger further industry convergence. Hence, innovation in the NFF-sector is a very complex endeavour which requires network structures to get access to new technologies as well as a combination of public and private funding to reduce the risks associated with the development of radical new food products. To give an overview of the technology platforms involved with R&D in the NFF-sector and further investigate converging trends on the technology side, Table 3 has been derived.

⁵ Source: Own analysis undertaken in the 4th quarter of 2004 based upon the databank Sci-Finder™. It has to be noted that for the ease of conducting the study, this patent analysis did not differentiate between patent applications and granted patents.

Table 3: Technology platforms in nutraceutical and functional foods development

	Extraction Isolation Purification	Fortification Processing Formulation	Fermentation	Metabolics	Nutri-genomics	Plant Biotechnology
Objective	Ultra-filtration, thermal techniques in order to extract bioactive compounds from raw materials	Enrichment of a traditional food with an ingredient plus ensuring its shelf life and chemical stability	Fermentation of bacteria for generating new bacteria strains, or use their expressed products	Understanding the biochemical pathway of bioactive agents	Investigation of links between food and genetics aiming to tailor food according to individual health requirements	Genetic modification of plants in order to increase or decrease certain nutrients
Example	Extraction of sterol and stanols from plants	Enrichment of a fruit juice with calcium	Production of probiotic ingredients or end-consumer foods	Linking of certain ingredients to the glucose metabolism in order to develop micronutrients for diabetes II prevention	Identification of personalized food ingredients based on a person's DNA-profile	Genetic modification of rapeseed; enhancement of long-chain polyunsaturated fatty acids (BMBF-Project Napus 2000)

While extraction and purification are more related to the use of raw materials which contain bioactive food ingredients, the genomics approach is traditionally not common in food but rather a drug oriented technology. As for nutrigenomics, they can be seen as the food counterpart of pharmacogenomics, since both are based on genomics as an underlying technology platform aiming at developing personalized foods or drugs (Burill, 2003). Thus, a trend towards technological convergence can clearly be identified. This gets further supported by a study undertaken by KPMG which analysed research activities of university departments in North America. According to this study, there is an increasing interest shown by food and nutrition departments but also even more from pharmaceutical faculties and medical schools calling for multidisciplinary research projects (KPMG, 2002). One example is a multi centre clinical study comparing the food supplements containing glucosamine and chondroitin with celebrex, a blockbuster arthritis drug. This research project takes part under a U.S. National Science Foundation programme.

3.3. Market context of the Nutraceuticals and Functional Foods sector

Defining the relevant market is a difficult task in converging industries, since boundaries are blurring to the same degree as product definitions are overlapping. Hence, in the case of nutraceuticals and functional foods it is difficult to distinguish foods from drugs, since both products are starting to serve similar functions with the target of preventing certain diseases. However, one common distinction of the two product areas is their intended product function.

According to Clydesdale (1996), products of the food-like NFF-sector are consumed for preventive uses. This implies that they deliver only a future benefit (see Table 4). Drugs, on the other hand, deliver an immediate effect. But as the previous paragraph and the example of

phytosterols have illustrated, this distinction of food vs. drug by product function does not always hold: phytosterol-enriched foods bring an immediate benefit of reducing the blood-cholesterol level (Weststrate and Meijer, 1998). On the other hand the pharmaceutical industry is also aiming at the segment of prevention. Looking at the technological field of genomics, both food and drugs may be able to deliver benefits to a targeted segment of the population. Hence, product functions are blurring, which is even more reinforced by the consumer trend of seeking to combine health benefits in food products. This trend is especially strong in the U.S. where, according to a survey conducted in 2001, 61,2% of the population uses nutraceuticals and functional foods as part of the normal diet (Halsted, 2003).

Table 4: Product functions of nutraceuticals and functional foods vs. drugs

Functions of nutraceuticals&functional foods:	Functions of drugs:
Prevention	Treatment and prevention
Future benefit	Immediate effect
Broad-brush approach	Targeted population
Safe	Benefit > Risk

Convergence regarding the demand side has been recognised by big food players, like Unilever. As expressed by their former Chairman Niall Fitzgerald “*people want vitality because they are living longer and there will be periods of time when they are not working full time. The other thing that will be more important is products that have a physical but also an emotional benefit*”. This quotation illustrates that consumers of the NFF-sector are seeking multiple functions such as health or physiological ones. It means that in the eyes of an increasing number of consumers a food should not only be nutritious but also health enhancing and may be even convenient as well as a source of ‘guilt free indulgence’. These market developments require manufacturers to anticipate, identify and respond to certain consumer trends relevant to the particular food category.

Evidence for the increasing demand for health promoting foods can be observed in the growing awareness of consumers regarding health promoting benefits and the link between diet and health (Gray et al., 2003). According to a study on a global level undertaken by the British food research organization Leatherhead Food International, the three most well known indication areas of the NFF-segment are heart health (e.g. products lowering the risk of cardiovascular diseases), gut health (e.g. products enhancing the function of the digestive system) and bone health (e.g. products lowering the risk of osteoporosis). Considering the

different product classes and formulations of the diversity of ingredient categories the breadth of applications and, thus, the large array of opportunities for innovations in this segment is self-evident. Thus, from an end-consumer perspective an ingredient can be launched in several ways: It can be incorporated in food as a functional food, as a dietary supplement, as a liquid formulation, or even as a medical food available in a pharmacy (see Table 5 for an overview).

Table 5: Ingredient categories and bioactive compounds

Ingredient Category	Bioactive Compound	Indication	Product example
			Manufacturer
Prebiotics	Oligofructose, Inulin	Gastro intestine	PRO Muesli
			Orafti – ingredient manufacturer
Probiotics	Lactobacillus Bifidobacteria	Gastro intestine	LC1 -yoghurt
			Nestlé – ingredient and product
Phytosterols	<i>e.g.</i> β -sistosterol	Cardio vascular diseases	Becel Pro Active margarine
			Unilever- endproduct Cognis - ingredient
Poly unsaturated fatty acids (PUFAs)	ω -3-fatty acids ω -6-fatty acids	Cardio vascular diseases	ω -3-milk
			Natrel-milk and ingredient coating
Proteins, Peptides; Aminoacids	Creatin Lactoferrin	Enhanced muscle functions	Creapure- dietary supplement
			Degussa Bioactives ingredient + end product
Dietary Fibre	Pectin	Protection of colorectal cancers	WASA Bread
			Barilla
Vitamins	Vitamin A;C;E Folate	Antioxidant effect (anti-tumor)	ACE-Drinks
		Decrease risk of neural tube defect	Fortitec: end product BASF: ingredients
Minerals	Calcium, Magnesium...	osteoporosis	One-A-Day Dietary Supplement
			Bayer Consumer Health Care

However, nowadays the use of ingredients in food products is mainly limited by the taste. This limitation can be overcome by technological advancements in micro encapsulation. By applying this new technology an ingredient can theoretically be incorporated in any food matrix (Beutel and Scheper, 2004). For instance, the bitter taste of some lacto bacteria, the reason why probiotic bacteria are commonly found in dairy products, will not be a problem if encapsulation techniques are used. In addition, it has to be noted that there are certain requirements which not all ingredients incorporated in foods found on the shelf meet. For instance, ingredients have to:

- effectively exert a beneficial effect on the consumer (duration of shelf life),
- stay safe in the food matrix in the sense of being non-pathogenic and non-toxic,
- contain a large number of viable cells (*e.g.* in the case of probiotics),

- survive in the gastrointestinal tract, and
- have good sensory properties.

These requirements call for detailed knowledge of the ingredient and its food matrix as well as possible interactions due to external factors. Thus, fortification seems to be a task which food companies cannot handle themselves – they are depended on the detailed knowledge about “ingredient behaviour” of their suppliers. Another challenge is that consumers often have only limited understanding of diet-health relationships. This is even truer when it comes to really new products involving new claims (Jones and Bourque, 2003). Nutrition education seems to be necessary to complement the establishment of claims. The dilemma of a lack of consumer knowledge regarding the functions of ingredients gets exacerbated by the fact that communication strategies are highly restricted by different legislations.

Concluding, the requirements for a company to engage in innovation in functional foods and nutraceuticals are comparably high, food companies lack the technological know how while pharmaceutical companies lack detailed consumer market competences. How do companies from these different industry backgrounds target this market and develop innovation strategies?

4. Research Strategy, Sample and Data Analysis

4.1. Research Strategy

The novelty of the research on industry convergence and its impact on innovation strategies motivated an explorative approach involving a qualitative case study analysis. The application of this method is favourable in terms of practicability and research design which can be explained by the following citation of Yin (1994: 6) “*In general case studies are the preferred strategy when “how” or “why” questions are being posed, ..., and when the focus is on a contemporary phenomenon within some real life context*”. According to Glaser and Strauss (1967), the aim of case study research is to “discover grounded theory” by comparing different cases. This enables to explore the emerging market and consequently explain the different paths companies have chosen regarding innovation strategies. The analysis of qualitative information is then followed by a critical review of existing contributions to “*enfold the literature and identify conflicting and similar contributions*” (Eisenhardt, 1989: 544). This paper combines secondary data collected from companies, regulatory institutions,

and industry associations as well as primary data. The unit of analysis is the R&D project level.

4.2 Sampling and data analysis

This paper presents the results of primary qualitative data generated from 54 in-depth interviews with project managers active in the field of R&D, new business development, corporate innovation management, and marketing of functional foods and ingredients of firms in the pharmaceutical, speciality chemistry, and food industries. The R&D case project was chosen as the unit of analysis. The successful closure of a project in the NFF sector was used as a sampling criterion. Each respondent came from different organizations and provided information on only one project. Thus, the 54 case histories are independent observations. The interviews were conducted following a two-step process:

- (1) **Semi-structured-type questions** to describe the background of the organization, the characteristics of the sample R&D project and the particular innovation strategy; and
- (2) **Structured-type questions** to collect detailed information on the importance of different sources of ideas, evaluation methods and criteria, and on the impact of existing competences for developing an innovation strategy.

Following Greene *et al.* (1989) a triangulation process was used to combine qualitative and quantitative data analysis approaches with the intent to benefit from complementary information in the data from both structured and semi-structured-type questions.

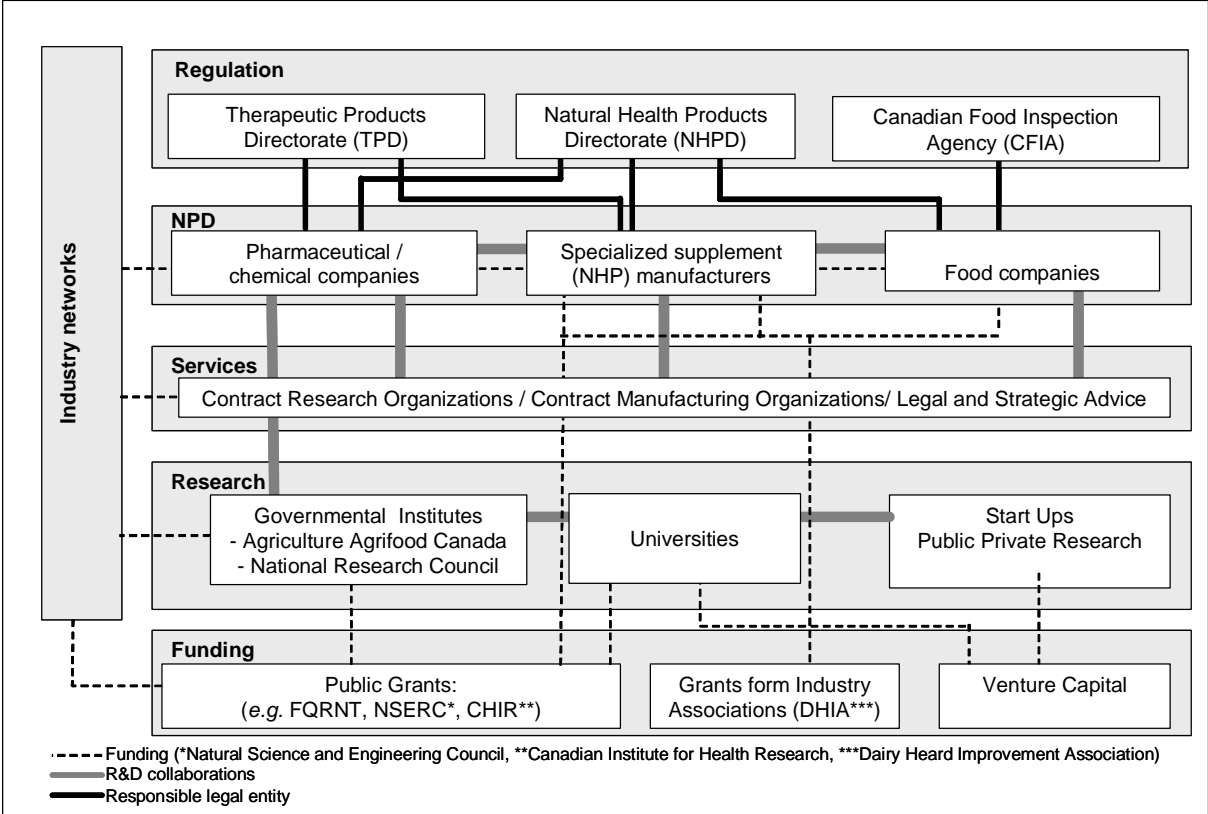
5. Empirical Analysis and Findings

5.1 Description of NFF-Network serving as basis for the sample

The data collection for this PhD-project took place in the Province of Quebec in Canada. The identification of the sample has been facilitated through a database of affiliate companies of the Institute of Nutraceuticals and Functional Foods (INAF) an NFF-network in Quebec. The sampling has led to 54 cases. These have been drawn from 54 different organizations, including technology-driven pharmaceutical and chemical companies as well as market-driven food companies. The sample R&D projects of affiliate organizations of the industry network INAF have in most cases been conducted in different forms of collaboration as illustrated in Figure 3 below. That means that an innovation project is seldom an activity one company is able to conduct by itself. These inter-industry collaborations make it difficult to assign any industry affiliation to most of the R&D projects as they are undertaken in a broader network with partners of different industries and public research institutes. This can already be interpreted as a sign of convergence. The reasoning behind collaborations can be seen in the fact, that organizations pursuing innovation strategies for hybrid industry segments face resource gaps. Therefore, R&D projects are often conducted in inter-industry networks. Regarding the emerging NFF-sector, there exist several networks in Northern America. Among these the INAF is the

most important one for the Province of Quebec, which accounts for more than half of the nutraceutical R&D activity throughout Canada (Saives and Cloutier, 2002). INAF itself is supported by the Quebecois and Canadian governments as well as its affiliated industry members. It serves as a research partner for multinationals or local companies of different industry origin. These member organizations of INAF (*i.e.* food companies, pharmaceutical and chemical companies) have been the object of this study, while per company only one innovation project has been analysed.

Figure 3: The NFF-cluster in the Province of Quebec, Canada



As illustrated in Figure 3 the NFF-sector in Quebec consists of a complex structure involving a combination of public and private sources in funding and research activities. It shows that innovation in converging industries involves different knowledge areas. For instance the food industry, with not much R&D competencies, relies on contract research organizations (CRO) undertaking the research needed to file a product authorization at the regulatory bodies. This often also includes external legal advice related to authorization processes at the newly founded Natural Health Products Directorate.

Due to the strong Quebecois life-science sector, which can be found in a cluster-like formation in the Montreal area, projects owned in the science-driven pharmaceutical and specialty chemical sector are represented in the sample. Food companies – especially in the dairy and beverage sector – are also important players of the NFF-sector in Quebec and on a global scale which is also reflected in the sample. Hence, the NFF-sector of Quebec is representative in terms of players, technology and market

developments in the emerging NFF-sector. It is also important to note that many U.S. firms like the food beverage company Ocean Spray as well as Davisco Foods use the Province of Quebec as a test market before going to Europe, since its consumer structures present a blend of North American and European influences. The same holds true for some European companies (especially the French due to cultural similarities) to enter the North American market. Therefore, the Province of Quebec can be seen as a representative market allowing to study the “hybrid” convergent NFF-sector as an illustration of industry convergence.

5.2 Motivations to enter the NFF-segment and typical hurdles and problem areas

Before looking at the strategies different actors pursue, the interviewees have been asked to describe the most important motivations to enter the NFF-sector as well as the challenges and hurdles they face. Since strategies have to ensure a dynamic fit with a fast changing environment, it is important to understand the particular challenges special to the NFF-sector from an organizations point of view. This subsequently allows understanding the innovation strategy and front end decision making accordingly. Different categories of general motivations as well as problem areas and barriers have been identified by inductive coding. The most important motivations to enter the segment can be summarized as follows:

- market growth due to demographic change and rise in self-medication,
- higher margins than in conventional foods,
- less tough regulated than the pharmaceutical industry (clinical trials etc.),
- option to expand the ingredient business and move downstream in the value chain,
- additional possibility to strive for returns on investment of cost intense R&D,
- option to develop a new segment close to the existing cosmetic or feed ingredient one.

These motivations are confronted with different problem areas and barriers to enter the NFF-segment. According to the qualitative analysis (content analysis and inductive coding) of which 4 major problem areas have emerged, the barriers to innovation in the NFF-sector are subsumed under the categories of (a) Technological problems, (b) Regulatory problems, (c) Intellectual property problems, and (d) Difficulties arising from inter-industry differences. These four major categories together with their particular subcategories can be summarized as follows.

(a) Technological problems

NFF-sector specific technological problems can be integrated into four subcategories as detailed in Table 6. The quotations serve as examples taken from a range of quotes which have been coded and therefore classified as belonging to a certain problem category. They are drawn from a large range of quotes and, thus, have to be understood as examples illustrating certain problem areas.

Table 6: Problem areas concerning innovation: (a) Technology

Problem category		Examples from case studies
INGREDIENT TECHNOLOGY	Clinical trials	<p>“You simply cannot conduct a clinical study since in some cases the product is just not stable, and furthermore its purity cannot be compared to NCEs.”</p> <p>“How can you show a long-term effect? Preventional studies are hard to do.”</p>
	Quality variations	<p>“If the source is a natural one, and you extract a certain ingredient from naturally occurring raw material, you depend on the quality of the harvest.”</p> <p>“Marine Biomass is nothing like a NCE, its quality is very unstable.”</p>
	Food matrix	<p>“The ingredient application possibilities of lactic bacteria are limited by its taste, probiotics are quite bitter, so you cannot use it for everything.”</p> <p>“Taste is also very crucial when it comes to launch probiotics in the U.S., Americans do not like the sour taste of natural lactic cultures.”</p> <p>“We had to work long on encapsulation, since we had to make sure that there is no aftertaste or oxidation in our functional beverage.”</p>
	Interactions	<p>“There can be problems with interactions of the ingredient and pharmaceuticals or other products, we need clinical evidence on side effects of supplementation, which are costly and hard to obtain.”</p>

For instance, in the NFF-sector the preconditions for **clinical trials** such as a homogeneous purity and chemical stability of the bioactive compounds are not fulfilled which makes any reliable testing difficult compared to more homogeneous new chemical entities (NCEs). In addition, the preventive effects are difficult to show. Furthermore, many of the bioactive compounds are derived from natural raw materials, which are subject to **quality variations** of the harvest. This means that raw material shortage may occur as certain qualities are not available. Furthermore, even though the bioactive properties of an ingredient have been scientifically documented, the commercialization of that ingredient may be hindered by problems regarding the fit with a certain **food matrix**, taste or special cultural differences in taste. Moreover, a largely unresolved problem can be seen in the various **interactions** between nutraceuticals, foods and pharmaceuticals.

(b) Regulation

The second problem category regulation, as detailed in Table 7, comprises missing **international harmonization** with respect to product approval, categorization and health claims: Even on a national level there is a lack of clarity with respect to **definitions** of, for instance, clinical trials and requirements needed to obtain a health claim. The difficulties regarding any **communication** of health claims presents another major hurdle for innovation in the NFF-sector as expressed by various respondents. Next to restricted communication possibilities, product approval may be difficult to obtain due to strict **authorization** procedures.

Table 7: Problem areas concerning innovation: (b) Regulation

Problem category		Examples from case studies
REGULATION	Missing harmonisation	<p>“Health Canada often has a different definition of ingredients than the EU. We wanted to import a soluble fibre from France. But now, we cannot claim that our products are rich in fibre, since the EU fibre definition does not fulfil the Canadian requirements. Therefore, we cannot issue a claim ‘contains fibre’”.</p> <p>“The legislation is a huge problem for expanding to other markets: what is a pharmaceutical in France is a Food product here, and vice versa.”</p>
	Missing definitions	<p>“We could not get our clinical study approved in the first case, because Health Canada wanted the same process as for drugs, since there was a lack of common understanding what a NFF-clinical study should look like.”</p> <p>“In Canada we do have the Food Directorate, Health Canada and nowadays the newly founded Natural Health Product Directorate which somehow falls in between the two, thus it is not quite clear who is really regulating what.”</p>
	Communications	<p>“The limitations are clear, you have to spend much on substantiating a physical health benefit, at the same time you are not allowed to communicate it.”</p> <p>“Right now we are just having a very soft claim, but our plan is a stronger claim as ‘restores the balance of the intestinal flora’, but this would require a clinical study which we cannot afford.”</p>
	Authorization	<p>“Bacteriocins are not yet listed and approved. They are not marketable and not promotable at all and we cannot create a demand. A solution would be to apply for authorization in a new product category, but this process is too lengthy and costly.”</p> <p>“The regulation on dairy products is quite tough in Canada and limits options for the NFF-segment.”</p>

(c) Intellectual property problems

A related regulatory problem illustrated in Table 8 is the category of intellectual property issues, which is first of all expressed by the fact that natural health products are not new, since they are naturally occurring. As a consequence, in many cases, **product patents are not possible**. Patentable is then only the application or the process. Especially the latter one is generally more difficult to enforce than a product patent. Hence, there is a trade off between likelihood of market approval (higher if the product is natural) and patentability (higher if the product is not already - naturally - existing). Since many R&D projects, which aim at new technologies are undertaken in collaborations, patent disputes and **IP-negotiations** have been mentioned by the respondents as another impediment to innovation. A wide spread problem with respect to public private R&D collaborations is also the question of when a university researcher is allowed to **disseminate research results**, which may lead to problems during the end of an research collaboration threatening the R&D project.

Table 8: Problem areas concerning innovation: (c) Intellectual property rights

Problem category		Examples from case studies
INTELLECTUAL PROPERTY RIGHTS	Limited options to patent	<p>“The dilemma of this market: natural is better to be approved, but you have less options to receive a patent.”</p> <p>“Patenting natural products is extremely difficult, all you can do is a process patent, but then your competitors just need to alter the process if the patent scope has not been broad enough and you are gone.”</p> <p>“We would never think of entering the very high end medical nutrition segment, with strong claims, you need to do very costly clinical trials to obtain a claim but on the other hand you cannot patent the substance, so you’ll never be able to amortise your R&D costs.”</p> <p>“In food there is opposed to pharma no protection of the bioactive (natural) ingredient. Therefore, the ingredient itself cannot be patented, and no claim can be protected.”</p> <p>“IP issues are a big hurdle, same for the convention on Biodiversity as well as the question of patentability of higher life forms.”</p>
	IP-negotiations	<p>“IP-negotiations between university and industry are often a problem, university often relies on industry funding initially, but then when it comes to commercialization, it wants to own 100% of the IP, so the industry partner drops out.”</p> <p>“The problem is, that the university wants to be a co-author on the two new patents, in order to receive royalties from our company.”</p>
	Dissemination of results	<p>“For a university researcher it is important to communicate research results, this is not always easy. In some projects we made an agreement with the university and our company to not publish anything in the first 6 month after termination of the project. This is the time we as a manufacturer need to make arrangements for patent application.”</p>

(d) Inter-industry differences

As stated above in Figure 3 illustrating the NFF-Cluster in Quebec, R&D projects are considerably often undertaken in inter-industry collaboration. Since different industries are using different “*industry recipes*” as documented by Spender (1989) this may lead to industry convergence-related difficulties as detailed in Table 9. The most obvious problem regarding this category are conflicts in R&D collaborations which originate in **industry differences**. These differences get expressed by different assumptions on R&D, such as shorter R&D cycles and a smaller R&D budget in the food industry. In addition, small scale food ingredient start-ups, who license out their R&D outputs, stated that pharmaceutical companies try to “*get rid of competition from preventive products*”. Another dominant problem related to innovation in converging industries seems to be the rising importance of new fields of knowledge, leading to competence gaps as. In particular, the interviews reveal that manufacturers of end-consumer goods have to continuously track down consumer awareness and acceptance of certain ingredients and end products, which requires a detailed understanding of consumer demands and insights. This is not owned by players from the pharmaceutical and chemical industries. In contrast, the adaptation of existing technologies to food products seems to be a challenge for the low-tech food industry as illustrated by the quotes in Table 9.

Table 9: Problem areas concerning innovation: (d) Inter-industry differences

Problem category		Examples from case studies
INTER-INDUSTRY DIFFERENCES	Collaboration difficulties due to industry differences	<p>“With our collaboration partner from the food industry we do have a lot of time pressure, since he wants the product on the market as soon as possible, but this is not always easy for us being the ingredient technology developer.”</p> <p>“It is a problem sometimes to collaborate with the food industry, in order to receive a claim: The food industry does not want to engage in clinical trials, since this is too expensive. It also has shorter R&D cycles.”</p> <p>“In food there is little willingness to take risks. The margins are smaller, so you cannot invest millions of dollars in uncertain clinical studies.”</p> <p>“Promoting licenses on new ingredients is not always easy for small companies; they sometimes get bought by the pharmaceutical industry in order to prevent their use in prevention. Pharma does not want to see any substitutes.”</p>
	Unfamiliar knowledge	<p>“From a technology standpoint, we would not be able to undertake this R&D project, since the technology is still too young. The collaboration with [a research institute] is very important. We give them our end product, and they adapt the new probiotic bacteria strain to it.”</p>
	Value chain	<p>“We have to convince the farmers to follow a certain, more complicated procedure in growing cranberries. This might be more expensive, at the same time there is the risk whether the market will reward us.”</p> <p>“Entering the functional food segment means a trade off in sacrificing the “normal” returns from conventional milk for risky, but higher returns from a functional milk. The limiting factor is the shelf space, we fear that there might not be on top sales but cannibalization and what if the product flops?”</p>
	Negative spill overs	<p>“There is so much rubbish on the market that it is very difficult to differentiate yourself: For instance, lactic bacteria often do not enter the intestine alive, since they are very instable, but manufacturers don’t care and no one verifies their activity in the end product.”</p> <p>“This behaviour harms us all, there are these supplement companies promoting their “super ingredients”, put them into capsules and issue very doubtful claims, then Health Canada gets after them and ends it, but then after one month they do have a similar product under a different name.”</p>

Another subcategory of industry related difficulties are problems related to **value chain** coordination. This problem type seems to be typical for systemic innovations, which do not stand alone but require adaptation of complementary assets of partners up- or downstream in the value chain. A fruit juice producer who wants to enhance the concentration of certain antioxidants in his juice has to ask its suppliers to alter production and cultivation processes of certain natural raw materials, which may lead to resistance from the supplier side. Another industry related problem are **negative spill over effects** from shady market partners. These introduce dubious products carrying health claims without any scientific substantiation. As one interviewee puts it: *“some marketers just want to come up with good stories, but often complete effects on the metabolism are not known, the structure of the molecule is not clear, and the biochemical reaction pathways are not known.”*

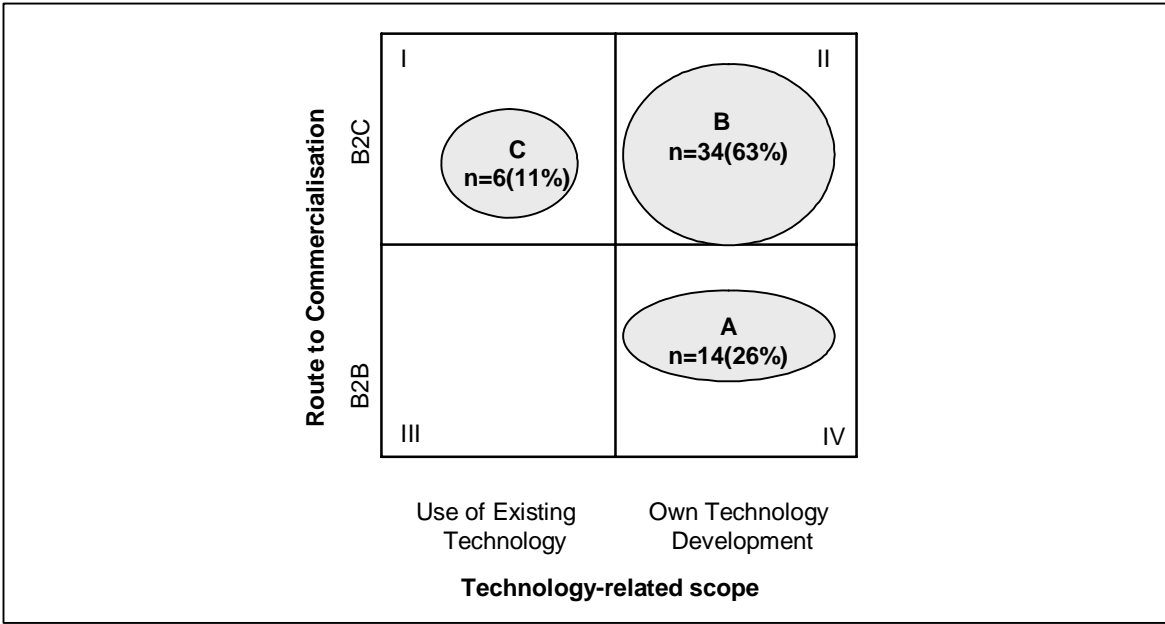
5.3 Identification of generic innovation strategies in the NFF-sector

This problem analysis summarizes some of the major sector-specific challenges for innovation in the converging NFF-sector as mentioned in the interviews. The next question, therefore, is how the different players in the segment conduct innovations strategies and what kind of different project types can be identified. Consequently, the following section takes a closer look at the characteristics of the

innovation projects in order to identify different types and innovation strategies. The output is a typology of R&D-projects which builds the basis for conducting a differentiated, project type-specific analysis of front end decision making.

From the 54 R&D projects examined, it can be observed that innovation strategies differ significantly on the basis of sources of ideas, evaluation and sources of competences involved. Hence, there exist different “plans for technology and product/market combinations”. In some cases, the project has been generated internally from past R&D activities, and in other cases, external trends had triggered R&D projects for this new market. These differences can be traced-back to the nature of the specific R&D project. While some projects leverage existing competencies in either consumer good or technology development, others focus on both. Based on these observations, the sample of 54 projects was divided into three groups presenting a different innovation strategy in the NFF-sector (see Figure 4).

Figure 4 „Real“-types of innovation projects in converging industries



The first generic project type, constituting **Group A**, stands for a R&D project, which includes the development of a new technology commercialized on the B2B-market. R&D projects of this type have been commonly conducted by technology-driven pharmaceutical and specialty chemical firms. Projects within **Group B** also involve a new technology development but they differ from A regarding commercialization. While Group A only commercializes on the B2B-market, Groups B launches finalized consumer goods on the B2C-market. It has to be noted that Group B mainly consists of technology-driven firms, which are traditionally commercializing their R&D outputs on B2B-markets. With regard to the emerging NFF-sector, perceived as an end-consumer market, the B2C-commercialization activities seem new to most of the innovating companies in Group B. The third

generic type of R&D projects in the sample, which is constituting **Group C**, does not develop own technologies, but uses existing ones. This group consists of consumer-driven food companies.

As indicated in Figure 4, a possible project type III (Group D) using existing technologies applied to the B2B-sector did not happen to occur in the sample. This may be due to the fact, that the converging NFF-sector is triggered by new technology advancements and trends in B2C-food products incorporating functions of pharmaceuticals. Hence, a R&D project type using existing technologies applied to B2B-markets is by definition not occurring in this sample. The reasoning is that the NFF-sector emerges as a new end-consumer sector.

Moreover, Figure 4 indicates how the R&D projects are distributed with respect to the typology. The real type II as **Group B**, which can be labelled as “**technology-intense B2C-product developer**”, presents the largest group accounting for 34 projects. This is followed by real type IV, **Group A**, as the “**technology developer**”, who develops new technologies for commercialization on B2B-markets and consists of 14 projects. Real type I, **Group C**, termed as the “**B2C product developer**”, which uses existing technologies, is the smallest one accounting for only 6 projects. As discussed and explained above, real type III, did not occur in the sample.

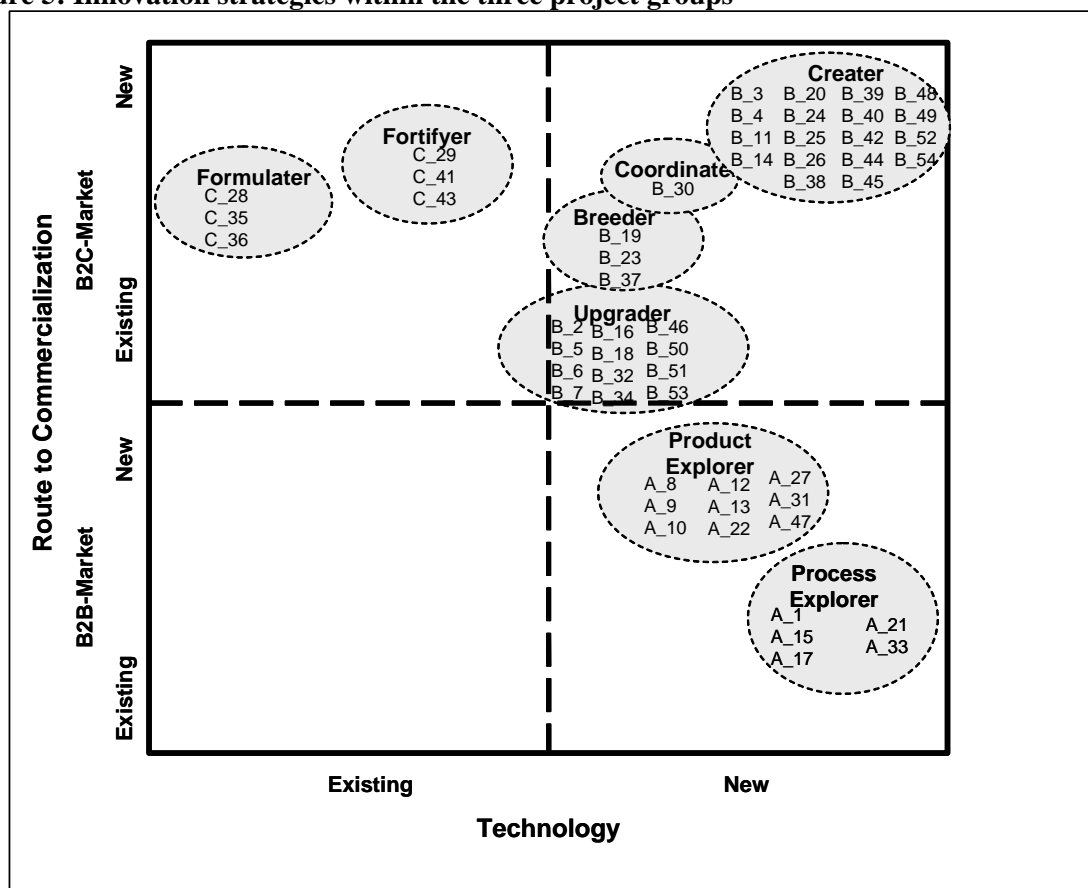
Looking at the particular cases, it can be observed that even though different capabilities are required for addressing this new segment, not all companies possess these: some try to internally develop the missing capabilities while others engage in strategic alliances and still others do not adapt to the changing environment. It seems that, even though industries converge and grow together one can still observe different innovation strategies.

5.4 Identification of specific innovation strategies typical for the NFF-sector

In a second step of the analysis after cross-case comparison to identify generic innovation strategies in the sample, a within-group analysis has taken part to understand differences within the groups. Depending on the degree of newness regarding involved technologies and the chosen commercialization strategy (on a Business to Business (B2B) vs. a Business to Consumer (B2C) market) it was possible to identify 8 different innovation strategies of actors pursuing innovations for the NFF-sector (see figure below).

Subsequently, the eight innovation strategies will be discussed by analysing the particular market and the technological “plan” of each type. Additionally, the major barriers to innovation for each innovation strategy type are presented.

Figure 5: Innovation strategies within the three project groups



(a) Innovation strategy types in Group A

Regarding Group A, which resembles technology development projects focussing on the B2B-market, the two innovation strategies “*process explorer*” and “*product explorer*” as illustrated in Figure 5 have been identified. A number of five projects in Group A distinctively explores new processes to find new technology platforms. These are long-term projects conducted in technology-driven firms as detailed in Table 10 below. Regarding commercialization, these projects aim at substituting an existing technology platform. Hence, they focus on existing segments and get launched on the B2B-market

Table 10: Innovation strategies within Group A “Technology developer”

	Type (affiliation)	Barrier to innovation	Innovation strategy		Case Example
			Market	Technology	
Group A	Process Explorer (Pharma/ Chemical Industry)	<ul style="list-style-type: none"> Inter-industry R&D cycle Use of new technologies very restricted in food sector 	<ul style="list-style-type: none"> Substitution of an existing production platform 	<ul style="list-style-type: none"> Exploration of a new platform for technology development 	Application of a new technology for the fractionation of peptides (A_17)
	Product Explorer (Pharma/ Chemical Industry)	<ul style="list-style-type: none"> IP-Negotiation with Partners University IP Policy Missing purity of food ingredients Funding for risky, long-term projects, R&D cycles too long 	<ul style="list-style-type: none"> Some licenses have been commercialised. Not, yet, any application in an end product 	<ul style="list-style-type: none"> Exploration of a new ingredient or a new interaction of ingredient and metabolism 	Explore gene-diet interaction (Nutrigenomics) with regard to coronary heart disease risk and obesity (A_47)

The second innovation strategy which emerged from within-group analysis explores new product technologies for the commercialization as new ingredients on new B2B-market segments. These projects are involving specialized technological knowledge brought together in various R&D collaborations of technology-intense firms. An example, mentioned in Table 10 is the emergence of nutrigenomics-based products, which can also be seen as an expression of the complementary convergence of nutritional science and genomics leading to a new technology and potentially new customized products. Players of the food industry are not yet involved, as projects are still of exploratory nature. Licenses present the major route to commercialization here.

(b) Innovation strategy types in Group B

With respect to Group B, developing “technology-intense consumer products”, four distinct innovation strategies have been identified as illustrated above in and described in Table 11 at the end of this section. These can be distinguished as follows: The “*creator*” can be described as a project following a “new-new” combination regarding the pursued innovation strategy as a plan for technology and market. New ingredients, *e.g.* new bioactive peptides, with a new market application of the ingredient in a supplement are a frequently observed example here. The companies which are following this innovation strategy are technology-driven specialty chemical or pharmaceutical ones and are in most cases collaborating with the food industry. In some cases of Group B the market entry has been done stepwise. There have been the steps of first launching the new ingredient in the less tough regulated feed sector or in cosmetics. This has been followed by entering the NFF-segment with a supplement positioning. In geographical terms, the entry to the emerging NFF-segment has often been pursued in the U.S. market as a supplement first, since it is less strictly regulated regarding novel ingredients than the Canadian or the European market. This innovation strategy type shows product families, which build the basis for the step-wise market entry. Hence, as regards the “*creator*” there may be several steps of related market entry until a technology-intense consumer product has been finally launched on the NFF-Market as an end-consumer product.

Another distinct innovation strategy type to be observed in Group B is the “*coordinator*”. This innovation strategy type is on the technology side very actively monitoring and evaluating technological advancements relevant to the NFF-sector. There is little own basic research as well as seldom an own B2C-distribution network. The coordinator as a “hub” manages various R&D collaborations as well as contract research organizations (CROs), contract manufacturing organizations (CMOs) and marketing collaborations. The coordinator presents the focal company managing a larger network or value creation alliances. Due to little specific

investments he remains very flexible and can react fast to promising market and technological trends by incorporating and combining different sources of external knowledge. This innovation strategy can be observed in a technology-driven organization, with own research facilities. The reasoning for maintaining own R&D competencies can be seen in the fact that the coordinator has to have the experience to understand external technological developments in the sense of absorptive capacity. The coordinator also has to be able to combine different sources of knowledge.

Table 11: Innovation strategies in Group B “Technology-intense B2C-product developer”

	Type (affiliation)	Barrier to innovation	Innovation strategy		Case example
			Market	Technology	
Group B	Creator (Pharma/Chemical Industry)	<ul style="list-style-type: none"> Authorization for new ingredients University IP-policy Inter-industry difficulties in collaboration Missing exclusivity since composition patent not possible Funding of clinical studies First mover disadvantages 	<p>Creation of a new ingredient with a certain effect on physiological functions</p> <p>Stepwise:</p> <ul style="list-style-type: none"> feed cosmetics supplement food ingredient medical food with Partners 	<ul style="list-style-type: none"> Own technological development, In some cases technological collaborations with universities or contract research organizations (<i>e.g.</i> in relation to clinical trials) 	Identification of a new bioactive peptide targeting the occurrence of coronary vascular diseases (CVD) which gets sold as an supplement as well as part of a functional food (B2C) in a strategic alliance with a food company (B_4) see also (B_20); (B_38); (B_39);(B_40)
	Coordinator (Pharma/Chemical Industry)	<ul style="list-style-type: none"> In NFF margins are smaller than in pharma Own basic research not feasible 	<ul style="list-style-type: none"> Consumer products sold through partners. Industrial products via existing channel 	<ul style="list-style-type: none"> Little own basic research. Complex network of licenses and CROs 	Medical food with anti-angionese properties to complement zytostatika in a cancer prevention and treatment (B_30)
	Breeder (Pharma/Chemical Industry) (Food Industry)	<ul style="list-style-type: none"> Value chain problems Technology: complex interactions IP: Dilemma of naturally occurring bioactive increasing the chances for approval, but natural means not new, thus limited options to patent Regulatory uncertainty 	<ul style="list-style-type: none"> Specialty chemical firms enter into marketing partnerships with food companies Often a line extension in the case of a food company to benefit from existing brand loyalty. 	<ul style="list-style-type: none"> Depends on the interaction of several players in the value chain. Change of existing production processes instructed by external technological knowledge One focal company has to supervise it 	<p><u>Specialty chemical firm:</u> Change of the way how cranberries are grown in order to increase the concentration of antioxidant ingredient (B_19)</p> <p><u>Food company:</u> Change the natural milk fat by feeding CLA rich flaxseed for CLA-milk (B_23)</p>
	Up-grader (Pharma/Chemical Industry) (Food Industry)	<ul style="list-style-type: none"> Natural ingredient hard to patent-missing incentive to validate health effects by clinical studies No clear guidelines for clinicals, confusion about which authority regulates what Natural ingredients not as pure as NCE, makes it difficult to test clinically Partner of food industry not willing to conduct clinical study, since it is too long and costly R&D cycles not acceptable for FMCG 	<p>(M) Supplement > Medical Food An existing supplement contains pharmaceutical agents, this is shown in a larger clinical study. The product is then sold also as medical food.</p> <p>(F) “Old” Food > Functional Food Existing functions of a food are shown to have a positive effect on physiological body functions. These findings are then used to apply for a claim.</p>	<p>(M) The company is collaborating with CROs etc. to characterise and purify the component in order to understand the effect on a molecular basis for building a larger clinical study.</p> <p>(F) Traditionally food companies have no own technological resources to show the functional effect. Research collaborations are prevalent.</p>	<p>(M) A probiotic culture has shown an effect on curing chron disease. The hypothesis is tested by clinical trial (Phase II), the tests have been successful, so that the ingredient will now also be sold as a medical food in a higher concentration. (B_16)</p> <p>(F) An existing CVD-food supplement is tested for being effective in weight control, in order to expand it to the growing market for obesity (B_2), (B_34).</p>

Thirdly, the innovation strategy type “*breeder*” refers to projects which are altering an existing product by changing its production processes. By modifying the “production process” of plant- or animal-derived food products, a company is able to naturally enrich its products. Animal-derived foods or food ingredients get naturally enriched by altering the meat, egg or milk qualities through special nutrient concentrations in animal feed. Regarding plants, certain fertilizing and cultivation methods are employed to increase the concentration of particular bioactive compounds allowing the plant extracts to qualify for special health claims. The technology part, as the case projects show, has often been carried out in collaboration between a raw material processing company owning the product and an university or private research institutes owning the technological know how of how to alter the production processes. In this sample, a number of two R&D projects classified as based on changes throughout the value chain, thus “breeders”, are of food industry origin, while one case occurred in a specialty chemical firm. The label “breed” can be understood as a systemic innovation since it requires adaptation of market partners in order to make the innovation work.

The “plan” for innovation of 12 cases within Group B builds on existing end-consumer market applications (like supplements etc.) and applies new technological knowledge in order to upgrade existing consumer products of the NFF-segment. The term “*upgrader*” describes the project aim to scientifically substantiate a given bioactive property of an existing product in order to extend an existing food supplement to the status of a medical food (compare Table 11 (M) supplement gets upgraded to medical food). With respect to a food company, the aim can also be to first of all uncover and substantiate a health property of an existing food product, which then allows applying for a health claim (compare Table 11 (F) conventional food gets upgraded to a functional food). This often involves clinical data or other scientific studies which necessitate collaboration of the food industry with a contract research organization owning the needed technological competencies.

(C) Innovation strategy types in Group C

In contrast to Groups A and B involving an own technology development, R&D projects in Group C do have a limited technology development scope, since these projects use existing technological knowledge for their development of consumer goods. The companies are originating in the food industry. As illustrated in Table 12, two different innovation strategy types, the “*fortifier*” and the “*formulator*”, have been identified.

Table 12: Innovation strategies within Group C “B2C-product developer”

	Type (affiliation)	Barrier to innovation	Innovation strategy		Case example
			Market	Technology	
Group C	Fortifier (Food Industry)	<ul style="list-style-type: none"> ▪ The consumer has to be familiar with the benefit, especially if you cannot make a direct health claim (C_41) ▪ Technological problems of chemical stability of the ingredient and its taste (C_29) 	<ul style="list-style-type: none"> ▪ The functional food product gets sold as a line extension to benefit from existing brand loyalty. 	<ul style="list-style-type: none"> ▪ The Food Company generally does not have any technological skills. ▪ Ingredients get customized to the individual food matrix by the supplier 	Food company which extends its fruit beverage line with a fortified product containing a health promoting ingredient. The ingredient has been customized to the beverage in a close supplier relationship (C_41)
	Formulator (Food Industry)	<ul style="list-style-type: none"> ▪ Approving new ingredients is not possible, since there is no time and money for clinical testing (C_35) 	<ul style="list-style-type: none"> ▪ Identify existing successful ingredients and put them into new formulations 	<ul style="list-style-type: none"> ▪ The ingredient technology is bought in, just the formulation is done by the manufacturer. 	A supplement manufacturer buys a lutein ingredient and creates a new liquid formulation which is targeted at the elderly (C_35) (C_36)

The “*fortifier*” uses an existing, approved and legally authorized ingredient technology in order to fortify his conventional food products. The fortifier’s supplier, traditionally a specialty chemicals company, serves not only as ingredient supplier. He also carries out other parts of the value chain of its customer, such as ensuring a technical fit with the food matrix and in many cases also regulatory compliance. The reasoning for forward integration of the supplier can be seen in the lack of technological competencies of his customer. This lack of technology-related knowledge may otherwise present a barrier to the adoption and diffusion of the technology-intense ingredients. The innovating food company is therefore depending on the supplier’s technological application knowledge related to fortification.

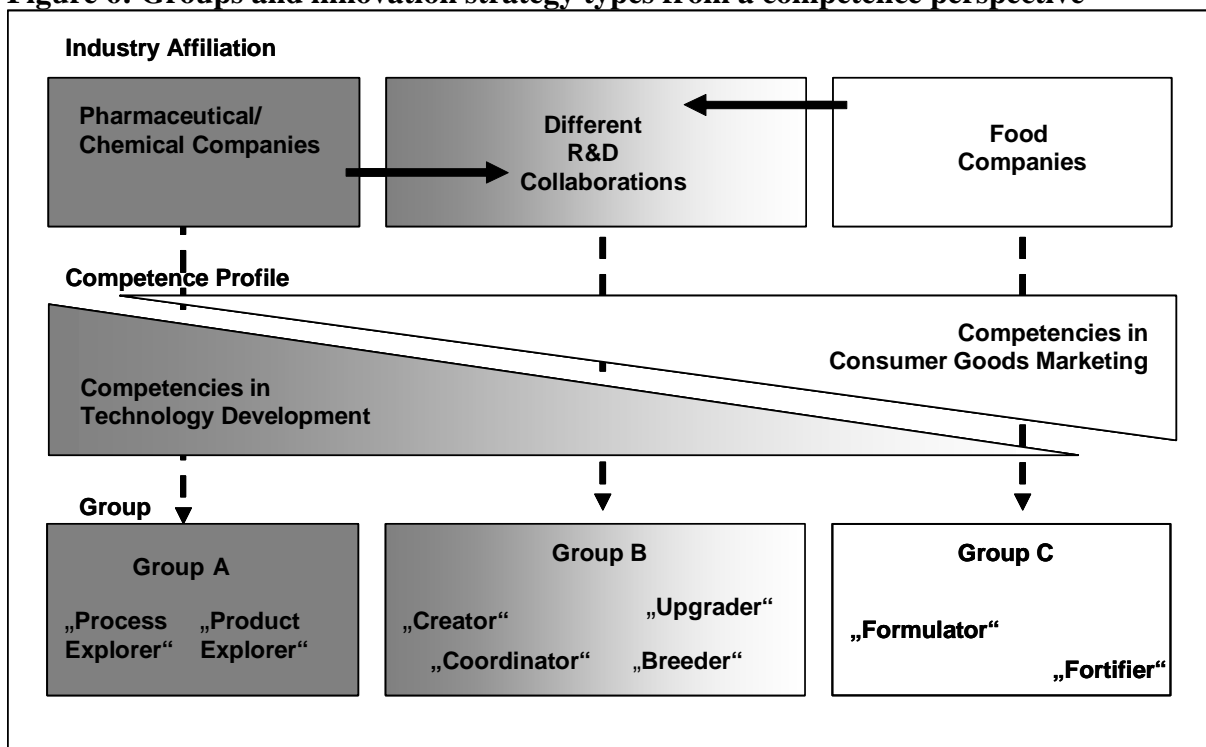
The innovation strategy type “*formulator*” also uses existing technologies, so that the process enters the development phase very fast. This innovation strategy uses existing ingredients and reformulates them to a new consumer product. In contrast to the fortifier, he does not ingrate existing ingredients into conventional food products, but applies them to new supplement formulations (*e.g.* a liquid supplement, or a pill). The degree of newness of these products is comparably low. It is just the formulation which presents a new application of the ingredient technology. The general market application has existed before, so has the ingredient technology.

6. Discussion of Findings

To conclude, three different generic groups of R&D projects in the converging NFF-segment have been identified in this paragraph. These project types differ with respect to scope and route to commercialization: Group A focuses on technology development, which gets

commercialized on B2B-markets. Players here are technology-driven companies of the pharmaceutical or chemical industries. Group B comprises R&D projects, which combine new technology development with applications for B2C-markets. As indicated in Figure 6 some of the projects can originate in both industries and are undertaken in strategic partnerships (*i.e.* upgrader and breeder), but the creator and the coordinator are clearly initiated in the technology-driven, pharmaceutical and chemical industries. Group C focuses on the development of new consumer products by using existing technologies. It consists of affiliates of the low-tech food industry.

Figure 6: Groups and innovation strategy types from a competence perspective



The Resource Based View in linking resources to the strategy pursued allows explaining, why certain industry players do employ more technology-intense R&D-Strategies than others. It gives a clear explanation why the Innovation Strategy “Technology Developers” is employed by the R&D-intense Pharmaceutical and Chemical Companies. However, it does not explain what enables different players of different resource-sets according to different industry backgrounds to pursue innovation strategies addressing the same industry segment as a product of industry convergence. The RBV regarding its core competence approach does not seem to be appropriate as an explanatory concept which serves to explain the innovation strategy of “technology-intense market developers”. Strong B2C as well as R&D capabilities are required. Taken together these are owned neither by the food nor by the pharmaceutical

and chemical companies. Following Leonard-Barton (1992) core capabilities can lead to core rigidities as in the case of a pharmaceutical company trying to market a consumer product with its existing sales and marketing forces skilled in technical pharmaceutical marketing addressed to health professionals. The lack of capabilities in consumer marketing has led to the failure. On the other hand several food companies with “soft-health-claims” lacking a scientific support and a molecular understanding of the nutrients are depending on the technology-intensive chemical and pharmaceutical companies.

When capability requirements change due to external developments as it is the case in converging industries, companies need to achieve a dynamic fit if the chosen Innovation Strategy requires both: strong marketing and strong technological capabilities as in case B. Here the dynamic capabilities approach offers a suitable theoretical explanation: Dynamic capabilities – defined as “*the firm’s ability to integrate, build and reconfigure internal and external competences to address rapidly changing environments*” (Teece, Pisano and Shuen 1997: 516) – can be manifested in inter-industry alliance formation. As the analysis of the NFF-sector shows inter-industry R&D collaborations are the prevalent phenomenon and aim at combining the Consumer-Market insights as well as the Distribution system of the Food industries with the R&D and legal competences of the Chemical and Pharmaceutical industries enabling scientifically grounded and legally authorized products.

Here arises the question of how the two different industries with different basic assumptions of R&D can engage in collaborations? That this is an important issue show different cases of a preliminary ending of alliances due to different R&D-intensities, R&D cycles, IP-Strategies. One interviewee with a food industry affiliation boiled the problem to the point: “*in Fast Moving Consumer Goods you simply can not wait for a 10 years clinical study just to tell you that your product is safe – we need to come up with new marketing strategies to convince our category management in issues like shelf space...*”. This statement demonstrates that just adding two capabilities in an inter-industry relation might not be sufficient. Combinative (Kogut and Zander, 1992) or Meta capabilities (Danneels, 2002) as the capability to reconfigure and acquire a new capability are needed for successful formulation of Innovations Strategies in Converging Industries. This indicates that Innovation Strategies for focussing on the new inter-industry segment which require R&D as well as B2C marketing capabilities are not based on existing core competences but on dynamic capabilities. Thus, managers active in the field of R&D in the NFF-Sector need to have awareness of developments in other industries in order to identify the needed competences for the particular Innovation Strategy chosen.

7. Conclusions

This paper presents a framework to understand how companies of different industry backgrounds can develop an Innovation Strategy for a market built on industry boundaries. The arising market of functional foods and nutraceuticals is quite unique in this respect, because it not only demands competences of different industry origins but also motivates former B2B companies of the chemical and pharmaceutical industry to engage in new business models to serve the B2C market.

First of all the paper identifies the competences needed to successfully compete on this new industry segment and delivers a typology of different Innovation Strategies. Empirical findings indicate that the Innovation Strategy firms follow in converging industries only partly depends on its existing core competences - whereas the ability to sense new market and technological developments and dynamic competences like alliance building play a major role. The case study derived typology may help companies to decide on their Innovation Strategy: If a technology intense B2B-rooted company aims at just exploiting and leveraging its existing core competences in technology development relevant to the NFF-sector it should pursue a pure "technology developer" strategy and not try to also directly build on its B2B marketing skills to address end consumers, which requires more distinct B2C marketing skills. The same is true for a marketing intense food company, which should be following a "market developer" strategy enabling the exploitation of B2C marketing skills. However, these two strategic options might not be feasible in terms of capturing the most value. That is why the third innovation strategy type of group C which can be seen as "Technology-intense Market Developers" is pursued by the majority of companies in the new segment. In order to be able to employ such a strategy companies have to be aware that they will face a resource gap. Thus, dynamic capabilities will be critical for the acquiring new capabilities or forming inter-industry alliances. This contribution has introduced a typology for different Innovation Strategies, however, it does not explain how inter-industry alliances function and what barriers there are according to different assumptions on R&D. Thus, the example of nutraceuticals and functional foods as a case of convergence of industries opens up an interesting field for future studies.

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