Exploring Knowledge Processes in User-Centred Design

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Abstract: This research focuses on analysing knowledge processes of the design process, especially the early phases of the design process that can be called concept design. It aims at developing a body of knowledge that builds on the relevant issues toward user-centred design in a form of a framework. This is intended to apply, organise and synthesise processes, theories and concepts from the separate but linked disciplines of knowledge management and human-computer interaction, hence addressing one of the most essential topics and goals of system design, i.e. how to define what is needed in the system and how the system should mediate human activities—for the purposes of this research, in the context of interest-based communities and mobile technology. The framework is based on the following propositions: (1) The participants of design process include designers and users as actors, both of which are seen to possess knowledge needed toward successful design; (2) this knowledge is proposed to be context-specific, hence being specific for certain users using certain technology; (3) for the user as well as for the design professional there are some things that are known but have not been articulated; and (4) the knowledge processes transforming tacit knowledge into explicit knowledge by users and designers are linked and need to be combined, finally (5) toward knowledge embedded into concepts, products, or services. Overall, the research highlights how knowledge processes enable user involvement and capturing tacit (and novel) user knowledge toward successful concept design/design.

Keywords: user-centred design, concept design, knowledge process, tacit knowledge

1. Introduction

This research focuses on one of the most essential topics and goals of system design, ie. how to define what is needed in the system and how the system should mediate human activities. In doing so, it embraces the principle of user-centric design. In the background of this research is research conducted between 2002-2005 toward designing mobile communication devices for interest-based communities (presented in Still et al. 2002, Ijäs et al. 2003; Isomursu et al. 2004; Still et al. 2004; and Still et al. 2005). These communities are formed by individuals with a shared interest, expertise, and passion in a focused area that can be just anything (Wellman 1988; Rothaermel and Sugiyama 2001; Preece, 2000; Preece and Maloney-Krichmar 2003), and are technologically mediated, usually with web-based technology, but also with mobile technology, for example as described by Rheingold (2002). "Today's mobile phone business is not about selling the uniform black brick to everybody, but just the opposite—designing and delivering the right product for specific kinds of use" (Kiljander and Järnström,2003: 16) describes the requirements for design of this research. During an extensive literature review it became clear that the "popularity" of focus of design needs has contributed toward the following: (1) it is discussed and analysed within many disciplines, usually with an interdisciplinary approach (2) therefore the amount of relevant literature is vast, (3) therefore there is a multitude of relevant theories, approaches and methods, both academic and professional, and (4) the concepts have seldom universal definitions that are agreed by all. In addition, (5) the context of organisations tends to dominate current research, and (6) few design studies concentrate on needs of an interest-based group or community. Also, (7) the interdisciplinary research team exploring the mobile communication of interest-based communities was accustomed to operating within the scope of organisations.

To address the above-mentioned challenges, this research aims at developing a body of knowledge that builds on the relevant concepts and approaches toward user-centred design in the form of a framework. The framework synthesises terminology and concepts from human-computer interaction, HCI, (user, usability, technology, context/use-context, user involvement, designer, product concept) as well as from knowledge management, KM, (knowledge process, tacit knowledge, explicit knowledge, embedded knowledge). KM is regarded appropriate for this study, as it concentrates on the collective process of knowledge creation (for example in Nonaka and Takeuchi 1995) and the need to embed the achieved knowledge in concepts, products and services. It further emphasises the complexity of knowledge (McInterney 2002, Nätti 2005), overall trying to answer how to better create, use and manage knowledge in organisations (or groups)—relevant for the interest-based communities sharing and creating knowledge. For addressing the design for technology for mediating human activities, HCI as a discipline was selected for its focus on users: when exploring the human understanding, (residing first and foremost, in the practices in which the human participates (Taylor

Reference this paper as:
Still K(2007) "Exploring Knowledge Processes in User-Centred Design" *The Electronic Journal of Knowledge Management* Volume 5 Issue 1, pp 105 - 114, available online at www.ejkm.com

1993) it has developed procedures, methods and tools that facilitate the design of more effective interfaces and devices better adapted to users and user groups. Hence, HCI was utilised to go beyond a single user (Bannon 1992) to address technology supporting interest-based communities for the special context of this research, and it was further refined with concept design process/user-information based concepting, and interaction design as they are considered applicable approaches for designing mobile technology (Jones and Marsden 2006).

2. Design as knowledge activity

Design is said to a cognitive activity, thought work (Beyer and Holzblatt 1998). Several researchers have described new product development as a knowledge intensive activity (for example Nonaka and Takeuchi in 1995 with one of the earliest applications for the knowledge creation process, the new product development of a bread machine) and have used the knowledge-based view of the firm and the RandD process (Davenport and Prusak 1998, Kessler 2003). Recent research has furthermore emphasised the role of data/information/knowledge in new product development and innovation. For example, Zahay et al. (2004) were looking at sources, uses and forms of data in new product development, centring on reducing uncertainties related to "what do they want" (referring to users); Adamides and Karacapilidis (2006) were "seeing knowledge and information flows as key determinants of successful innovation and new product development process"; and concept design is described as an "information-intensive process" (Takala et al. 2006, p.62).

2.1 Need for context-specific knowledge

As in processes in general, design process is seen to transform certain inputs into desired outputs. Based on the knowledge-view, these inputs and outputs are considered to be knowledge. People involved in the concept design, design process (or in new product development) are seen to be knowledge workers engaged in knowledge processes. These knowledge processes are high added value processes in which the achievement of goals is highly dependent on the skills, knowledge and experience of the people carrying them out. In design process, knowledge workers are seen to operate by taking into account multiple inputs (generally a wide set of unstructured data and information) to perform difficult tasks and make complex decisions among multiple possible ways of doing the work, each one implying different levels of risk and possible benefits (Cervera 2006).

Still, even (or maybe especially) in knowledge management literature, there is no single agreed upon definition of knowledge. Knowledge is seen to be something more that information, something that adds value to information—it has been conceived as "information put to productive use" (Kakabadse et al. 2003). Overall, words such as meaning, application, use, integration, action, and know-how have been used to explain it and its value. Hence, it is seen to be directly linked to information and (Nonaka and Takeuchi 1995), with a traditionally linear process of data-information knowledge that has been challenged by Davenport and Prusak (1998) who state that non-manageable amounts of knowledge become data. The key attribute for knowledge is that it exists and resides in the heads of people—"Humans possess knowledge" stated Bollinger and Smith (2001:8). Hence, it is problematic to separate the process of knowing and its resulting knowledge (Orlikowski 2002). This furthermore implies that (1) committing explicit knowledge to a medium (such as paper) changes it into information (2) people have different interpretations on the knowledge and information based on their expertise, values etc., (3) information that artefacts contain is not the same as the knowledge required to use them, all of which can influence the design process.

One encompassing definition for knowledge is:

> *"A fluid mix of framed experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information. It originates and is applied in the minds of knowers. In organisations, it often becomes embedded not only in documents and repositories but also in organisational routines, processes, practices and forms." (Davenport and Prusak 1998: 5)*

For the purpose of this thesis, the definition above has been used to formulate a working definition of knowledge needed for/during design process:

> *"A fluid mix of framed experience, values and contextual information of users, combined with framed experience, values and contextual information of professionals and their expert insight that provides a framework for evaluating and incorporating new experiences and information into concepts, models and artefacts. It originates and is applied in the minds of users and design professionals. In design process, its sources include documents and repositories, routines, processes, practices and forms, but those can also be products of the process itself."*

The above-presented definition for knowledge needed in the design process included the component "contextual information". Context is central to all explanations of social science and though it has been said to be something that "everyone knows it is there, but nobody is sure where- or what- it is" (Keith 1994:230). It is generally studied as equivalent to the situation, in which an individual is immersed—for example as people, places and things that surround the user--but also as contingency, with specifying key situational factors which impact the context, as well as with frameworks that provide individuals with a situated context for action, filtering out some stimuli (Johnson 2003). Hence, it is seen that a person's behaviour is influenced and mediated through the context (Jones and Marsden, 2006: 136). In the HCI arena, the term use-context (also called context-of-use), is at the interface between user and technology (also other than computer, its hardware or software), and means users, tasks, equipment, and physical and social environment in which a product is. Contextuality of knowledge highlights the specificity of the knowledge. In other words, the fact that the knowledge created during the design process is specific to that user (users or user group), using that specific technology, at a specific time. Therefore, the requirement for context-specific knowledge translates into need of thorough and deep understanding of user(s). With this, usability, which is now widely recognised as critical to success of an interactive system or product (Maguire 2001) can be reached. It is generally agreed that usability (referring to how to support users in their tasks) is achieved through the involvement of potential users in system design (Karat 1997).

2.2 Need for user and designer knowledge

Toward the success and ultimate survival of the company, understanding the needs that people have regarding a certain product or situation has become essential. Organisations have realised that they cannot rely on designers, developers, or specialists (or the technology originators of Gibson and Smilor 1991) to know how to design products and services to meet customer needs. The people that need to be included can be called customers (who order and/or pay the product), users (who interact with the product), or consumers (who use the product). User-centred research, which can be said to be the guiding principle for most design processes nowadays, centres on the user. The term for user's interaction with this principle is called user involvement. User involvement usually describes direct contact with users, and it is considered to mean participation, involvement, or integration of users in the design, evaluation and implementation of new products. A clear definition of user involvement is lacking in the system design world. The concept has been used synonymously with "including users in the design process" (Nesset and Large 2004) and with "focus on users" "contacting with system users", "consulting end-users" and "participation of users" (Kujala 2002). Involvement is encouraged at all phases of the design process, but it is oftentimes seen to be most efficient and influential in the early stages of system development (Ehrlich and Rohm 1994). It is nowadays considered essential and valuable in understanding user needs and achieving successful, usable products, and it has been seen to provide the needed knowledge about the user for design activities. Users and designers are seen to have distinct roles and separate contributions that they can make to the design process. The increasingly active roles of users in user-centred design—performing one or multiple roles of users, testers, informants, co-designers or design partners (Nesset and Large 2004)—are consequently seen to lessen the distinction between users and designers, and supporting better understanding and cooperation. Even though the presence of designer (and his/her knowledge) is traditionally omitted from the explanations of user involvement, it is clear that the designers are expected to be "contacting with system users" or "consulting end-users", generally focusing on users. Recently, the relationship between users and designers has been explained with metaphorical terms such as engineer designer and component user; doctor designer and patient user; student designer and master user; coach designer and athlete user (Jääskö and Keinonen 2006), at least partly answering the accountability and responsibility issues of users and designers.

Still, the reality remains problematic: "It is widely accepted that users should be involved in developing interactive systems and that involving the users—even indirectly—has proved to be very challenging in practice, especially in the product development context "(Iivari 2006: 636). Even more problematic it comes, when the design aims for a concept, something that is novel, something that does not exist yet, or "asking consumers what they want is useless, because they do not know what they want" (Kleef et al. 2005: 181). Also, it is generally recognised that oftentimes the views and knowledge of some design process participants tend to dominate. This can be seen from the fact that the design process in seen to be political by nature, and all design in in/for someone's interests (Karasti 2001), from the time and resource limitations of the design process in

real life (which can lead to designers stating the users are not aware of the real-life technical and cost limitations), as well as from the traditional "if we build it, they will come"- philosophy. Furthermore, the designers' knowledge of system design as well as of users—which has also been called design thinking (Beyer and Holtzblatt 1998) or technical experience and expertise to suggest potential design factors and alternative solutions—has often been emphasised. Therefore the knowledge considered legitimate within system design is not seen to be the knowledge of those who use the technology, who are seen to experience the system, but are not seen as experts in HCI and are not considered to be able to analyse or articulate directly their requirements (Smith and Dunckley 2002).

2.3 Need for tacit and explicit knowledge

The study is based on the notion that the participants of the design process, namely users and designers, both possess knowledge needed toward the successful design. Furthermore, for the user as well as for the design professional there are some things that are known but cannot be articulated. "Tacit knowledge" has been described as personal, non-articulated, silent, hidden experience-based and skill type bodily knowledge and "what we know but cannot articulate" (Polanyi1966, Nonaka and Takeuchi, 1995), and explicit knowledge then is objective, sequential, digital and rational, or what we know and can articulate (synthesis of Polanyi 1966, and Nonaka and Takeuchi 1995:8). The classical knowledge process model by Nonaka and Takeuchi (1995) sees organisational knowledge being created through a continuous dialogue, or interaction, between tacit and explicit knowledge. Individuals develop new knowledge, but organisations play a critical role in articulating and amplifying that knowledge. This transformation of tacit into explicit knowledge has also been called "vertical knowledge transfer", highlighting the "horizontal knowledge transfer", e.g sharing knowledge in face-to-face contacts and the overall knowledge transfer is described as occur through direct personal interaction and intermediated transfer with codified, explicit, available knowledge (Nätti 2005). For the purposes of this research, knowledge transfer is seen to be a knowledge process in itself, which is included in the process of knowledge creation.

The knowledge spiral by Nonaka and Takeuchi (see Figure 1.) centres on "knowledge conversion" and identifies four different patterns of interaction between tacit and explicit knowledge:

- Socialisation involves the sharing and exchanging of tacit knowledge between individuals to create common mental models and abilities, most frequently through the medium shared experience (apprentices learn by observation and imitation of experts, children learn by observation and imitation of adults etc.)
- Externalisation is the process of articulating tacit knowledge into comprehensive forms that can be understood by others into explicit knowledge (into models, concepts, analogies, stories and metaphors). Hence, there are two processes operating: (I) individuals sharing their mental models with others, and (II) also reflecting and analysing their own mental models hence creating conceptual knowledge.
- Throughout the combination phase, existing explicit knowledge is combined or reconfigured in order to generate new explicit knowledge. The three processes that result in systemic knowledge include (I) capturing and integrating new knowledge. (II) disseminating new knowledge, and (III) editing and processing new knowledge.
- Internalisation is the process of adding to explicit knowledge (principles, procedures, methodologies) into tacit new knowledge (in the form of sensations, memories, images) through experimenting in various ways, through real life experience or simulations. The resulting synthetic knowledge is shared throughout the organisation, and converted into tacit knowledge by individuals.

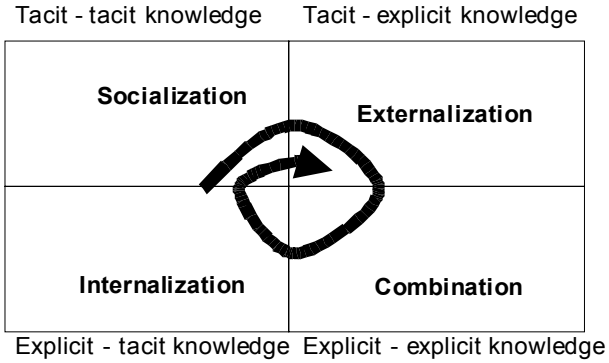

Figure 1: Knowledge creation process (Nonaka and Takeuchi 1995)

The model by Nonaka and Takeuchi is widely used, as it is seen to resonate with organisational learning crossing individual, group and organisational levels (Inkpen and Crossan 1995). However, it is also recognised to be a simplification of reality, which the further limitations of (1) simplifying the ambiguous nature of knowledge (Alvesson et al. 2002) and (2) focusing on "knowledge" instead of "knowing" (Orlikowski 2002).

3. Framework for user-centred design with knowledge processes

The goal of the design process can be expressed as: to enable the context-specific knowledge process in which the tacit knowledge of users and design professionals is modified to explicit knowledge, combined and finally embedded in a concept, product or service. Hence, the construct (see Figure 2.) of understanding and analysing user-centred design with a knowledge-based approach is presented with two components: (1) toward context-specific knowledge, with (2) linked knowledge processes of users and designers. These components are presented with examples of applying them to the context of interest-based communities and mobile technology (presented in *italics* in this paper and also found in Still et al. 2002, Ijäs et al. 2003; Isomursu et al. 2004; Still et al. 2004; and Still et al. 2005).

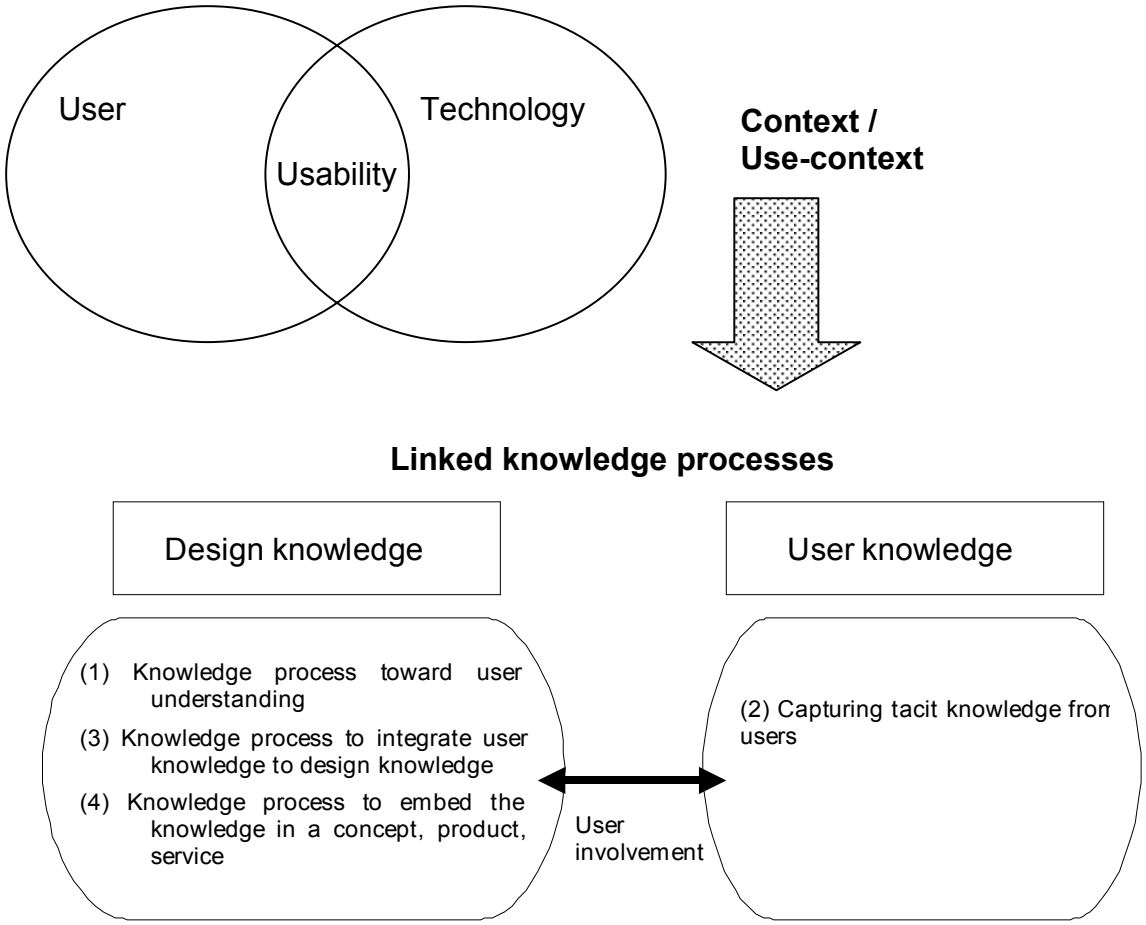

Figure 2: Knowledge-based framework for user-centred design.

3.1 Toward context-specific knowledge

The knowledge processes are proposed to build on the existing context-specific knowledge. It is suggested that the existing context-specific knowledge is primarily explicit knowledge. Capturing it is seen integral and useful for the purposes of the design process, and many times can be seen to provide a certain level of user understanding. The quest for context-specific knowledge is made possible with designers' building on their existing knowledge of technology, the different facets and approaches to usability and use-context (based on their experiences) as well as their understanding on users in general. This is proposed to occur through a thorough analysis of the context-specific knowledge: user, technology, usability, and use-context.

Users interact directly with the design factors that determine usability and benefits of the system, and their resulting knowledge is also context-specific. Contrary to the designers, who "can make use of their own experiences and visions during the process of designing a new product" (Jääskö and Keinonen 2006), much of users'

approaches and experiences with the usability and use-context most often have not been clearly articulated, leading to the need for knowledge transformation processes. It is integral that designer/design team appreciates the context-specificity of the knowledge. This moves the designer away from the "universal" or "cookie-cutter" approaches, and allows for creative methods of involving the user toward user understanding.

The research context of interest-based communities and mobile technology presented a challenge for this research. Not only was there limited research available that was related, but also the research team was accustomed to operating within the scope of organisations and their members. Hence, the research included a comprehensive exploration into the world of communities in general, looking at virtual communities, online communities and interest-based communities, their communication and collaboration using technology. Some of the results are presented in table 1. (and this analysis and its representation can be seen to be processes as well as results of knowledge processes of researchers, collecting user information, interpreting it, discussing it and finally presenting it in an explicit form).

Table 1. Exploring the context of interest-based communities.

	Virtual stables community	Birdwatchers community
People	7-14 year old horse-aficionados (girls)	Birdwatchers of different ages
Shared purpose	Horses, horseback riding, and other related activities	Birds, especially rare birds and their observation
Rules	Unwritten and even written rules guiding behaviour and content-creation	Written manual by a formal association
Shared context	Virtual world, mostly fantasy taking place in virtual world	Real-world experiences are shared in virtual world
Shared content	Clip-art pictures, copied photos, stories about horses and related activities, places	Original photos of birds, stories about sightings, weather info, location info
Technology	Web pages with guest-books	Web pages, discussion forums,, mailing lists, SMS-messaging using mobile phones

3.2 Linked knowledge processes

At the core of the framework is the understanding that both the users and the designers need to move on the knowledge spiral with their own, separate though interlinked knowledge processes. These knowledge processes happen within a person's head, and as such they are not something that a person does consciously, but are a natural process. The goal of representing these processes with a framework and with the knowledge-spiral model by Nonaka and Takeuchi (1995) is to emphasise the interplay between tacit and explicit knowledge. User understanding, which can be called background information—gaining a rich picture of what makes up the detail of the users' lives, the things they do and us (Jones and Marsden 2006)—is generated during the first knowledge process of the designer, when the explicit knowledge about users is interpreted and combined with the existing design knowledge (both tacit and explicit) of the design team. As in all the knowledge processes within design process, the context-specific knowledge is combined with the general design knowledge.

In the research about interest-based communities and mobile technology, user understanding was partly conducted with sharing the space of the community. The physical space of community members was shared during interviews and observations. For example, researchers observed members of virtual stables using their desktop computer to participate in the community activities as well visited a stable. In addition, researchers shared the virtual environment (web pages and discussion forums) in which the communities interact:

- Researchers participated in the discussion forums of birdwatchers (sometimes only following the discussion, sometimes with active participation
- Researchers analysed the content and structure of web pages of virtual stables—finding out user knowledge such as 63 percent of virtual stable home pages had photos (mostly copied from picture libraries) in them
- Researchers analysed the development of community communication in case of

birdwatchers, including the current use of mobile technology

To gain access to tacit knowledge of users as well as to integrate that to the tacit and explicit knowledge of the designers, further knowledge spiralling is needed. As designers are the primary actors on the designing process, the knowledge created during the first knowledge process enables them to involve the users to the process in an appropriate and useful manner.

In involving the interest-based community members to the design process, the research team faced severe problems. For example, in the case of birdwatchers, researchers wanted to observe the community activities in real-life situations at a bird observatory, but very few birdwatchers arrived to the observatory during the observation times and observation methods did not trigger community activity as no rare birds were sighted. In the case of virtual stables, achieving a natural and relaxed atmosphere with the pre-teen and teenage girls proved difficult, and resulted in quick answers such as "I don't know", "It's ok", and "That would be nice". Hence, it became integral to use a method that would involve users in an appropriate, useful and successful manner—which resulted in creating a method of web-based storytelling environment for the virtual stable community, enabling the community members to activities that are natural to them in the virtual stable community context. The community members were asked to write stories about how they would use a dedicated mobile device at a real stable and at a virtual stable environment. Users are regarded as an essential part of the process and can act as co-designers. As a result of their knowledge process, their tacit knowledge becomes apparent for the purposes of the design process. This knowledge from user(s) is hence not the design professional's view or translation of the user needs, separate of the use and user, as in the traditional way in design process. Nor is it simply seen to be the user's response to the questions "what do you need" or "what do you want", which could be communicated during some user involvement activities.

The online enquiry method of web-based storytelling for virtual community members resulted in 24 narratives of users using a mobile device in the virtual stable environment, and 29 stories narratives of using a mobile device in the stable environment. Clearly, these were explicit, written descriptions, but hardly something that by themselves can act as description of user requirements. One example of a story received is:

> *I sit down by the computer and take out my mobile device. I connect it to computer and transfer all my recordings and pictures to the computer and load them to the Internet. I open up the guest book of my virtual stable and write the most important messages to the mobile device. In addition, I add the horse's neighs I recorded the home page of my virtual stable so that everyone visiting my virtual stable can hear them. I add new pictures to the virtual horses' pages and also add a video I shot at the stable. I have drawn pictures of horses at a real stable and I add those to the virtual stable (Jannika, 11 years)*

The context-specific explicit knowledge from designers may influence this knowledge creation process, which is something that designers need to be aware of. However, user understanding gained from the previous knowledge process can assist in this. The participation of users is not enough, as designers and other professionals are needed to complete the design process. The resulting knowledge is seen to be a synthesis, an outcome of the knowledge process as well as the knowledge process itself by design professionals and by users. This knowledge and process have been generated and understood through specific courses of action aimed at turning existing situations into preferred ones in specific contexts.

In the case of virtual stables, the research team analysed all the stories, and found them to be relevant and very descriptive. Furthermore, analysis according to the functions the mobile device was seen to perform, brought following situated knowledge such as camera function was seen in 66 percent of the usage scenarios at real stables and in 50 percent of the usage scenarios involving virtual stables. In the case of bird-watchers, designers created use-cases of communication to describe the user behaviour:

> *Sofia receives Mari's message about a rare bird sighting, as it matches her profile. Because she is vacationing out-of-town, she uses her mobile to change her profile so that she does not get any more updates about that bird (hence only paying for receiving one message).*

Furthermore, knowledge itself is not enough, but it needs to be used, materialised, or embedded in concepts, models, and artefacts. As knowledge is sometimes seen to be valuable only when it is shared, also the knowledge gained during the design process is seen to be successful only when applied toward a concept or product. This concept represents the design in a way that it can be demonstrated, altered and discussed (Jones and Marsden 2006), hence providing a base for furthering the design process. This can be seen to require for researchers ability to look at the

challenge from different angles and to elaborate the initial solutions to produce the concept descriptions for decision- making (Takala et al. 2006)

In the context of virtual stables, based on the users' narratives, researchers used for example contextual inquiry methods of affinity diagrams to transform the knowledge derived from user involvement, combined this with their own knowledge, evaluated the value of both of this knowledge in the concept creation process—and chose to present this as a prototype of an enhanced concept for a dedicated mobile device. This device (a) emphasised the buddy element, as it was seen as a friend-like thing that supports and even gives advice to the user, (b) included a key-pad for faster alpha-numerical input (based on the fantasy and stories being at the core of community), (c) allowed easy and versatile use of different functions, (d) supporting a rich use of multimedia, and augmenting that even with smell-recorder. The use-cases presented about birdwatchers were organised by researcher to show the integration of communication technology—demonstrating how the community members fluently use both computers and mobile phones, but also showing how knowledge sharing between these technologies brings challenges to users, as different formatting might be needed, and the knowledge transfer does not happen automatically.

The need for multiple linked knowledge cycles of designers and users should be highlighted when moving from beyond concept, and as each concept or prototype is seen as a stepping-stone for next and better ones (Jones and Marsden 2006). Hence, even though the framework exhibits only one knowledge process for users, in many cases there might be need for user involvement several times, for example first with concept, then with prototype, and then with the product itself, as well as with evaluation of all of these. Evaluation and subsequent selection can be seen to be based on the criteria that the presentation itself produces, or against a set of fixed criteria, based on a company's business strategy, identified customer needs or business environment drivers (Takala et al. 2006). Overall, knowledge-based description for design process with linked knowledge processes of users and designers is compatible with the process of user-information-based concepting (Jääskö and Keinonen 2006), with interaction design (Jones and Marsden 2006) and with the product concept process (Takala et al. 2006), all of which are seen applicable to the initial phases of design of mobile devices/technology—which was the specific context of this study, as it did not go beyond prototyping (case virtual stables) or with concepting (case birdwatchers). The framework can be seen to explain the phases/layers of these other approaches to design process (see Table 2), therefore addressing the needs and roles of designers and users as well as the contextuality of knowledge.

Table 2: Knowledge-based approach to design explaining other approaches to design.

Product concept process (Takala et al. 2006: 60)	Interaction design (Jones and Marsden 2006: 94)	User-information-based concepting (Jääskö and Keinonen 2006: 99)	Knowledge-based approach to design
Background research/information acquisition—to explore a wide range of possibilities to identify opportunities.	Understanding users—having a sense of people's capabilities and limitations	Constructing an understandable picture of the user's present behaviour: 1. Collecting user information 2. Interpreting user information	Knowledge process toward user understanding, first round(s) of designers knowledge process, where designers share, exchange, collect, interpret, and understand context-specific knowledge about users, technology and usability, and user involvement
Concept generation/creation	Developing prototype design—representing a proposed interaction design	Description of new user behaviour	Capturing tacit knowledge from users allowing users to actively contribute their knowledge to the design process with their knowledge process Designers' knowledge process to integrate user knowledge to design knowledge
Evaluation—selection from the concepts.	Evaluation	Description of a new concept	Designers' knowledge process to embed the knowledge in a concept, product, service—or description of new user behaviour (this can then serve as starting knowledge for the next cycle)

4. Discussion

This paper described the user-centred design process as a set of context-specific knowledge processes, which address the dichotomies of (1) designer vs. user, emphasising the value of knowledge from both, based on the principle of user-centricity, and (2) tacit vs. explicit knowledge, accentuating the interplay between them, based on the principle of knowledge-based approach. Both are generally used to understand design process, however, their combination is not typical. Hence, this paper presents a novel perspective into the design process. The framework emphasises the context-specificity of knowledge that acts as inputs and outputs of the design process. The knowledge processes of designers and users are fuelled by this knowledge. Especially valuable is seen the tacit knowledge, which needs to be made explicit during the user-centred design process. As the tacit knowledge has not been articulated before, it is seen to provide new insights and hence value to the design process. The framework was created and used in the context of interpreting and understanding the process of designing mobile communication technology for interest-based communities. Because the framework is partly a result of the challenges faced during the research process – it was created and applied simultaneously—the framework was considered constructive and applicable when designing for the interest-based communities. It helped to organise the related, relevant concepts, provided means for seeing the connections between the different concepts, and guided the research process in general. In the context of the research, the framework supported the achievement of the research process goals, which included not only gaining thorough knowledge about the interest-based communities and their members' expectations about mobile technology, but also embedding the knowledge into concepts of dedicated mobile devices and applications that could be used by the community members.

It is proposed that the framework can be applicable outside its original scope of interest-based communities. This is proposed because the concepts and approaches used in the framework are usually also utilised outside the context of the study (namely in business and learning organisations). At least, it is suggested that people participating in design processes in general could consider (a) the elevated role of the user, as the framework demonstrates a visible, active and needed role, (b) the means and methods of involving the user, as universal, cookie-cutter approaches may not provide the desired outcomes, (c) the roles and responsibilities of designers progressing beyond the explicit and visible, toward tacit knowledge that brings the fresh and innovative knowledge needed for the design.

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