EXPANDING THE SOCIAL DIMENSION: TOWARDS A KNOWLEDGE BASE FOR PRODUCT-SERVICE INNOVATION

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ABSTRACT
The extension of businesses to incorporate the provision of function as a service in supplement to standalone products is an ongoing movement in manufacturing industry. In short, this means that the development intent should be guided by the need of 'performance in use' that the customer wants, e.g. thrust rather than an engine. By this, the established knowledge base challenges the development team. This paper embarks from the assumption that there are three main challenges, i.e. (1) innovation activities, (2) customer data acquisition and (3) the transformation of data into design information. The purpose is to discuss knowledge sharing activities to contribute to product-service innovation. In this study it has been found that contemporary data acquisition activities filter out important dimensions of knowledge. Thus, does not provide a sound base for service provisions.

Keywords: product development, product-service systems, knowledge sharing, user oriented design, innovation

1 INTRODUCTION
Reduction of lead-time and cost as well as quality improvements continue to be vital challenges to increase competitiveness on existing markets for manufacturing companies that are acting on a worldwide business-to-business arena. In addition to these issues, manufacturing industry addresses the extension of business models towards service offerings, both to provide leverage on existing markets but also to reach, or create, new businesses. This changes what kind of products that is sold, and is thought of as a special case of servitization, where the use of an integrated solution brings added value to the customer [1]. Also, there are expectations on these service business models to provide for sustainable development by, e.g. reduced waste flows [2]. Within the Product-Service System (PSS) realm, the terms used to describe these kinds of integrated offerings differ, for example, Integrated Product and Service Engineering [3], total care [4], functional products [5] and, functional sales [6].
In common, PSS offers are contracted on the characteristic to provide *'functions per unit'*, e.g. in the aerospace domain this is expressed as power by the hour or thrust on wings [4]. This is a way to express that the product has to fulfill certain user needs, instead of portraying a product as a thing, e.g. a jet engine. In this way, PSS can be compared to 'providing services'. There are expected advantages of PSS offerings, for instance the customers are foreseen to get better overview of the cost for using the product and, the manufacturer, or rather a collaborating extended enterprise, is expected to take a step closer to customers and thereby also create a more stable business climate [4].
Though, there are also challenges, particularly from an engineering design perspective. The focus on selling performance (in use) or functions (fulfilled) in PSS offers raises a number of key aspects. First, since the performance makes up a final solution, instead of a solitary physical thing, a continuous innovation process is part of a service providing approach. Broadly, product development describes a process where the physical thing should be stable over time, only supporting incremental improvements on the existing product. And, in turn, services are aimed to support the physical product's operation. In opposite, having performance at the user's place as design intent, the solutions that fulfill such functions can, over time, differ. Hence, seizing innovation opportunities more strategically than today is vital in future product development processes.
Second, this situation insists on ways to handle the dynamics of innovative processes [7] [8], where what to develop, what it should do and who should use it become a concern in early phases [9], i.e. prescribing a more open approach to innovation. The orientation of design activities goes from a

physical thing to what objectives the customer like to achieve, thereby a focus on the function of the product becomes a characteristic for PSS. As a consequence, the acquisition of user needs have to be done in a solution independent way [10].
Third, the next step after collecting user needs is the interpretation of them into statements that should guide the design teams. These statements are translated in different ways by the designers [11]. In industry today, the transformation, interpretation and application of user needs is a critical. In a product-service innovation context, the need expressions become more elusive, particularly if the customer is interested in a long term provision of functionality, e.g. thrust appropriate to fulfill the company's goals over the next 10 years. A complication is that such non-product related needs usually cannot be directly articulated by customers [12], subsequently, the acquisition of such needs is not straightforward to perform either. Seen from a knowledge perspective, product-service innovation is cross-disciplinary teamwork where the management of user data is a key to the integration of a product perspective and a service perspective.
In this paper, we embark from an assumption that knowledge sharing of elusive user data benefits innovation in general, but product-service in particular. The purpose here is to discuss knowledge sharing activities to contribute to product-service innovation processes.
In the following, the research method is described. Next, a theoretical point of view is outlined, and a description of industry practice is presented. In the last section, a discussion contrasting theory and described practice is done to provide us to make a concluding remark.

2 METHOD

In general, the active participation in research projects provides background data. Discussions of product development have been performed within totally nine different manufacturing companies during a 10-year period. In common, the companies are acting on a global business-to-business arena. All research projects have been performed in a close industry-academia environment, where both formal (scheduled and planned) and informal (e.g. in-between) meetings have occurred along the way.
In particular, the empirical ground for the study presented in this paper has been found within three of these nine companies. The companies' product development projects are related to a range of different product, but all are organized in a product-oriented structure.
During the course of the research study, data has also been generated in eight 'virtual meetings' supported by teleconferencing equipment and so called shared applications. On average five informants have participated in each virtual meeting, with all three companies being represented in all of those meetings. The overall theme for these data generation activities has been '*practices for knowledge sharing in manufacturing industry*', and a particular interest in seven in-depth interviews has been in '*knowledge sharing of user needs in design teams*'. The informants represented different roles within the marketing and the product development departments, this made the data material both rich and nuanced. Respondents have suggested relevant persons that could contribute to the empirical data within their respective companies. The interviews were tape-recorded and partly transcribed.
The approach in the in-depth interviews has been to start by posing open questions, or rather encouraging the informants to just tell something about their '*knowledge sharing*' activities. From this first 'story' words that the informants used were put into the subsequent questions. Thus, the 'story' approach allowed the in-depth interviews to find out and to clarify the situation by using the informants' own vocabulary and words, i.e. dig deeper into the area. Consequently, the analysis of the data has yielded a description of knowledge sharing activities and user data management that have a high potential to be grounded in the informants' point of view. The data has been analyzed in a holistic manner, i.e. expressions are interpreted in their context and not as sole entities. Such analysis provides a description for how the informants experience their every day knowledge sharing activities in product development. The excerpts that are presented in chapter four in this paper, are chosen to visualize an overview (a pattern) that have evolved from the analysis. That is, the excerpts are not 'endpoints' describing unique perspectives.
During the analysis, we encountered a challenge. The individual informants used the word 'we' in some answers. In some cases 'we' seemed to be used to describe a belonging to an occupational role, i.e. product developers or marketing staff. In other cases, the term seemed to relate to the members of a particular project. And, in additional cases, 'we' seemed to describe the informant as a member of the company as a whole. We have put the excerpts into a wider context to, as best as we could, minimize some dimensions of confusion.

For organizations, the problem is not to define knowledge. They have to find ways to communicate their knowing and to make it beneficial for the company, and how to capture, formalize, store and disseminate knowledge are typical industrial knowledge management activities. Yet, it contributes to our purpose to elaborate on the concept of knowledge from a theoretical point of view.

3 KNOWLEDGE AND RELATED CONCEPTS

Making the company's intellectual assets transparent (and thus also able to capture and reuse) is key to many firms, also bringing with it the dilemma to value something, which is highly intangible in its nature.

Knowledge is traditionally defined as '*justified true belief*'. From a positivistic point of view, the word '*true*' is emphasized, meaning that knowledge can only consist of facts that are (quantitatively) testable. Beliefs, common sense, gut feelings etcetera are thereby not considered as knowledge. Emphasizing '*justified*' rather than true makes it possible to address a wider range of knowledge dimensions, i.e. dynamic and humanistic, and thus also asserts that knowledge is created in social interactions amongst individuals and groups [13]. In this perspective, humans can convey knowledge by intellect and/or by skills.

Further, it becomes important to categorize information as different from knowledge. Information can be separated from context and humans, while knowledge is context dependent and part of a human's mind and body [13]. From a knowledge management point of view, knowledge is explained as actionable information [14]. By doing so, a link between individuals (who can take actions) and external sources (e.g. other individuals or information systems) can be discerned.

Usually, two types of knowledge are mentioned in literature, namely tacit knowledge and explicit knowledge [13]. Explicit knowledge has similarities with information [14], that is, it can be expressed in formal language and is relatively easily shared, processed, transmitted and stored [13]. Tacit knowledge is, on the contrary, described as highly personal since subjective insights, intuitions and hunches are part of this group [13].

Local knowledge is another concept that in some aspects aligns with the idea of tacit knowledge, particularly in the sense that such knowledge is closely intertwined in human experiences. Local knowledge is described as emerging in interaction among people and their experiences with the situation at hand, e.g. projects, operations or physical objects [15]. Seeing, doing and interacting (with someone, something, somewhere) creates local knowledge. To differentiate local knowledge from an expert type of knowledge a distinct view of two categories is presented [15, p.12]:

'Expert'	**'Local'**
Theory-based	Practice-based
Abstracted, generalized	Context-specific
Scientifically constructed	Interactively derived
Academy-based	Lived experience-based
Technical-professional	Practical reasoning
Explicit	Tacit
Scholarly	Everyday

Cohen [16] draws on the work of Nonaka [13] and points out that there is a difference between 'knowledge' and 'knowing'. The noun knowledge implies that knowledge is a thing, an independent object or stock, thereby it seems doable to 'capture', 'distribute', 'measure' and 'manage' knowledge. The gerund knowing proposes a process which is not separable from those who knows, however it is beneficial to 'promote', 'motivate', 'encourage', 'nurture' or 'guide' knowing. Based on this, some distinctions between the perspectives on knowledge in west and east are highlighted [16] (p.24):

West	**East**
Focus on explicit knowledge	Focus on tacit knowledge
Re-use	Creation
Knowledge projects	Knowledge cultures
Knowledge markets	Knowledge communities
Management and measurement	Nurturing and love
Near-term gains	Long-term advantage

A distinction like this provides only part of the story, since combinations, connections and relationships are vital for knowledge activities. Thus, it is suggested that a firm's knowledge base should be built upon a perspective of 'both' rather than favoring 'either/or' [16]. Basically, to be able to apply a 'both' perspective it has to at least be acknowledged that the coin actually has two sides.

3.1 Company knowledge base

A knowledge base can be described as facts, rules and procedures gathered and organized into schemas [14]. However, as discussed above, all dimensions of knowledge cannot be captured and formalized. In fact, a firm's knowledge base encompasses more than what is produced in activities [17].

Nevertheless, Nonaka et al [13] present four categories of organizational knowledge assets: experiential, conceptual, routine and systemic, see Figure 1. They define assets as *"firm-specific resources that are indispensable to create values for the firm"* [13, p.20].

The knowledge assets are built up by the inputs, outputs and moderating factors of knowledge creation. Knowledge creation, in turn, is described as a continuous process, which transforms *"the old self into a new self by acquiring a new context, a new view on the world and new knowledge"* [13, p.8], hence there is similarities with learning processes. Even though, the assets are presented as separate entities in Figure 1, they are explained as interrelated, dynamic and constantly evolving. Consequently, an effort to capture a snapshot of the assets is not enough for a company that would like to seriously manage organizational knowledge [13].

Experiential Knowledge Assets	**Conceptual Knowledge Assets**
Tacit knowledge shared through common experiences • Skills and know-how of individuals • Care, love, trust and security • Energy, passion and tension	Explicit knowledge articulated through images, symbols and language • Product concepts • Design • Brand equity
Routine Knowledge Assets	**Systemic Knowledge Assets**
Tacit knowledge routinized and embedded in actions and practices • Know-how in daily operations • Organizational routines • Organizational culture	Systematized and packaged explicit knowledge • Documents, specifications, manuals • Database • Patents and licenses

Figure 1. Categories of knowledge assets [13, p.20]

At the top left in Figure 1, experiential knowledge assets are represented; these consist of shared hands-on experiences inside and outside the company boundaries, but also emotional knowledge, such as facial expressions, gestures, enthusiasm and worries. This makes experiential knowledge assets firm-specific, difficult-to-imitate and thus also provides a competitive advantage [13]. 'Love' is not clearly explained, but can be interpreted as concerning good or bad aspects and represent empathy for other's opinions [18], e.g. interest in how the company is appreciated internally and externally.

At the top right in Figure 1, the conceptual knowledge assets, which have tangible forms, are shown. Due to their manifestation in products etc. they are easier to grasp. Also, these can be means to express some tacit knowledge since they can work as a trigger for people [19]. Though, the efforts to come to terms with what people perceive are still difficult [13].

At the bottom left in Figure 1, routine knowledge assets are outlined. These assets are practical in their nature and are reinforced and shared through, e.g. continuous exercises and certain patterns of thinking in the day-today business of the organization.

At the bottom right in Figure 1, the systemic knowledge assets are exemplified; product specifications and legally protected intellectual properties fall into this category. These assets can relatively easily be

transferred since they are the most 'visible' type [13]. Further, Nonaka et al [13] emphasize that systemic knowledge assets is the main focus for contemporary knowledge management.

3.2 Knowledge sharing

To gain organizational advantages of a knowledge base, the individuals' entities of knowledge have to be shared amongst the members and actors of the organization. On an overarching level, knowledge management captures such activities. As indicated above, knowledge is represented in an unstructured manner within organizations. In such situations, knowledge management becomes an active and strategic tool to organize it [14]. However, the perspective of 'organizing' makes the effort focused on re-use, monitor and control, as opposed to a view of spurring and nurturing the learning of new knowledge [20]. The creation of new knowledge is an important issue to enhance the pace of innovation; such a strategy includes creativity [21] and open innovation [22]. Avoiding the not-invented-here attitude and learning from outside experts is at the heart of open innovation [23]. Studies have found that a number of innovative products have their origins in unlikely sources, for example outside lead-users [24].

Product-service innovation is based on early integration of different knowledge domains, i.e. product and service. Grant [25] proposes a hierarchy of integration of knowledge, which is not a typical administrative hierarchy of authority and control. The individual's specialized knowledge consisting of both an explicit and a tacit domain builds a base, yet it is proposed that there should be an emphasis on tacit knowledge here since individual specialized knowledge usually is in the form of 'know-how', 'skills' and 'practical knowledge'. From this base, a number of levels are described, namely single-task capabilities (e.g. machining of a feature), specialized capabilities (e.g. assembly of component), activity-related capabilities (e.g. manufacturing capabilities), broad functional capabilities (e.g. operations capabilities) and cross-functional capabilities (e.g. new product development). It is concluded that integration of individual knowledge at all levels is a key (this is also what distinguishes it from an administrative hierarchy), and that top down decision-making is inefficient for knowledge integration [25].

By this view of individuals as important for knowledge integration, the issue of *'knowing who knows'* [26] is critical. To efficiently provide for integration of relevant capabilities those who possess them have to be identified and made available for the organization. *'Knowing who knows'* is troublesome for in-house development projects; the challenges for cross-company projects (such as open innovation or product-service innovation) could be even far more problematical.

4 KNOWLEDGE SHARING IN PRACTICE

In this section, excerpts from the informants are used to describe and visualize the empirical result. This means, that descriptions, interpretations and analysis are interwoven in this section. The excerpts do not describe unique standpoints, but rather a pattern found in the analysis of the study.

The informants from the companies had experiences from different occupational roles within their respective firms, though they all had an educational background as engineers. This way of making a career within the firm seemed like a common way to become an experienced employee and thus gain broader capabilities. One of the companies was in an expansion phase, 30 % of the personnel had worked less than two years. One representative expressed a company view, when he said:

> *"We have started to realize that too much of the knowledge is in the head of the experienced staff."*

In particular, the informants found that the reasoning or logics for decisions was perceived as difficult to transfer. In some cases, a mentor-apprentice strategy was used to train novice employees. Besides this, a lack of structure was perceived particularly to introduce new personnel. An informant exemplified it with the statement that:

> *"Different managers have different strategies to get newcomers up to speed"*.

The issue of building a knowledge base was discussed, what does that mean and what activities have to be carried out? One product developer provided a developer point of view when he said that:

> *"The work approach filters out those things that are not so important to do. There are things that are not so profitable. It's about putting resources into the things we really should deal with."*

Thus, by giving priority to some of the product developers' work tasks the knowledge assets also get prioritized according to importance. One interpretation we can make is that the informant relies on the organizational structure to make sure that only relevant knowledge is fed into the processes, also indicating that there could be a 'culture' of not questioning whether or not the knowledge is appropriate in relation to the task. Another interpretation is, of course, that the organizational structure really makes sure that the right things are prioritized and that relevant knowledge is transferred. However, considering the fact that all the companies are organized according to a product structure, an extension towards an integration of services could be at risk.
Another product developer had a different answer and explained that:

> *"It is not only about 'downloading knowledge', but also about structuring the knowledge so that it can be used in a modular way.* [Giving an example of one of their products] *which consists of parts with their own properties and knowledge pieces. There is a lot included in this. Externally, it is also about understanding the customer's context."*

An interpretation of this explanation could be that the view of the physical product as the core knowledge for a product developer is evident. Also, a point of view of knowledge as being an object (or mainly explicit) can be discerned in such analysis. Further, an interpretation of the positioning of the customer's context as something external indicates that dealing with customers is not a part of the product developers' work.
Commonly, the product developers informants used the phrase: *"…to sit in the knees of the customer"* to describe the strategy at the customers' site. An interpretation of such an expression is that the product developers perceive it necessary to work very close to customers, but also that they might perceive it like being 'in the hands' of demanding customers. In general, product developers' work and interaction with customers was through evaluation of prototypes and field tests. The differences in customer interaction were explained by an informant from the marketing department. He explained that product developers have a certain purpose for interaction (the test or evaluation of a product), a specific agenda (established types of tests) and a time plan of their own (in what procedure and when to test it). An interpretation of this explanation can be that product developers know what kind of data (technical, measurable, related to a thing) they should bring back home. Hence, can provide 'evidence' for if they have successfully obtained the required information or not, i.e. managing explicit knowledge. The informant from the marketing department compared their situation by saying:

> *"It's a big difference to visit customers starting from a blank sheet."*

A difference in how customer interaction was perceived was also discernable by the different expressions from marketing informants. They said: *"…being exposed to customers (or customer needs)"*. An interpretation of this is that the marketing informants recognize the situation (needs or customer expressions) to be diffuse and that it could include risks for misinterpretations. Also, the expression can hint that marketing might perceive the task as fairly complex. One marketing informant explained that:

> *"To understand customer needs is, for me, to understand human beings. That is what it is all about. For example, what is their basis for their decisions? It is almost like psychology."*

Further, being aware that different representatives from the companies are interacting with customers on the basis of distinct objectives, a product developer explained:

> *"Different representatives meet the customer at different occasions. It is not easy to merge. Who has the complete understanding? Understanding of customer value is dispersed across many different persons who have different information about the customer and their needs. The company has different persons at the customer site as well: technicians, purchasers, service-personnel and so on."*

The informants told us, that the marketing department used a range of tools, methods and procedures for the acquisition of customer data. Yet, common sense was mentioned as a key to generate need statements. One marketing informant said that if one key person should leave the job for another occupation, transferring such common sense was going to be problematic. Based on his own experiences, he promptly suggested that a good starting position for a newcomer was to turn to what is documented. This was in his perception the easiest way, but reflecting on what is actually documented he said:

"You have to be brief and everything cannot be written down. The formulation that I have used might not mean the same for someone who does not have my experience. Furthermore, some knowledge can be written down, while some cannot. Dealing with customers is a bit like dealing with feelings…it becomes very… You have to be there! You will never understand the customers reality if you haven't been there."

When talking about applying knowledge about customers into product development, a marketing informant used a metaphor to explain what happens:

"It's like having a glass full of needs… in the end the developer has but one drop to analyze."

The metaphor gives a sense of a process where the knowledge about customers has to go through several steps before it reaches the product developer. An interpretation of the procedures for managing such knowledge is that customer information is distorted or lost along the way. The marketing informant continued to explain the situation:

"Since we are a large company, anyone can understand that much of the knowledge will disappear on the way. But, the worst thing that can happen is that somebody adds something during the way. Then what finally reaches the product developers will be something else."

Generally, at the companies, the marketing and sales department performs specific customer data acquisition activities. Internal face-to-face meetings with a mixed (marketing, product development, business, experts etc.) project team are used to transfer the result from the acquisition activities. One aim for these meetings is to further analyze customer data and compare the result to the company strategy and success indicators. These success indicators are perceived as the description of the customer needs.

The product developers used visualization tools to describe customer information, e.g. Power Point presentations, sketches on whiteboards, matrixes like Quality Function Deployment (QFD): 'House of Quality'. A product developer informant commented the fidelity of the customer information, which is transferred from marketing and analyzed in mixed team meetings:

"QFD feels good, but it starts with prioritized customer values. How do we acquire these? What questions do we ask our customers? We don't have the knowledge to dig deeper!"

In this excerpt, the word 'we' can provide for different interpretations. Put into the context that QFD is a company strategic tool, 'we' might then mean 'the company'. Alternatively, 'we' could mean the marketing department considered that the informant is questioning the way to acquire customer data. An interpretation based on the whole context indicates that 'we' could mean the product developers, i.e. they are aware that aspects have been filtered out during the way, but do not have procedures (alternatively competences) to trace the information sources. Considering the fact that product developers are not involved in early customer interactions (before prototype and field tests), such an interpretation seems even more plausible.

In a general discussion of sharing experiences within the development team one product developer informant emphasized:

"…it is difficult to share knowledge about why things went well or bad, or why something is difficult."

Such an expression can be interpreted in different ways. The difficulties can relate to company culture (openness, allowing different point of views to be expressed, meeting formats, turn taking when speaking etc.) or it can relate to individual issues such as the difficulties to articulate experiences (lack of words, lack of expressions, stickiness of such knowledge etc.). However, most likely and to some degree both interpretations could be plausible, since knowledge sharing is a complex task.

5 TOWARDS A KNOWLEDGE BASE FOR PRODUCT-SERVICE INNOVATION

Knowledge has no direct value for a company if it cannot be transformed into some kinds of performances. A typical company point of view is that knowledge is the company's most valuable asset; often such a view puts protecting intellectual property as important. The open innovation strategy [22][23] prescribes procedures that are more based on sharing and a win-win perspective. Yet, the two strands do not have to be on a course of collision. Knowledge related to product concepts, manuals, databases etcetera, i.e. typical conceptual and systemic knowledge assets [13], are

established within manufacturing companies and are, or at least should be, protected from leakage. By developing procedures for cross-company cooperation that allow sharing of individuals' skills, know-how and passion for design, i.e. typical experiential knowledge assets [13], open innovation activities are supported. In turn, the routine knowledge assets [13] at each company, e.g. daily work operations, things people just do, are made more visible and lessons can be learned. Taking issues for granted, e.g. we have always done like this, and will always do like this (i.e. not-invented-here syndrome) is a barrier for re-learning and for moving into product-service innovation.

Based on the empirical result in the study presented here, the knowledge flows in early phases of product development can be described as an over-the-wall transformation process, where the wider knowledge base is converging towards physical products (traditional, existing) in very early phases. Customer information, whether it is the customer's own expressions or if it is the company representatives interpretations of them, is typically consisting of tacit and/or local knowledge, in this way the diverse facets of this type of knowledge does not reach its recipients. The metaphor "a glass" of customer's needs that is turned into "a drop" of needs which one informant in this study gave, is a valid representation for how knowledge about customers has to pass several 'filters" before they are applied in technical development. Hence, the procedures support an approach that reduces uncertain and unstructured customer information early on. But, in fact, such tacit knowledge is part and parcel of product-service innovation. Due to a focus on providing performance in use it is necessary to let 'fuzzy' and contextual knowledge be present throughout the early development. If the knowledge is managed like this, there is a risk that the knowledge base becomes too scarce for product-service innovation.

In our study, we have found that both tacit knowledge and explicit knowledge are generated in the customer data acquisition activities. But, the study indicates that there are obstacles that make it difficult to transfer tacit knowledge, experiences etc. from marketing to product developers. And, maybe also from one product developer to another (as the informants explained it is difficult to share things that went well or bad). In general, the activities to transfer knowledge from one part to another are performed in face-to-face meetings, and it could be argued that how these meetings are performed might be an obstacle as such. For example, QFD was mentioned by the informants as serving as a template, despite not providing background and rationale for the statements, i.e. necessary contextual knowledge for product-service development. Therefore, we propose a checklist that could provide a basis for better understanding of the social dimensions of knowledge needed for innovations. When conducting innovation activities:

- *Aim for multidisciplinarity* – a mix of perspectives and knowledge domains increase innovation opportunities (good ideas often come from unexpected sources).
- *Allow fair talking time/participant in meetings* – in general, one person is in charge and the one that is talking (passing on information). This dominance needs to be broken.
- *Support perspective alignment* – the activities should clarify and visualize distinct perspectives. An agreement that there are conflicting perspectives is a good starting point for problem solving.
- *Provide meeting participants to listen to all points of view* – normally, people prepare their own 'saying', their turn to talk, at the expense of listening.
- *Provide building on each other's point of view* – the knowledge domains of services and products are distinct and integration is non-trivial to accomplish.
- *Prevent judgments of other's point of view* – criticizing people for their opinions does not contribute to knowledge creation.
- *Enable metaphorical work* – experiencing, doing, seeing and so on, support understanding of tacit knowledge.
- *Support a learning process* – new knowledge appears in the interface (tension) between distinct knowledge domains.
- *Allow awareness of work progress* – to avoid endless discussions and to contribute to the topic at hand.

Note that 'meeting" refers not only to what happens in meeting rooms, but it refers more broadly to a range of formal and informal activities, e.g. group discussions in different contexts.

6 CONCLUDING REMARK

From the starting position that sharing of tacit knowledge benefits innovation in general, and product-service innovation in particular, the purpose in this paper has been to discuss knowledge sharing activities to contribute to such innovation processes. We have performed empirical studies in three manufacturing companies and found that company representatives gather both tacit and explicit knowledge about customers, though in different ways. Generally, marketing staff manages early acquisition activities and generates more tacit and experience based knowledge, but also they lean on more qualitative capabilities to do so. Product developers' manage late acquisition activities and collect mainly explicit and product related knowledge, but also apply more quantitative capabilities to obtain the information from customers. These distinct activities give rise to a challenging situation when sharing the gained knowledge. We have found indications of problems to transfer experience-based knowledge between marketing and product development; such early activities are commonly performed in face-to-face meetings. One such problem is that the customer information, particularly the tacit dimensions providing contextual background, is narrowed down too early due to, as it seems, an established procedure. This means that the experience-based knowledge does not guide later stages and could provide a knowledge base that is too scarce for product-service innovation. To extend activities with a social dimension that is needed for sharing experience based knowledge we have proposed a checklist that could be used to spur reflections for how develop a knowledge base for the purpose to integrate service and product knowledge in innovation activities.

Admittedly, our perspective has been from engineering design, hence we have not considered innovation from a service perspective. This point of view is utterly important in further research. Also, we suggest future studies of product-service innovation based on an organizational perspective.

ACKNOWLEDGEMENTS

We greatly appreciate the invaluable input from the informants. The support from PIEp, ProViking THINK and CiiR are also gratefully acknowledged.

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