9 July 2011

The Dynamics Of Interaction: Exploring A Living Lab Innovation Process From A Community Of Practice Perspective

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ISBN: [978-1-86435-644-1]; Full paper

THE DYNAMICS OF INTERACTION: EXPLORING A LIVING LAB INNOVATION PROCESS FROM A COMMUNITY OF PRACTICE PERSPECTIVE

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Abstract

This paper is based on a living lab project, which is an open, user-centric, innovation approach, where several actors from industry, user groups and academia are involved. The research question is: How can interaction dynamics be understood in a living lab innovation process? We applied an action-oriented research approach, where the empirical results are from The Find Project (TFP), which aim is to customize an ICT product based on the needs of a user group. The findings are analyzed from a community of practice perspective where three different communities, i) researchers from Halmstad Living Lab (HLL), ii) ICT developers (ICTD) and iii) next of kin of demented elderly persons (NOKD), represented the unit of analysis. We identified situations and activities that played a vital role for the innovation process in terms of boundary interaction dynamics. The contribution of our research to innovation theory is a combination and further exploration of the boundary spanning and communities of practice theories. We have developed a conceptual model describing the dynamics in boundary interactions of an ICT innovation process with regard to boundary objects-in-use and brokering. The conceptual model highlights two different levels of brokering: i) inner-level brokering and ii) outer-level brokering.

Keywords: Innovation, learning, boundary interaction, interaction dynamics, brokering, communities of practice.

1 INTRODUCTION

The point of departure of the research presented here is an interest in innovation and learning and the intertwining of these during an innovation process. Innovation activities can generally be understood as scientific, technological, organizational, financial and commercial steps that lead to, or are intended to lead to, an implementation of innovations (OECD 2005). During the last ten years researchers have focused on other innovation approaches than the one used within one particular firm or within one specific R&D department in an organization. Open innovation (Chesbrough 2006), user driven innovation (Hippel 2005) and living lab (Eriksson et al. 2005) are all examples where co-creation between a multiplicity of actors and stakeholders is in focus during an innovation process. However, collaboration and interaction across different disciplines, professionals, cultures etc is not an easy thing to achieve. This leads to an interesting challenge of crossing sectors and boundaries of such kinds and understanding various forms of interaction that take place at the interface between different groups of stakeholders across those sectors.

Our approach is based on a living lab project that is a user-centric innovation process involving several actors from industry, user groups and academia. We will present findings from an ICT innovation process where an organization (the ICT developers) collaborates with a user group consisting of people not belonging to an organization, but driven by an interest: caretaking of a demented person (such as a wife, husband, father, mother or other next of kin) and researchers from Halmstad Living Lab. The empirical findings in this paper are results of a project called *The Find Project* (TFP). The aim of the TFP was to customize an ICT product based on the needs of a user group. The ICT product to be customized consisted of a sender and a receiver that worked together in a mission to find missing objects according to the ICT developers (ICTD). The sender and the receiver were to be customized to fit the needs of next of kin of elderly demented persons. The goal of the TFP was to develop a new customized working prototype, not a conceptual prototype. About 14 people were involved in TFP: three researchers from Halmstad Living Lab (HLL), three ICT developers (ICTD) and the group of eight next of kin of elderly, demented persons (NOKD).

Having a living lab process as the main source for the empirical data in the research we will in this paper explore how the theories of communities of practice (Wenger 1999; Wenger et al. 2002) might provide insights about interaction dynamics in innovation activities. Hence, the aim of this paper is to describe and analyze the interaction dynamics in a user-centric innovation process from a community of practice perspective. The research question is: How can interaction dynamics be understood in a living lab innovation process?

In order to approach our question we use and combine theories of boundary spanning (Cohen and Levinthal 1990) and communities of practice (Lave and Wenger 1991). Boundary spanning is an activity that gathers information at the interface of the firm's external environment and translates and communicates that information to managers and employees inside the firm. According to (Levina and Vaast 2005; Lindgren et al. 2008) boundary spanning is addressed as the intersection at which organizations collaborate and the authors propose boundary spanners-in-practice and boundary objects-in-use. A community of practice perspective (Lave and Wenger 1991) is also related to learning and innovation (Hildreth and Kimble 2004). Innovation is closely related to boundary spanning and learning is related to boundary relations (Wenger 1999). It therefore becomes natural to explore an innovation process from a community of practice perspective. In the call for papers for the track Innovation Theory, Research and Practice in Information Systems (Avital and Lyytinen 2010) on ECIS 2011, the first line reads "Overall, innovation is about spanning or breaking the prevailing boundaries". The source of innovation lies in the interface between an organization and its environment (Hislop 2004). This puts the innovation process into a more social context, where relations and connections of several people and activities take place across various types of boundaries. In (Levina and Vaast 2005) the community of practice perspective is disregarded for its limitations in addressing power dynamics. Levina and Vaast (2005) and Lindgren et al. (2008) address boundary objects from boundary spanning, but not from the communities of practice perspective. Boundary bridging is described in communities of practice as a boundary relation that

consists of two intertwined parts: boundary objects (artefacts) and brokering (activities and situations) (Wenger 1999; Wenger et al. 2002).

The contribution of our research to innovation theory is a conceptual model describing the dynamics of interaction in a boundary setting (such as an innovation process) from a community of practice perspective. The process highlights two different levels of brokering: i) inner-level brokering and ii) outer-level brokering.

2 UNDERSTANDING BOUNDARIES AND COMMUNITIES OF PRACTICE

This section starts with an overview of user-centric innovation and then takes a closer look at boundary spanning and boundary relations occurring in learning and innovation processes. Here, we use boundary interaction, which are described as a mix of boundary spanning-in-practice (Levina and Vaast 2005) and boundary relation (Wenger 1999) inspired by perspective making and perspective taking. All three parts affected the present research before, during and after the TFP innovation process.

The innovation process in TFP was inspired by user-driven innovation (Hippel 2005; Hippel 2005; Hippel 2007) and the living lab approach (Eriksson et al. 2005). One of the main motives for the approach is that, during the process, we wanted the NOKD to be active, not only as a reference group but more as co-creators. User-driven innovation and living lab are examples where the focus is on co-creation between a multiplicity of actors and stakeholders during an innovation process. A living lab is (Bergvall-Kåreborn et al. 2009) characterized by: a user-centric process; facilitating user influence; engaging relevant partners; and performed in real-life contexts. The main reason why we refer the TFP to an innovation process is that the activities in the process are intended to improve a product with regard to the needs of a new customer group which will change the everyday practice of that group (OECD 2005). In the present research the customer group is next of kin of elderly, demented persons (NOKD), which will be regarded as one particular community of practice in the research.

2.1 Boundary spanning and innovation

The idea of combining an interest in learning together with an interest in innovation is not new (Cohen and Levinthal 1989; Cohen and Levinthal 1990); it has been recognized for more than 20 years. In the Cohen and Levinthal (1990) paper, the authors identified a firm's absorptive capacity as crucial to the firm's innovative capacity. The absorptive capacity is about recognizing new, valuable, external information, assimilate it and apply it to commercial ends. The absorptive capacity takes place at the boundaries of a firm and its environment. Absorptive capacity is connected to the organizational level where certain boundary activities are integrated and performed as boundary spanning or gate-keeping activities (Cohen and Levinthal 1990). During such boundary spanning the boundary spanner uses several artefacts such as scenarios, physical prototypes, design drawings and other types of documents to communicate and collaborate organizationally. The focus is on the activities within the organisation, not on activities together with representatives from the environment. Boundary spanning can be described as a sharing of expertise between boundaries (Levina and Vaast 2005). Levina and Vaast (2005) describe the role of a change agent, boundary spanners-in-practice, who produces and uses artifacts, boundary objects-in-use. Yoo, Lyytinen et al. (2005) discuss an innovation process from complementary social translation, which is identified as combining two previously unconnected communities (Yoo et al. 2008).

2.2 Boundary interactions and communities of practice

A community of practice (COP) is a group of people that shares a concern (or a set of problems) and deepens their knowledge by interacting on an ongoing basis (Wenger et al. 2002). A COP has three characteristics (Wenger 2006): It has an identity defined by an interest; members engage in joint

activities and they develop a shared repertoire of resources. Learning is described as an ability to negotiate new meanings within a COP, to create engagement in COP and to deal with boundaries between COPs (Wenger 1999), an inter-community learning process (Hislop 2004). Learning and working are interrelated, compatible, intertwined and connected to innovating (Brown and Duguid 1991).

A COP is of course in a state of continuous change - way of seeing, way of doing and way of interpreting - due to the boundary relations that take place between different COPs. The inter-community process is also important (Cook and Brown 1999) because it helps to overcome some of the problems the community may create for itself (Brown and Duguid 1991).

Some authors have raised criticism of the inter-community process: the dynamics of inter-community knowledge sharing processes has been neglected in much of the COP literature (Hislop 2004) and COP is limited in addressing the power dynamics in the inter-community process (Levina and Vaast 2005). The dynamics of knowledge sharing within and between COPs is likely to be qualitatively different, with the sharing of knowledge between communities being typically more complex and more difficult (Hislop 2004). The importance of examining and knowing more about the inter-community dynamics is reinforced by more open and user-centric innovation approaches. There have been attempts to use the theory of brokering and boundary objects in innovation settings (Hislop 2004; Lundkvist 2004; Manville 2004) but they all discuss the lack of dealing with dynamics.

The beauty of COPs is that they are not limited to specific contexts and organizations but transcend boundaries, as argued in Boland & Tenkasi (1995). In order to understand this complex inter-community process of learning we use the concepts of perspective making and perspective taking (Boland and Tenkasi 1995) as an inspiration for defining boundary interaction. Perspective making represents the first step, in which knowledge creation is built and re-built for shared understanding and communication within a community of practice (Boland and Tenkasi 1995). What is needed to make this happen is objects (boundary objects) or subjects, i.e. brokers, that can serve as a boundary spanners in order to support meaning creation and bringing in new perspectives in a brokering process between communities of practice. Boundary objects serve to coordinate and communicate perspectives for some purpose (Star 1990). Boundary objects play an extremely important role as a shortcut to communication and as playgrounds for knowledge sharing among different communities of practice (Brown and Duguid 1991; Cook and Brown 1999). Brokering is the second part of the duality, carried out by people who introduce elements of practices from one COP into another COP (Wenger 1999). Boundary objects can also be used by a broker in a brokering situation.

2.3 Boundary interaction

In this paper boundary interaction is interpreted and used as a combination of boundary spanning-in-practice (Levina and Vaast 2005) and boundary relation (Wenger 1999) inspired by perspective making and perspective taking (Table 1).

Boundary Interaction	
Boundary spanning	Boundary relation
- Recognizing new valuable external information, assimilating it and applying it to commercial ends (Cohen and Levinthal 1990) - Organizational roles, firm vs environment (Lindgren et al. 2008) - Activities and artefacts, Boundary spanners-in-practice and boundary objects-in-use (Levina and Vaast 2005)	- Between COPs (Wenger 1999; Wenger et al. 2002) - Brokering, meaning and alignment (Hislop 2004; Lundkvist 2004; Manville 2004) - Boundary objects – Coordinating (Wenger 1999; Wenger et al. 2002) - Perspective making and perspective taking (Boland and Tenkasi 1995)

Table 1. Describing boundary interaction

Thus we see mainly two forms of boundary interactions evolve: brokering activities and boundary objects in use. By using the concepts as a duality we also regard boundary interaction as a more inter-organisational activity, while boundary spanning is interpreted in a more intra-organisational view.

3 RESEARCH APPROACH

The research approach in the TFP innovation process has similarities with action oriented research approaches. The researchers intervene in order to facilitate a change based on a theoretical framework (Avison et al. 1999; Baskerville 1999; Baskerville and Myers 2004). In the action oriented research approach, there is always a balancing between involvement in the change process (the problem solving) and the research process (McKay and Marshall 2001) which is further inspired from the clinical perspective (Schein 1987; Schein 1995), dialogical action research (Mårtensson and Lee 2004) and the double imperatives of action research (McKay and Marshall 2001). In the clinical perspective Schein argues that the process should be client driven, i.e. the needs of the client are more important than the needs of the researcher. Thus, the focus should be on client's issues rather than involving the client in the researcher's issues.

We made a literature survey to develop a conceptual understanding of innovation and learning. The survey was conducted in two areas, user-centric innovation processes and learning related to innovation. Particularly in Wenger (1999) we found a starting point for the literature survey on boundary relations. This was followed by a search for literature addressing inter-community boundary relations and innovation (Hildreth and Kimble 2004). The classical paper by Levinthal and Cohen (1990) was the starting point for addressing boundary spanning. This was followed by a search in high ranked IS journals for a thorough literature review of boundary spanning, which was found in (Levina and Vaast 2005; Lindgren et al. 2008).

3.1 Data gathering - the TFP innovation process

The TFP innovation process was initiated at a meeting between the ICTD and representatives from HLL. At the meeting the ICTD demonstrated their product and raised some doubts about their product. They were uncertain as to whether their product corresponded to the needs of the next of kin of elderly, demented persons. The main idea in TFP was to learn more about the needs of the kin in order to customize (in this paper customization is interpreted as significant improvements to an existing product) the ICT product based on the needs.

The ICT product that was to be customized consisted of a sender (grey in Fig 1) and a receiver (white in Fig 1) that worked together in a mission to find missing objects (in the TFP, a missing person) according the ICT developers (ICTD). When the ICTD developed their product they had a broad perspective of a missing object. This could have been almost anything: a stolen car, a missing container of goods or a demented person.

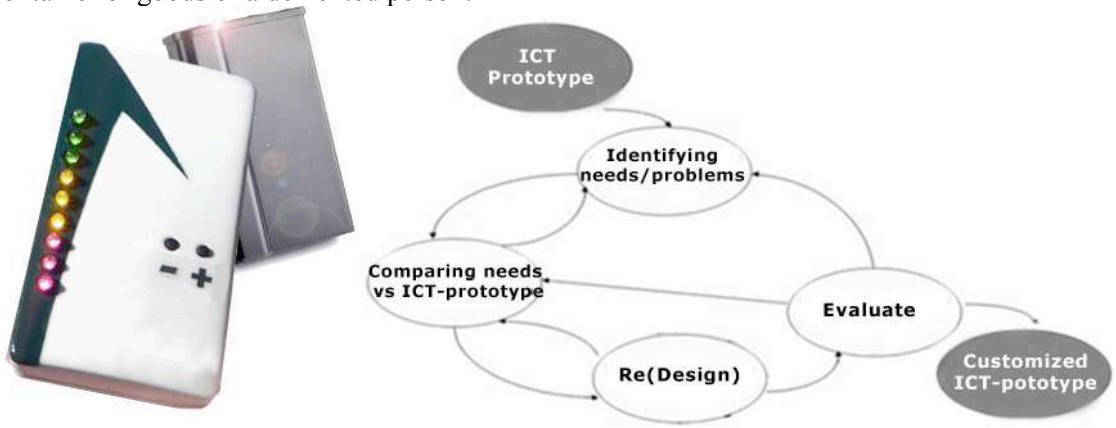

Figure 1. Left: Sender and receiver, Right: The TFP process

In the TFP the workshops were held in an apartment that has been a meeting place for next of kin of demented and people with dementia. During the workshops data was gathered as field notes, documents (Scenarios, low-fi prototypes etc) and photos. After every workshop we had a follow-up meeting where the material was structured in a chronological order. The apartment is equipped with

tools and artefacts and serves as a test laboratory for NOKD. The apartment is an example of a real-life context, which is crucial in Living Lab practice. The TFP innovation process (see also Fig 1) was inspired by principles from user-centred design (Preece et al. 2002) and user-centric innovation (Svensson and Eriksson 2009). The process has been tested and used in several projects in which researchers from HLL have been involved.

The first phase in TFP, *identifying needs and problems* (Fig 1), consisted of three main activities: planning, workshop and a follow-up meeting. During the planning meeting, HLL and ICTD collaborated on the structure of the workshop. The workshop consisted of presentations, demonstration of the ICT product, creating scenarios in groups and follow-up discussions. The main reason behind the scenario-inspired technique was to get a rich description of the life situation and caretaking among the NOKD.

The second phase in TFP, *comparing needs vs ICT prototype* (Fig 1), followed the same structure as the first phase. At the planning meeting, a comparison between the needs of the next of kin, presented in mind map (Buzan 1995), and the ICT product was made which resulted in a list of statements and questions where there seemed to be a difference between the functionality and design of the ICT product and the actual needs of the next of kin. During the workshop the list of statements and questions served as a starting point for a group discussion about the list to be able find misunderstandings and misinterpretations. The second part of the workshop was started when the list of statements and questions was adjusted and approved by the next of kin – to individually prioritize the most important statements and questions on the list.

The third phase in TFP, *(Re)Design* (Fig 1), followed the same structure as the first two phases. At the planning meeting we planned a design activity based on the three selected statements and questions. The workshop started with a presentation of the design activity, followed by group work and ended with a presentation of the group prototypes.

3.2 Data analysis – a COP perspective of TFP

The empirical data from the TFP were analyzed in a systematic continuous manner during and after the innovation process. Over this period we deepened our insight by working with the empirical material. In the analysis that was geared towards boundary interaction dynamics, three communities of practices were involved. With respect to brokering concepts and the three characteristic of a COP (Wenger 2006), we regard the different stakeholders (NOKD, ICTD and HLL) as three different communities of practice (Wenger 1999; Wenger et al. 2002). NOKD's practice is caretaking, ICTD's practice is development of ICT products and HLL's practice is research. From the findings we identified situations that affected the innovation process to a greater extent in terms of boundary interaction and their consequences for further actions and learning in the project. A model was developed based on the insights. The model was developed as a means to conceptualize the dynamics of interactions between the communities of practice (HLL, ICTD and NOKD) regarding boundary interaction (as a mix of boundary-spanning-in-practice and boundary relation).

4 EMPIRICAL FINDINGS AND BOUNDARY INTERACTIONS

We have selected four different areas from the TFP innovation process where the dynamics of boundary interaction were analyzed. The first (4.1) boundary interaction took place at the first workshop in the *identifying needs and problems phase.* The second (4.2) and third (4.3) boundary interaction took place at the workshop at which we were *comparing needs vs ICT prototype and* the fourth (4.4) boundary interaction took place *at the (re)Design* workshop.

4.1 The scenario boundary interaction activity

At the first workshop the researchers from HLL had introduced *scenarios* as a technique for capturing ideas and needs for the ICT product and the ICTD demonstrated their product. The boundary

interaction took place when the NOKD were working with the scenarios. They discussed quite loudly and wrote down a question (Fig 2): "If a demented person disappears, where would I start to look?" They also wrote a note (Fig 2): "Direction indication! Use the internet to get an indication of where the person is." They also underlined some of the statements that they had written on the paper.

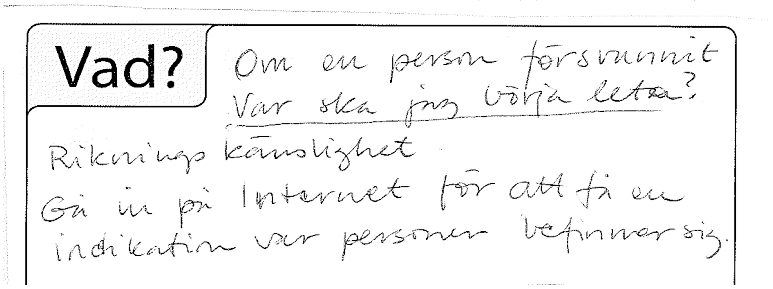

Figure 2. A scenario note

When the NOKD had written the notes and the questions, they called for one of the ICTD representatives and during the dialogue several additional questions arose, such as: "Is it hard to get an indication of the direction?" and "Is it possible to connect the sender/receiver to internet and get a position on a map?" The representative for the ICTD answered the questions and started a dialogue asking follow-up questions: "What do you mean?" and "What do you mean by location of direction?" During the dialogue the ICTD placed himself in a chair and took part in the following work with the scenarios. Several times he said, "this is really interesting and useful input".

The workshop at which the first boundary interaction took place is regarded as a user-centric innovation activity (Bergvall-Kåreborn et al. 2009) as well as a boundary interaction relating to the ICTD's role as boundary spanner (Levina and Vaast 2005) in the inter-community learning process (Hislop 2004). The three different groups, NOKD; ICTD and HLL, are interpreted as three different communities of practice. All of the COPs share a set of problems, a mutual concern and interact within the COP on an ongoing basis (Wenger 1999; Wenger et al. 2002). In the inter-community learning process, HLL act as a broker (the workshop) (Wenger 1999) when introducing a boundary object (the scenario - technique). The ICTD also act as a broker or boundary spanner-in-practice (Levina and Vaast 2005) (when presenting the product and taking part in dialogue) and their product as a boundary object-in-use. It is interesting to note that the brokering and boundary objects presented by HLL were used in the inter-community relation during the innovation activity between the NOKD and the ICTD.

4.2 The newspaper-clip boundary interaction activity

The second boundary interaction was initiated by Lars (a member of the NOKD) when he presented a newspaper clip (Table 2). HLL had started the workshop and presented a mind map as a summary of the last workshop. Lars said he wanted show us something. He produced the newspaper clip (Table 2) and described what had happened to him and his wife rather recently.

 ...långe sen som han gick fri från ett fängelse-straff. **Kvinna hittades välbehållen** **VARBERG.** Den 73-årige dementa kvinnan lämnade sin bostad i Varberg klockan 21.40 i måndagskväll. När hon inte hade kommit hem 22.15 larmade hennes man polisen. Polisen startade upp sökandet och påträffade kvinnan några timmar senare. Kvinnan var utom fara, förutom att hon var lite nedkyld.	**Female found in good condition (12/2-2009)** The 73 year old demented female left her apartment in Varberg at 21.40 on Monday. When she did not return at 22.15 her husband (Lars) called the police. The police started searching for the female and found her a couple of hours later. The female suffered from slight hypothermia and her life is not in danger.

Table 2. Newspaper clip

He explained that similar accidents had happened afterwards. Lars had a two-fold purpose in showing the newspaper clip. First, he wanted us (HLL and ICTD) to get a deeper understanding of the life situation of a NOKD. Second, according to Lars, one essential need was to point out that most situations in which demented persons become separated from the NOKD are close to their homes or when the NOKD is rather near the demented but cannot find her or him. He described two other occasions. The first was when they were at an airport and she suddenly disappeared just before they were to board the airplane. The second occasion was at the Gothenburg Opera where she disappeared during the break between the acts. These two situations were extremely stressful for both Lars and his wife.

One of the representatives from ICTD started to ask follow-up questions, such as: "How far did your wife go?" and "What is the maximum reach of the sender and receiver?" During the discussion the NOKD supported these ideas and recognized themselves in Lars' description. The NOKD claimed that the maximum reach of the sender and receiver should be 500 meters - a longer reach is not necessary. The ICTD started a discussion after the boundary interaction, and their opinion was that Lars' input was truly important: "Maybe this is the first time we really understand the life situation of a NOKD." I asked Lars after the boundary interaction why he acted as he did. He answered: "Because the ICTD and HLL listen to our opinion and to some extent are engaged in our wellbeing."

In a COP perspective, Lars acted as a broker (Wenger 1999) in the boundary interaction by using a boundary object (the newspaper clip) (Levina and Vaast 2005). The effects of the brokering and boundary object were twofold: i) a deeper understanding of the life situation (ICTD) and ii) a design guideline (a reach of 500 meters and near the home range). Lars presented the newspaper clip at a group meeting attended by three different COPs, which led to a process of perspective making and perspective taking (Boland and Tenkasi 1995) involving all three COPs. The dynamics in the boundary interaction involved many people from three COPs, many ideas and some boundary objects; this is not very well described in the literature (Hislop 2004). At the end of the boundary interaction, the ICTD could answer such questions as: "Why is their product important?", "Where should their product work?", "What it should do?" and "To some extent, how it should work?" The discussion had an impact on the ICTD and the further development of the ICTD product. When Lars described why he acted as he did, he described the boundary interaction being dependent on earlier boundary interactions and said that a kind of trust had been established during their involvement in the scenario boundary interaction.

4.3 The questionnaire boundary interaction activity

The third boundary interaction took place when the NOKD was asked to fill out a questionnaire. The questionnaire contained 17 statements that the NOKD should rank from most important, "1", to least important, "6". They were not allowed to rank all statements but had to choose six of the 17. When the NOKD had completed the questionnaire, the HLL made a quick summary and presented the results (based on the score) to the ICTD and NOKD (Table 3).

The results started a lively discussion between members of the NOKD and between NOKD and ICTD. Among the most frequently made comments between members of the NOKD were: "Did you choose that statement?" and "I didn't, but I think that it is important." Most of the questions posed by the NOKD to ICTD included: "Is it possible to have that function?", "Does it cost any extra?" and "How exactly will you do this?" The NOKD was very curious about how the ICTD should develop the new improved prototype. After the discussion I talked to the ICTD and asked: "What did they think about the results?" The answer was: "We take the results seriously, mostly because we had been involved in the process. If we hadn't been involved there's a chance that the results could have ended up in the bottom of my desk drawer."

The next of kin should be able to control the geographical position of the demented.	1
It is important that the sender and receiver are simple and easy to use, with few functions.	2
Indication of the battery status.	3
The receiver should indicate direction.	4

Table 3. Ranking from the questionnaire

There were boundary objects-in-use in the above described boundary interaction activity (Levina and Vaast 2005): the questionnaire and the results of the questionnaire. It is notable that the boundary objects were related to each other in a brokering situation, i.e. what happens in one situation affects the other situation. Both the ICTD and NOKD were in a sense brokers by actually ranking statements and discussing them. Trust appeared to be truly important and was built by taking part and being engaged in the process of perspective making and perspective taking. The ICTD were involved in the making of the questionnaire; they had also been involved when Lars told his story and participated in an open dialogue with the NOKD. Trust established in the process affects the trustworthiness of an object that could be a boundary object-in-use. It is notable that the 500m limitation of the sender was not among the statements that were highly ranked, which indicates a need of a follow-up process

4.4 The prototype boundary interaction activity

The main objective of the fourth and last boundary interaction activity had was to build and design a low-fi prototype (Fig 3). The NOKD had to their help at the workshop: paper, pencils of different colours, flower foam bricks, scissors, sticky tape, post-it notes and scalpels. The instruction was simply: "lets get creative in the designing of a low-fi prototype". Before the workshop HLL and ICTD had a discussion about how the workshop would go, how the NOKD would react to the workshop and whether they would they become involved. Most of the NOKD members were over 65 years. They truly started to work when the workshop started; there was absolutely no cause for our earlier concerns. They discussed different solutions, made sketches, used the scalpel to cut the flower foam brick and laughed a great deal. They presented their low-fi prototypes of the sender and receiver after about 90 minutes. An animated discussion started during the presentation of the different ideas, and the ICTD had many questions. One of the groups presented a receiver inspired by a compass, which would indicate the direction (Fig 3). The sender would be located inside a piece of jewellery for mainly two reasons: the person with dementia would want to wear the sender and routines are important for a person with dementia, where it is easier to learn a new routine if the person has a desire to wear the sender.

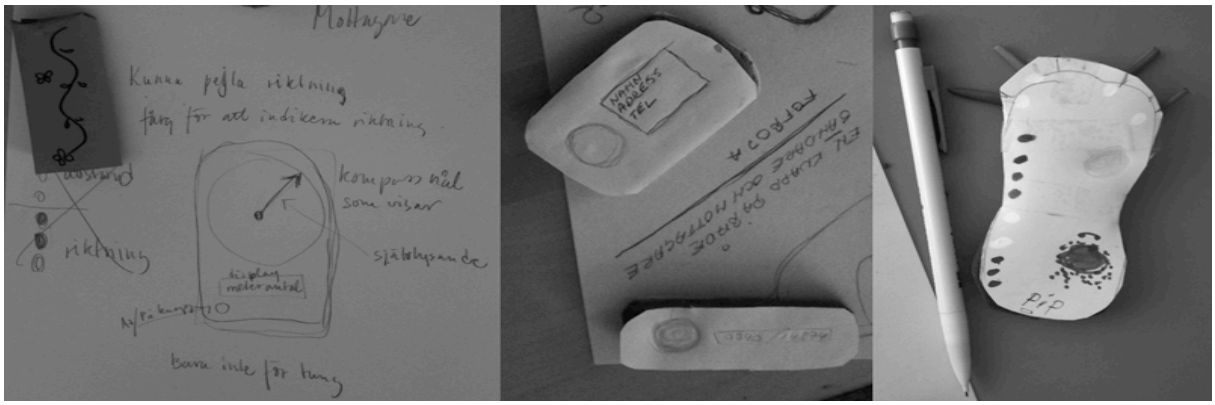

Figure 3. To the left a paper prototype of the receiver inspired by a compass and a sender inside a piece of jewellery; in the middle a sender with a nametag and a button; to the right, a receiver made of paper, a flower foam brick and flower sticks.

The other group presented a low-fi prototype of the receiver (to the right in fig 3) that should be easy to grip and had light-emitting diodes at the top indicating the direction and to the left indicating the distance. The prototype also had a speaker that responded when a person pushed the button on the sender. The sender should have a nametag (middle fig 3), the main reasons behind this are that a demented person can forget their name and the space on the sender was unused.

The ICTD was surprised after the workshop by the engagement, the quality of the prototypes, the ideas and that the process had worked so well. This was the first time that they had really worked

together with users (creating artefacts and taking part in group discussions) over a longer process. In other innovation processes they had employed the users as a control group for ideas.

All of the low-fi prototypes were boundary objects-in-use in the above described boundary interaction activity (Fig 3). The discussion in the groups between NOKD and ICTD during the boundary interaction is an example of brokering, where it was rather unclear who the broker was. If we compare the prototypes with the results of the questionnaire and the newspaper clip it becomes clear that there were contradictions, but also consistencies, in the process. The first contradiction was that "simplicity", "easy to use" and "few functions" were very highly ranked in the questionnaire. However, the actual prototype was complex with new functions (speaker) and many light-emitting diodes. The second contradiction was that geographic position (visualized on a map by mobile or web) was mentioned in the scenario and was highly ranked in the questionnaire but was not mentioned in the presentation of the prototypes by the ICTD or the NOKD. The prototype was consistent with the earlier results: indication of direction and intended to be used 500 m within the home range (which was lost in the third boundary interaction).

4.5 Summary and implications

We will highlight three considerations and implications for understanding and facilitating in innovation activities regarding boundary interaction during a user centric innovation process. The analysis is to a great extent influenced by the dynamics in boundary interaction activities including brokering and boundary objects. TFP innovation process has been described as collaboration between three communities of practice (Wenger 1999; Wenger et al. 2002) where learning and working are inseparable (Brown and Duguid 1991) in the innovation activities (OECD 2005). So, the *TFP innovation process could be regarded as a inter-community-of-practice learning process*.

Firstly, we identified brokering situations that were of a special kind. Herein, brokering is about alignment and creating meaning (Hislop 2004; Lundkvist 2004; Manville 2004) on two different levels: *inner level and outer level*. *Inner level brokering* relates to trust and engagement. One example of inner level brokering is when Lars shows the newspaper-clip and talks about his wife. The inner level brokering situation could be described as a process of perspective making, perspective taking (Boland and Tenkasi 1995) between NOKD and ICTD were a boundary object was used (the newspaper clip). In a sense it was more of perspective making and less perspective taking from NOKD and the opposite from ICTD. The underlying reason why Lars did this was "the developers listened" and he felt trustful as he became so engaged in the process. So, the knowledge and competence of the NOKD was truly important for the inner level brokering in the innovation process.

We further identified situations where a kind of *outer level brokering* appeared. For this purpose we saw the need and necessity of an emergent boundary spanning competence. The appearance of a new role took place (Levina and Vaast 2005). *The role can be regarded as an expert on outer level brokering for inner level brokering situations*. We could see several situations where the role was undertaken by the HLL community members, by their engagement in developing a common viewpoint that adequately captured the dynamics of relations between the other communities of practice. This role was played out both spontaneously and intentionally by the HLL community members. The aim of this role-taking was primarily to break boundaries in order to reach to mutual understanding between the various communities of practice.

Secondly, the workshops in the TFP innovation process were built not only around dynamic activities, but also important artifacts' (Levina and Vaast 2005). So, the ideas of boundary spanners-in-practice was supported by boundary objects-in-use (Levina and Vaast 2005). First, many activities, such as discussion between COP's, creation of scenarios and other group activities were intertwined with artifacts, boundary-objects-in-use. For instance, one such boundary objects-in-us negotiated in the living lab process was the scenario that was related to the mind-map, which in turn was related to the questionnaire and the prototype. Another example was about the consistency and contradictions between the boundary objects-in-use, which then were needed to be handled in the outer level brokering process, including negotiating boundary objects-in-use. *Hence, several boundary objects were used, produced and re-produced with the particular focus on innovation of the product.*

Thirdly, the research indicates that boundary interaction in an innovation activities are also about trust and feeling comfortable with the actual environment. In the literature about inter-community interaction, trust and engagement (and the underlying dynamics) needs to be explored further (Hislop 2004). From our findings we can argue for the importance of the boundary context in innovation activities when dealing with trust and engagement in a living lab process. In order to meet a user group's need for more convenience it was necessary to bridge the gap between their problems and needs of the ICT product as well as their related use of it in the later run. It was therefore important to ensure that the NOKD maintained trust in their knowledge about and engagement in the innovation. The NOKD needed to feel that they controlled their own motivations and needs and therefore realised that they had a good command of the innovation process. We saw how the NOKD actually felt comfortable in the apartment were their demented family members and next of kin's usually met. By making the environmental prerequisites and conditions highly visible and present as a boundary context in the user-centric innovation process have led to that the NOKD feel their interests were accommodated more effectively. Also, it was in this room, or apartment, where the NOKD had all their meetings and performed much of their daily activities together. By being in their space might empower the NOKD group and makes them more accountable for important input (perspective making) in the user-centric process.

In this section we have presented three implications for understanding and facilitating innovation activities regarding boundary interaction in a living lab process. These three implications indicates that facilitating could be understood as *outer level brokering for inner level brokering situations in a boundary context with regard to trust end engagement*.

5 THE DYNAMICS OF INTERACTION IN A LIVING LAB PROCESS: TOWARDS A CONCEPTUAL MODEL

The research provides us with insight from the dynamics of the interactions that occurred between the various types of stakeholders in an ICT innovation process. The ideas of boundary spanners-in-practice and boundary objects-in-use (Levina and Vaast 2005) are supported by our empirical data. Thus, the dynamics of interactions are now presented in a conceptual model (see Figure 4), which consists of a number of essential activities that were considered important for facilitating learning in boundary interaction activities.

The conceptual model is a description of an innovation process, with innovation activities consisting of intertwined boundary interaction activities aiming to facilitate learning. The model aims to capture an overall process, where essential boundary interaction activities, objects and issues are highlighted. Specifically, these boundary interactions are crucial to consider in order to facilitate perspective making and taking between several communities participating in an innovation process. In each boundary interaction boundary objects-in-use and brokering were connected with other boundary interactions in an intertwined process. Consequently, the conceptual model highlights two different levels of brokering: i) inner-level brokering and ii) outer-level brokering. The outer level and inner level brokering is visualized together with the perspective making and taking process in the conceptual model.

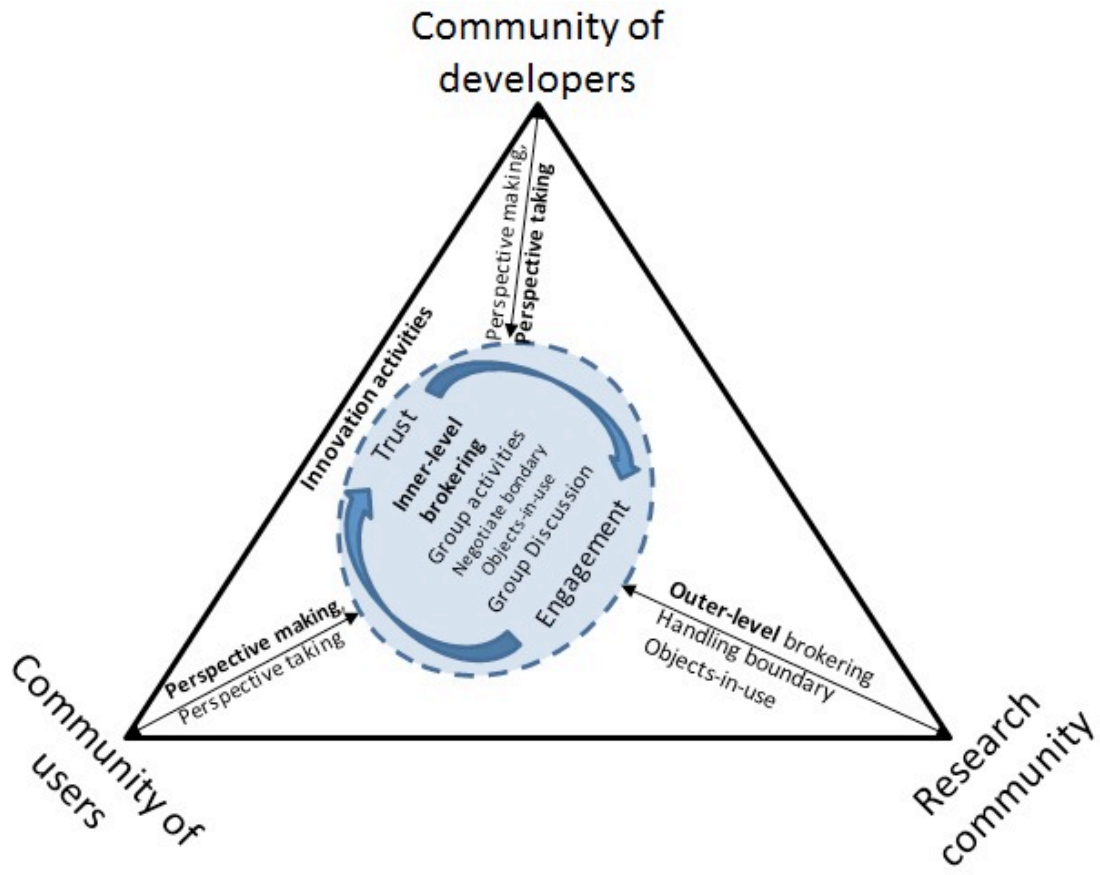

Figure 4. The conceptual model of boundary interaction dynamics

Inner-level brokering concerns the boundary interaction that aims to facilitate perspective taking between COPs internal to the process, i.e. that boundary objects and activities are used, produced and re-produced with the particular focus on innovation of the product. Here, brokering is about alignment and creating meaning (Hislop 2004; Lundkvist 2004; Manville 2004), and the brokering relation activity could also be described as a process of perspective making and perspective taking (Boland and Tenkasi 1995) between NOKD and ICTD. In a sense it was more of a perspective making and less a perspective taking from NOKD and the reverse from ICTD (Fig 4).

Outer-level brokering concerns the boundary interactions that aim to facilitate that constant iterations, feedback and reflections are undertaken as an interactive dialogue, which is considered important for innovation from a more process-oriented view. Herein, *brokering for* an iterative process with reflections and creations of perspective taking and engagement activities is facilitated. This is different from trying to build a joint field of a completely new community, as the aim of this new competence and role-taking (by the HLL mainly) was primarily to break boundaries in order to reach a mutual understanding between the various communities of practice. The role became a neutral, interpretive partner, who could be a catalyst for various perspectives and make them approach each other. The outer level broker can help maintain the legitimacy of the organization by providing information to important client groups, stakeholder groups or communities. Conceptually, outer level brokering also supports inner level brokering as well as boundary-objects-in-use. Outer level brokering aims to arrange for that constant iteration, feedback and reflections are undertaken as an interactive dialogue during and between group activities, which is considered important for innovation from a more process-oriented view.

6 CONCLUDING REMARKS

The aim of this paper was to describe and analyze the dynamics in a user-centric innovation process from a community of practice perspective. We have characterized such an innovation process by presenting a conceptual model of boundary interaction dynamics. The model indicates that activities of boundary interaction dynamics have an impact on the innovation process. First, these activities led to actions and consequences that were important to the subsequent phase in the innovation process, i.e. learning from iterations and actions. The emergent properties of actions undertaken by the participants formed a good basis for learning and perspective taking across community boundaries. Things and views that someone thought of as important for motivating the project, for reaching the goal, for taking the "right" action. Members of the three communities combined and transformed different views and objects of concern for the innovation process, such as problem motivation, scenario descriptions, prototypes etc.

The contribution of our research to innovation theory is the conceptual model describing the dynamics in boundary interaction activities during an innovation process. We have combined and further developed theories of boundary spanning and communities of practice in order to highlight a more nuanced description of boundary interaction dynamics. In our research, the context was an innovation process with three different COPs and its boundaries. This differs from the innovation process context in the article by Levina and Vaast (2005), where the context is between two firms or between two departments within a firm.

References

Avison, D., F. Lau, M. Myers, et al. (1999). "Action Research." Communications of the ACM **42**(1).

Avital, M. and K. Lyytinen. (2010). "Track: Innovation Theory, Research and Practice in Information Systems." Retrieved 2010-11-29, 2010, from http://project.hkkk.fi/ecis2011/track_innovation_theory.htm.

Baskerville, R. (1999). "Investigating Information Systems with Action Research." Communications of The Association for Information Systems **19**(2).

Baskerville, R. L. and M. D. Myers (2004). "Special issue on action research in information systems: making is research relevant to practice-foreword." MIS Quaterly **28**(3): 329-336.

Bergvall-Kåreborn, B., C. I. Eriksson, A. Ståhlbröst, et al. (2009). A Milieu for Innovation – Defining Living Labs. ISPIM 2009, New York.

Boland, R. and R. Tenkasi (1995). "Perspective Making and Perspective Taking in Communities of Knowing " Organization Science **6**(6): 350-372.

Brown, J. S. and P. Duguid (1991). "Organizational Learning and Communities-of-Practice: Toward a Unified View of Working, Learning, and Innovation " Organization Science **2**(1): 40-57.

Buzan, T. (1995). The MindMap book. London, BBC Books.

Chesbrough, H. (2006). The Era of Open innovation. Managing innovation and change. D. Mayle, Sage.

Cohen, W. M. and D. A. Levinthal (1989). "Innovation and Learning: the two faces of R & D." The economic journal **99**(397): 569-596.

Cohen, W. M. and D. A. Levinthal (1990). "Absorptive Capacity: A new perspective on learning and innovation." Administrative Science Quaterly **35**(1): 128-152.

Cook, S. D. N. and J. S. Brown (1999). "Bridging Epistemologies: The Generative Dance Between Organizational Knowledge and Organizational Knowing." Organization Science **10**(4): 381-400.

Eriksson, M., V.-P. Niitamo and S. Kulkki (2005) "State-of-the-art in utilizing Living Labs approach to user-centric ICT innovation - a European approach."

Hildreth, P. and C. Kimble, Eds. (2004). Knowledge Networks:Innovation through communities of practice. London, Idea group.

Hippel, E. v. (2005). Democratizing innovation, MIT Press.

Hippel, E. V. (2005). "Democratizing innovation: The evolving phenomenon of user innovation." Journal für Betriebswirtschaft **55**(1): 63-78.
Hippel, E. v. (2007). Horizontal innovation networks--by and for users. Industrial and corporate change, Oxford University Press.
Hislop, D. (2004). The Paradox of Communities of practice:Knowledge sharing between communities. Knowledge Networks:Innovation through Communities of practice. P. M. Hildreth and C. Kimble. London, Idea group.
Lave, J. and E. Wenger (1991). Situated learning: legitimate peripheral participation. Cambridge, Cambridge University Press.
Levina, N. and E. Vaast (2005). "THE EMERGENCE OF BOUNDARY SPANNING COMPETENCE IN PRACTICE: IMPLICATIONS FOR IMPLEMENTATION AND USE OF INFORMATION SYSTEMS." MIS Quarterly **29**(2): 29.
Lindgren, R., M. Andersson and O. Henfridsson (2008). "Multi-Contextuality in Boundary-Spanning Practices." Information Systems Journal **18**(5): 641-661.
Lundkvist, A. (2004). User networks as sources of innovation. Knowledge Networks:Innovation through Communities of practice. P. M. Hildreth and C. Kimble. London, Idea group.
Manville, B. (2004). Building customer communities of practice for business value:Success factors from Saba Software and other case studies. Knowledge Networks:Innovation through Communities of practice. P. M. Hildreth and C. Kimble. London, Idea group.
McKay, J. and P. Marshall (2001). "The dual imperatives of action research " IT and People **14**(1): 46-59.
Mårtensson, P. and A. S. Lee (2004). "Dialogical Action Research at Omega Corporation." MISQ **28**(3).
OECD (2005). Oslo Manual: Guidelines for Collecting and Interpreting Innovation Data, OECD Publishing.
Preece, J., Y. Rogers and H. Sharp (2002). Interaction Design: Beyond Human-Computer Interaction, Wiley.
Schein, E. H. (1987). The Clinical perspective in fieldwork.
Schein, E. H. (1995). "Process consultation, action research and clinical inquiry: are they the same?" Journal of Managerial Psychology **10**(6): 14-19.
Star, S. (1990). "The structure of ill-structured solutions: boundary objects and heterogeneous distributed problem solving." Distributed artificial intelligence **2**.
Svensson, J. and C. I. Eriksson (2009). Challenges with User involvement in a Living Lab context. eChallenges 2009, Istanbul.
Wenger, E. (1999). Communities of practice: learning, meaning, and identity. Cambridge, Cambridge University Press.
Wenger, E. (2006) "Communities of practice:a brief introduction."
Wenger, E., R. Mcdermott and W. M. Snyder (2002). Cultivating communities of practice. Boston, Harvard Business School Press.
Yoo, Y., K. Lyytinen and R. J. Boland (2008). Distributed Innovation in Classes of Networks. Proceedings of the 41st Hawaii International Conference on System Sciences.