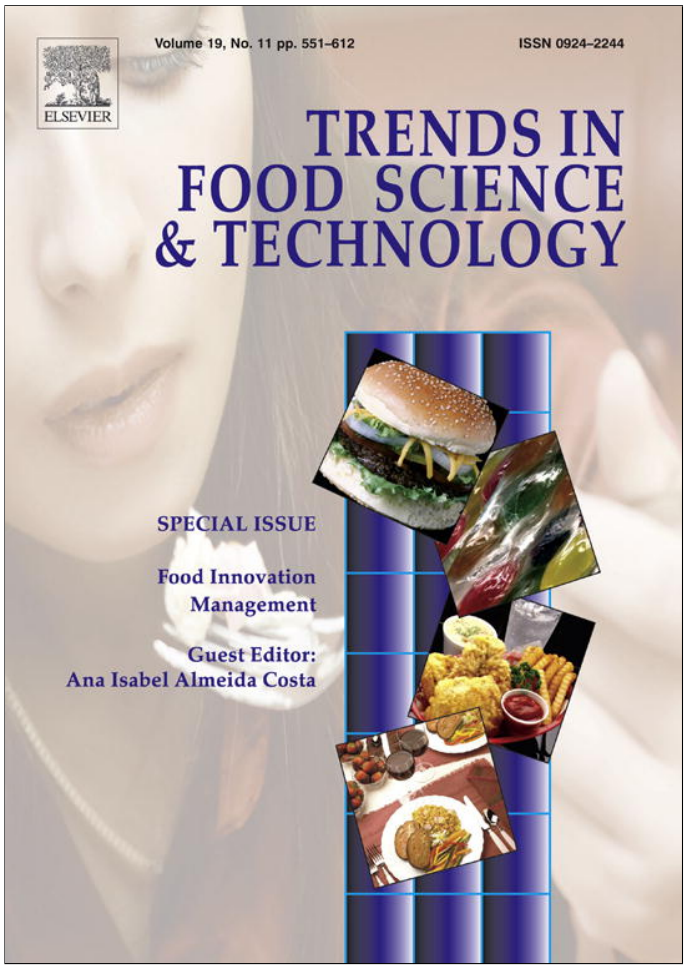

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TRENDS IN FOOD SCIENCE & TECHNOLOGY

Review

User-oriented innovation in the food sector: relevant streams of research and an agenda for future work☆

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The aim of this paper was to give an overview of relevant streams of research that can form a basis for research on user-oriented innovation in the food sector. We define user-oriented innovation as *a process towards the development of a new product or service in which an integrated analysis and understanding of the users' wants, needs and preference formation play a key role*. We distinguish three relevant streams of research that may provide a basis for research on user-oriented innovation in the food sector: research on the formation of user preferences, research on innovation management, and research on interactive innovation. We show that the relevance of these three streams of research for the food sector depends on which type of innovation we are dealing with, and we propose a distinction of three types of food innovations depending on which actors in the food chain are involved in the innovation process. We conclude that while much relevant material exists, little has been specifically developed for or applied to the food sector, and we present five topic areas where food-related research is urgently needed.

Introduction

It is a well-known fact that innovation is a major driver of economic growth. Recently, the political debate about innovation has focused a great deal on *user-oriented* innovation. It has been realized that innovation does not always result from new high-tech advances in order to lead to competitive advantage and increased welfare, and that in practice user-oriented innovation is just as widespread as technology-oriented innovation (Danmarks Erhvervsråd, 2004).

User-oriented innovation is not new to the food sector. The *fork-to-farm* approach to food chains – meaning that all actors in the food chain should maximise value creation

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for the end user – has been promoted in various guises. But several recent developments make user-oriented innovativeness of the food chain more important than ever:

- Food products are increasingly being accompanied by *intangible* elements that an industrial development practice dominated by technical solutions and established plants must deal with in the manufacturing of material products (Grunert, 2002; Grunert, Bech-Larsen, & Bredahl, 2000).
- There is an increasing demand for individualized products according to customer wants, short response time, and dynamic adjustments of company competencies according to new market needs or technological opportunities.
- Public demands with respect to sustainable resource utilization, considerations concerning ethics and the environment and improvement of the work environment will not merely challenge the organization of production, but also affect innovation of products, services, and distribution forms.

The major aim of this paper was to give an overview of existing research streams that provide a useful basis for future research on user-oriented research in the food sector. We distinguish between three streams of research: understanding user preferences, innovation management, and interactive innovation. We will show that the relevance of these three streams of research for the food sector depends on which actors in the food chain are involved in the innovation process, and develop for this purpose a distinction of three types of food innovations. We will show that, while much relevant material exists, little of it has been applied to or developed for the food sector, and we will on this basis propose an agenda for future research on user-oriented innovation in the food sector. First, however, we need to define the term *user-oriented innovation*.

From user-driven to user-oriented innovation

User-driven innovation is a phenomenon first observed and described in the 70s by von Hippel (1976, 1978). He documented a number of cases where customers did not wait for manufacturers to launch new products, but proceeded to modify or adapt existing products according to their own needs of their own accord (von Hippel, 1988). Well-documented examples can be found in a number of business-to-business markets, where customers for example adapt machinery and equipment to their own needs, for example medical surgery equipment (Lüthje, 2003), and pipe hangers (Herstatt & von Hippel, 1992). Also, examples on business-to-consumer markets exist. For example, some argue that the invention of mountain bikes primarily originates from cyclists who started modifying standard bikes for use outside the road system (Lüthje, Herstatt, & von Hippel, 2005). In every case, a manufacturer subsequently adopted the idea, industrialized the production and thus commercialised the customers' innovation.

In the course of time the use of the term user-driven innovation has been extended considerably. Thus, today it is often used not only to cover situations where users initiate the innovation, but for all forms of innovation where there has been a good measure of user involvement in the innovation process. This extended meaning of the concept thus also covers situations where the manufacturer initiates the innovation and subsequently involves users in the development process, and even situations where the manufacturer uses an agent to involve users in the innovation process (e.g., a trend spotter or a market research agency). A number of related concepts exist in the literature, including *early customer integration* (Gassmann & Wecht, 2005), *participatory design* (Mayhew, 1999), and *user-centred development* (Ketola & Ahonen, 2005). In order to distinguish this broader concept from the original concept, we will use the term *user-oriented innovation* in this paper, and define it as *a process towards the development of a new product or service in which an integrated analysis and understanding of the users' wants, needs and preference formation play a key role*. Users can be both direct customers and end users. The concept of user-oriented innovation includes both customers *and* end users, and is thus broader than the concept of consumer-led innovation (Costa & Jongen, 2006; Grunert & Valli, 2001).

Research relevant for user-oriented innovation: arm's length vs. interactive innovation[1]

There are three streams of research that are of relevance for user-oriented innovation. First, research on how users form preferences for products and services can provide useful input for user-oriented innovation. Such research has been conducted mainly for end users, i.e., consumers, and to a lesser degree also for certain types of professional users. Second, research on how user-oriented innovation processes can be managed in the innovating organization, including questions on how to integrate user information into the innovation process and on how to create cross-functional cooperation among those parts of the innovating organization dealing with user intelligence, production, and technological research and development, respectively. Third, there has been research on how two or more partners, for example a producer and his immediate customer, can innovate jointly.

The relevance of these three streams of research depends on the type of innovation process we are dealing with, and here an important distinction is whether the innovating company deals with a mass market or not. Consumer markets are mass markets, but also certain parts of the catering and retailing markets may be regarded as mass markets, as

[1] We are greatly indebted to Ann Clark from the University of Southern Denmark for suggesting this distinction.

are markets for supplies when the number of potential customers is large, for example supplies to corner shop bakeries. When dealing with mass markets, it is impossible to innovate in interaction with all users, and attempts to innovate in a user-oriented way thus draw on indirect ways of obtaining information about user preferences, often involving the use of quantitative methods to characterize large populations of users. This type of innovation is sometimes also called arm's length innovation, since users do not interact directly with the innovative organization. When dealing with markets with a small number of potential buyers, on the other hand, direct interaction between producer and user becomes possible, and user-oriented innovation can be built around a users' direct involvement in the innovation process. This type of innovation may be called interactive innovation, and is typical of many business-to-business markets. In the food area, it is characteristic for how producers deal with the big players in catering and retailing, but also for many relationships between major players at the various stages of the food value chain.

We want to look at user-oriented innovation of *food products*. We define a food product as a product with origin in agriculture or fisheries that is sold for consumption by private households. This implies that any food product, defined in this way, involves both a raw material based on farming or fisheries, at least some minimal degree of processing, and distribution from primary production to the end user. Innovation with regard to food products thus eventually always faces a mass market. At the same time, innovation in food thus may involve several actors, though one of them may be dominant in the innovation process, and the same innovation process may involve both arm's length and interactive innovation. We may distinguish three fundamental types of innovation based on the mix of arm's length and interactive innovation. Type I is the classical food new product development case, where the innovation process occurs largely in-house in a food processing company. The type of user interaction is mostly arm's length with regard to the consumer, possibly supplemented by a smaller degree of interactivity with retailers who have to be convinced to put a product on the shelf. Type II is the case where a retailer takes the initiative for the innovation, usually as part of the retailer's own label programme. Retailer and food processing company will engage in interactive innovation, and in addition there may be some extent of arm's length innovation facing consumers, where both retailers and food processors may be the actors engaging in consumer contact. Finally, type III is the case where innovation spans the whole value chain from primary production to retailing, for example when meat or milk are modified to add functional properties. Since the innovative raw material has to be turned into a differentiated consumer product, there will be interactive innovation between farmer and food processing company, and possibly also with the retailer. Again, some degree of arm's length innovation with regard to consumers may occur as well, in these cases usually initiated by the food processing company. The three types are a gross simplification – as noted above, other cases can occur – but serve a heuristic purpose in the following discussion.

Understanding user preferences: the basis for user-oriented innovation in mass markets

Analysing preference formation and quality perception

As noted, innovation for mass markets is characterized by the lack of personal interaction between the innovator and the users – or, at least, most users. User-oriented innovation for mass markets therefore usually involves characterizing the population of potential users by sampling techniques, and/or in-depth characterization of a small number of users where such insights are deemed to be especially valuable.

Although user-oriented innovation is here defined as a process towards the development of a new product or service in which an analysis and understanding of the users' needs and preference formation plays a key role, this does not imply that the aim is to develop products and services the users are able to articulate the need for themselves. It is a well-known phenomenon that users, and in particular *consumers*, often are not able to articulate their need for really innovative products, because their thinking is framed by the products currently on the market. Also, reactions of potential users when confronted with highly innovative new product concepts are not always reliable, as they may find it difficult to imagine the use of these innovative products in their daily lives.

In order to deal with this problem, the innovation literature has used the term *latent needs* for needs that users are not aware of, but that they will become aware of once the product tapping those needs is on the market (e.g., Leonard & Rayport, 2000). However, we should also note that the concept of latent needs has no theoretical foundation in the buyer behaviour literature. The buyer behaviour literature has, though, carried out considerable research (mostly based on psychological theory) on how buyers form preferences for products that come on the market (see Grunert, 2005b, for an overview), and has developed methods that can be used to measure factors that may influence this preference formation process.

A major aim in the preference formation literature has been to explain the subjective trade-off that potential users perceive between what one has to offer in order to get the product – where price is the major component – and what one gets. What a potential user expects to get out of a new product is often analysed in terms of the *perceived quality* of the new product, relative to existing products. Food companies' attempts to develop products that consumers will embrace may therefore be characterized as an attempt to *create the right quality/ies* for their customers and end users.

There is a huge body of literature on quality perception, both in general and specifically for food. There are

approaches looking at the multidimensional nature of quality, usually with point of departure in *multi-attribute attitude models* (Ajzen & Fishbein, 1980), where the overall evaluation of an object is explained in terms of its perceived characteristics, the evaluation of those characteristics, and an integration rule. There are hierarchical approaches like the *means-end approach* (Gutman, 1982; Zeithaml, 1988), where emphasis is on explaining how consumers come to like certain product attributes by establishing mental links to self-relevant consequences and the attainment of life values (for applications in the food area, see, e.g., Fotopoulos, Krystallis, & Ness, 2003; Jaeger & MacFie, 2000. The means-end approach is the closest we get to a theoretical foundation of the *latent needs* concept in the consumer psychology literature. There is a growing literature on how consumers form *expectations* about the quality of products before they are bought, based on previous experience and quality cues (e.g. Poulsen, Juhl, Kristensen, Bech, & Engelund, 1996; Steenkamp, 1990; Steenkamp & van Trijp, 1996), and on how the relationship between quality expectations and quality *experience* affects satisfaction and future purchases (e.g. Oliver, 1997). *The Total Food Quality Model* (Grunert, 2005a, 2005b, 2007; Grunert, Hartvig Larsen, Madsen, & Baadsgaard, 1996) has proved useful for integrating these various approaches into one conceptual framework specifically for analysing quality perception of food.

A full understanding of how consumers evaluate food quality must also take contextual factors into account. Food consumption and quality preferences must be seen as integral parts of daily life, where food consumption is embedded in various kinds of practices that people engage in (Kjærnes & Holm, 2007). They may for example include a practice of family meals in order to accommodate for a harmonious family life, a practice of maintaining bodily wellbeing, strength and functionality while doing other things – work or leisure activities, or a practice of socialising with significant others, of taking a break and resting, of celebrating etc. (Gronow, 2004; Kjærnes & Holm, 2007). Linking food and situations involves deciding the appropriate 'fit' between the status of foods and the status of situations. Western cultures rank foods on a hierarchical scale, where animal products and especially meats rank higher than products of vegetable origin, which again rank higher than cereals (Twigg, 1984). And the status of eating situations may be ranked according to time spent on preparation, number and status of participants, expenditure of time and money, degree of ceremony etc. According to norms in culinary culture, foods are appropriate in any given situation when its relative position on the food scale corresponds to the relative position of the situation in question (O'Doherty Jensen, 2002). Pizza may be appropriate for family meals in front of the telly on a Friday night, but not for formal celebrations among relatives. Research in preference formation and quality perception must take such contextual and situational factors into account.

Søndergaard (2003) has suggested a new product development model that takes an understanding of consumer quality perception as its point of departure (Fig. 1). The basic message of the model is that the quality to be perceived by consumers is to be taken as a starting point, and that the concrete attributes to be built into the product, just as the concrete product attributes to be communicated to the prospective buyer, should be derived from this, and not the other way round. This contrasts with widespread practice in the food industry where the physical product is

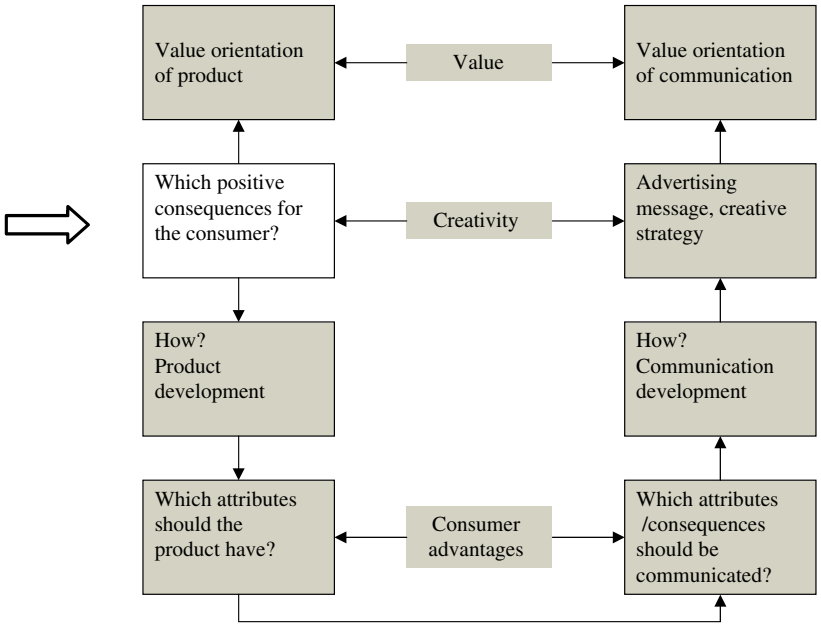

Fig. 1. Product development based on quality positioning (based on Søndergaard, 2003).

developed first, and the positioning of the product in the mind of the consumer follows later. According to Søndergaard, the starting point for successful consumer-driven innovation should be a positioning of the product in terms of certain qualities which are desired by consumers because they tap into their life values, thus creating purchase motives. This positioning of the product has to be translated into a physical product in the product development process. The physical product will result in consumer exposure to intrinsic cues, which result in the perception of quality before/during the purchase and during preparation/consumption. These have to be complemented by the right set of extrinsic cues so that the overall quality perception corresponds to the positioning.

The approach described above is applicable to all three types of innovations distinguished here, but is most straightforward in a type I innovation, where both understanding of consumer preferences and physical product development are concentrated in one actor. In a type II innovation, both retailer and food processing company may have relevant input for the understanding of consumer preferences – the retailer based on the analysis of scanner data, the producer based on some of the techniques described in the next section. Interactive innovation among them will be necessary as a complement, where information about consumers is exchanged, a common interpretation reached and agreement on implications for the product to be developed achieved. When the analysis of consumer preference formation in relation to processing possibilities shows that only a change in the raw material will lead to a competitive differential compared to existing products, a type III innovation results, usually initiated by the food processor. However, type III innovations can also be initiated by the primary production sector. Linking to consumer preference formation is equally important in such cases for innovation success, but usually less common, since the primary sector is more remote from consumers and often does not possess the competences to engage in an analysis of consumer preference formation.

Methods for analysing consumer quality perception and preference formation

A broad range of social science methodologies is available for analysing quality perception and preference formation, and since the audience of this paper will include readers with no familiarity with the social sciences, we will give a very brief sketch of the range of methods available (see van Kleef, van Trijp, & Luning, 2005 for a good review covering a broad range of techniques).

Like in all of the social sciences, there is a basic distinction between qualitative and quantitative techniques. Qualitative methods are ideal in studies where the objective is to understand the meaning of a social phenomenon as experienced by the informants themselves. Such knowledge is obviously important in the context of user-oriented innovation. Qualitative methods are particularly useful when knowledge about a subject is sparse. Therefore, qualitative methods are ideal in the early fuzzy-front-end of the innovation process, where the objective is, for example, to gain a deeper understanding of user needs (manifest or latent) in order to be able to formulate a product concept, but knowledge about consumers' experience, their beliefs and understanding may also be valuable in later phases of product development. There are two types of qualitative methods that are relevant when researching user needs: interviews and observation. *Interviews* may be personal depth interviews or focus group interviews, and especially the latter are also widely used in innovation practice in the food industry. The *observation method* originates in ethnography, but is increasingly used as a tool that can provide input to the idea generation phase of product development. For instance, recently a major fish producer applied the observation method in Danish households in order to provide input to the development of new fish products, and in sports settings it has been used to help develop new and healthy products for children and adolescents (Sylow, 2005). Observation is often used to supplement interviews, as it can yield insights on issues that are not easily articulated. For example, consumers can be observed in the actual use or buying situation and issues that would otherwise not have surfaced through interviews may be detected.

From the discussion above it can be concluded that qualitative methods play an important role when researching user needs. Qualitative methods are most useful when the objective is to gain a deeper understanding of user needs and are therefore mostly applied in the early phases of the product development process, such as idea generation, idea screening and conceptualization. Both interview and observation methods can be applied in research on consumers as well as on business-to-business users. Finally, it should be noted that qualitative methods can be used alone or they can be combined with quantitative methods that are discussed in the following.

Quantitative methods estimate relationships between concepts in a way that is generalizable to a sample of potential users of a product. A vast arsenal of methods is available, and only three will be mentioned here. *Importance-performance analysis* (IPA; see Martilla & James, 1977; Slack, 1994) is a tool that supports decision-making on where to focus resources when attempting marginal improvement of products. *Category appraisal*, or *perceptual mapping*, aims at visualising how consumers perceive a certain product category on two or more dimensions. Products that consumers perceive as similar will be placed in the map close to each other, whereas products positioned far from each other are perceived as very different. The dimensions constituting the map can be viewed as the key factors driving consumer perception within the category (Carroll & Green, 1997; Green & Rao, 1972). In the context of user-oriented innovation, perceptual mapping provides insight into these key dimensions, which can result in valuable inspiration for developing new products. *Conjoint analysis*

(Green & Srinivasan, 1978, 1990) and *discrete choice analysis* (Maddala, 1983; McFadden, 1974) are a set of methods used to analyse how a set of predefined product attributes contributes to preference for a product. After having identified relevant attributes (e.g., on the basis of consumer interviews), the basic approach is to define realistic levels for each of these attributes (e.g., a basic level and two feasible improvement levels), combining them into a factorial design. The attribute combinations derived from the factorial design define a set of product profiles to be tested. A survey is then conducted where respondents are confronted with the product profiles in the form of a verbal description and/or picture and asked to indicate his or her preferences. The output of the statistical procedures describes the effect that a certain attribute level had on participants' preferences. The methods can help the product developer assess what impact a given product attribute or improvement is likely to have on overall preference. Furthermore, optimum attribute level combinations can be identified (Carroll & Green, 1995; Green, Krieger, & Wind, 2001; Moore, Louviere, & Verma, 1999).

Because of the fundamental importance of the sensory properties of foods, such as appearance, odour, taste, flavour, aftertaste, texture and trigeminal characteristics, *sensory science* has developed into a distinct methodological branch (e.g., see Lawless & Heyman, 1998; Martens, 1999; Meilgaard, Civille, & Carr, 2007; Murray, Delahunty, & Baxter, 2001). The two fundamental questions answered by sensory analyses are (1) whether two or more products are perceived as significantly different in their sensory properties, and which attributes characterize the difference across the sensory modalities and (2) which of two or more products are preferred for their sensory properties, and why. The first question is linked to descriptive sensory analysis, whereas the second one is linked to affective or hedonic liking/preference-based sensory analysis. Both can be linked *via* various data analytical techniques. Thus, this allows the construction of a perceptual map of the product's key sensory properties in relation to its inherent quality characteristics and the preferences associated with these. In many instances sensory analysis used to focus on a product's physical (intrinsic) quality attributes, but more recently extrinsic quality cues have received more emphasis. Dijksterhuis and Byrne (2005) have put forward that the time has come to move from – mere – description to explanation, i.e. to study why a certain attribute is perceived and preferred with a certain intensity, and why another may not be, and since the subject matter of sensory analysis is about perception, requiring a link of sensory science and perception science. Another important issue in the further development of sensory methods is a better integration of subconscious processes. When it comes to making choices about food, the underlying reasons for our likes and dislikes are not easily accessible to our reasoning (Dijksterhuis & Byrne, 2005), but still sensory objective descriptive methods rely largely on panellists' conscious action (Frandsen, Dijksterhuis, Brockhoff, & Martens, 2003; Köster, 2003).

Descriptive sensory analysis in combination with affective sensory analysis carried out with potential users of the product can be considered central to promoting success in innovation with respect to the end user. Objective sensory measurements combined with affective sensory analyses are particularly suitable for testing the effectiveness of product improvements/optimization and new product development (NPD) potential. Furthermore, they allow a targeted adjustment of sensory properties with the purpose of obtaining a higher degree of consumer satisfaction (Byrne, 2006; Moskowitz, Beckley, & Resurreccion, 2006; Muñoz, 2002). From a number of key perspectives sensory measurements are clearly integral to user-driven innovation adding much fundamental and applicable insight as to why consumers form preferences for certain foods and not others.

Analysing users in mass business-to-business markets

As noted above, the principles for analysing users in mass business-to-business markets for furthering user-oriented innovation largely follow those set out for consumer markets (cf. above). When there are many potential users, as for example when selling standard food ingredients, agricultural commodities for further processing, or meal components to small and medium size catering customers, joint innovation with individual users will not usually be possible. Input to the innovation process is replaced by an analysis of potential users' quality perception and preference formation.

While there is much less research on industrial mass markets than on consumer markets, the basic principles about preference formation and quality perception are the same. There are, however, a few major differences that have been discussed in the industrial buying literature (e.g., Cova & Salle, 2000; Kennedy, 1982; Moriarty, 1983; see also Baker, 2002). The first relates to differences in purchase motives. Where individual or family needs are in focus on consumer markets, the purchase motives on industrial markets are professional in nature. The second relates to the degree of professionalism and formalization of the buying process. An industrial buyer may have more explicit and formal procedures for formulating quality requirements for the merchandise to be bought, and also for selecting suppliers based on sales offers or tendering material. The third relates to the degree of risk: consumer food buying decisions are not usually very risky, because individual food items are all low price and an off-the-mark purchase can be corrected at the next buying occasion. This does not apply to supplier selection decisions of food processors, catering companies or retailers. Such decisions may involve considerable financial risk, risk of product malfunction, and risk of disruption of the buyer's own production process if the supplies ordered either are not delivered in time or turn out to be faulty. Consequently, risk

perception will be a major driving force in supplier selection. A fourth difference relates to the fact that in an industrial context supplier selection is often distributed over more than one actor, who may have different roles in the decision-making process and also different criteria for quality perception and preference formation. The term *buying centre* has been coined in the industrial buying behaviour literature to describe the set of persons involved in making any particular buying decision.

User-oriented innovation on industrial mass markets thus has to take into account these possibly diverging user expectations within the same buying organization, and it has to take into account the risk perception and buying procedures in the organization of the potential user. All of these are researchable with largely the same set of methods discussed above. For example, focus groups can be conducted with chefs, observational methods can be applied in catering companies, and importance-performance analyses, conjoint analyses and other quantitative methods can be applied to professional decision-makers (Skytte & Blunch, 2005).

Analysis of user preference formation in industrial mass markets is something that typically occurs in the context of a type I innovation, and may or may not be supplemented by an analysis of end user preference formation. Whether both industrial and end user preferences are deemed relevant may be linked to whether the innovative properties of the new product to be developed have implications for end users or not. An innovative way of delivering baking mixes to small corner bakeries may go unnoticed by end users and an understanding of the bakeries' preferences may suffice. When the development of new baking mixes involves the use of genetically modified material, it will be different, though, since end users are known to have preferences for (or mostly against) the use of such ingredients in food production.

Innovation management: the role of market orientation

Pros and cons of market orientation

Generating information on potential users, their quality perception and preference formation, as discussed in the preceding section, is commonly regarded as a major element in having a market-oriented approach to product development. Market orientation is often defined as a three-step process of collecting, disseminating and responding to market information (Kohli & Jaworski, 1990). Generating and disseminating information on user and market needs and incorporating these into product development is a prerequisite for user-oriented innovation, because it is essential to gain an understanding of user needs and then to incorporate this knowledge into product development. Many studies have found market orientation to be positively related to company performance (Cano, Carrillat, & Jaramillo, 2004; Kirca, Jayachandran, & Bearden, 2005), and one possible explanation for this positive relationship is the impact that market-oriented activity has on product development. Several studies have concluded that market orientation is important for the successful outcome of innovation (Atuahene-Gima, 1996; Cooper & Kleinschmidt, 1996; Montoya-Weiss & Calantone, 1994), and this has also been documented specifically for the food industry (Kristensen, Østergaard, & Juhl, 1998).

However, it has also been argued that market orientation may lead to what is called the 'incremental innovation trap'. Market orientation with its emphasis on expressed needs of current customers may lead companies towards incremental rather than radical innovation. Having the ear too close to the voice of mainstream customers may induce companies to ignore emerging technologies and emerging markets. To avoid getting caught in the incremental innovation trap, many scholars now agree that market orientation must be complemented by a learning orientation in order to gain sustainable competitive advantage and to develop radical innovations. Learning orientation is a means directly affecting a company's ability to challenge old assumptions about the market and how the company should be organized to address it. Another approach to shed light on the link between market orientation and a company's radical innovation capability is to distinguish different types of market orientation, namely responsive and proactive market orientation. *Responsive market orientation* refers to the generation, dissemination, and use of market information pertaining to the current customers and product domain and focuses on expressed customer needs. In contrast, *proactive market orientation* is concerned with discovering and satisfying customers' latent, unarticulated needs through observation of their behaviour in context to uncover new market opportunities; with working closely with lead users; with undertaking market experiments to discover future needs; and with cannibalizing sales of existing products.

In food innovation, it is useful to put this discussion into the context of the food chain. As noted above, users in food innovation can be both industrial customers and end users, and there is a development towards greater incidence of type III innovations that involve multiple actors. A producer that traditionally has been incrementally innovative by being market oriented towards its immediate customers may become more proactive by adding insight into the preference formation of end users. The opposite case is also possible – large food producers that traditionally have a core competence in analysing end user needs may become more proactive in their innovation processes by supplementing this arm's length approach to innovation by more direct interaction with retailers.

Cross-functional cooperation and representation of user knowledge

New product development is an interdisciplinary activity requiring contributions from nearly all functions in a company and especially cooperation between those doing actual development and those representing the user or even

bringing them to the organization. By bringing together members from different functional departments and combining their different expertise and knowledge in one team, the aim is to reduce the uncertainty inherent in the development of new products, to increase speed of the development process and to heighten the quality of the end result. Griffin and Hauser (1996) have summarized empirical research relating to cooperation between marketing and R&D and concluded that all studies reviewed either support or are consistent with the hypothesis that cooperation enhances project success. Also, research that has examined factors that impact the success of new products has found that the use of cross-functional teams in product development is a key success factor (Cooper, 1994; Cooper & Kleinschmidt, 1996).

Despite the potential of cross-functional product development teams, the use of such teams is not without its problems. Obtaining successful collaboration can be a challenge. This is usually attributed to differences in orientations, goals, departmental cultures as well as languages that functional representatives bring to the team. Especially integration between marketing and R&D has been the focus of research indicating that disharmony between marketing and R&D is the rule rather than the exception (Moenaert & Souder, 1990). Also Dougherty (1992) found that functional diversity resulted in product development teams where members had very different views on the innovation process. When teams were unable to recognize and reconcile their different perspectives, they failed to be successful.

Where the processing of knowledge within a certain knowledge domain may be guided by established methods, practices and rules of thumb, the exchange of knowledge across specialised domains is much more challenging (Bucciarelli, 1994, 2005). Carlile (2002) describes difficulties in transferring knowledge in new product development across the specialised functions of sales and marketing, product design, manufacturing engineering and production. Innovative solutions demand a transformation of knowledge across functions, where established understandings and knowledge practices within each individual domain are challenged. A growing strand of empirical research has pointed at the role of boundary objects in the successful transformation of knowledge across knowledge domains (Carlile, 2002; Star & Griesemer, 1999).

The interaction between development and use may vary along the 'biography' or the 'life' of a product. Synthesis-oriented approaches – like concurrent design or integrated product development – to product development (Hein & Andreasen, 1987) suggest an array of methods to be applied along a product's life cycle from idea over conceptualization and product design to manufacturing, distribution, sales and scrapping, recycling, etc. In this perspective, it becomes clear that markets, prices and costings are interwoven with the creation of supplier-user networks in the development of product-service systems (McAloone & Andreasen, 2006). Also, new approaches to conceptualization (Hansen & Andreasen, 2005) may favour user orientation by emphasising analysis of user contexts and scenarios for user interaction with artefacts in line with integration of knowledge from engineering practices, technology and a range of other sources.

Akrich (1995) has pointed at the users' various perspectives and pictures that can be found in different departments (design, manufacturing, sales, marketing) and to different professional groups in a company. These departments may have different 'sensors', tools and 'observatories' in order to understand and work with users and markets. The implication is that different interpretations of user preferences compete and that the resulting configuration of users may act as an invisible hand instead of being the outcome of conscious choice. Based on these observations, user-oriented innovation should not just focus on users and their preferences, but also on the way users are 'created' in the design process.

Interactive innovation: innovation in cooperation among actors

Inter-organizational relations, knowledge sharing and trust

When a manufacturer develops new products in close cooperation with an industrial customer, we may still call this user-oriented innovation due to the fact that the user's needs play a key role. However, it may also be perceived as cooperation with the purpose of developing new products aimed at the subsequent parts of the value chain – what we called a type III innovation above. Such types of innovation are of increasing importance in the food sector (Royers & Rogers, 1998; Wierenga, 1997). It is a development driven by differentiated end user demands, which have to be dealt with at different levels of the value chain. It requires new set-ups both for the diffusion of market intelligence across the chain and for coordination of responsiveness among chain members (Grunert *et al.*, 2005). Consumer demands concerning health properties, animal welfare, food safety, environmental considerations and the use of genetically modified organisms (GMOs) are all examples where evolving and heterogeneous consumer demands create needs for end user-focused market orientation that extends across the whole value chain. This requires cooperation on product development among two or more actors in the food value chain, which in turn is dependent on the actors' ability to create long-term relationships, trust and commitment.

It is worth noting that the literature does not give much direction on how to work together with a customer or a supplier on developing products. Whereas membership of the same organization facilitates what Zucker (1986) calls 'institutional-based trust', the incentive to share the knowledge that is essential to product development is not the same when the parties belong to different organizations. Hence, trust seems to be a key parameter in inter-organizational product development, in that it can be conceived as a type

of expectation that alleviates the fear of one's exchange partner acting opportunistically (Bradach & Eccles, 1989; Gulati, 1995). Trust between two partners is normally perceived to develop over time; for example, Gulati (1995) found that familiarity through earlier alliances breeds trust, and that companies develop close bonds with each other through repeated interaction. Through ongoing interaction companies learn about each other and develop trust around norms of equity or develop what Shapiro, Sheppard, and Cheraskin (1992) call 'knowledge-based trust'.

Some forms of governance in value chains are more apt to create this form of trust than others. In some countries parts of the food sector have a tradition for cooperative forms of governance. While this form of governance has been criticized for its volume orientation and slow decision-making (see for an overview of the arguments Nilsson & Björklund, 2003), it has the creation of mutual trust as a core competence and may lead to advantages when interactive innovation becomes more important (Grunert, 2005c).

Innovation in networks

There has been some research on innovation in networks, which is relevant to address here, since a network can just be regarded as a value chain with several actors at one or several horizontal layers. It has been shown that companies that can draw on a network of customers, suppliers, research institutions and competitors are more likely to have higher product and process innovation success (Ritter & Gemünden, 2003). However, there are substantial differences in companies' ability to handle networks. This concerns both a company's ability to improve its overall position in a network with regard to resources and activities, and its ability to handle individual relationships. Conducting a survey of German mechanical and electrical engineering companies, Ritter and Gemünden (2003) found that a company's network competence, defined as 'a company-specific ability to handle, use, and exploit interorganizational relationships', has a strong positive influence on the extent of inter-organizational technological collaborations and on company's product and process innovation success. The study also found that four organizational antecedents have an impact on a company's network competence: access to resources, network orientation of human resource management, integration of intra-organizational communication, and openness of corporate culture.

Bidault, Despres, and Butler (1998) looked at factors making network cooperation between buyers and suppliers in product innovation more likely. They suggest three groups of factors: (1) environmental pressure, (2) social and industry norms and (3) organizational choice. Environmental pressure includes factors such as pressure of competition and of increasing pace of product innovation as well as technological advances such as expanding variety of technology and complexity of production. Social and industry norms relate to the behavioural norms that exist in a particular industry or society. Traditionally, some industries tend to have an open relationship with their suppliers, just as some societies, as for instance the Japanese, tend to predispose companies to practice ESI. Regardless of industry characteristics or country culture, individual companies also differ in their norms and values, which may influence their choice of whether to integrate suppliers into their development process or not. At least in parts of the food sector, all three factors seem to point at an increasing use of networks in innovation in the future.

von Hippel (2005) has provided a range of examples of how certain users (lead users or more or less professionalized communities) can take on a role as designers to interact with product developers in companies. Lead users are users whose present needs will become widespread in a market months or years ahead. Since lead users are familiar with conditions that lie in the future for most others, they can serve as a need-forecasting laboratory for market research. However, recent research has found that not only do users take on the role of innovators, but they may also establish and organize the innovation network that is required to support their inventions on their way to the market (Lettl & Gemünden, 2005). In a study on the role of users in radical innovation projects, Lettl and Gemünden (2005) discovered that in some cases users were not only innovators, they also played an entrepreneurial role in that they formed and coordinated a network of experts with complementary knowledge bases and resources. In some countries, certain retailers have acted as lead users in the promotion of organic food and were instrumental in bringing about a network of farmers and food producers filling the increasing demand.

The Actor-Network Theory (ANT) approach (Callon, 1986; Latour, 1999) provides a theoretical foundation that defines the generation of ideas and knowledge and the development of working artefacts as network-building processes. Creation of networks and changes in relations between actors in networks are seen as the outcome of translation processes defining the content of the network (the idea, fact or product it embraces and supports). Actor-Network Theory points at the translation of knowledge from a variety of sources as the main process in the constitution of socio-technical spaces for product idea generation. Multiple players are involved using various, often conflicting, interpretations of problems and solutions based on the specific working of a network of people, objects or machines as translators (Alting, Clausen, Jørgensen, & Yoshinaka, 2007). A key issue is how user studies or representations of users are translated into a space for innovation and product design. The notion of 'socio-technical space', as suggested by Clausen and Yoshinaka (2005, 2007), is intended to contribute to the understanding of the distributed nature of socio-technical complexity and its management. In a socio-technical design space, social players interact with one another, with technological artefacts, and with management concepts and technologies. This approach,

not yet applied to the food sector, may be a promising avenue for providing a better understanding of the integration of multiple users into a network-based innovation process.

An agenda for future research on user-oriented innovation in the food sector

We have now presented a broad range of research streams that are of relevance for user-oriented innovation in the food sector. However, as the reader may have observed, most of it was either not about food or not about innovation, and sometimes even not about either of those. There is thus a broad platform to build on, but there is also an urgent need for more research that deals specifically with user-oriented innovation in the food sector. We will list five areas where we think such research is especially needed.

First, there is a need for basic documentation of the phenomenon and its effects. As we have shown, user orientation is a matter of degree, varying all the way from user-initiated to shallow forms of user involvement. In addition, we have shown that users may be immediate customers, end users, or both. A first useful step would be to map the incidence of these various forms of user-driven innovation in the food sector. A second step would be to link it to outcome variables for the food producers involved. Do higher degrees of user orientation lead to higher success rates with new products? To higher profitability? Or do they improve company reputation, as a result of the positive connotations that go with user orientation, but which are otherwise unrelated to company performance? Another question is whether and how increased user orientation leads to a broader agenda and new focus in product development, including social trends like health, environmental or cultural issues. These are questions that we do not currently have answers to.

Second, why are food producers not more user oriented in their innovation? Although we do not have exact figures on the incidence of user orientation, as noted in the preceding paragraph, it is widely believed that innovation in the food sector could be much more user oriented than it currently is. What are the barriers? Does it have something to do with general barriers to openness and learning orientation, or are there specific barriers preventing more end user involvement? To what extent can these barriers be attributed to established engineering practices and the efficiency focus that has been the prevalent competence path in the food industry in the past, and to the mental models that it has created? Can user orientation in the food industry be supported by new collaborative patterns and learning across product development, marketing and specialised knowledge domains in, e.g., technology? Can increased user orientation contribute to the realignment of collaborative structures? Institutional theory would be a good point of departure for investigating these phenomena, and the more general market orientation literature provides some ground to build on as well.

Food production is characterized by value creation being spread across a range of actors, from primary production *via* various levels of processing, suppliers of ingredients and machinery to catering and retailing. While reactions to changing consumer demands previously mostly were handled at the level of processing, both the nature of consumer demands (importance of processing characteristics like animal welfare and environmental impact, importance of health characteristics) and the changing nature of biotechnology (new ways of exploiting biological diversity in primary production) lead to a new distribution of innovation across the actors in a food chain, resulting in more of what we have called type III innovations. This raises, thirdly, the question of the optimum kind of business model and associated innovation strategy for various actors in a chain or network, whether different degrees and types of user-oriented innovation would be suitable for different actors, and how they should organize their interfaces in order to optimize competitiveness of the whole food chain. While there has been considerable research on supply chain management, and some, much more limited, work on demand orientation of supply chains, looking at chains and networks from the viewpoint of user-oriented innovation is – well, innovative. Experience from other industries points at the importance of involving users and a range of new players like small innovative businesses and consultancies actively as mediators of new cultural trends and political concerns in the development of new innovative networks. There is therefore a need to carry out research on the involvement of a range of players in the development of food products and services, such that a diversity of perspectives and knowledge areas can be represented in the process from conceptualization over development to implementation.

A fourth research need refers to the link between theory and methodology. As noted in the review section, we have a good range of theories on buyer behaviour, but neither the theories nor their accompanying methods are geared to an innovation context. On the other hand, some customer analysis methods (examples include conjoint analysis, perceptual mapping, and a fair share of the methods in sensory analysis) are applicable in an innovation context, but are not anchored in buyer behaviour theory (for example, conjoint analysis assumes multi-attribute decision-making which buyer behaviour theory suggests is rather rare in the food area). We should move towards aligning theory and methods with the aim of applying them in an innovation context. This does not imply that theory or method development should start from scratch, but that both should be part of an incremental and interdependent development with a view to application in user-oriented innovation in the food sector. Choice of theory and methods determines which kind of knowledge will be channelled into the innovation process; for example, ethnographic methods in

studies of users, use practices and consumption will lead to a different view of user preferences and the user world than sensory analysis. This raises the important research question of how different combinations of theoretical approaches and methods create different portraits of users and translate user knowledge differently into the innovation process.

Our fifth and final research area deals with a fundamental issue of innovation: what is the interdependency between bringing new products on the market and the development of user needs? The innovation literature has ignored this question by hiding behind the term 'latent needs', implying that needs for new products are indeed pre-existing and can be uncovered, even though users are unaware of them. As already noted, this assumption is not theoretically justifiable. The food area, which is characterized by both many new products coming onto the market *and* a relatively slow change in eating habits and consumer preferences, may be ideal for the study of the interdependency of product innovation and user needs and preferences.

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