# Living Lab Activities as the Starting Point for Developing ICT Studies in Higher Education

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**Abstract**

In order to respond to the challenges posed by rapid technological development, new competence and operating models are required in the design of information and communication technology (ICT). This, on the other hand, requires developing the content and methods of education in the field. This paper describes an experiment which aims to develop education in Business Information Technology studies at Laurea University of Applied Sciences (UAS).
The educational starting point for the development work was to produce novel competence in interaction design in the Business Information Technology degree program at Laurea and in the field of human-computer interaction (HCI). As a result of the development work, a pedagogical model uniform with a UCD process has been created. The aim of the pedagogical model was to provide ICT students with the capability to act as developers in a UCD process. The developed study module forms "*a dual innovation model"* comprising the continuous development of research methods through "*a test bed environment*", and the application of developed knowledge in Laurea's research and development (R&D) projects. The dual innovation model has been utilized in diverse R&D projects in the Living Labs Network activities of Laurea UAS. It has also been adopted as a pedagogical model in the Business Information Technology degree programme.

**Keywords**

Living lab, user centered design, participatory design, business information technology, higher education

## Introduction

New technology is interactive and intelligent. Individuals in today's society must be able to daily deal with diverse information and communication technology devices and applications, which may appear complex and difficult from the user's point of view. Traditional designer-centered approaches to design cannot resolve the challenges faced in the development of modern interactive technologies. For interaction design professionals, understanding the complexities of human-technology interaction is not enough; what is also needed is the ability to internalize the priority nature of the user perspective in interaction design and understand the possibilities of user participation in the innovation process. (Luojus & Vilkki, 2008). Issues related to users or

the product's use, which may seem simple at first, might turn out to be crucial in terms of product design (Hyysalo, 2006).

User-centered design (UCD) is an increasingly common model for the product and service design innovation process. The three main principles of user-centered design are: (1) drawing attention to users and purposes right at the beginning of the design process; (2) empirical usability measurements, and (3) iterative design (Gaver, Boucher, Pennington, & Walker, 2004). UCD is beginning to focus increasingly on observing emotions and aesthetics alongside cognitive and functional factors, which has required development of the process. An issue revealed by user data that seems simple may turn out to be crucial in terms of the product's use. Acquiring data on end users is one of the key skills in product development (Hyysalo, 2006). Particular attention is paid to planning the user experience in relation to the product or service. We develop methods, tools and techniques for gathering information on the user experience (UX), usability and suitability of ICT technology products or services for their usage context.

The everyday life context of an end user, which, through different research settings and methods, has been made the object of information gathering for a UCD process, has recently been termed 'Living Lab' (LL) (Luojus, 2008). Literature approaches the Living Lab concept from diverse perspectives. It is referred to as a set of methods (e.g., Eriksson, Niitamo, Kulkki, & Hribernik, 2006; Niitamo, Kulkki, Eriksson, & Hribernik, 2006), an approach (Ståhlbröst, 2008; Schaffers, Cordoba, Hongisto, Kallai, Merz, & van Rensburg, 2007; Ballon, Pierson, & Delaere, 2005), but also as an environment, ecosystem and system.

Without a consistent description of the Living Lab concept and operating model, it is difficult to reach a coherent definition. The Living Lab concept's creator William Mitchell proposed that UCD research methods can be utilized in everyday life context of end users, for sensing, prototyping, validating and refining complex design solutions, *"which are increasingly necessary in our evolving living environments"* (Eriksson et al., 2006). According to many approaches, Living Lab is seen as an "*open innovation platform*", which offers RD&I services in a "*real-life context*". Many researchers share the view that the research methods of user-centered design are applied in Living Lab research and development activities. The innovativeness of the Living Lab approach is generally seen as being grounded on a mutually enriching dialogue that takes place in this open environment between different actors, such as end users, researchers, businesses and public bodies.

In this article, we describe an experiment aimed at formulating an educational programme that equips students to function as professionals and innovative developers in the changing operating environment of their fields by using the user-centered design process in their work and by applying appropriate research and development methods. We also examine the preconditions for the further development of research methods as well as the advancement of competence development in the context of the research and development activities of business partners, partner networks and the Living Lab ecosystem.

## Living Lab Activities: User-centered design

User-centered studies in the field of human-computer interaction (HCI) favor qualitative methods, because research data compiled by these methods provide stimuli that allow ideas and insights to be created and opportunities to share them (Mattelmäki, 2006). Hanington (2003) divides UCD methods according to their objectives and results into three categories: (1) traditional methods are typically quantitative methods, such as market analysis, inquiries, surveys, interviews or focus groups. The data gathered by traditional quantitative methods provides an extensive view of the field of the design, but it does not fulfill the needs of the UCD process for interactive technology products, because generalizations fail to define individual and exceptional properties (Hanington, 2003; Gaver et al., 2004); (2) applied methods refer to the adoption of well-established research methods from different disciplines in UCD. These methods are usually qualitative methods of ethnography, sociology and culture studies, including self-documentation, observation and interaction methods, such as heuristic evaluations or thinking aloud. However, the objectives of design research depart from the humanistic tradition; applied methods are used for understanding the end users, the usage and the use contexts of technology; and (3) innovative methods are mostly suitable at the beginning of the design process, because they are used to increase an understanding of users' needs, emotions, values, dreams, and feelings of pleasure (Hanington, 2003). Designers should strive to understand and to interpret personal, social and cultural characteristics of end users as broadly as possible, because their design solutions will be evaluated and assessed in relation to them (Mattelmäki, 2006).

Traditional methods are appropriate for examining large masses of people, whereas innovative methods can be used to achieve more in-depth results when examining individuals and small groups (Hanington, 2003). The most important thing in planning user research and choosing research methods is that the information gathering supports the main objectives of the design process. Another essential aspect is to plan how the acquired information can be interpreted, used, shared and modified in the future (Hanington, 2003; Hyysalo, 2006). The use of a relevantly chosen method is cost-effective (efficient output/input ratio) and able to:

- Support the user's position and impact (from an object to a subject);
- Motivate and inspire user participation;
- Describe the user's everyday context, a genuine user context, user experience and environment, uncover the user's hidden needs and emotions (life in genuine contexts);
- Make tacit knowledge and weak signals visible;
- Concretize and analyze user study results, and inspire product and service development;
- Discover available potential to find new product and service innovations;
- Promote creativity and innovativeness.

Sleeswijk, Visser, Stappers, van der Lugt and Sanders (2005) divide user research methods into three categories according to the focus of the method: say/think, do/use and know/feel/dream. '*Say/think*' relates to interviews and to explicit knowledge, whereas '*Do/use*' relate to observation of use situation. '*Know/feel/dream*' refers to physical or visual aids to allow people to visualize and describe their expectations and dreams, or tacit knowledge (Sleeswijk et al., 2005).

According to this distinction proposed by Hanington (2003) and Sleeswijk et al. (2005), the most innovative or in-depth methods are creative and participatory. These methods are intended to understand people's feelings, emotions, values and dreams:

> "*Sometimes the objectives are thoughts never really thought, let alone expressed in words. These questions require tools to help the users to express themselves through metaphors and associations, sometimes revealing very delicate and irrational motives. Creative and projective methods offer these ways of expression*" (Mattelmäki, 2006, p. 31).

In other words, one of the major challenges of user research is to make tacit and latent knowledge visible. These types of studies require methods for examining phenomena that cannot be grasped by means of direct observation and understanding. In making tacit knowledge visible, the most important issues are finding an applicable research method, cooperation and working methods. (Luojus, 2010). Although a number of user-centered design methods are still relevant, new methods are necessary for addressing the challenges of making tacit and latent knowledge visible.

**Towards Student-centered Research and Development**

Laurea University of Applied Sciences is focused on service innovations. Laurea's pedagogical model is Learning by Developing (LbD), which is based on learning through R&D. In the LbD model, both students and teachers can develop their competencies by participating in R&D projects that address the phenomena and problems of real-life workplaces, which require the generation of new knowledge. Teaching progresses through R&D projects conducted in close cooperation with companies and other organizations.

The LbD-based innovation process and Laurea's 8,000-strong student body enable rich interaction with end users, companies, and the public and third sectors in R&D projects. Thus, Laurea's way of integrating the three tasks of Finnish universities of applied sciences – (1) education; (2) research, development and innovation; and (3) regional development – is very compatible with '*the Living Lab philosophy*'.

The starting point for the development work was to produce novel competence by integrating teaching and studying with genuine workplace development. The development work focused mainly on user participation in the innovation process, the development of UCD and Living Lab research methods, and generating new design solutions or service innovations. Professionals from ICT companies and academics in the field of ICT were consulted in the planning phase of the study module.

The objectives of the development work were: (1) to disseminate a problem-based, developmental and research-oriented higher education approach to studying; and (2) to link assignments to real-life projects in collaboration with companies in the field of ICT. In addition, the development work aimed to provide students with competence (3) to gather, structure and apply information in authentic development contexts; (4) to use various development tools and

models in a diverse and flexible way in the different phases of the UCD process; and (5) to apply UCD processes and research methods in their studies and various R&D activities.

Several traditional UCD research and service design methods and tools are used in the Business Information Technology degree programme at Laurea. In particular, the focus of our R&D interests was on developing new research methods, techniques and tools for gaining a better understanding of end users, usage and the context of use.

In order to carry out the development work, we arranged a practical experiment that combined five study units under the single ICT Production Process (25 credits) study module, which followed the model of human-centered design of interactive systems, also known as the user-centered design (UCD) process (Figure 1).

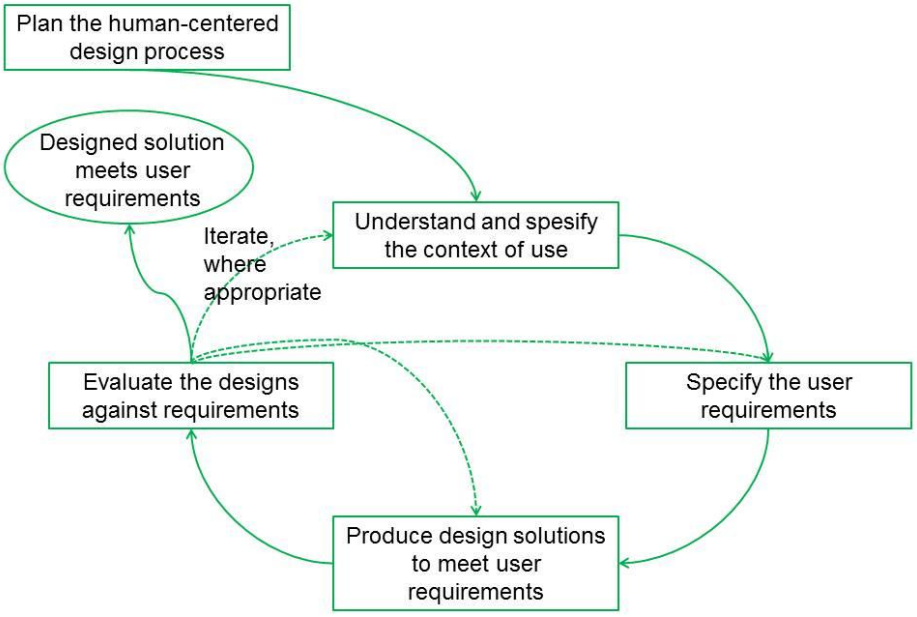


**Figure 1. Human-centered design for interactive systems (Adapted from ISO 9241-210).**

The experiment involved a dual purpose: In the study module, students complete intermediate ICT studies in conjunction with a module on user-centered design, which are integrated into an R&D project. This meant that the students had two parallel tasks to complete: (1) to design an interactive system to solve authentic development needs, and (2) to apply UCD research methods that support collaboration between end users and interaction designers and the creation of mutual understanding. The coursework involved three different levels: (1) exploring the theoretical background of different development tools and models as well as research methodology; (2) applying theory to R&D in practice, and (3) evaluating theory, models, activities, the development process, tools and their use. Reflexive examination of theory and action promoted diverse and creative use of tools and models.

The studies in the ICT Production Process module formed a dualistic innovation model (Figure 2) with the following elements: (1) a continuous development process in "*a test bed*", where applied and innovative UCD methods, tools and techniques are tested in an authentic

development setting in a safe and guiding learning environment; and (2) the application of developed research and development competence in Living Lab activities conducted in Laurea's diverse R&D projects (Vilkki, 2008). Researchers, other experts, operating environments and research methods are always selected individually depending on the needs and objectives of each R&D project.

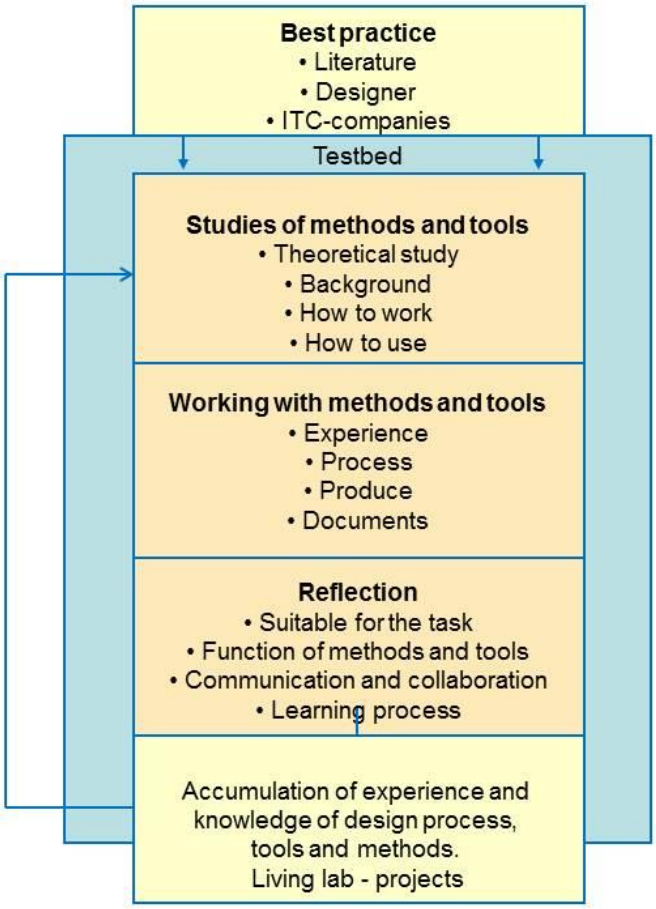


**Figure 2. A dualistic innovation model (Vilkki , 2008).**

## Developing Participatory Research and Design Methods

A test bed environment forms the core of development efforts, where competence in user-centered design is advanced through experimentation with new research methods, techniques, tools and tailored design process models. The new UCD research and development methods are developed to gather information on users' needs, dreams, experiences, values and on the physical, social and technical usage context, as well as on the usability and suitability of the developed product or service to users' lifestyles and everyday lives. '*Mutual reflection'* on the gathered research data with the end users, who participate in the UCD process, helps researchers and interaction designers to gain a better understanding of users' world. (Luojus, 2010). The following are examples of participatory technologies and tools that were developed by students and tested in a test bed environment.

The objective of Hyökki's master's thesis was to find out how visual eye tracking data (Figure 3) could be used as a medium for creating shared understanding between users and designers, especially in the area of service design. Whereas eye tracking data is usually analyzed with statistical measures, Hyökki's study focused on a qualitative discussion on the use of the eye tracking data as a medium in the service design process dialogue. The pilot study examined the first impressions created by a library and the way users found library materials. The study indicates that gaze replay can be used as a catalyst towards a richer explanation. Participatory interpretation of visual eye tracking data brings users and designers together in constructive dialogue. (Hyökki, 2011).


**Figure 3. A snap shot of gaze replay in a pilot study on a library space (Hyökki, 2011).**
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Lahti's study focused on the way the generative participatory RuffProto design tools designed by Lahti functioned in a participatory design workshop. RuffProto tools (Figure 4) include artifacts that can be attached together with magnets and Velcro, symbolizing ideas and user interface elements relating to digital equipment for participants. User data summary cards designed by Lahti aim to facilitate the analysis of the participatory workshops results (Lahti, 2011).

**Figure 4. Observing the use of a RuffProto prototype in a real-life context (Lahti, 2011).**
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A high number of Business Information Technology students take part in R&D projects in either national or international networks such as Kinos, Get a life, Quadruple Helix, Helsinki Living Lab, ICT-SHOK/Flexible Services/User Driven Open Innovation, BALLAD/Baltic Living Labs. For example, Hoffren's thesis project was executed as part of the international, EU-funded Ballad project with the overall objective of creating a common business model for the Living Labs Network in the Baltic region. Hoffren examined the Living Lab approach from the perspective of small and medium sized companies (SME). The aim of the study was to determine what conditions and expectations SMEs have for their involvement in Living Lab activities. The study combined both traditional interview methods and a participatory co-design approach. Hoffren designed a Living Lab toolkit or game (Figure 5) to assist SMEs in perceiving the Living Lab concept and its opportunities as well as to further define the conditions and expectations of SMEs for their involvement in the Living Lab (Hoffren, 2011).

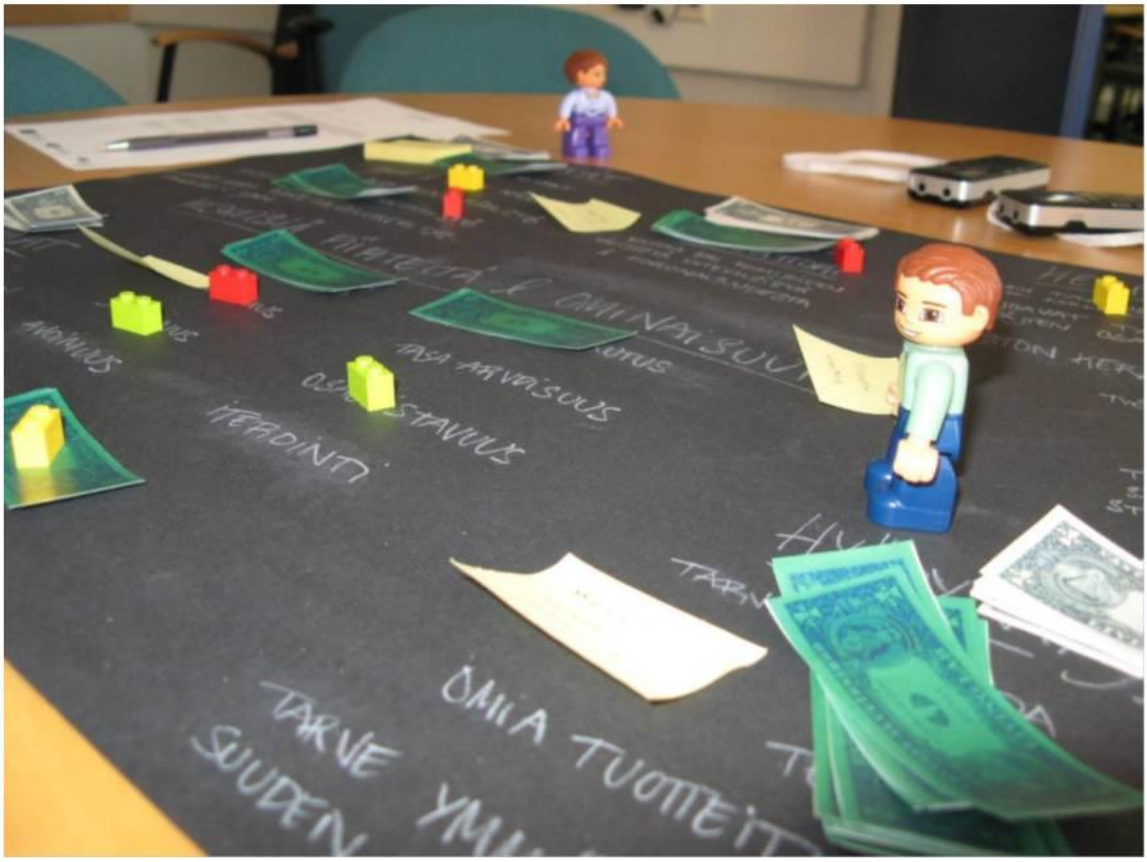


**Figure 5. The Living Lab: Assisting SMEs (Hoffren, 2011.)** *Published with permission of the copyright owner.*

The aforementioned participatory methods, technologies and tools encourage users to express their thoughts, needs, wishes, feelings and experiences. All of the tools aim to explicate tacit and latent knowledge. The projects that are currently in progress provide new and interesting opportunities to integrate students into research and development activities in an international context. For example, the "User-Centred Design for Innovative Services and Applications" (UFISA) project facilitates the development of joint education between universities in Southern Africa and Finland. The partner universities join their activities around an important multidisciplinary area of education and development: user-centered design of information and communication services for communities. The education programme benefits communities in Southern Africa through innovative ICT-based prototype services. The universities benefit from the communities by being able to provide international teaching in real-life settings which are linked to functional living labs in Southern Africa.

Another project called "Confident Motion" (COM'ON) addresses the perceived orientation and navigation challenges and special needs that older people experience throughout the whole chain of travel using public transportation. The overall objective of the COM'ON project is to develop a mobile platform and associated services, which offer coping support to older persons using public transportation. The development of COM'ON is based on user-centered methodology.

End users inform, co-create and evaluate the design solutions in every step of the design process, from user understanding, idea generation and concept development to the prototyping and evaluation of the final prototype. User needs are identified, new design solutions are generated and user requirements are specified through ethnographic studies, observations as well as participatory workshops and usability evaluations. The concept evaluation and prototyping activities include co-creation workshops and user evaluation in a living lab environment. Business model innovation will be an integrated part of the concept development process.

**Results**

Previously, higher education has mainly adhered to a traditional academic pattern of lectures, assignments and exams. Theory and exercises had formed series of unrelated assignments. Laurea's way of integrating its three tasks by using the LbD model has offered opportunities to reform teaching and learning practices. Linking studies to genuine R&D projects with outcomes that benefit real-life workplaces offers a new motivating dimension for higher education.

The Living Lab as a learning environment provides students an incomparable opportunity to participate in the development of an entirely novel type of innovation culture. In Living Lab research activities, users are involved in the innovation process from the outset and in partnership with students, experts, businesses and other stakeholders. This approach enables students to develop more in-depth and practice-based competencies, including from the point of view of sustainable development and the promotion of well-being. The results achieved by Laurea's Business Information Technology students in diverse Living Lab projects exceed the learning objectives (Luojus & Vilkki, 2008). In addition, student members in Living Lab projects have been successful in finding employment.

Innovative businesses particularly appreciate multichannel research methods that produce in-depth user data, which can be used to generate increasingly rich and in-depth, qualitative information on users (e.g., visual ethnography, reflective user studies), and the opportunity to actively participate in research. The refreshing ideas of students as representatives of "the next generation" in research teams have been warmly welcomed.

The competence gained through participation in national and international networks and R&D projects have made Laurea '*a strong Living Lab actor'*. Laurea Living Labs Network, which comprises different Laurea units and research teams, is part of the European Network of Living Labs (ENoLL). The membership opens up excellent cooperation opportunities both for Laurea UAS and its partner network. The ENoLL membership enables the sharing of best practices and the further development of Living Lab activities together with other network members.

The integration of higher education studies in Business Information Technology, Living Lab research and development activities on the one hand and the LbD model on the other seems to fulfill the statutory requirement for Finnish universities of applied sciences to combine education, R&D and regional development. Laurea has been appointed as a Centre of Excellence both in education (2008-2009 and 2004-2005) and in regional development (2006-2007 and 2003-2004) by the Finnish Higher Education Evaluation Council (FINHEEC). On the basis of its

LbD model, Laurea was nominated as a Centre of Excellence in Education for 2010 – 2012. Some of the aforementioned R&D projects were evaluated by FINHEEC.

## Conclusion

Although current Living Lab activities may appear product- or company-driven, the approach can offer technologies and tools for developing (digital) service systems (cf. service dominant logic), where the development target is larger than a single product and can comprise the networks of several producers. The benefits of openness and multi-actor collaboration have been recognized, but their practical implementation is still somewhat rare. Completely new concepts and methods that cross the traditional boundaries of disciplines are necessary in the processing of extensive entities (Kuutti, Keinonen, Norros & Kaasinen, 2007). The new methods developed need to address the following challenges: (1) the Living Lab approach aims at a more permanent innovation ecosystem than those enabled by one-time interview or observation studies; (2) the innovativeness of the Living Lab ecosystem can be considered to be based on the meeting of different actors acting in an open innovation environment; and (3) in a Living Lab ecosystem, owing to the openness of the knowledge creation processes and the multi-actor approach, the research is focused on entities larger than single products, such as the design of living and operating environments (Luojus 2010). Although the Living Lab approach is traditionally considered to offer great benefits particularly in the development of ICT-based solutions, in principle, it can be applied in any product or service development process.

Living Lab thinking has proved to be coherent with Laurea's LbD model and to integrate the three tasks of Laurea. Interest in Living Lab thinking has arisen in several Finnish universities of applied sciences, and diverse partnership networks have been formed around Living Lab activities among the institutions. It appears that universities of applied sciences and their partnership networks can play a significant role in maintaining Living Lab activities in Finland.

Process development is the most important outcome of the development work. A qualitative research approach and the application of research methods of diverse disciplines form a basis for innovative UCD methods and process development. The aim of the development work was to provide in-depth knowledge on topics such as user experiences, diverse use contexts and culture of usage as well as the adoption of new technological applications and devices. The use of methodological triangulation and mutual reflection on the gathered research data with the end users creates prerequisites for multifaceted analysis and increases the reliability of results in R&D projects. Besides data gathering methods, we also developed methods for analyzing the gathered data in collaboration with interaction designers and end users. Versatile use of creative and collaborative methods reinforces multi-actor collaboration and the explication of tacit knowledge. Mutual reflection on user data and the creation of shared meaning with end users has enhanced our ability to empathize with the user. We see '*the user's world as a source of innovation'.*

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