Department of Engineering Design and Production

Advancing the Lead User Method and its Adoption in Organizations

Pia Helminen

Aalto University

DOCTORAL DISSERTATIONS

Aalto University publication series
DOCTORAL DISSERTATIONS 165/2016

Advancing the Lead User Method and its Adoption in Organizations

Pia Helminen

A doctoral dissertation completed for the degree of Doctor of Science (Technology) to be defended, with the permission of the Aalto University School of Engineering, at a public examination held at the Stage of Aalto University Design Factory on 23 September 2016 at 13.00.

Aalto University
School of Engineering
Department of Engineering Design and Production

Supervising professor
Professor Kalevi Ekman

Thesis advisor
Associate Professor Sampsa Hyysalo

Preliminary examiners
Professor Cornelius Herstatt, Hamburg University of Technology, Germany
Dr Eija Kaasinen, Principal Scientist, VTT Technical Research Centre of Finland

Opponent
Professor Christian Lüthje, Hamburg University of Technology, Germany

Aalto University publication series
DOCTORAL DISSERTATIONS 165/2016

ISBN 978-952-60-6974-6 (printed)
ISBN 978-952-60-6973-9 (pdf)
ISSN-L 1799-4934
ISSN 1799-4934 (printed)
ISSN 1799-4942 (pdf)
http://urn.fi/URN:ISBN:978-952-60-6973-9

Unigrafia Oy
Helsinki 2016

Finland

441 697
Printed matter

Aalto University

Abstract

Aalto University, P.O. Box 11000, FI-00076 Aalto www.aalto.fi

Author
Pia Helminen

Name of the doctoral dissertation
Advancing the Lead User Method and its Adoption in Organizations

Publisher School of Engineering

Unit Department of Engineering Design and Production

Series Aalto University publication series DOCTORAL DISSERTATIONS 165/2016

Field of research Engineering Design and Production

Manuscript submitted 16 October 2015 **Date of the defence** 23 September 2016

Permission to publish granted (date) 9 June 2016 **Language** English

☐ **Monograph** ☒ **Article dissertation** ☐ **Essay dissertation**

Abstract

A key to being a successful business is not only being able to respond to demand but being able to anticipate future demand. This is easier said than done, as understanding what users need is one of the areas of most persistent and costly failure in product development. The importance of involving users in the development of both products and services has been widely noted, but some users develop solutions on their own. This is not a marginal phenomenon, but innovation by users and so called lead users can be found in all fields ranging from post-it-notes to sporting equipment and surgical instruments to banking services, for example. The lead user method is described as a process that companies could apply in their product or service development in order to benefit from lead users. Despite its documented advantages, the LU method has not gained ground as a standard part of companies' toolbox for product and service development.

In this dissertation, a qualitative approach building on semi-experimental set-ups, a multiple case study, and a longitudinal two-case case study was used to explore the challenges involved in the use of the LU method and to provide remedy and direction for its use in organizations that are seeking to benefit from lead users. First, this dissertation improves the concepts and means available for lead user identification. Second, it generates more understanding on and alternative means for transferring the lead user knowledge. Third, it sheds light on the factors that challenge the adoption of the LU method in an organization and provides suggestions on how the adoption hurdles could be overcome.

It was found that instead of general resistance to user ideas or new ways of working or the cost and time required by the LU method, it is the difficulty of transferring and retaining the knowledge of how to conduct a LU project that hinders its adoption in an organization. The case analyses demonstrate that the LU method features skill components that are more costly and difficult (i.e. "sticky") to transmit among employees than the adopter organizations were prepared for. Rather ironically, it is the same phenomenon that user innovation research has identified as one of the key reasons for why users hold solution and trend information and why lead users should be utilized in the first place.

Keywords lead users, lead user method, user innovation, product development, service development, organizational adoption

ISBN (printed) 978-952-60-6974-6 **ISBN (pdf)** 978-952-60-6973-9

ISSN-L 1799-4934 **ISSN (printed)** 1799-4934 **ISSN (pdf)** 1799-4942

Location of publisher Helsinki **Location of printing** Helsinki **Year** 2016

Pages 253 **urn** http://urn.fi/URN:ISBN:978-952-60-6973-9

Tekijä
Pia Helminen

Väitöskirjan nimi
Edelläkäyttäjämenetelmän edistäminen ja sen omaksuminen organisaatioissa

Julkaisija Insinööritieteiden korkeakoulu

Yksikkö Koneenrakennustekniikan laitos

Sarja Aalto University publication series DOCTORAL DISSERTATIONS 165/2016

Tutkimusala Koneenrakennustekniikka

Käsikirjoituksen pvm 16.10.2015 **Väitöspäivä** 23.09.2016

Julkaisuluvan myöntämispäivä 09.06.2016 **Kieli** Englanti

☐ **Monografia** ☒ **Artikkeliväitöskirja** ☐ **Esseeväitöskirja**

Tiivistelmä

Ollakseen menestyviä yritysten täytyy pystyä vastaamaan kysyntään sekä nyt että tulevaisuudessa. Tämä on helpommin sanottu kuin tehty, sillä käyttäjien tarpeiden ymmärtäminen on vaikeaa ja siten yksi yleisimmistä ja kalleimmista epäonnistumisen syistä tuotekehityksessä. Käyttäjien osallistamista tuote- ja palvelukehityksessä pidetään tärkeänä, mutta osa käyttäjistä kehittää ratkaisuja kuitenkin täysin itsenäisesti. Kyse ei ole marginaalisesta ilmiöstä, vaan käyttäjien tekemiä innovaatioita sekä niin kutsuttuja edelläkäyttäjiä on kaikilla toimialoilla ja tuotekategorioissa post-it-lapuista urheiluvälineisiin ja kirurgien työkaluista pankkipalveluihin. Edelläkäyttäjämenetelmä on prosessi, jota yritykset voivat käyttää saadakseen hyötyä edelläkäyttäjistä. Vaikka edelläkäyttäjämenetelmästä on todettu olevan yrityksille paljon apua, se on käytössä silti vain harvoissa yrityksissä.

Tämä väitöskirja pohjautuu kvalitatiiviseen tutkimukseen, joka koostuu semi-kokeellisista järjestelyistä, usean tapauksen tutkimuksesta sekä pitkittäisestä kahden tapauksen tutkimuksesta. Väitöskirjassa tutkittiin haasteita, jotka liittyvät edelläkäyttäjämenetelmän käyttöön organisaatioissa. Ensiksikin väitöskirjassa parannetaan käsitteitä ja keinoja, jotka liittyvät edelläkäyttäjien löytämiseen. Toiseksi saadaan ymmärrystä ja uusia keinoja liittyen siihen, kuinka edelläkäyttäjien tietoa ja osaamista voidaan siirtää yritykselle. Kolmanneksi väitöskirjassa selvitetään, millaiset asiat vaikeuttavat edelläkäyttäjämenetelmän omaksumista organisaatiossa, ja annetaan ehdotuksia, kuinka omaksumista voidaan helpottaa.

Tulokset osoittavat, että vastustus käyttäjien ideoita tai uutta työtapaa kohtaan tai edelläkäyttäjämenetelmän vaatima aika eivät niinkään haittaa menetelmän omaksumista mutta ymmärrystä siitä, kuinka menetelmää sovelletaan, on vaikea siirtää ja säilyttää organisaatiossa. Tapausanalyysit havainnollistavat, että edelläkäyttäjämenetelmä vaatii taitoa ja kyvykkyyttä, mitä on vaikeaa välittää työntekijöiden välillä (niin kutsuttu "tahmea" tieto). Onkin hieman ironista, että kyse on samasta ilmiöstä, jonka käyttäjäinnovaatiotutkimus on tunnistanut yhdeksi pääsyyksi sille, miksi käyttäjiltä on ylipäätään vaikea saada tietoa ja miksi juuri edelläkäyttäjiä kannattaisi hyödyntää kehitystyössä.

Avainsanat edelläkäyttäjät, edelläkäyttäjämenetelmä, käyttäjäinnovaatiot, tuotekehitys, palvelukehitys, omaksuminen organisaatiossa

ISBN (painettu) 978-952-60-6974-6 **ISBN (pdf)** 978-952-60-6973-9

ISSN-L 1799-4934 **ISSN (painettu)** 1799-4934 **ISSN (pdf)** 1799-4942

Julkaisupaikka Helsinki **Painopaikka** Helsinki **Vuosi** 2016

Sivumäärä 253 **urn** http://urn.fi/URN:ISBN:978-952-60-6973-9

Acknowledgements

When I finished my master's thesis, I was sure it had been the most fun and interesting academic project I had ever experienced. I remember having thought that I would be happy to start another one the next day. And soon I did, although at that time I never thought it would take this long to finish...

I am particularly grateful for the support from my advisor Sampsa Hyysalo. I can honestly say that my work would not have matured from licentiate's to doctoral without your help. I also want to thank Mikael Johnson for being not only an academic senior to me but an all-round wise person – I truly value your advice. Katja Hölttä-Otto is to blame for jump-starting my research: first of all for introducing me to the concept of Lead User and later for helping me publish my first article. And we won! You have always been my "big sister in engineering". And Kalevi Ekman, my professor, your classes were the place where it all started for me.

Throughout this project I have been fortunate to be surrounded by fellow academics with whom I have been able to share the ups and downs of research. On top of that you have also become my friends. My dear Inuse colleagues Samuli, Louna, Cindy, Jouni, and Stefi, the IRIS people Mari, Katriina, Mikko, Tiina, Taija, and Marja, the fish in the aquarium Miko, Maria, Tua, Satu, Matti, Riiku, and Senni, and all other colleagues I have crossed paths with at the Department of Industrial Engineering and Management, the Department of Design, and the Aalto Design Factory, I want to thank you all from the bottom of my heart for sharing this experience with me – and for tolerating my bad sense of humor. And of course, parts of this thesis could not exist without my co-authors, who I would like to sincerely thank for their contributions.

This research has been made possible thanks to the Aalto School of Engineering, and several research projects funded by TEKES, Academy of Finland, and Emil Aaltonen Foundation. I also wish to thank all the kind YLE people, especially Raimo Lång and Marja Paavilainen, for letting me hang around for so many years. And I of course appreciate the critical reading and valuable comments of pre-examiners Cornelius Herstatt and Eija Kaasinen.

Last but not least, I want to thank my brother Juho and mother Tuija, and all my friends, especially Katja, Kaisa, and Tuomas, for being there, for supporting me until the finish line, and for giving me something else to think about. Special thanks go to Riksu, who has always believed in this project even when I have been losing faith.

Finally, my beloved children Saima and Veikko, I can say to your relief that mom is now out of school and "a real grown-up".

Helsinki, August 2016
Pia Helminen

Contents

List of Abbreviations and Symbols

API	Application Programming Interface
B-to-B	Business-to-business
B-to-C	Business-to-consumer
CPM	Collaborative Physical Modeling
HCD	Human-Centered Design
LU method	Lead user method
NIH	"Not invented here" syndrome
NPD	New Product Development
NSD	New Service Development
PD	Participatory Design
UCD	User-Centered Design
UXD	User-Experience Design

List of Figures

List of Tables

List of Publications

This doctoral dissertation consists of a summary and of the following publications which are referred to in the text by their numerals.

I. Hannukainen, P., & Hölttä-Otto, K. (2006). Identifying customer needs - Disabled persons as lead users. In Proceedings of IDETC/CIE 2006, 18th International Conference on Design Theory and Methodology (DTM). September 10-13, Philadelphia, Pennsylvania, USA: ASME 2006 International Design Engineering Technical Conferences & Computers and Information in Engineering Conference. Best paper award winner.

II. Tuulenmäki, A., & Helminen, P. (2009). Lead users of positional value. In Proceedings of 8th European Academy of Design Conference (pp. 453–458). April 1-3, Aberdeen, Scotland.

III. Hyysalo, S., Helminen, P., Mäkinen, S., Johnson, M., Juntunen, J. K., & Freeman, S. (2015). Intermediate search elements and method combination in lead-user searches. International Journal of Innovation Management, 19(1).

IV. Helminen, P., Ainoa, J., & Mäkinen, S. (2015). Designing user innovation toolkits: exploring the interrelation between solution space and module library. International Journal of Design Creativity and Innovation. doi:10.1080/21650349.2015.1043351

V. Helminen, P., Mäkinen, S., & Holopainen, M. (2016). Better user-developer communication in service development by collaborative physical modelling. International Journal of Services and Operations Management, 23(2), 169–186.

VI. Hyysalo, S., Kohtala, C., Helminen, P., Mäkinen, S., Miettinen, V., & Muurinen, L. (2014). Collaborative futuring with and by makers. CoDesign, 10(3-4), 209–228.

VII. Helminen, P., Mäkinen, S., & Hyysalo, S. (forthcoming). Organisational adoption of the lead user method: a follow-up study on intentions versus actions. International Journal of Business Excellence.

Author's Contribution

I. Identifying customer needs – Disabled persons as lead users

The author was responsible for the original idea and research design. Collecting and analyzing the data was done alone by the author. The author had main responsibility in writing the article and also presented the work in IDETC/CIE 2006 conference.

II. Lead users of positional value

This work was done in co-operation with Tuulenmäki. Tuulenmäki and the author co-designed the original idea and co-wrote the article. Tuulenmäki finalized the article and presented the work in the 8th European Academy of Design Conference.

III. Intermediate search elements and method combination in lead-user searches

Data collection, data analysis, and literature review was shared work among the authors. The article was also co-written. The original idea was Mäkinen's.

IV. Designing user innovation toolkits: Exploring the interrelation between solution space and module library

The original idea and research design were developed in co-operation with Ainoa. Ainoa was responsible for data collection. Data analysis was shared work with Ainoa. Literature review was shared work among the authors. The author had main responsibility in writing the article.

V. Better user-developer communication in service development by collaborative physical modelling

Data collection was shared work among the authors. Data was analyzed and the original idea developed together with Mäkinen. The author had main responsibility in writing the article.

VI. Collaborative futuring with and by makers

Data collection and research design were shared work among the authors. Data was analyzed by Kohtala and Hyysalo. The author participated in the literature review and in writing the article.

VII. Organisational adoption of the lead user method: a follow-up study on intentions versus actions

Data collection and data analysis was done and the original idea developed in co-operation with Mäkinen. The author had main responsibility in writing the article.

1. Introduction

1.1 Background

A key to being a successful business is not only being able to respond to demand but being able to anticipate future demand – what the users will need in the future and who these users will be. This is easier said than done, as literature indicates that the failure rate of new products is on average around 40 % (Castellion & Markham, 2013; Cooper & Kleinschmidt, 1986; Crawford, 1977; Page, 1993; The Standish Group, 2013) and out of the products that survive, only few become widely accepted (Utterback, 1996). Understanding what users need is one of the areas of most persistent and costly failure in product development (Hyysalo, 2009a, 2010, p. xxiv). The Standish Group, for instance, has studied the success and failure among IT projects and found that a staggering 50 % of product features are hardly ever used, meaning that needs of the users are poorly understood. On the other hand, the relations between the development team and other stakeholders were found to be the most critical factor in differentiating between successful and unsuccessful projects (The Standish Group, 2013).

The importance of involving users in the development of both products and services has been widely noted (e.g., Alam, 2002; Prahalad & Ramaswamy, 2004). In fact, there is a growing body of literature concentrating on the paradigm shift from producer-centered, intracompany innovation to a more open, user-driven innovation process (e.g., West, Salter, Vanhaverbeke, & Chesbrough, 2014; von Hippel, 2005). A literature stream has concentrated on identification of user or customer needs and how these needs can be incorporated into products and services (e.g., Hauser & Clausing, 1988; Kaulio, 1998; Pals, Steen, Langley, & Kort, 2008). The streams of user-centered design and participatory design offer numerous approaches on how to learn about users and their needs and how users can be involved in the development of products and services (e.g., Johnson, 2013; Schuler & Namioka, 1993).

Significant to the dissertation at hand is that users can also be a source of new product ideas, and some users even develop their own solutions (e.g., Hyysalo, Juntunen, & Freeman, 2013b; Lettl, Herstatt, & Gemuenden, 2006; Raasch, Herstatt, & Lock, 2008; von Hippel, 1986, 2005). This is not a marginal phenomenon, but innovation by users and so called *lead users*[1] can be found in all

[1] Lead users are users who face needs before the majority of the market and benefit significantly from obtaining solutions to those needs (von Hippel, 1986, 1988), see section 2.3.

fields ranging from post-it-notes to sporting equipment and surgical instruments to banking services, for example (e.g., Hienerth & Lettl, 2011; Lüthje, 2003; Oliveira & von Hippel, 2011; Shah, 2000; von Hippel, 2005).

Innovation by lead users have been studied since the 1970's (e.g., von Hippel, 1976, 1978b). Following the footsteps of von Hippel, research has explored the occurrence, characteristics, and motives of lead users (e.g., Hienerth, Pötz, & von Hippel, 2007; Lüthje, 2004), lead user communities (e.g., Franke & Shah, 2003; Schreier, Oberhauser, & Prügl, 2007), lead user identification and lead users' position in social networks (e.g., Belz & Baumbach, 2010; Kratzer, Lettl, Franke, & Gloor, 2015; Stockstrom, Goduscheit, Jørgensen, & Lüthje, 2012; von Hippel, Franke, & Prügl, 2009), and user innovation toolkits (e.g., Franke & von Hippel, 2003; von Hippel & Katz, 2002). The *lead user method* is described as a process that companies could apply in their product or service development in order to benefit from lead users (e.g., Churchill, von Hippel, & Sonnack, 2009; Herstatt & von Hippel, 1992; Lüthje & Herstatt, 2004; von Hippel, 1986).

Although cooperation with lead users has been shown to be an effective means to gain insight into the latent trends and solutions available in the user domain and to further transform this knowledge into product and service concepts (Herstatt & von Hippel, 1992; Lilien, Morrison, Searls, Sonnack, & von Hippel, 2002) and lead user-generated ideas have been shown to be more innovative and novel than those generated in-house (Lilien et al., 2002; Poetz & Schreier, 2012; Urban & von Hippel, 1988), majority of companies still focus on satisfying only the expressed and current user needs by utilizing traditional methods like focus groups or customer surveys (Dahlsten, 2003; Flint, 2002; Slater, 2001) or user-centered design and participatory design methods (Hyysalo, Repo, Timonen, Hakkarainen, & Heiskanen, 2016; Johnson, 2013; Schuler & Namioka, 1993). The LU method appears to have gained less ground as an everyday approach among companies. Companies are interested and satisfied with using the LU method, but seldom adopt it as standard part of their operations – this is the message from all previously reported cases as well as those studied in this dissertation. (Hienerth, Keinz, & Lettl, 2011; Hyysalo et al., 2016; Keinz, Hienerth, & Lettl, 2012; Olson & Bakke, 2001)

There is scant research on why this is so. The seminal empirical work by Olson and Bakke (2001) examines the implementation of the LU method in an IT company, but only few studies have followed. Hienerth et al. (2011) report on a multi-case comparison, where they explore effective strategies to overcome internal resistance in established companies wishing to introduce user-centric business models. Keinz et al. (2012) have touched on the subject in their review paper on organization design for user innovation. Olson and Bakke (2001) emphasize the importance to follow up on companies after initial LU method trials and call for a longitudinal approach together with a wider cross-section of cases in order to provide proof of the merits and weaknesses of the LU method.

Lilien et al. (2002, p. 1056), in their thorough investigation into the lead user idea-generation process compared to more traditional methods, call for research including: (1) further empirical study of the process in other organizations, (2) new method development regarding how to identify users

holding leading-edge information of commercial value; (3) new methods to obtain information from lead users and build that information into commercially viable new product and service offerings, and (4) designing and studying the organizational metrics and structures that lead to successful implementation of new processes like the LU method.

The above reasoning continues to provide footing for this dissertation. The LU method is still viable, even as idea competitions, crowdsourcing, and user communities have taken the bulk of attention of user innovation research since the turn of the millennium (e.g., Bogers & West, 2012; Franke, Lettl, Roiser, & Tuertscher, 2013; Koskela, Näkki, & Pikkarainen, 2009).

1.2 Aim of the Research

There is a considerable amount of studies that show how user innovation has played a major role in the development of products and services, both B-to-C and B-to-B (see section 2.2). Most of these studies paint a picture of the main events of the product or service development after they have occurred, or report the degree of users innovating per category (based on surveys, mainly). These studies thus provide good proof of the innovative potential of users and especially lead users, but leave companies seeking to benefit from this potential empty-handed.

In this dissertation, the LU method and its use in organizations are studied. The LU method comprises four main steps (see section 2.4): 1. Start of the LU process including team formation and goal setting, 2. Identification of needs and trends, 3. Identification of lead users, and 4. Concept design with lead users (Churchill et al., 2009; Lüthje & Herstatt, 2004; von Hippel, 1986). On the face of it, this seems like a simple and straightforward process. The first bottleneck of the process though becomes the identification of lead users, as identifying them reliably is the prerequisite for the LU method to be able to yield commercially attractive innovations (Franke, von Hippel, & Schreier, 2006). Lead user identification has also been found to be the most burdensome and time-consuming step of the method (Keinz et al., 2012; Lilien et al., 2002; Olson & Bakke, 2001). Bilgram et al. (2008, p. 421) conclude that "research in this area indicates that companies are still facing considerable problems in efficiently identifying suitable users".

User innovation research has contributed to the range of available search methods (see section 2.4.1), has sought to rationalize these search processes in terms of presenting process depictions (Churchill et al., 2009), formalized some of the strategies developed in doing these searches (von Hippel et al., 2009), as well as pursued comparisons and simulations for establishing the efficiency and efficacy between different lead user identification methods (Poetz & Prügl, 2010; Stockstrom et al., 2012; von Hippel et al., 2009). However, in reality the identification processes are more complicated and the question is no more

about the choice of identification method alone. This leads to the first objective of this dissertation, which is

1) *to further improve the concepts and means available for lead user identification.*

The last step of the LU method – the concept design – is typically organized as a workshop arrangement where both company representatives and the identified lead users are present (Churchill et al., 2009; Hienerth et al., 2007; Lüthje & Herstatt, 2004), but only sketchy instructions on how to run the workshop are available in the literature (Churchill et al., 2009). Literature also suggests the use of user innovation toolkits (von Hippel & Katz, 2002; von Hippel, 2001) and company-hosted user communities (Jeppesen & Frederiksen, 2006), but not specifically as alternatives to the LU workshop (see section 2.4.2). The need to elaborate on how the concept design with lead users should be organized is highlighted especially in the case of immaterial and complex services (Oliveira & von Hippel, 2011; Skiba & Herstatt, 2009). The second objective of this research thus is

2) *to gain more understanding on and alternative means for transferring (lead) user knowledge.*

As presented above, there is little research on why the LU method has not been adopted widely in companies, although there is piles of evidence of its potential. At the same time many comparable methods, such as contextual design (Beyer & Holtzblatt, 1999), have spread. The research so far has concentrated on the project-level, exploring individual LU projects and ceasing data-gathering at the end of the project. As LU projects tend to yield favorable results, this kind of research concludes at recommending the LU method. Nevertheless, the method remains unknown to most companies. The only study that has followed the occurrences in the company after the pilot project is the one of Olson and Bakke's (2001). They found the time and effort needed to sustain the LU method and the personnel turnover in the organization to be the two most important reasons for the non-adoption of the method. This dissertation builds on the previous research and as its third objective seeks

3) *to explore the factors that challenge the adoption of the LU method in an organization.*

In sum, the aim of this dissertation is to shed light on the challenges involved in the use of the LU method and to provide remedy and direction for its use in organizations that are seeking to benefit from lead users.

1.3 Structure of the Thesis

This dissertation comprises seven research papers which have been published in international peer-reviewed journals and conferences, and an introductory part that consists of 6 chapters. In chapter 2, relevant literature is presented starting from how the understanding of innovation has changed over time and then moving to the topics of user innovation, lead users and the LU method, how lead users are identified and how companies can work with them, and finally reviewing the LU method use in companies and factors challenging the LU method adoption. Chapter 3 explains methodological foundations and outlines the research process including empirical data collection and analysis. In the fourth chapter, summaries of the included publications are presented. Publications I–III correspond to research objective 1) and publications IV–VI to objective 2). The third objective is treated in all publications but is covered most thoroughly in publication VII. Chapter 5 provides findings. Chapter 6 delivers the theoretical and managerial contribution of this dissertation, and also proposes avenues for future research.

2. Frame of Reference

2.1 Changing Understanding of Innovation and User Roles

The way innovation is understood has changed dramatically over the decades. The linear model – research, development, production, marketing – has been the most accepted model of innovation since the World War II (Kline & Rosenberg, 1986; Rothwell, 1994). During the first two decades after the war, there was an emergence of new industries, along with regeneration of existing sectors, based largely on new technological opportunities. The ideas to be developed into products were stemming from scientific discoveries and new technologies, which is often called the "technology-push" model. The second generation of the linear innovation model entered when competition intensified and strategic emphasis on marketing was growing resulting in the "market-pull" model where ideas stemmed from the needs in the marketplace, but were then followed by a linear development process. (Rothwell, 1994) In the linear model, the role of users is to be mere consumers where their only choice is between use and nonuse of the innovation (Hyysalo, 2010).

The linear model with no feedback paths within the ongoing process depicts a chain of causation that holds only for some innovations: Often innovations are not based on scientific breakthroughs but companies review and combine their existing knowledge in order to meet a perceived market need (Kline & Rosenberg, 1986). Kline & Rosenberg's (1986) chain-linked model presents innovation as a process were feedback is part of the cooperation between the product specification, product development, production processes, marketing, and service components of a product line (see Figure 1).

In the chain-linked model, **K–R** depicts links through knowledge to research (and return paths). If problem is solved at node **K**, link **3** to **R** is not activated. Return from research (link **4**) is problematic (therefore dashed line). **D** means the direct link to and from research from problems in invention and design. **I** depicts the support of scientific research by instruments, machines, tools, and procedures of technology. **S** depicts the support of research in sciences underlying product area to gain information directly and by monitoring outside work. The information obtained may apply anywhere along the chain. (Kline & Rosenberg, 1986)

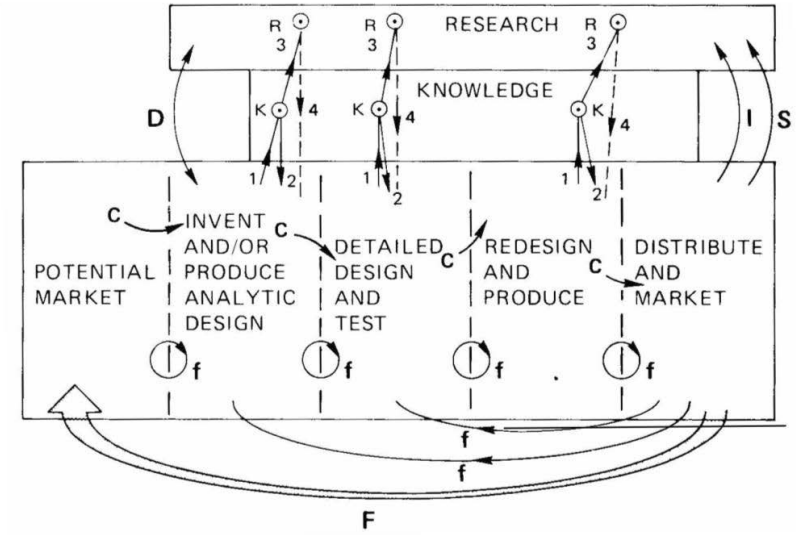

Figure 1. Chain-linked model of innovation. C = central-chain-of-innovation; f = feedback loops; F = particularly important feedback. (Kline & Rosenberg, 1986)

Kline and Rosenberg highlight the cyclicality of this model: "each market need entering the innovation cycle leads in time to a new design, and every successful new design, in time, leads to new market conditions" (1986, p. 290). They also make a point that challenges the simplicity of the linear model: "The fact is that most important innovations go through rather drastic changes over their lifetimes – changes that may, and often do, totally transform their economic significance. The subsequent improvements in an invention after its first introduction may be vastly more important, economically, than the initial availability of the invention in its original form." (1986, p. 283) Nonetheless the chain-linked model assumes that users are not an integral part of innovation activities (let alone R&D) *during* its development phases and its transformative interplay with other knowledge therein.

The linear model with little enhancements kept thriving during the 90's. The many variations of the model differed mainly in how the steps of the model were called. To give examples, Cooper's (1990) steps included idea, preliminary assessment, detail investigation, development, testing & validation, and full production & market launch, whereas Ulrich and Eppinger's (1995) steps were planning, concept development, system-level design, detail design, testing and refinement, and production ramp-up. In engineering, the linear process was modified so that the different steps were taken in parallel rather than in sequence in order to shorten the lead time. This process was termed concurrent engineering (Sohlenius, 1992). In these models user needs were (or were not) taken into account in the beginning of the process and user were possibly also considered at the time of testing.

A noteworthy take on explaining innovation is the one of Van de Ven et al.'s (1999), who report on longitudinal studies carried out in the Minnesota Innovation Research Program. The development of 14 diverse innovations was

tracked in real time and in their natural field settings. It was found that none of the innovations developed in a simple linear sequence or stages or phases of activities over time. "The innovation journey" thus is neither sequential and orderly, nor is it a matter of random trial and error, but it is best characterized as *a nonlinear* dynamic system (see Figure 2).

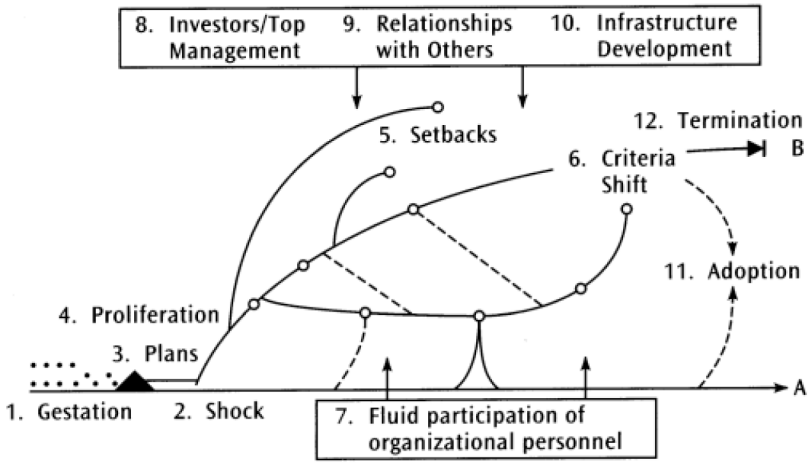

Figure 2. "Fireworks" model of innovation (Van de Ven et al., 1999, p. 25)

Van de Ven et al.'s model distinguishes between three main temporal periods – the initiation period, the developmental period, and the implementation/termination period – that are divided into 12 common process characteristics (Van de Ven et al., 1999, pp. 23–24).

The initiation period

1. Gestation: Innovations are not initiated on the spur of the moment, by a single dramatic incident, or by a single entrepreneur. In most cases, there was an extended gestation period lasting several years in which seemingly coincidental events occurred that preceded and set the stage for the initiation of innovations
2. Shock: Concentrated efforts to initiate innovations are triggered by "shocks" from sources internal or external to the organization.
3. Plans: Plans are developed and submitted to resource controllers to obtain the resources needed to launch innovation development. In most cases, the plans served more as "sales vehicles" than as realistic scenarios of innovation development

The developmental period

4. Proliferation: When developmental activities begin, the initial innovative idea soon proliferates into numerous ideas and activities that proceed in divergent, parallel, and convergent paths of development.
5. Setbacks: Setbacks and mistakes are frequently encountered because plans go awry or unanticipated environmental events significantly alter the ground assumptions of the innovation. As setbacks occur, resource and development time lines diverge. Initially, resource and schedule adjustments are made and

provide a "grace" period for adapting the innovation. But, with time, unattended problems often "snowball" into vicious cycles.

6. Criteria shift: To compound the problems, criteria of success and failure often change, differ between resource controllers and innovation managers, and diverge over time, often triggering power struggles between insiders and outsiders.
7. Fluid participation of organizational personnel: Innovation personnel participate in highly fluid ways. They tend to be involved on a part-time basis, have high turnover rates, and experience euphoria in the beginning, frustration and pain in the middle period, and closure at the end of the innovation journey. These changing human emotions represent some of the most "gut-wrenching" experiences for innovation participants and managers.
8. Investors / top management: Investors and top managers are frequently involved throughout the development process and perform contrasting roles that serve as checks and balances on one another. In no cases were significant innovation development problems solved without intervention by top managers or investors
9. Relationships with others: Innovation development entails developing relationships with other organizations. These relationships lock innovation units into specific courses of action that often result in unintended consequences.
10. Infrastructure development: Innovation participants are often involved with competitors, trade associations, and government agencies to create an industry or community infrastructure to support the development and implementation of their innovations.

The implementation/termination period

11. Adoption: Innovation adoption and implementation occurs throughout the developmental period by linking and integrating the "new" with the "old" or by reinventing the innovation to fit the local situation.
12. Termination: Innovations stop when implemented or when resources run out. Investors or top managers make attributions about innovation success of failure. These attributions are often misdirected by significantly influence the fate of innovations and the careers of innovation participants.

Not all components of the model are the same in all innovations, and for innovations of greater novelty, size, and temporal duration, the key process elements are expected to be more pronounced. Van de Ven et al. (1999, p. 53) also highlight that it is misleading to assume that development of an innovation is completed during the implementation period, because much reinvention (Rogers, 1995) occurs. Van de Ven et al. admit that adopters may modify an innovation to fit their local implementations setting, but the user is still seen as the terminus of the innovation process, the organization monopolizing the process.

Along with the rise of software development came cyclical innovation processes. Agile development refers to relatively quick development cycles where working software is produced and user evaluation is possible in each cycle (Beck et al., 2001). The idea of cyclicality was presented also outside software development in propositions such as the Cyclic Innovation Model (CIM) (Berkhout, Hartmann, van der Duin, & Ortt, 2006; Berkhout & van der Duin, 2007). In

CIM, new technologies (such as scientific discoveries) and changes in the market (such as new user needs) continually influence each other in a cyclic manner enabling a dynamic process where eventually innovations build on innovations. The cyclicality thus enables more frequent input of user needs and a more rapid evolution of an innovation compared to a linear innovation model. In CIM it is in fact possible to hear echoes of the ideas that were presented in Kline and Rosenberg's chain-linked model already back in 1986.

Parallel to Kline and Rosenberg's (1986) influential article, the role of user in the innovation process was discussed elsewhere. Lundvall (1985, 1988) highlighted out the importance of interactive learning between users and producers in successful product innovation. Eric von Hippel turned the whole thing around and claimed that the source of many innovations is in fact users, not companies (von Hippel, 1976, 1986, 1988). Before jumping to this issue of user innovation – that is the most relevant model with regard to the dissertation at hand – we take a look at open innovation.

Traditionally companies have relied on internal innovation that is based on the assumption that successful innovation requires control. Companies generate their own ideas and then develop them, build them, market them, distribute them, service them, finance them, and support them on their own. Chesbrough (2003) calls this closed innovation and claims that it makes companies run in circles: Companies invest in internal R&D, make discoveries that enable the company to bring new products and services to market, realize more sales and higher margins, and then in order to improve the products and services, the company needs to re-invest more in internal R&D. The concept of open innovation is a paradigm that assumes that in addition to internal ideas, companies can and should use external ideas and external paths to the market, in order to advance their technology and products. This includes buying or licensing knowledge, processes, or inventions (i.e. patents) from outside. It should also work the other way around: Internal inventions not being used in a company's business should be taken outside the company through licensing, joint ventures, or spin-offs. (Chesbrough, Vanhaverbeke, & West, 2006; Chesbrough, 2003)

The open innovation model is still inherently linear without any feedback or feed-forward mechanisms. According to Trott and Hartmann (2009, p. 729) "the only distinguishing difference is that in the open innovation model, ideas (technologies, knowledge) can freely 'fly in' and 'fly out' of the funnel that runs from opportunity scanning to business incubation" (see Figure 3). Trott and Hartmann call for innovation models that would once and for all get rid of the notion of linearity in the innovation process.

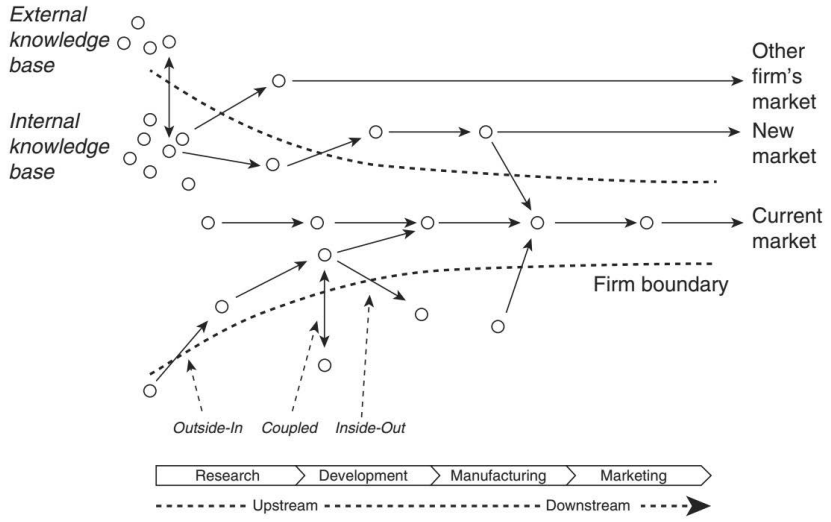

Figure 3. The open innovation model (Chesbrough & Bogers, 2014).

While open innovation is a broad term comprising all forms of external innovation, user innovation means innovation carried out specifically by users. Users are individual consumers (or companies) that expect to *benefit* from using a product or a service, whereas manufacturers expect to benefit from *selling* a product or a service (von Hippel, 2005, p. 3). Traditionally users have been seen as passive consumers who merely consume the products that manufacturers develop. In reality, users have always been making modifications to products when needed (see section 2.2).

Gassmann et al. (2010) see the user perspective as one of the nine perspectives to open innovation. Piller and West (2014, p. 29) on the other hand see that open innovation and user innovation "are at best partly overlapping perspectives on this distributed model of innovation". Open innovation and user innovation study different phenomena, open innovation being a firm-centric paradigm that is primarily concerned with leveraging external knowledge to improve internal innovation, whereas user innovation is "mainly about individuals using innovation to address their own (often unique) needs, without regard to firm success and often as part of a socially embedded community" (Piller & West, 2014, p. 29).

Here is where we arrive at the overarching standpoint of the dissertation at hand: Nowadays the cyclic nature of innovation is recognized and it is understood that the cycle can also change its course, meaning that users can be the source of innovation. Next we will take a closer look at user innovation.

2.2 User Innovation

> "In the first fire-engines, a boy was constantly employed to open and shut alternately the communication between the boiler and the cylinder, according as the piston either ascended or descended. One of those boys, who loved to play with his companions, observed that, by tying a string from the handle of the valve which opened this communication to another part of the machine, the valve would open and shut without his assistance, and leave him at liberty to divert himself with his playfellows. One of the greatest improvements that has been made upon this machine, since it was first invented, was in this manner the discovery of a boy who wanted to save his own labour." (Smith, 1776, pp. 15–16)

The idea of users innovating is not new. In fact, studies of user-driven innovation have started emerging since the 1960's (Enos, 1962; Freeman, 1968; von Hippel, 1976). As pointed out by Bogers et al. (2010), one of the earliest examples of user innovations was given by Adam Smith in 1776, quoted in the beginning of this section. Since then examples have amassed in numerous fields including the development of sporting instruments (Franke et al., 2006; Hienerth, von Hippel, & Berg Jensen, 2014; Hyysalo, 2009b; Raasch et al., 2008; Shah, 2000; Tietz, Morrison, Lüthje, & Herstatt, 2005), medical devices and technology (Chatterji & Fabrizio, 2012; Habicht, Oliveira, & Shcherbatiuk, 2013; Lettl et al., 2006; Lettl, 2005; Lüthje, 2003), scientific instruments (Riggs & von Hippel, 1994), renewable energy technologies (Hyysalo et al., 2013b; Juntunen, 2014), baby products (Shah & Tripsas, 2007), banking services (Oliveira & von Hippel, 2011; van der Boor, Oliveira, & Veloso, 2014), and library information systems (Morrison, Roberts, & von Hippel, 2000), to name a few.

Research so far suggests that the frequency of user innovation in broad samples of consumers is about 4–6 % (de Jong, 2011; Kuusisto, de Jong, Gault, Raasch, & von Hippel, 2013; Ogawa & Pongtanalert, 2011; von Hippel, de Jong, & Flowers, 2012). In some special fields the amount of users creating innovations among all users has been shown to vary from 10 % to as high as 40 % (Franke & Shah, 2003; Franke & von Hippel, 2003; Lüthje, Herstatt, & von Hippel, 2005; Lüthje, 2003, 2004; Morrison, Roberts, & von Hippel, 2000; Urban & von Hippel, 1988).

Recently, user's role also in technique development has been studied. Hinsch et al. (2014) analyze the processes by which users generate and diffuse new techniques in the field of medical devices. They also explore the interdependencies between user-generated techniques and subsequent changes to product use and product innovation, and their findings suggest that user innovation in techniques triggers product innovation by users and manufacturers. This leads to conclusion that users' contributions to total innovation output are much higher than previously considered (Hinsch et al., 2014).[2]

Users innovate because they have no better alternative. What is interesting about user innovation is that the designer of the solution – the user – benefits

[2] Technique development has also been noted by Hienerth, von Hippel, and Berg Jensen (2014) in their thorough exploration of innovation development in the whitewater kayaking field.

directly from the innovation. This is not the case when a company develops the solution. Users do not care how the need is met, as long as it is met. Companies, on the other hand, need to struggle with many things other than the optimal solution: product portfolios, strategy, manufacturing capability, etc. They are, in fact, not out to serve each individual user optimally. Users can come up with the most suited solution for themselves, because they are searching for the best possible functional solution to their own problem. For example, according to the studies by Kristensson, Magnusson, and Matthing, who have carried out various experiments on user involvement in the development of mobile ICT services, user-generated ideas are more innovative and better match users' needs than the ideas generated by developers (Kristensson, Magnusson, & Matthing, 2002; Kristensson & Magnusson, 2010; Magnusson, Matthing, & Kristensson, 2003; Magnusson, 2003).

2.2.1 Related Concepts

The concept of user innovation is often confused with other well-known concepts, such as user- (or human-) centered design or participatory design. Even though the end-result of these activities may be the same – an outcome that is fitting to the user – there are many important differences. According to ISO 9241-210, the goal of user-/human-centered design is "to make systems usable and useful by focusing on the users, their needs and requirements, and by applying human factors/ergonomics, and usability knowledge and techniques" (International Organization for Standardization, 2010). What is characteristic of user-centered design methods is that it is still the designer at the R&D organization who takes the center stage. Users provide the designer with information and ideas for solutions that she can use when designing the product. This is in contrast to user innovation, where it is the user that innovates with or without the company.

The user-centered design approaches offer a variety of methods for user needs assessment: interviewing (group, open, structural, etc.), contextual inquiry (Beyer & Holtzblatt, 1998, 1999), design probes (Gaver, Dunne, & Pacenti, 1999; Mattelmäki, 2006), observing, etc. All of these methods help the designer learn about the needs of the targeted user. Thus, the company first learns about user's needs and then develops a corresponding product to meet that need. Even if the user has developed some type of solution to his/her need, companies very often overlook user's solution, registering only the need. The main difference between user innovation and user-centered design thus is who carries out the actual innovation. In user-centered design the innovator is predominantly still the designer who works in a company.

In the zone between user innovation and user-centered design reside many *participatory design* methods (collaborative design in Figure 4, see below). Participatory design aims to conduct design with users, facilitating innovative activities by the users, but also including elements where designers develop solutions for the users (Bødker, Kensing, & Simonsen, 2004; Voss et al., 2009). However, participatory design typically depends, as the name suggest, on design collaboration between designers and users and in this regard differs from "pure"

user innovation. Moreover, as we come to discuss later, product development approaches that build on user innovation and users who are most likely to innovate, differ considerably from the ideals of democratic and representative participation that characterize participatory design (Hyysalo, 2010; Voss et al., 2009). The lead user methodology (see section 2.4) is interested only in the quality of the innovation and innovative ideas that can be built (Churchill et al., 2009).

The terms mass customization, personalization, and tuning relate intimately to user needs. Äijälä (2007) categorizes these terms as follows: The goal of *mass customization* (Piller, 2015; Pine, 1993) is to design, manufacture, market and deliver reasonably priced products that satisfy individual user needs. Cars, for example, are mass customized, i.e. the buyer gets to choose from a large variety of alternatives such as colors, materials and accessories. *Personalization* also aims at satisfying user needs, but unlike in mass customization, the company only gives the user tools to modify the product according to his/her personal needs. The company approves and enables personalization, but the user carries it out. At one point, mobile phone manufacturers offered interchangeable covers for phones, so that the user was able to modify the appearance of the phone to his or her liking. *Tuning* is product modification done completely by the user. The company plays no role in tuning, whereas in personalization, the user does modify the product, but the modification process is designed at the company. Therefore only tuning can be classified as user innovation. Car-tinkerers make a classic example of users who tune products.

A more general categorization of the variety of design activities that reside between the two poles – users and producers – is the one of Hyysalo and Johnson's (INUSE Research Group, 2015), where they categorize the activities with respect to agency given to these two poles. In the producer-end of this range, users are seen only as an *inspiration* for design or at most the producer is immersed in use and can benefit from her own experience in the user domain. User-experience design (UXD) and human-centered design (HCD) (or user-centered design UCD) mean *investigating* the user and her needs, wants, and limitations, the producer still dominating the design of the product or service. *Cooperation* between the user and the producer can be collaborative or co-creative. Collaborative design (including participatory design) takes users as design partners to help determine product or service needs in a synchronous collaboration, main responsibility of design still remaining with the producer.[3] In co-creative design, the work is partially done by users in a long-term asynchronous process. Producers provide solutions but users build on them as they take them into use (Botero & Hyysalo, 2013; Henderson & Kyng, 1991). At the user-end of this range users innovate for and by themselves. They dominate the design but can benefit from technical or social arrangements provided by the producer, such as crowdsourcing, open API, or user innovation toolkits, which can be seen as forms of firm hosted user design (see more in section 2.4.2). Users may also innovate by themselves entirely. This innovation by users, however, is

[3] See Johnson (2013), Maguire (2001), or Muller and Kuhn (1993) for more detailed listings of available methods in UXD, HCD, UCD, and participatory design.

increasingly taking place in conjunction to both offline and online *communities*, whether empowered by a company or by self-organizing as independent user innovator communities, such as Wikipedia or Linux. The range of these activities is depicted in Figure 4.

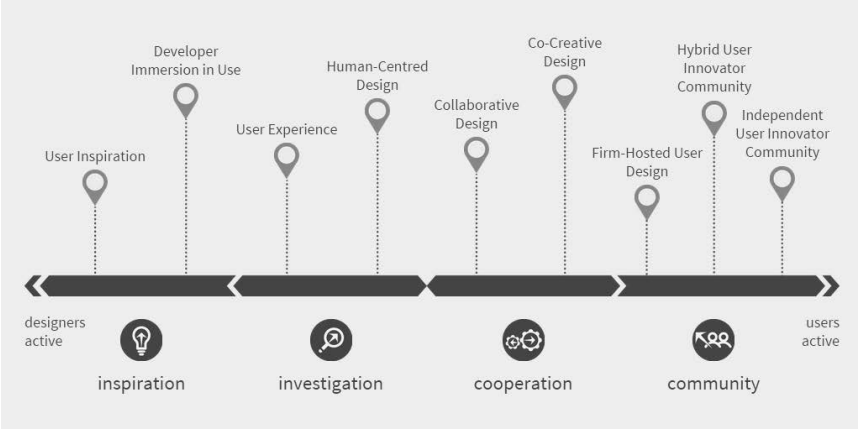

Figure 4. The range of design activities according to Hyysalo and Johnson (INUSE Research Group, 2015; see http://codesign.inuse.fi/approaches).[4]

To better grasp the concept of user innovation – the phenomenon that characterizes the user-end of the continuum – von Hippel (1986) developed the term Lead User that is introduced next.

2.3 Lead Users

Innovations diffuse over time, as portrayed by the example of mobile phone penetration in Finland: In 1990 only 5 % of Finns had a mobile phone, in 1998 already 55 %, and by the end of 2008 the rate was 130 %, that is on average 1.3 phones per person (Statistics Finland, 2009). Today there is a clear need for a mobile phone. But what will the market need tomorrow? How can we learn about a new market when the market does not yet exist?

Rogers (1995) talks about the diffusion of new ideas through a society, and the fact that a considerable time lag exists from the introduction of a new idea to its widespread adoption. The main elements in the diffusion of new ideas are: (1) an innovation (2) that is communicated through certain channels, (3) over time (4) among the members of a social system. Not all new ideas or innovations diffuse[5], but when they do, it is a phenomenon that is very difficult to restrain. For instance, the Chinese were unsuccessful in their attempt to maintain their position as the only knowledge of gunpowder. And today, the secret of the nuclear bomb is no longer a secret. (Rogers & Shoemaker, 1971; Rogers, 1995)

[4] I have carried out most the research reported in this dissertation as a member of INUSE Research Group. This figure is part of the Codesign Journey Planner developed by Hyysalo and Johnson who are members of INUSE. See more at http://codesign.inuse.fi/about

[5] See the very beginning of this dissertation (page 11) for the discussion of the failure rate of new products.

According to the diffusion model, an innovation is completely diffused when it has been adopted by 100 % of the members of the social system to which it has been introduced. Rogers (1995) divides the adopters into five categories: innovators, early adopters, early majority, late majority, and laggards. When a large amount of data is arranged on a symmetric bell curve, the shares of these five categories are roughly as follows (Rogers, 1995, pp. 282–285):

- Innovators: the first 2.5 % who adopt a new technology. They are "venturesome" almost to the point of obsession, and willing to absorb high costs and uncertainties for the reward of being first to adopt new technologies.

- Early adopters: the next 13.5 % to adopt. They find it easy to imagine, understand, and appreciate the benefits of a new technology. By many they are considered as "the individual to check with" before using a new idea. The highest number of "opinion leaders" is found among the early adopters.

- Early majority: the next 34 % to adopt. They adopt new ideas just before the average member of a system. They follow with deliberate willingness in adopting innovations, but seldom lead.

- Late majority: the next 34 % to adopt. They are skeptical about innovations and often adopt only because of the peer pressure those who have already adopted. They often have relatively scarce resources, which means that most of the uncertainty must be removed before they feel safe to adopt.

- Laggards: the final 16 % to adopt. They are traditionalists and tend to be suspicious of innovations. They possess almost no opinion leadership. The point of reference for the laggard is the past.

It must be remembered though than no-one has an absolute status of belonging to any of these categories. The same person can be an early adopter regarding a certain product, but a laggard regarding something else (Hyysalo, 2009a, p. 98).

The theory of lead users relies on the idea that there is always somebody who has the need first, and that the rest of the marketplace will have the need later. There are always users whose present needs foreshadow general demand (Rogers & Shoemaker, 1971). Von Hippel (1986) defines lead users of a novel or enhanced product, process, or service as those displaying two characteristics with respect to it:

1. Lead users face needs that will be general in a marketplace – but face them months or years before the bulk of that marketplace encounters them, and

2. Lead users are positioned to benefit significantly by obtaining a solution to those needs.

According to the first lead user characteristic, the "ahead of an important market trend" variable, there are users who experience new needs and are prepared to generate innovations that substantially differ from existing market offers. The second characteristic, the "expected benefits" variable reflects the possibility of the users initiating the development of a new solution if the solution would bring them significant benefit (von Hippel, 1988, 2005). In other words, lead users are well ahead of market trends and have needs that go far beyond those of the average user (von Hippel, Thomke, & Sonnack, 1999).

It is important to distinguish between lead users and the categories defined by Rogers (1995) (see Figure 5). A lead user acts solely on his or her needs, while Roger's innovators and early adopters are driven by their interest in the new technology. In other words, as stated by von Hippel (von Hippel, 2007, p. 300): "Note that lead users are not the same as early adopters of an innovation. They are typically ahead of the entire adoption curve in that they experience needs before any responsive commercial products exist – and therefore often develop their own solutions."

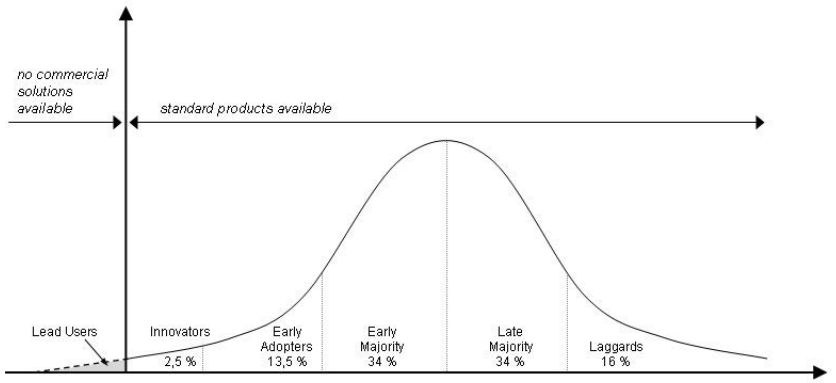

Figure 5. Lead users' position on a market trend compared to Rogers's diffusion curve [author's depiction based on von Hippel (2005) and Rogers (1995)].

When companies try to be customer-oriented, they usually look at the targeted customers. The problem with the customers of the target market is that they tend to have less elaborated needs understanding due to existing tools that suite them "well enough" so that they have not needed to question how these tools could be improved (Hyysalo, 2003). Most customers are therefore unable to reveal information that enables the company to create breakthroughs. This makes lead users very appealing to companies – lead users do not base their views on existing products but on their needs. "In contrast, lead users would seem to be better situated in this regard – they 'live in the future' relative to representative target-market users, experiencing today what representative users will experience months or years later." (Lilien et al., 2002, p. 1044)

Who are lead users then? A lead user is often somebody who is trying to improve his or her way of working rather than consciously trying to invent. Like the developer of the World Wide Web Tim Berners-Lee says: "It was something

I needed in my work" (Brody, 1996). Berners-Lee wanted simply to solve a problem that was hindering his efforts as a consulting software engineer at CERN, the European Organization for Nuclear Research in Geneva. Mainly to become more efficient, he developed a system that provided easy-to-follow links between documents stored on a number of different computer systems and created by different groups. He expanded the idea he had developed at CERN and made it available on the Internet in the summer of 1991. (Brody, 1996)

Sporting equipment is an area where innovations are often developed by lead users. Shah (2000) shows that innovations in skateboarding, snowboarding, and windsurfing have typically been developed by a few early expert participants in those sports. The innovating users are in their teens or early twenties and technically unsophisticated. They develop their innovations via learning-by-doing in these novel and rapidly evolving fields. This is the key here: to literally stay or go ahead in the game they must seek to invent.

Another sports related lead user originated example is that of a heart rate monitor. The idea for the heart rate monitor was originated by Seppo Säynäjäkangas, a professor of electronics, already in 1975. He enjoyed cross-country skiing, and he started wondering what methods could be used to monitor the development of his condition. Suomen Hiihtoliitto (Finnish Ski Association) soon became interested in the idea and started developing a prototype with professor Säynäjäkangas, and in 1977, Säynäjäkangas founded Polar that is nowadays a world-leader in the business. Heart rate monitors became utilized by all competitive athletes, and nowadays the heart rate monitor has diffused to serve a big part of people who enjoy recreational sports. (Polar, 2007, 2015; Wikipedia, 2015)

The energy bar was invented by Olympic marathoner Brian Maxwell. He conceived of the idea of an endurance-boosting bar for athletes after "bonking" (what runners call the point at which the body runs out of carbohydrates and starts burning muscle) in a 1983 race. Working with his girlfriend Jennifer, a nutritionist, the pair came up with an energy bar that athletes could eat before and during events. In 1986, they began making PowerBars in their kitchen. In addition to athletics, examples of lead user innovation can also be found in abundance in other harsh conditions, such as aerospace and military solutions, or hostile environments (Hyysalo & Usenyuk, 2015).

However, cases can be found virtually in any field. For example, when 3M, a diversified technology company, was trying to develop cheaper and more effective infection control in the area of surgical drapes[6], they went to gather information outside the target market, in order to find lead users. They travelled to hospitals in Malaysia, Indonesia, South Korea, and India, and learned how people in less than ideal environments attempt to keep infections from spreading in the operating room. They interviewed veterinarians who had great success keeping infection rates low despite cost constraints and the fact that their patients were covered with hair and didn't bathe. They also interviewed

[6] Surgical drapes are thin adhesive-backed plastic films that are adhered to a patient's skin at the site of surgical incision, prior to surgery. Surgeons cut directly through these films during an operation.

Hollywood makeup artists who had learned effective ways to apply nonirritating, easy-to-remove materials to skin – which is important to the design of infection control materials. With the help of lead users, 3M was able to create three new product-line concepts. (von Hippel et al., 1999)

It should be noted that lead users are not necessarily just individual consumers; they can also be large companies. For example, if an airplane manufacturer develops a tool to help build airplanes, it has developed an innovation as a user. In contrast, when it develops an innovative new aircraft to manufacture and sell, the innovation is classified as a manufacturer innovation. (von Hippel et al., 1999) Enos reported already in 1962 that almost all of the most important innovations in oil refining were developed by user firms (Enos, 1962). On the other hand, lead users can also be embedded in the companies, meaning employees that are also users of the company's products (Schweisfurth & Herstatt, 2014).[7]

When trying to identify a lead user, it should be remembered that lead users can also be found from a totally different branch of industry than the one of the possible application. If a manufacturer of materials used in automobiles identifies a trend toward lighter, higher strength materials, the company may find the lead users at the front of this trend are aerospace firms rather than auto firms, because aerospace firms may be willing to pay more than auto firms for improvements of these attributes. (von Hippel, 1986) Veterinarians in contrast to physicians of human patients, or aerospace industry in contrast to automobiles are called advanced analogous fields. These are markets that face similar problems but perhaps in a more extreme form. If an automobile manufacturer aimed to design an innovative braking system, it might start by trying to find out if any innovations had been developed by drivers with a strong need for better brakes, such as auto racers. Next, it would look to a related but technologically advanced field where people had an even higher need to stop quickly, such as aerospace. And, in fact, aerospace is where innovations such as antilock braking systems (ABS) were first developed: military aircraft commands have a very high incentive to stop their vehicles before running out of runway. (von Hippel et al., 1999)

Often lead users solve their problems by utilizing existing commercial products in ways not anticipated by their manufacturers (von Hippel, 1986). In the case of the ABS, had the automobile manufacturer actually looked at the users of the leading edge – the auto racing teams – they would have noticed that race car drivers had learned to manually pump their brakes and the automobile manufacturer would not have had to go to aerospace industry in the first place (von Hippel, 2005).

As lead users' present strong need is likely to become general in a marketplace, but it will take months or even years for that to happen, lead users can be used as a need-forecasting laboratory for marketing research. In addition to the need data, they can provide valuable new product concept and design data, because of their attempt to fill the need they experience. (von Hippel, 1988) Developing

[7] Kotro (2005, 2007) has studied product development in a company that designs and produces sports and precision instruments, and where the product developers are also users of the products. Kotro introduced the term 'hobbyism' that refers to the employees' passion for sports and the employees' relationships with sports communities as an important reference for understanding users in the product development process.

products to meet these needs that are still latent for the majority of the market allows a company to anticipate trends and to leapfrog competitive products. Analysis of data from lead users can improve the productivity of new product development in fields characterized by rapid change (von Hippel, 1986). In their study on kite surfing, Franke et al. (2006) analyze the relationship between the commercial attractiveness of innovations developed by users and the intensity of the lead user characteristics embodied in those users. It is illustrated in Figure 6 that when moving from low to high in the expected variable (LU component 1), the proportion of innovating users rises. Similarly, when moving towards the position in ahead of a trend (LU component 2), the attractiveness of innovations rises. Franke et al. also found out that a single component of the lead user definition – being at the leading edge of a marketplace trend –predicts both user innovation likelihood and innovation attractiveness.

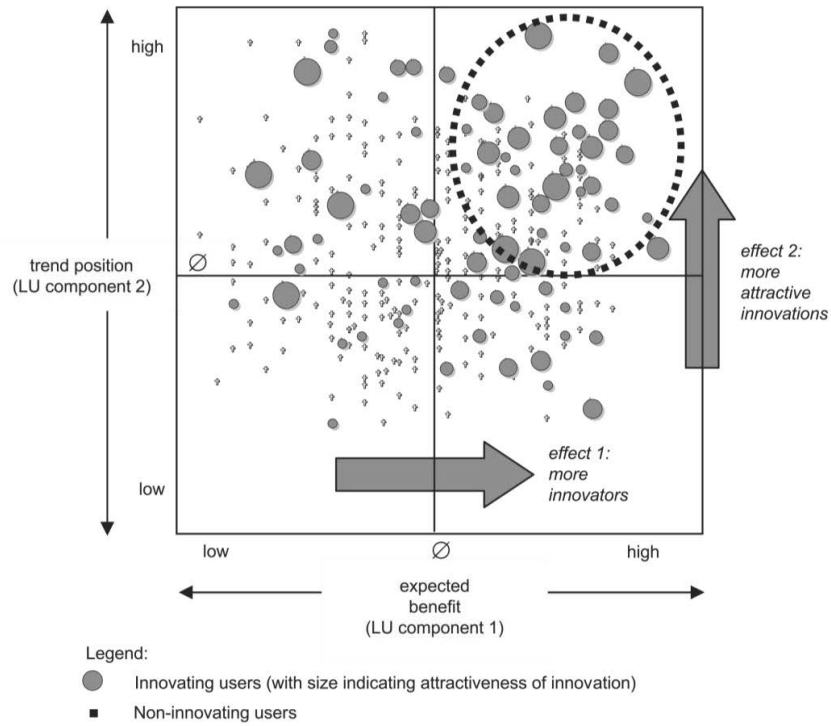

Figure 6. The effect of the lead user characteristics on the attractiveness of lead user generated innovations. In the area highlighted in segmented circle, the largest fraction of users innovate, and average innovation attractiveness is high. (Franke et al., 2006)

Lead users are "the ultimate users" to find, in order to benefit from the innovation potential of users. Next, literature is explored focusing on the LU method and especially, how lead users can be identified and how companies can work with them.

2.4 Lead User Method

When von Hippel first introduced the term lead user in 1986, he also suggested a four-step process on how these lead users should be utilized: 1) Identify an important market or technical trend; 2) Identify lead user who lead that trend in terms of a) experience and b) intensity of need; 3) Analyze lead user need data; 4) Project lead user data onto the general market of interest. (von Hippel, 1986)

In 1988 Urban and von Hippel introduced a more general methodology for concept development and testing consisting of the following four steps (Urban & von Hippel, 1988, pp. 570–571):

1. Specify lead user indicators
    a. Find market or technological trend and related measures

Lead users are defined as being in advance of the market with respect to a given important dimension which is changing over time. Therefore, before one can identify lead users in a given product category of interest, one must specify the underlying trend on which these users have a leading position, and must specify reliable measures of that trend.

    b. Define measures of potential benefit

High expected benefit from solving a need is the second indicator of a lead user, and measures or proxy measures of this variable must also be defined. In work to date, we have found three types of proxy measures to be useful. First, evidence of user product development or product modification can serve as a proxy for user benefit because, as we noted previously, user investment in innovation and user expectations of related benefit have been found to be correlated. Second, user dissatisfaction with existing products (services and processes) can serve as a proxy for expected benefit because it is logical that the degree of dissatisfaction with what exists will be correlated with the degree of expected benefit obtainable from improvements. Finally, speed of adoption of innovations may also serve as a surrogate for high expected benefit. Early adoption and innovativeness have been found often correlated with the adopter's perception of related benefit (Rogers & Shoemaker, 1971).

2. Identify lead user group

Once trend and benefit indicators are specified, one may screen the potential market based on the measures specified above via questionnaire and identify a lead user group. This is accomplished by a cluster analysis of the survey-based lead user indicators to find a subgroup which is the leading edge of the trend being studied and displays correlates of high expected benefit from solutions to related needs.

3. Generate concept (product) with lead users

The next step in the method involves deriving data from lead users related to their real-life experience with novel attributes and/or product concepts of commercial interest. This experience may include modifications to existing products or new products which they have created to meet their needs. Creative group sessions can be used to pool user solution content and develop a new product concept. In some cases the user solution may represent not only a concept but a fully implemented product.

4. Test lead user concept (product)
The needs of today's lead users are typically not precisely the same as the need of the users who will make up a major share of tomorrow's predicted market. Indeed, the literature on diffusion suggests that, in general, the early adopters of a novel product or practice differ in significant ways from the bulk of the users who follow them (Rogers, 1962). One therefore next assesses how lead user data are evaluated by the more typical users in the target market. This can be done by employing traditional concept (product) test procedures after segmenting lead and non-lead user responses.

Later on, also Lüthje and Herstatt (2004) and Churchill et al. (2009) have presented versions of the lead user method. Both processes are essentially similar to the one of Urban and von Hippel. The steps of Churchill et al. include: 1. Preparing for your lead user project, 2. Identifying trends and key customer needs, 3. Understanding the needs and solutions of lead users, and 4. Improving solution concepts with lead users and experts. The four-step process of Lüthje and Herstatt remains the most cited one and is illustrated in Figure 7.

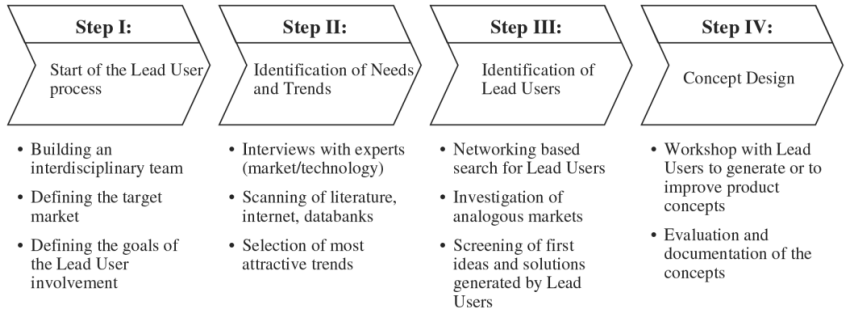

Figure 7. The process of the lead user method (Lüthje & Herstatt, 2004, p. 561).

Next the literature is reviewed regarding the steps III and IV that are the most relevant ones to this dissertation.

2.4.1 Lead User Identification

Literature to date has suggested the following methods and directions as a means to identify lead users (for extended discussion, see publication III).

Screening is a common approach for finding lead users (Belz & Baumbach, 2010; von Hippel et al., 2009). It is based on collecting information from every member of a population in order to identify the members with desired attributes. However, the rare nature of the sought lead user attributes can make screening inefficient (Sudman, 1985). For example, Lüthje (2000) reports screening 2043 persons to identify 22 lead users – a sampling efficiency of only 1.1 %.

Snowball sampling (Goodman, 1961; Welch, 1975) or the *"telephone networking approach"* as labeled in the Lead User Project Handbook (Churchill et al., 2009), means that individuals are asked to identify people who have a desired

characteristic, or who can provide important information. The Lead User Project Handbook also suggests *site visits* when initial telephone interviews have revealed interesting user-developed innovations (Churchill et al., 2009).

Pyramid sampling (i.e. *pyramiding*) is a variant of snowball sampling; asking for nominations of individuals who know more or have more of the sought attribute (Lilien et al., 2002; von Hippel et al., 2009, 1999). It has been found to be more efficient than snowball sampling. Von Hippel et al. (von Hippel et al., 2009) have tested the efficiency[8] of pyramiding compared to screening, and in their study of 663 pyramiding search chains found the effort of pyramiding search to be only 28.4 % of the effort of screening. Stockstrom et al. (Stockstrom et al., 2012) analyzed simulations of a total of 13 188 search chains and found pyramiding to require, on average, 31 % of the effort[9] of screening.

Investigation of analogous fields is a name lead user researchers have given to exploring fields in which similar challenges are present as in the search field under consideration (Lüthje & Herstatt, 2004). Lead users identified in the "advanced analog" fields are found to develop innovations that are most radical relative to conventional thinking (von Hippel, 2005). A well-known example of this is the case of 3M trying to develop surgical drapes (the material that prevents infections from spreading during surgery). The most valuable users were found in veterinary hospitals and among make-up artists in Hollywood (von Hippel et al., 1999). The cross-industry innovation case of the anti-lock braking system (ABS) transferring from the field of aerospace to standard cars is a further example (von Hippel et al., 1999; von Hippel, 2005). Poetz and Prügl (2010) addressed the potential of pyramiding for crossing domain-specific boundaries by analyzing 1147 interviews conducted in the course of pyramiding search processes in eight lead user studies. In their study more than one third of those interviewees who were able to provide a valid referral in their interview, could refer to one or more analogous domains previously unknown to the searcher.

Domain experts (sometimes called lead-use experts) are people who are highly knowledgeable of the user domain area but not necessarily the lead users (or other rare subjects) sought for. Domain experts can be asked to point out lead users (Churchill et al., 2009).

User communities have in some studies been used for finding prominent lead users for example in mountain biking, rodeo kayaking, or renewable energy equipment (Hienerth, 2006; Hyysalo, Juntunen, & Freeman, 2013a; Lüthje et al., 2005).

Broadcasting means advertising the need for a solution or expertise in hope that relevant people self-select to respond (Jeppesen & Lakhani, 2010; Lakhani, 2006). A common form of broadcasting is to post a problem on an Internet discussion forum or a mailing list of a special interest group. Broadcasting has been combined with pyramiding in several lead user projects (e.g., Hienerth et al., 2007).

[8] 'Efficiency' here means the chain length, i.e. "number of nodes from start to end point" (von Hippel et al., 2009, p. 1401).

[9] 'Effort' is used in parallel with 'efficiency', i.e. "number of chain links" (Stockstrom et al., 2012, p. 21).

Idea competitions follow the idea of broadcasting. Submissions to the contest are evaluated by an expert panel and users whose submissions score highest receive an award from the manufacturer (which is often granted the right to exploit the solution in its domain). Piller and Walcher (2006) claim that idea competitions are often faster and less laborious (and expensive) compared with screening and pyramiding.

A virtual stock market (VSM) means bringing a group of participants together via the Internet and allowing them to trade shares of virtual stocks. Spann et al. (2009) explored the use of VSMs in identifying lead users in the product category "movies". They concluded that VSMs are an effective means to attract and filter large numbers of anonymous customers for the identification of lead users on the Internet.

Seeking out innovative solutions to reveal innovating users behind them is another way to find lead users as lead users are likely to be more invested in such development than other users (Bilgram et al., 2008). Many lead users have developed prototypes, modifications, or other iterations of existing products to meet their needs, which the products on the market do not yet satisfy (Baldwin, Hienerth, & von Hippel, 2006; von Hippel, 1976, 1988).

Doing "*netnography*" in user forums is a recently established method for analyzing online communities (Kozinets, 1998, 2010). It was applied by Belz and Baumbach (2010) to identify lead users in an online community. Also others have explored virtual communities for lead user identification (e.g., Bragge, Tuunanen, & Marttiin, 2009; Franz & Wolkinger, 2003; Tuunanen, Bragge, Häivälä, Hui, & Virtanen, 2011). Lead users might also be through social media (Ernst, Brem, & Voigt, 2013), such as new technology product blogs (Droge, Stanko, & Pollitte, 2010) and Twitter (Pajo, Verhaegen, Vandevenne, & Duflou, 2013, 2014; Tuarob & Tucker, 2015). Bilgram et al. (2008, p. 425), similarly hypothesized that in web 2.0 "leading edge users are likely to be already committed to communities as active members".

Some of the above search strategies have been presented as process depictions (e.g., Churchill et al., 2009). Some have also been formalized, such as pyramiding by von Hippel et al. (2009). There are also studies that have explored the potential of different methods, such as a study of the potential of pyramiding for crossing domain-specific boundaries by Poetz an Prügl (2010). Some have pursued comparisons and simulations for establishing the efficiency and efficacy between different lead user identification methods, such as comparisons between screening and pyramiding (Stockstrom et al., 2012; von Hippel et al., 2009) or idea competitions and screening (Piller & Walcher, 2006). So far, the above identification strategies have been seen as alternatives, although trials have emerged using two search methods in parallel (Hienerth et al., 2007) or sequentially (Keinz & Prügl, 2010, p. 280).

2.4.2 Working with Lead Users

The final step of the lead user method – working with lead users in order to generate or improve new product (or service) concepts – is typically organized as a workshop arrangement (Churchill et al., 2009; Hienerth et al., 2007; Lüthje & Herstatt, 2004). Next we take a closer look at lead user workshops and review also other possible strategies for lead user integration.

Workshops
In the LU workshop, the identified lead users and company representatives (including a facilitator) are brought together for two to three days (Churchill et al., 2009; Lüthje & Herstatt, 2004; von Hippel et al., 1999). Typical steps of the workshop according to the Lead user project handbook (Churchill et al., 2009, pp. 140–145) are:

1. Establishing a common context for the work: The facilitator first briefly explains the overall task, after which participants take turns introducing the group to their areas of expertise as it relates to the workshop task. The aim is to orient participants to the task as quickly as possible. (LU workshop typically begins in the afternoon.)

2. Decomposing the overall task into subproblems: The aim of this step is to make it easier for participants to do detailed solution work in parallel breakout groups. Subdivision can be done according to different functions that must be performed by the new product/service or by different types of design problems that are to be solved. The boundaries between subproblems should be defined in such a way that the work of solving one subproblem does not affect the work of solving the others. (The morning of the second day.)

3. Generating solutions to subproblems: Each subgroup contains a mix of lead users, external expert attendees, and at least one company representative. The detailed design work and problem-solving is done during this portion of the workshop. The output of the subgroup, i.e. different solution ideas, are represented visually (sketches of simple prototypes) by each subgroup so that the entire group can clearly picture the solutions developed. (This step takes at least a half-day.)

4. Improving and evaluating solutions: Here the subgroups present their most promising ideas and unsolved problems to the entire group that then works together to further develop and evaluate various solution ideas according to criteria provided by the facilitator. For solution refinement, the group may go through several iterations of improving and evaluating solutions as a whole group and then doing more detailed refining of them in breakout groups where memberships can vary. (The morning of the third day.)

5. Combining and finalizing solutions: The aim here is to arrive at one integrated solution or several solutions. This step may involve several iterations of combining and evaluating solutions as an entire group and then refining the solutions again in subgroups in order to reach the final "best" solution or several alternative solutions. The finalized concepts should be leading edge approaches to the design problems worked on and fit within the economic and technical constraints that were presented to the group. The facilitator makes sure that the best concepts are clearly portrayed in words and sketches or diagrams, flipcharts, and notes.

Lüthje and Herstatt (2004) bring to the fore the effort of organizing such a workshop, which is a considerable investment of human and financial resources. They call for research about benefits of workshops compared to integrating individual lead users or nominal groups of lead users. They do not, however, state what the other modes of integration could be like.

User Innovation Toolkits

The next generation of working with lead users has been the creation of toolkits. Users are specialists, when it comes to using the product or service. They possess information on what they want to do with the product, how, where and when, whereas the developers know much about manufacturing methods and technologies critical for the product to be able to function. Transferring the need-related information from the user-side to the developer requires time and money. When information is costly to transfer from one locus to another, it is called "sticky". The stickiness occurs, when acquiring the information requires certain tools, education, or complementary information. (von Hippel, 1994)

If transferring the need-related information from the user to the developer is costly, why not try to do the opposite? Von Hippel and Katz (von Hippel & Katz, 2002; von Hippel, 2001) propose so-called toolkits for user innovation. In their approach, users are seen as sources of possible solutions, not only need-related information. But in order to help users carry out the innovation task, they need to be equipped with toolkits containing relevant solution-related information. The user innovation toolkit divides the design task into subtasks. In principle, the need-related design tasks are assigned to users and solution-related tasks are assigned to developers. For example, the travel industry has invested in "unsticking" its solution-related information – airline schedules, hotel reservations, car rentals – by providing the users with possibilities to create their own solutions online. (von Hippel & Katz, 2002).

A well-designed toolkit should enable the user to create solutions through *an iterative trial and error process*. Possible *solution space* should be narrowed down to such solutions that are possible for the developer to produce. The toolkit should be *"user friendly"* in the sense that users do not need to engage in much additional training to use them. Users should be able to operate the toolkit with their customary design language and skills. There should be *a module library* included in the toolkit, consisting of commonly used modules that the user can incorporate into his or her custom design. This will prevent the user

from having to "re-invent the wheel", and allow the user to focus his or her design efforts on the truly unique elements of that design. Most importantly, the toolkit must enable fluent communication between the user and the developer, i.e. *"speak the same language"*. This means ensuring that products and services designed by users with the help of the toolkit will be producible on developer production equipment without requiring revisions by developer-based engineers. (von Hippel & Katz, 2002; von Hippel, 2001)

The first toolkits emerged in a primitive form in the 1980s in the high-tech field of custom integrated circuit design and manufacturing. Not understanding user needs completely, while the products became more and more complex, led the cost of the design and development work to reach unbearably high levels. A significant amount of the costs went to correction work of mal-designed products. The introduction of the toolkits approach was able to cut down the development time by two-thirds or more. (von Hippel, 1998) Another example is Nestlé that developed user innovation toolkits in order to enable chefs of Mexican sauces to create customized recipes that can easily be transferred back and reproduced in Nestlé's factories. By using the user innovation toolkit, the time of custom food development was cut from 26 weeks to 3 weeks. (von Hippel, 2001)

Toolkits for Idea Competitions (TICs)

Piller and Walcher (2006) distinguish between toolkits that focus on getting access to need information and that focus on getting access to solution information. They claim that these toolkits differ in how users are motivated to use them. The users of the first type of toolkits are motivated by the capability of the manufacturer to directly produce the individual solution for them, but in the second case the individual user will benefit only much later (if at all) from her contribution (Franke & Piller, 2003; Piller & Walcher, 2006). Some type of rewards (e.g., cash rewards, licensing contracts, or non-monetary acknowledgements) are thus needed. Piller and Walcher take this further and introduce competitive mechanism as an explicit measure to foster and encourage user innovation. The idea of toolkits for idea competition (TIC) is to ask a group of (competing) users to submit solutions to a given task within a given timeframe. Submissions are evaluated by a panel of members from the solution seeker (i.e. the company seeking to benefit from lead user solutions), and ranked accordingly to a set of evaluation criteria developed by the company. The highest scoring submissions receive an award from the company, which is often granted in exchange for the right to exploit the solution. Piller and Walcher claim that winning contributors intuitively should show lead user characteristics, making such a toolkit also a measure for self-selection of lead users. The company could later invite these identified lead users to subsequent lead user workshops.

Company-Hosted User Communities

The costs of company-to-user and user-to-user communication has lowered because of available tools for online communication. As Jeppesen and Frederiksen (2006) list, companies have adopted online communication as a way to build brands (Muniz & O'Guinn, 2001), support product use (Moon & Sproull, 2000),

collect feedback and ideas (Williams & Cothrel, 2000), and to charge community-based customer access fees (Armstrong & Hagel, 1996). The rich body of research shows that lead users can often be found in communities (both live and virtual) where they reveal their ideas and inventions and support each other in solving their problems (Franke & Shah, 2003; Hienerth, 2006; Hyysalo et al., 2013a; Lüthje et al., 2005; Schreier et al., 2007). A company seeking to benefit from lead users can try to tap into those existing communities or turn the tables and create and host an online user community to attract user innovators.

Jeppesen and Frederiksen (2006) study a company-hosted user community for computer-controlled music instruments and show that user innovators that create the most important contributions in these communities are likely to be lead users. They also find that innovative users in this kind of community are likely to be hobbyists rather than professionals. This positively affects sharing of innovations in the community, since hobbyists are not in competition with each other and do not have anything to lose by sharing unlike professionals. Sharing on the other hand is a key condition for company-hosted communities to succeed. Users of these communities are motivated by recognition from peers, but more importantly, by recognition from the company hosting the community. Anticipated firm recognition explains why innovative users are drawn to the community and why they openly share their innovations. This leads to the conclusion that companies wishing to benefit from innovative users should credit these innovators and their innovations visibly.

2.5 Lead User Method Adoption in Organizations

The LU method has been around since the 1980's but – despite its documented advantages – it has seldom become a widely used tool in product and service developers' toolbox. In this section, literature is reviewed first for documented LU method use and after that for factors that affect LU method adoption in organizations.

2.5.1 Review of LU Method Use in Organizations

We now take a look at studies where the use of the LU method or other type of collaboration with lead users is reported. There are 22 industry cases compiled in Table A1 of **publication VII**. It is noteworthy that since the cases are not reported in an equal manner, we cannot be sure if the users in all cases have in fact been lead users or if they are experts or other knowledgeable users. Most of the existing initiatives for integrating lead users are designed as projects with limited time frame and scope (Keinz et al., 2012). Most studies report successful results of the LU method application, but provide no information on how things have developed in the organization since the pilot project. Cinet (Olson & Bakke, 2001) remains the only case, where an academic study following the use of the LU method is available.

A comparable literature review is the one of Lehnen et al. (2014), where the implementation of the lead user approach into management practice is explored through an analysis of 255 publications in the German-speaking business press. Lehnen et al. find 40 different cases which describe the integration of lead users in detail[10] and over 200 cases where lead users are referred to.[11] Lehnen et al.'s review indicates that companies are interested in lead users, which at the same time makes it ever more relevant to explore why the LU method has not become widespread in companies.

[10] It remains unclear, whether these cases report one-time projects or longer term integration of lead users.

[11] Similar to our review, Lehnen et al. (2014) cannot be sure if their cases in fact report integration of true lead users.

2.5.2 Factors Affecting LU Method Adoption

The seminal empirical work by Olson and Bakke (2001) examined the implementation of the LU method at Cinet, the leading IT systems-integrator in Norway at the time. In this longitudinal case study, they followed the execution of the LU method at Cinet, but unlike other studies, they came back to Cinet after a year's time for a follow-up to see, which ones of the LU-generated concepts had lived on and if the LU method had been re-applied.

They found out that despite their initial intention to adopt the LU method and the fact that several of the lead user derived product concepts had been successfully implemented, the LU method or any other type of research on lead users had not been continued. Main explaining factors for returning to a technology push process were personnel turnover and lack of time it takes to utilize the LU method. None of the original LU method stakeholders were anymore at Cinet at the time of the follow-up, and only one current manager had peripheral knowledge about the LU project. He expressed that knowledge of the process had not been adequately transferred between the departing managers and their replacements. He was though planning on using focus groups on customers in the future, but would not necessarily recruit lead users due to the extra time needed to find them.

Olson and Bakke conclude that the time and effort required to sustain the LU method is a major obstacle to its adoption and/or regular use, particularly when there is no strong incentive to change the absence of any great reason for change was a factor in the failure of the LU method to "stick". They also point out that it is important to train subordinates when implementing a change, such as the LU method, in the NPD process. Whatever momentum the LU method might have generated was stopped dead when the original LU stakeholders left the firm, they explain.

Table A2 of **publication VII** provides a review of articles, even though lacking in empirical data comparable to Olson and Bakke, which discuss the adoption of the LU method and give insights to the possible factors that hinder or promote the use of the method. The factors are grouped in 17 categories: attitude, context, credibility, effort, IPR, marketing, measuring, motivating lead users, NIH ("not invented here" syndrome), no change driver, organization, other risks, ownership, predictability, process, staff turnover, and team.

Broadening the search area to factors related to using customers as a source of new product ideas in general, Nambisan (2002) points out that firms often find it difficult to locate appropriate customer innovators in a cost-effective manner and that capturing of customer knowledge can also be a challenge. He also ponders if and how appropriate incentives to foster customer willingness to contribute new product ideas should be created. According to Matthing et al. (2004) company's current structures, processes, and culture may prevent them from continuing customer involvement after a pilot project.

Hienerth et al. (2011) have explored the nature and implementation process of user-centric business models through a multi-case comparison between LEGO, IBM, and Coloplast. They state that among employees shifting to such

processes are often perceived as a "loss" of personal control and expertise, eventually exacerbating the "not invented here" syndrome.[12] Organizational inertia of established companies may prevent them from adapting to new conditions (Hannan & Freeman, 1984; Leonard-Barton, 1992).

Taking yet a broader view, adoption of new product development (NPD) tools have been studied by Nijssen and Frambach (2000). They found that the adoption happens more probably if top management is involved with the NPD process, the number of stages within the NPD process high, the more communication there is between departments and the more departments are involved in NPD, and if the NPD strategy is focused on turning out many new products. Nijssen and Frambach also show that former NPD tool and technique users are more likely to adopt new NPD tools and techniques.

In their study on organizational adoption of new service development (NSD) tools, Jin et al. (2012) found that theory of planned behavior constructs (i.e. attitude, subjective norm, and perceived behavioral control) are reliable predictors of organizational intention to adopt NSD tools, and that perceived usefulness and perceived ease of use positively influence attitude towards NSD tool adoption. Similarly, the degree of complexity of use is a major determinant of technology management tool adoption (Brady et al., 1997), and quality management tools that are easy to understand and implement are adopted whereas complex techniques are barely used (Fotopoulos & Psomas, 2009).

The LU method can also be considered as an item to be adopted and thus examined in the light of the diffusion of innovations theory (Rogers, 2003). Rogers's diffusion framework suggests the following factors that affect the adoption of a novelty in general:

1. Relative advantage: Degree to which an innovation is perceived as better than the idea it supersedes.
2. Compatibility: Degree to which an innovation is perceived as being consistent with the existing values, past experiences, and needs of potential adopters.
3. Complexity: Degree to which an innovation is perceived as difficult to understand and use.
4. Trialability: Degree to which an innovation may be experimented with on a limited basis.
5. Observability: Degree to which the results of an innovation are visible to others.
6. Presence of change agency and champions: who actively promote the novelty in a social system.

[12] Hienerth et al. (2011) present five strategies to overcome internal resistance in an organization: Launching user integration initiatives as experiments and improving them through evolutional learning; Collecting and distributing success stories to convince internal stakeholders; Provision of an IT environment which enables the company to benefit from user integration; Shifting the process, responsibility and required capabilities to middle management and employees; Using “soft” measures instead of “hard” financial measures to assess success at the start of an initiative.

The relative advantage of the LU method is difficult to evaluate before adoption (cf. categories "measuring", "predictability", and "process" in Table A2 of publication VII), which is also the case with its compatibility (categories "attitude" and "organization"). The LU method is complex and requires special skill, which is only partially available through books or tutorials (categories "effort" and "process"). The identification of lead users being a major and most crucial part of the LU method, partial execution and trials will not lead to results (i.e. identification of true lead users and thus LU-generated ideas) that would allow comparison with other methods (categories "effort" and "process"). Being complex and skill-intensive make the LU method difficult to transfer from one locus to another – from one person to another – which means the method in fact contains "sticky" information characteristics (von Hippel, 1994). Having to build the skill to be able to carry out the LU method results in poor trialability of the method and highlights the need for a change agent in the organization who possesses this skill. Frambach and Schillewaert (2002) distinguish between two levels of adoption decision, i.e. the organizational level and the individual adopter within an organization, meaning that the change agent can in fact be needed on both levels.

2.6 Positioning of the Thesis

First, the LU method is presented in the literature as a straightforward process (e.g., Churchill et al., 2009; Urban & von Hippel, 1988) where not enough attention is paid to the crucial step of lead user identification. Literature suggests methods like screening, broadcasting, snowballing, pyramiding, and their combinations (e.g., Jeppesen & Lakhani, 2010; Sudman, 1985; von Hippel et al., 2009) that might guide to lead users in the targeted or advanced analogous field. Publications I, II, and III examine this challenge and bring new ways of thinking to the table by improving concepts and means available for lead user identification. Publication I examines how disabled users can be seen as lead users for products that are being developed for able-bodied users. In Publication II a framework for easier lead user identification is proposed and two supporting concepts – situational and positional lead users – are introduced. Publication III clarifies the concepts related to lead user identification and presents a proof of concept for purposefully combining multiple search methods.

Second, after the suitable users have been identified, the problem remains how to transfer this sticky user knowledge to the company. Lead user workshops (e.g., Churchill et al., 2009) and user innovation toolkits (e.g., von Hippel & Katz, 2002) have been proposed as a solution. However, creating a toolkit can be a costly and timely task and a significant investment (Keinz et al., 2012), and until it is being used, there is no guarantee it will generate a favorable outcome. Publication IV explores through an experimental setup the interrelations of the components in a user innovation toolkit. Publication V introduces an approach for capturing designers' and users' views on a product or service by utilizing physical models in a workshop arrangement. Publication VI draws elements from both LU workshops and participatory design and presents a new variation to conduct futuring collaboratively as part of a major development project.

Third, it remains unclear why the LU method despite its documented value for companies has not gained ground as a standard part of companies' toolbox for product and service development. Publication VII, supported by Publications I–VI, sheds light on the factors that challenge the adoption of the LU method in an organization and provides suggestions on how the adoption hurdles could be overcome.

3. Methodology

3.1 Research Approach

The research topic of this dissertation is the LU method and its use in organizations. The aims are to understand *how* lead users can be identified, *how* the knowledge they possess can be transferred, and *why* the LU method is not adopted widely in organizations. "How" and "why" questions are explanatory and likely to lead to the use qualitative research methods, such as case studies or histories, as the preferred research strategies. This is because such questions deal with operational links needing to be traced over time, rather than mere frequencies or incidence. (Yin, 1994) According to Denzin and Lincoln (2000) qualitative research consists of a set of interpretive, material practices that makes the world visible. These practices turn the world into a series of representations including field notes, interviews, conversations, photographs, recordings, and memos to the self. "This means that qualitative researchers study things in their natural settings, attempting to make sense of, or to interpret, phenomena in terms of the meanings people bring to them" (2000, p. 3). Strauss and Corbin (1998, pp. 10–11) define qualitative research as "any type of research that produces findings not arrived at by statistical procedures or other means of quantification".

It is characteristic to qualitative research that samples are small in scale and purposively selected on the basis of salient criteria and that data are very detailed, information-rich, and extensive. When contrasted with quantitative research, the relevant question to be asked is not "how many cases?" but instead "which cases?" and "what do the cases represent or what were they selected for?" (Flick, 2009). Data collection methods usually involve close contact between the researcher and the research participants and are interactive and developmental, which allows for emergent issues to be explored. The analysis is open to emergent concepts and ideas and may produce detailed description and classification, identify patterns of association, or develop typologies and explanations. (Ritchie & Lewis, 2003)

When the research territory is not mature or clearly defined or when the research question remains vague, exploratory research is in order. Qualitative methods yield rich data that is needed in exploring new phenomena and for building theory about emerging constructs and their relationships. Even though the results of explorative studies may not generalize well, hypotheses and propositions can be derived for further qualitative inquiry or quantitative testing. (e.g., Bryman, 1984; Mayring, 2007; Yin, 1994)

Regarding lead user identification, research so far has mainly relied on quantitative studies that have pursued comparisons and simulations for measuring the efficiency and efficacy between different lead user identification methods. The real-life identification processes are, however, more complicated, so it becomes relevant to seek qualitative understanding on how lead users should best be identified. Regarding the practices on how lead user knowledge should be transferred, the territory within user innovation literature is still not thoroughly explored, which leaves room for exploratory research for building more understanding and propositions for new practices and means. The current research regarding LU method adoption in organization is qualitative but except for the study by Olson and Bakke (2001) has not explored the adoption after pilot projects, so longitudinal qualitative case studies are needed. The case study approach allows us to collect novel insights from the empirical world, as opposed to testing and validating existing theoretical models, and to gain a rich understanding of certain phenomena and their dynamics in a specific context (Yin, 1994).

This dissertation is based on seven research publications that embrace the qualitative research approach. Research for these publications has been carried out in separate research projects funded by Tekes (the Finnish Funding Agency for Innovation), Academy of Finland, Emil Aaltonen Foundation, and different industry partners during 2005–2014. The dissertation thus feeds from several different data sets collected at different point in time. Selected research methods and corresponding data per publication are presented in Table 1.

Table 1. Research methods and data.

Underlying theme	Publication	Method	Data
Lead user identification	I	Exploratory research, semi-experimental set-up	Photo diary (9 persons), notes from contextual inquiry (same 9 persons), interviews (9+3 persons).
	II	Conceptual analysis	
	III	Multiple case study	4+2 documented lead user identification processes including interviews and netnographic data.
Transferring lead user knowledge	IV	Exploratory research, semi-experimental set-up	Observed and documented toolkit-use (notes, photographs, physical outcomes) and short interviews (24 persons).
	V	Exploratory research, semi-experimental set-up	Audio+video recordings, still photographs, and physical outcomes of 6 workshops. Short group interviews after workshops, follow-up interviews.
	VI	Exploratory research, semi-experimental set-up	Audio+video recordings, still photographs, and physical outcomes of one workshop. Follow-up interviews (17 persons).
Lead user method adoption	VII	Longitudinal two-case case study	Interviews (55+9 persons), documents, and periodical captures of an online web service.

3.2 Research Process and Data Collection

Next the research process and data collection per publication are presented. Publication II is not reviewed at this point as it is a conceptual paper based on literature and exemplifying real-life illustrations.

3.2.1 Publication I

In this study, three members of three different groups of mobile phone users were studied and compared: deaf, blind, and ordinary users who see and hear well. The users were recruited through several associations and societies, such as Finnish Federation of the Visually Impaired and Finnish Association of the Deaf, and through personal contacts.

The methods used were photo diary based on a theme (B. A. T. Brown, Sellen, & O'Hara, 2000; Gaver et al., 1999) and contextual inquiry (Beyer & Holtzblatt, 1998) along with an open-ended interview (e.g., Patton, 2002). There were two meetings with every participant. The first meeting was a short 30-minute meeting where participants were given the photo diary assignment. The photo diary assignment consisted of a disposable camera and a stamped return envelope. The participants were instructed to use the camera for one day and to take a picture of "everything you use for communication, or use for receiving and transmitting information", i.e. newspaper, alarm clock, radio, mobile phone, signboards, etc. The blind participants were advised in practice on how to use the disposable camera.

Approximately two weeks later in the second meeting the contextual inquiry and the open-ended interview were carried out. In the same meeting the pictures taken in the photo diary assignment were discussed one-by-one and used as inspiration in the interview. An outside interpreter took part in the meetings with the deaf participants. The use of mobile phone was discussed and observed according to the principles of contextual inquiry. The disabled users were observed when using their mobile phones in their ordinary environment, such as home or work environment. The ordinary users were observed when using their mobile phones in special situations that included complete darkness, and noisy environment. In these special situations the ordinary users were asked to perform basic tasks, such as calling, receiving a call, sending a text message and receiving one. The starting point of the tasks varied in order to simulate everyday use of the product: the mobile phone was to be found in the pocket, in the bag, or in the surroundings in proximity of the user. The use of mobile devices was studied also in the ordinary environment in the same manner as was done with the disabled users. After going through the pictures of the photo diary, and the contextual inquiry, the participants expressed their views on their current mobile devices, their expectations, and desires.

In addition to the nine participants presented above, three other people were interviewed in order to gain a wider perspective on disability in general. Two of them had progressively lost a major part of the eyesight in their adulthood, and one had a similar visual disability but he also suffered from a severe hearing impairment.

3.2.2 Publication III

In this study, the data are six cases i.e. the four principal and two supportive lead user and user invention searches conducted in Finland during the years 2009–2012 by a six-person team using the mountaineering search strategy. The search processes were documented in detail: the type of the referral (see Table 2) and the search method (see Publication III, Table 2) on each step. All of the interviews conducted were transcribed and lead-userness was assessed with self-assessment questions drawing on Franke et al. (2006), using a similar operationalization of lead user characteristics. Lead-userness was measured by four seven-point Likert-scale questions; the scores were totaled without weighting, leading to a maximum rating of 28.

In the graphical documents of the search processes (see Figure 9 for an example) the horizontal axis represents time from left to right in relative terms, not as an absolute scale. The vertical axis represents lead-userness, that is, the sum of the self-assessment score. The lead-userness of those users whose inventions were identified in forums but who did not respond to our contact requests, were rated with the aid of three domain expert evaluators who also rated the innovativeness of the user-developed concept (Hyysalo, Johnson, & Juntunen, n.d.; Hyysalo et al., 2013a, 2013b).

3.2.3 Publication IV

The publication presents exploratory research on the interrelation of the module library and the solution space in a user innovation toolkit. A semi-experimental set-up of physical toolkits in the context of shopping center design was used. The puzzle-like toolkits consisted of building blocks made out of polystyrene foam of approximately 10 cm x 6 cm x 3 cm in size, each block representing a particular type of store traditionally found in shopping centers: shoe store, department store, clothing store, bookstore, café, etc. Each block was covered with colored paper. The reason for coloring the blocks was to make each group of blocks (such as cafés and restaurants) easier to recognize, both by the user and the facilitator. The use of physical blocks instead of pieces of cardboard, for example, was chosen in order to make more concrete to the user to construct a three-dimensional shopping center. Users were also provided with Post-It notes that they could use for labeling the blank blocks or if they wanted to add a brand name on a certain block.

We first ran a pilot study for testing the feasibility of our physical toolkit with nine users recruited from a pool of colleagues. Next, we designed three different versions of the toolkit and tested each on five different women aged 30–40. We chose this gender group since women have been found to enjoy shopping considerably more than men (Van Slyke, Comunale, & Belanger, 2002) and they also tend to spend more time and mental energy on shopping (Bakewell & Mitchell, 2003). All the users who participated in our study were living or working in the Helsinki area and they were all Finnish natives.

A toolkit session included one user and one facilitator (one of the authors) at a time. They were first introduced to the method and given a brief written assignment on what to do. The building process was photographed and notes were taken during the building. After building, a short interview followed.

Toolkit 1 consisted of 28 typical store blocks and 8 blank blocks that the user could label freely, totaling 36 blocks (the same as in the pilot study). This means that the user could work with a typical module library, but had unlimited solution space. In Toolkit 2, the user did not have the choice of labeling any blank blocks, but in addition to the 28 typical blocks, was provided with 8 special blocks. These were blocks that are rarely found in Finnish shopping centers: water amusement park, spa, amusement park, children's playground, fountain, bowling alley, downhill skiing center, and indoor sports hall. Now the solution space was limited, but the user had access to an extended module library. Toolkit 3 was created by combining the other two toolkits and thus consisted of 28 typical blocks, 8 special blocks and 8 blank blocks, the total number of blocks then being 44. It provided the user with both unlimited solution space and an extended module library.

3.2.4 Publication V

The dataset consists of three differing cases where we have used Collaborative Physical Modeling approach (CPM), altogether six workshops. In the first case, CPM was used for analyzing an existing service both by users and developers. In the second case, users and developers generated a new service concept. In the third case, we used CPM with lead users, who generated a new service concept.

The workshops were captured in audio recorders, and the audio tracks have been fully transcribed. Photographs were taken in frequent succession throughout the CPM sessions. Selected parts of the workshops were also recorded on video. The outcomes of the workshops were saved in a textual format, as it naturally emerges in the course of the CPM process. Immediately after the workshop, there was always a short feedback session, where participants expressed their feelings and thoughts about CPM. Our analyses rely on transcriptions and photos, backed up by watching the video on unclear moments, and on the physical outcomes of the workshops, i.e., the elements that are grouped into entities. The comparisons we make of the yield of different CPM sessions below are based on ordered pairs of elements. Regarding all three cases, we have had follow-up interviews. In the first and the third case, we have been following the developments in the provider organization by interviewing the key players yearly for the past three years. In the second case, we had follow-up interviews with the provider organization two years after the CPM workshops took place.

3.2.5 Publication VI

The data in this publication are from a full-day workshop with 13 lead users. The workshop participants were identified through snowball sampling (Goodman, 1961; Welch, 1975) by first listing the relevant maker communities, sectors and fields of expertise that would provide a diverse set of perspectives on the present and future of digital fabrication and maker spaces for the planned Helsinki Central Library that was the topic of the workshop. The workshop comprised of trend exploration facilitated by pre-categorized cards in the morning part of the day and a full-scale prototyping exercise in the afternoon.

The 13 workshop participants were of four nationalities with varying background related to the maker culture, such as the fab lab network, and open design and innovation. In the first phase of the actual workshop, the participants independently wrote down the most important trends they saw in making and maker spaces for the year 2020 using the pre-filled cards. These cards were post-it notes marked with one of five categories, 'technology', 'activities', 'sharing/organizing/IPR', 'safety/risks' and 'other'. The categories were determined on the basis of our prior research (Kohtala & Hyysalo, 2015; Kohtala, 2013, 2015). Each participant then shared with the others the three most important trends they had written down. The 'top three' trends were mounted on a wall, which was followed by an exercise of all participants identifying which of all the trends they felt were most important. After that we used a variation of the 'World Cafe' technique (J. Brown, 2002) where the most heavily starred issues were moved onto three flipcharts and the participants were grouped into three groups to discuss the sustainability implications of each.

The afternoon part of the workshop was held in the fab lab. The participants were instructed to add notes directly onto the machines and surfaces regarding solutions. In this exercise, we used the same pre-filled cards as in the morning part of the workshop. The final part of the workshop moved into collaborative mode from the individual and discussion-based format. Participants formed three groups and began to envision the activities, technologies and outreach of the pilot maker facilities. This proceeded by documenting the ideas directly onto the floor plans of the pilot maker space and then presenting and discussing them with the entire participant group.

The workshop set-up produced several types of data: audio and video recordings, still photographs, the post-its, and field notes made by the facilitators.

3.2.6 Publication VII

The research approach of this publication is a longitudinal two-case case study (Eisenhardt, 1989; Yin, 1994), our principal case being a national broadcasting company, Broadco, of around 3100 employees and our supportive case being a privately-owned software company, Softco, of around 70 employees. In both case companies a LU project was carried out. In Broadco, the authors were commissioned to plan and conduct the project, and in Softco, the authors acted as mentors and supervisors for the company employees. These two cases form a case comparison of high variation (Gobo, 2004; Patton, 2002): Broadco is

a large and established organization that already has a history of user involvement, whereas Softco is a small, young, and agile organization that has only recently begun to take steps towards user-centeredness.

The main data types in this study are semi-structured interviews that were transcribed verbatim, field reports written immediately after the interviews and events, documents, and periodical captures of an online web service (for case Broadco). There were altogether 55 interviews (with 50 individual interviewees) at Broadco and nine (with seven individual interviewees) at Softco, resulting in 1.6 % and 10 % of employees being interviewed respectively. At Broadco the interviews form a purposeful sample that covers first of all the LU pilot project participants (who were interviewed periodically during 2010–2014) and interviewees from all levels of the organizational hierarchy and all typical job descriptions. In addition, we used snowball sampling (Goodman, 1961) and emergent sampling following new leads during the fieldwork (Patton, 2002). At Softco, the interviewees were selected so that they covered both employees that were related to the LU project and also those that were not. In common with Broadco, interviewees were selected from all levels of the organizational hierarchy.

We also carried out a systematic literature review where we searched through the Science Direct and Scopus databases by using the keywords "lead users" and "lead user method", and by combining the words "company", "method", "organization", "adoption", and "organizational adoption". In addition to these two databases, we have performed similar searches in Google Scholar. We have also gone through all the articles that have cited the seminal work of Olson and Bakke (2001). Five propositions were derived out of the literature review.

3.3 Data Analysis and Methods

Qualitative analysis can be challenging because the amount of data is typically large. There is not a clear-cut formula for transforming data into findings. The lines between data collection and analysis are clear, when the data collection is based on surveys or standardized tests, but the fluid and emergent nature of naturalistic qualitative inquiry makes the distinction between data collection and analysis far less absolute. (Patton, 2002)

All studies that are reported in publications I–VII yielded rich data – for instance video and audio recordings, physical outcomes, documents, transcribed interviews, field notes – that have gone through content analysis. Content analysis was chosen to acquire a composite picture of the phenomenon and to provide categorizations comparable to the underlying frameworks and theories in each study (e.g., White & Marsh, 2006).

Inductive analysis has taken place in the form of content categorization, clustering, and coding for discovering patterns and themes that emerge from the data (Patton, 2002; Strauss & Corbin, 1998). Analytic induction was carried out in publications IV and VII, where propositions that had been derived from literature were examined against the data (Patton, 2002; Taylor & Bogdan, 1984). Content comparison has been used to compare the data of certain sub-groups

such as mobile phone use of the deaf, blind, and able-bodied users in publication I, utilizing the mountaineering approach for lead user identification in six separate cases in publication III, the use of different versions of a user innovation toolkit in publication IV, or the outcomes of varying CPM workshop arrangements in publication V (Beyer & Holtzblatt, 1999; Strauss & Corbin, 1998). In all studies, the first steps of analysis have been taken already when in the field, when emerging analytical insights have been recorded in field notes (Patton, 2002).

The largest amount of data was analyzed in publication VII. We applied the biography of technologies and practices approach (Hyysalo, 2010; Johnson et al., 2014), which means that we combined ongoing observation and interviewing with a historical reconstruction of the previous history of the companies and their user research method use (which was the focus of the research). Open coding of content in the frame of the current paper was used to sort the 55+9 interviews and the documents (Glaser & Strauss, 1967). Both cases were first written out as long narratives rich in detail but were later condensed to case descriptions that fit the allowed paper length. The five propositions that had been derived from the systematic literature review were examined in the light of the two cases (Patton, 2002; Taylor & Bogdan, 1984).

3.4 Reliability and Validity

Unlike in quantitative research, there are no straightforward tests that can be applied for determining the reliability and validity of qualitative research (Patton, 2002). The concepts are however explicit: “Validity deals with the notion that what you say you have observed is, in fact, what really happened. In the final analysis, validity is always about truth” (Shank, 2006, p. 111). Flick (2009, p. 387) summarizes validity as a question of whether the researchers see what they think they see. The concept of reliability comes down to whether or not (or under what conditions) the researcher would expect to obtain the same finding if she tried again in the same way (Kirk & Miller, 1986, p. 69). The bottom line behind these to concepts is that "data do not speak for themselves; there is always an interpreter, or translator" (Ratcliffe, 1983, p. 149).

The quality of recording and documenting data is central for assessing their reliability and that of succeeding interpretations. Increasing the reliability can be achieved for example by standardization of the way field notes are taken or by training interviewers and by checking the interview questions in test interviews. (Flick, 2009; Kirk & Miller, 1986)

Flick breaks down the concept of reliability to three aspects: First, data gathering needs to be explicit in order to make it possible to check what a statement of the subject is and where the researcher's interpretation begins. Second, the procedures how the data is gathered (in the field or interviews, for example) need to be made explicit in training and rechecking in order to improve the comparability of different interviewers or observers' conduct. Third, the reliability of the whole process will benefit from a detailed documentation of the research process. (Flick, 2009, p. 387)

Validity receives more attention than reliability, when grounding of qualitative research is discussed (Flick, 2009). Eisenhart and Howe (1992, pp. 657–663) propose the following five general standards for validity: 1) The fit between research questions, data collection procedures, and analysis techniques; 2) The effective application of specific data collection and analytic techniques; 3) Alertness to and coherence of prior knowledge meaning that the arguments must be built on some theoretical tradition or contribute to some substantive area or practical arena; 4) Value constraints referring to external value constraints, that is, the research must be worthwhile, and to internal constraints meaning that the research must be ethically sound; and 5) Comprehensiveness regarding the overall theoretical and technical quality of the research, thoughtful consideration and explanation of tradeoffs between different standards, and alertness and ability to employ knowledge from outside the particular perspective within which one is working.

Yin (1994, p. 34) differentiates between construct validity, which means establishing correct operational measures for the concepts being studied, internal validity, which means establishing a causal relationship, whereby certain conditions are shown to lead to other conditions, as distinguished from spurious relationships, and external validity by which he refers to establishing the domain to which a study's findings can be generalized.

Triangulation, researcher reflexivity, member checking, prolonged engagement in the field, thick description, and peer debriefing are commonly used and cited procedures to increase the validity of qualitative research. Denzin (1989) distinguishes between four types of triangulation: 1) data triangulation, i.e. the use of a variety of data sources in a study; 2) investigator triangulation, i.e. the use of several different researchers or evaluators; 3) theory triangulation, i.e. the use of multiple perspectives to interpret a single set of data; and 4) methodological triangulation, i.e. the use of multiple methods to study a single problem or program. Researcher reflexivity refers to reporting researcher's personal beliefs, values, and biases that may shape his inquiry (Creswell & Miller, 2000). In member checking the data and interpretations is taken back to the participants in the study so that they can confirm the credibility of the information and narrative account (Lincoln & Guba, 1985). Prolonged engagement refers to the idea that the longer the researcher stays in the field, the more the pluralistic perspectives will be heard from participants and the better the understanding of the context of participant views (Creswell & Miller, 2000). Thick descriptions refer to descriptions of the context, the participants, and the situation in rich detail that enable the reader to better understand and experience the events that are recorded in the data (Denzin, 2001). Peer debriefing means that someone who is familiar with the research or the phenomenon being explored reviews the data and the research process and thus challenges the researcher's assumptions, method choices, and interpretations (Lincoln & Guba, 1985).

Regarding this dissertation, the reliability of the research has been ensured first by gathering data by using several different procedures.[13] Second, when there have been several researchers gathering the data, the procedures have

[13] All empirical publications, i.e. publications I and III–VII.

been agreed upon beforehand: the same interview guideline has been used and the field notes have been made in the same way, for example. For transcribing the interviews we have used the same service provider for the whole dataset and the transcriptions have been made verbatim.

In all empirical publications, data triangulation has been carried out (Amaratunga & Baldry, 2001; Denzin, 1989). The explorative publications (I, IV–VI) contain a very rich set of data, and the burdensome analysis of video recordings has been carried out on occasion to support other levels of analysis. In publications III-VII the data have been not only collected but also analyzed by several investigators, thus enabling investigator triangulation (Denzin, 1989). After each session where data have been collected, the investigators have engaged in at the very least brief sharing and discussing of analytical insights that have just emerged while in the field, thus generating the very first layer of analysis in the field notes. Methodological triangulation has taken place in examining the research objective 1), as the corresponding publications I–III embrace different methodologies.

In publication VII, we have carried out member checking with the key informants (Lincoln & Guba, 1985). Also prolonged engagement in the field (Creswell & Miller, 2000) increases the validity of the research. Peer debriefing (Lincoln & Guba, 1985) has been used in all empirical publications.

The external validity (Yin, 1994) of the research varies. For example in publication IV, the participants were women aged 30–40 meaning that the results cannot be freely generalized into different populations. Characteristic to exploratory research, the findings have, however, been used to formulate hypotheses that can later be tested quantitatively with a more representative sample of participants (e.g., Bryman, 1984; Mayring, 2007; Yin, 1994). Similarly in publication I, the present sample of participants was able to illustrate the thus far unexplored concept of considering disabled persons as lead users for the able-bodied market. Publication III on the other hand presents research where there are six cases where real-life lead user identification has been carried out identically by repeating the mountaineering search process. That provides the first proof of concept of purposefully combining different lead user identification methods, i.e. the mountaineering approach, and invite further quantitative analyses for examining the efficacy of the mountaineering. In publication VII the two longitudinal cases form a case comparison of high variation (Gobo, 2004; Patton, 2002) thus increasing the external validity of the research. When it comes to all explorative publications (I, IV–VI), the driver for the research has been to address a real-life problem or question of organizations participating in each research project, which increases the ecological validity (Schmuckler, 2001) of the research.

4. Summary of Publications

4.1 Publication I: Identifying Customer Needs – Disabled Persons as Lead Users

The purpose of this study was to investigate the identification of lead users, specifically, if so called "extraordinary" users could be used as lead users. In this study the user needs of disabled and "situationally disabled" mobile phone users were compared. Three members of three different groups of mobile phone users were studied and compared: deaf, blind, and ordinary users who see and hear well. The needs of these groups were explored through a photo diary based on a theme and contextual inquiry along with an open-ended interview.

Traditionally, mainstream consumer product design has not explicitly considered the needs of disabled people. Their needs have rather been regarded as requiring extra support as in design-for-all principles and in added accessibility features to applications. Yet disabled people could also present positive opportunities for product design of mainstream products. In many ordinary circumstances we all suffer from a "situational disability" (cf. Perry, Macken, Scott, & McKinley, 1997). When there is no light, we cannot use our eyesight, for example. When there is a lot of noise, we are not able to hear. The examined user groups in this study were deaf, blind, and ordinary users, who see and hear well. A two-part goal was set:

A. to find out if the needs of extraordinary users (disabled users in this example) are in fact the same as those that ordinary users face situationally; and
B. to investigate if the extraordinary users also experience today what the target market may experience later, i.e. if they in fact do "live in the future" and thus are lead users and a valuable resource in customer need identification.

What was found is that the user needs of ordinary users in special situations (situationally disabled) correspond well to the needs of the extraordinary (disabled) users in ordinary situations. The disabled persons were found to experience needs that ordinary users may experience later. Also several examples of solutions already obtained by disabled persons were shown. When the data gathered through this study is looked at in reference to von Hippel's definition of lead users, it is found that the second lead user characteristic clearly applies to disabled users: Disabled users surely benefit significantly by obtaining a solution to their needs. What comes to the first characteristic, there are examples that show that the extraordinary users driven by their extraordinary needs have found solutions, like text messages amongst the deaf community

that have later become common among all users (Power & Power, 2004). There seems to be a similar trend in two-way video calling. This suggests, that in order to accelerate the adaptation of the new application, companies could investigate the needs of extraordinary users who already use various mobile two-way video communicating applications, and use the information to develop the new mobile phones (or other devices) to better match the (latent) needs of the public.

4.2 Publication II: Lead Users of Positional Value

The goal of this article was to develop a framework for better identification of lead users. In the literature, methods like pyramiding are suggested as a way to navigate from the target field to analogous fields, where the ultimate lead users can be found.

Through illustrative real world cases, the publication explains the complex of "intrinsic" (Normann, 2001), situational, and positional value of a certain offering in a consummation process, and shows that typically the term lead user (LU) refers to lead users of intrinsic value (whether or not there is an actual product yet available). Intrinsic value means the value that is released when the offering is used as intended: A mobile phone has value as a mobile phone, when one uses it for communication between spatially distributed people. When the phone is used in complete darkness or when driving a car, it still has intrinsic value, but the context of use is no longer in the intended value zone, but in a situational (dis)value zone. As is explained in Publication I, disabled users can be seen as lead users of this situational value. In this publication these users are termed situational lead users (SLU).

Besides intrinsic value, offerings also tend to have other type of value in another value system, or another consummation chain. When the illuminated screen of a mobile phone is used as a flash light, the outcome – to be able to open a door with a key in darkness, for example – is enabled by not the intended features of the product, but by so called by-features. The value that the offering positioned in another value system has, can be termed positional value in the publication. Therefore, it is proposed that users who fulfill their needs with by-features of a product are called positional lead users (PLU).

Nowadays, there are mobile phones with integrated flashlights (and also separate small flashlights that can be attached to a mobile phone) available on the market. It is hard to say how companies ended up with the idea of integrating a flashlight into their phones, but in retrospect one can say that the companies could have found the idea through examining positional lead users. This is analogous to the traditional lead user theory, which suggests that companies can benefit from lead user innovations.

In this work, the authors propose a framework which

1) provides systematic means of determining "the field" and "analogous fields", and eventually
2) makes it easier to identify potential lead users.

4.3 Publication III: Intermediate Search Elements and Method Combination in Lead-User Searches

The goal of this article was to clarify concepts related to lead user identification and to present a proof of concept for purposefully combining multiple search methods to overcome search method requirement constraints. The research is based on four principal and two supportive real-world cases of lead user searches conducted in Finland during the years 2009–2012.[14]

To date, much of the work regarding the identification of the rare lead users has centered around networking strategies, and proceeded by examining how individuals are linked to one another, in affinity to social network analysis (Newman, 2003). The rare subject networking searches, however, include frequent and important episodes where individuals are not linked directly to other people. Poetz and Prügl (2010, p. 906) report only 30.7% of referrals from an initial search domain to another domain as being linked to concrete people, 28.2% pointing to organizations or institutions, and 41.1% pointing to events, professions, products, literature, or technologies. Thus, the referrals to other entities than people amounted to 69.3% of the referrals to the knowledge that was in their line of argumentation potentially most vital. The issue is not limited to analogous fields: referrals to organizations, events, indexes, mass media, and computer-mediated communication (CMC), rather than to concrete people, are common in network searches also within a search domain. Research to date has not addressed such referrals apart from naming them in varying conventions as "implicit" or "less detailed," even though, as the above suggests, these referrals may have considerable importance in rare subject searches.

To aid handling such referrals during network searches, we explicate their status as intermediate referral types, and how these referral types relate to known search methods. The constraints set by intermediate referrals could potentially be overcome and their potential be capitalized through more extensive method combination in network searches than has been trialed to date.

The contribution of this publication is twofold:

1) We conceptually clarify what are the intermediate elements in networking searches and the effects they have on known rare subject search methods.
2) We present a proof of concept for purposefully combining multiple search methods to overcome search method requirement constraints, by elaborating an approach that uses multiple methods both in parallel and sequentially, and its application in four real world cases.

[14] The full search process depictions can be found in http://sn.im/mountaineering as animations.

4.4 Publication IV: Designing User Innovation Toolkits: Exploring the Interrelation Between Solution Space and Module Library

The aim of this article was to explore the interrelation of the module library and the solution space by using a user innovation toolkit in the context of shopping center design. Three different versions of a user innovation toolkit were created in the form of a "puzzle" containing physical building blocks. Toolkit 1 comprised a typical module library but with unlimited solution space. In Toolkit 2 the solution space was limited, but the user had access to an extended module library. Toolkit 3 provided the user with both unlimited solution space and an extended module library.

Utilizing physical models and representations collaboratively for transferring knowledge from user to developer is in the core of many methods, such as design games (e.g., Brandt & Messeter, 2004; Vaajakallio, 2012), design probes (e.g., Mattelmäki, 2006), and tangible business modeling (e.g., Mitchell & Buur, 2010). Many of these methods share common elements, such as design space and some type of modules, but the interrelations of these elements are not well understood.

In the development of user innovation toolkits, some of these elements have been fairly well conceptualized. According to the literature, the solution space must be limited in order to prevent users from developing a solution that the developer side cannot produce. On the other hand, it is assumed that users make use of the offered solution space and that toolkits that offer a large solution space allow substantial innovations. The role of the module library is to provide users with existing modules, so that they do not need to start designing from scratch. In this publication the above arguments regarding the solution space and the module library are examined.

The contribution of the article is twofold. First, this study on three different toolkits suggests that limiting the solution space is not necessarily as important as stated in the literature. It appears that offering the users unlimited solution space does not automatically lead users to take advantage of it, nor does it mean that if they do, they will come up with substantial innovations. The role of the module library is also not as straightforward as assumed. Even though users were offered an extended module library (Toolkits 2 and 3), not many special blocks were found in their designs. In the case of Toolkit 3, it was seen, however, that even if the extended module library failed to enrich the users' designs as such, it worked as inspiration when users exploited the unlimited solution space. Based on the above, two hypotheses were formulated for future quantitative analysis:

- H1: Users are restrained in ability to take advantage of the unlimited solution space if the module library consists of only typical modules.
- H2: For a user innovation toolkit to be able to transfer personal user needs, the solution space must be unlimited and the module library extended.

Second, there seems to be an ever-growing interest among designers to develop methods for user involvement in product and service design. Instead of explorative cooking with new ingredients each time, common elements of the

methods should be systematically studied, which unfortunately is often overridden by the time pressure of real-life design projects. As long as the role of these elements and their interrelations remain fuzzy, the methods for transferring the so-called "sticky" information (von Hippel, 1994) continue to require intense facilitation, hence preventing the development of digital tools and methods that could be used without facilitation over the Internet. Looking into the relationship of the module library and the solution space would thus benefit not only the development of user innovation toolkits but also other methods and techniques commonly used by designers.

4.5 Publication V: Better User-Developer Communication in Service Development by Collaborative Physical Modelling

In this article, we present a proof of concept for utilizing a physical modeling approach called collaborative physical modeling (CPM) to reveal the different stakeholder interpretations of a service and to extract these interpretations in a format that can be easily shared and compared, thus facilitating user-developer communication. To demonstrate the use of this method, CPM is used in three differing cases: First, CPM is used for analyzing an existing service both by users and developers. In the second case, users and developers generate a new service concept. In the third case, we use CPM with lead users (von Hippel, 1986, 2005), who generate a new service concept.

A persistent challenge seems to be how the service use experience embedded in the life and social networks of the user could be made visible, as well as how the communication between the users and the provider organization could be facilitated (e.g., Sundbo & Toivonen, 2011). Numerous studies have concentrated on the identification of user or customer needs and how these needs can be incorporated into products or services (e.g., Kaulio, 1998; Pals et al., 2008) and some methods aim at capturing an overall picture of how a user experiences a service, such as service blueprinting (e.g., Bitner, Ostrom, & Morgan, 2008), sociodrama (e.g., Torrance, 1975), the Storytelling Group method (Kankainen, Vaajakallio, Kantola, & Mattelmäki, 2012), and the event-based narrative inquiry technique (EBNIT) (Boddy, 2004, 2005).

Despite the availability of a variety of methods, there are challenges. Most methods require skills and competencies that often do not exist inside a company. Buying this competence from outside or educating employees inside the company can easily become expensive. This results in taking shortcuts where methods that are known in the company are applied even when they do not necessarily fit the purpose. Interpreting and sharing the collected user information within the service provider organization creates another challenge. Often methods yield user information in a format that is not easy to handle, such as audio or video files, photographs, or physical outcomes.

Encouraged by the literature on using physical representations, we report our experiences in using CPM in service development. It comprises free-form physical modeling and the model's structured disassembly that translates into

a textual format. With the help of the three cases, we present a proof of concept for utilizing a purposefully simple and inexpensive approach, extendable to different types of service development situations, to reveal the different stakeholder interpretations of a service and to extract these interpretations in a format that can be easily shared and compared.

The cases illustrate how by modifying the workshop setting, CPM becomes a method that is extendable to address different types of service development situations from analyzing an existing service to generating new service concepts. Moving from analyzing to generating, the method was enhanced with a pre-module: a futures module in the case of developers and 'ordinary' users, and a trigger module in the case of lead users.

4.6 Publication VI: Collaborative Futuring with and by Makers

The goal of this article was to report on our experiences in a futuring workshop with makers as part of participatory planning of Helsinki Central Library. By drawing elements from both lead user workshops and participatory design (PD), we conducted a workshop with 13 lead users, which allowed us to engage the local maker communities in identifying the issues relevant for a public maker space in 2020. The workshop comprised of trend exploration facilitated by pre-categorized cards in the morning part of the day and a full-scale prototyping exercise in the afternoon.

Maker spaces offer access to low-cost digital fabrication equipment. Their benefits and potential are gradually becoming recognized both by the public sector and industrial players. Making as a phenomenon has gained ground during the last decade, and the maker communities along with the technologies and practices that are present in a maker space have gone through a rapid evolution. This makes planning for prospective maker spaces challenging. In this article, the case of the new flagship public library in Helsinki is presented. The new library building is going to carry maker facilities for citizens in 2020. The planners therefore had to envision future making years ahead at 2013, when space requirements, ventilation, noise, hazards, and many other issues were being anticipated.

Even though PD and user innovation research are commonly referenced as being among the most formidable approaches to user collaboration (e.g., Buur & Matthews, 2008; Johnson, 2013; Pals et al., 2008), explicit mixing and crossover between the two has remained rare. In the challenging planning case of future maker spaces, we were curious to experiment what kind of outcomes mixing elements from these two prominent traditions would yield.

Instead of working with the prominent best experts such as university professors or consultants, we recruited future users to chart where their needs and practices may be heading and what solutions this may provide. The justification for this choice was that lead users already live in the future of others through having already faced the needs of the rest of the user population (von Hippel,

2005). On the other hand, PD has demonstrated how ordinary users can be capacitated to become competent in complex design situations (Bødker et al., 2004; Voss et al., 2009).

The contribution of this publication is twofold:

1) Our experiment indicates that collaborative futuring with participants in a workshop arrangement appears to provide relevant and substantive information for planning. The gained insights are such that it would be difficult or more costly to attain them by other means.
2) The collaborative workshop was placed as part of concrete and long-term engagement with user communities through the real-life prototype space. Both the yield and the relevance of solution information generated in the workshop were high, which indicates that the full scale real-life prototype allowed collaborative envisioning for the future instead of getting fixated in present-day solutions

4.7 Publication VII: Organisational adoption of the lead user method: a follow-up study on intentions versus actions

The goal of this study was to shed light on the factors that challenge the adoption of the LU method in an organization, based on 64 semi-structured interviews in two organizations – Broadco and Softco[15] –, where we first conducted or monitored the LU method process, documented the responses of the employees, and then conducted a follow-up study to see whether the lead user derived results, solutions, or the further use of lead users or the LU method have followed.

Cooperation with lead users has been shown to be a particularly effective means of gaining insight into the latent trends and solutions available in the user domain and of further transforming this knowledge into product and service concepts. LU generated ideas have been shown to be more innovative and novel than those generated in-house, but what makes lead users especially lucrative is that they often openly reveal their innovations to other users and to manufacturers.

Despite its advantages and its solid academic backing, the LU method – a process that companies could apply in their product or service development in order to benefit from LUs – appears to have gained far less ground as an everyday approach among companies than traditional methods, like focus groups or customer surveys, or user-centered design and participatory design methods. There is scant research on why this is so. By reviewing the literature for reported

[15] Broadco is a national broadcasting company, established in 1926 with around 3100 employees and a yearly turnover of about 450 million euros. Softco is a private company, established in 1991, with around 70 employees and a yearly turnover of around six million euros. Broadco is a large and established organization that already has a history of user involvement, whereas Softco is a small, young, and agile organization that has only recently begun to take steps towards user-centeredness. In Broadco, the authors were commissioned to plan and conduct the project, and in Softco, the authors acted as mentors and supervisors for the company employees.

LU method application in companies, factors that affect the LU method adoption in an organization, and the diffusion of innovations theory in general four propositions were derived:

- P1: The LU method is perceived to not be needed by the producer organization's employees, even after an initially successful pilot project.
- P2: The loss of staff familiarity with the LU method can reduce an organization's capability to continue using it.
- P3: The LU method requires a great amount of effort, which reduces the number of projects where it can be viably applied.
- P4: The LU method LUM has sticky information characteristics that hamper its repeated application in an organization.

These propositions were examined in the light of the two cases, and it was found that instead of general resistance to user ideas or new ways of working (P1) or the cost and time required by the LU method (P3), the case analyses point to the difficulty of transferring and retaining the knowledge of *how* to conduct a LU project (P2 and P4). It appears that the LU method features skill components that are more costly and difficult (i.e. "sticky") to transmit among employees than the adopter organizations were prepared for.

5. Findings

The aim of this dissertation was to shed light on the challenges involved in the use of the LU method and to provide remedy and direction for its use in organizations that are seeking to benefit from lead users. Three specific objectives were:

1) *to further improve the concepts and means available for lead user identification*,
2) *to gain more understanding on and alternative means for transferring (lead) user knowledge*, and
3) *to explore the factors that challenge the adoption of the LU method in an organization*.

Objective 1) has been treated especially in section 2.4.1 and in **publications I** (Hannukainen & Hölttä-Otto, 2006), **II** (Tuulenmäki & Helminen, 2009), and **III** (Hyysalo et al., 2015).

Many examples from the literature show that lead users, that is users, who experience new needs before these needs become general in the marketplace and who would greatly benefit if these needs were met, are "loaded with potential" to generate innovations that substantially differ from existing market offerings. It is notable, however, that examples concentrate on lead users of especially high performance level: marathon runners being lead users for casual joggers, or aerospace industry being a lead user industry from car manufacturer's standpoint, for example. For efficient lead user identification, also *low-performance users* should be considered (**publication I)**. In this study on mobile phones, the user needs of disabled users and those of situationally disabled users were compared. It was shown that user needs of situationally disabled users overlap with the needs of disabled users. There were also several examples of leading edge behavior of disabled users (i.e. the ahead of a market trend component), and it is concluded that disabled users can be seen as lead users when developing products for the large market of able-bodied users.

There are several, but fairly similar, versions of the lead user method available in the literature. One of the weak points of the method is when lead users should be identified on a certain field (or advanced analogous fields), or in the leading edge of a certain trend. A framework for better identification of lead users is proposed in **publication II** (see Figure 8). Lead users are traditionally understood to be lead users tied to the intended value of a class of products, even as their needs are not fully met by the designed-in characteristics of the products

available in the market. If a surgeon develops a better tool for the operating room, for example, he is a typical lead user (LU). When the phone is used in complete darkness or when driving a car, it still has "intrinsic" value, but the context of use is no longer in the intended value zone, but in a situational (dis)value zone. Operating properly in a situational (dis)value zone often requires accessories, add-ons or other extra features on top of the core features. When a blind person develops a solution that would help a user with full vision to better use the mobile phone in darkness, the blind person is a situational lead user (SLU).

Positional value is like a by-product of the intended value. Utilizing positional value dimensions usually requires utilizing by-features or by-assets. Therefore it is proposed that there must be lead users of positional value, analogous to lead users of "intrinsic" value and situational value. Accordingly, positional lead users (PLU) refers to people/companies who fulfill their needs with by-features of artifacts or assets originally intended for something-else. **Publication II** presents, how the proposed framework can be used for systematic identification of lead users by analyzing the core features, outcomes, situations when users are momentarily disabled, and the by-features of a product.

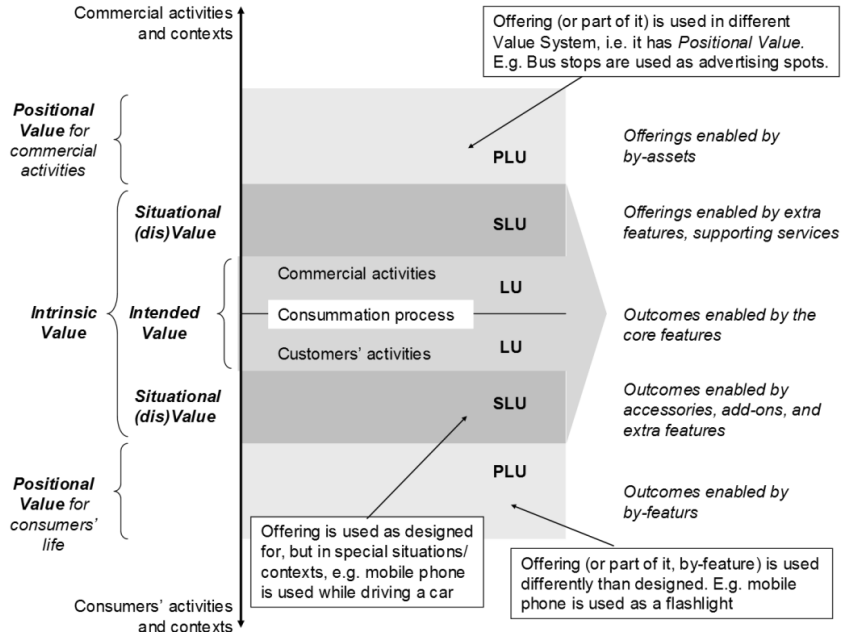

Figure 8. *Publication II, Figure 1:* Lead Users (LU), Situational Lead Users (SLU), and Positional Lead Users (PLU) in relation to the consummation process. (Tuulenmäki & Helminen, 2009)

To date, much of the work regarding the identification of the rare lead users has centered on networking strategies (pyramiding, snowball sampling) assuming that individuals are linked directly to other individuals (e.g., Churchill et al., 2009; Hienerth et al., 2007; Lüthje & Herstatt, 2004; Stockstrom et al., 2012). In the study by Poetz and Prügl (2010, p. 906), however, it was found that the

referrals to other entities than people amounted to 69.3% of the referrals. The status of such referrals can be explicated as *intermediate referral types* (**publication III**), and referral types altogether can be distinguished ranging from immediate referrals to pure intermediate referrals (see Table 2). The diverse LU identification methods, on the other hand, can be organized according to their sampling logic and their characteristics (see Publication III, Table 2).

Table 2. *Publication III, Table 1:* Different referral types and key requirements and possibilities associated to them. (Hyysalo et al., 2015)

REFERRAL CATEGORY	REFERRAL TYPES
Immediate referrals	**Person** An individual with a name
Semi-immediate referrals These referrals point to referents directly, but respondent-assistance is not immediate.	**Computer-Mediated Communication (CMC)** Interactive computer media (e.g. blog, forum, wiki, mailing list, social networking site, online community). Two-way communication.
	Solution User innovations, prototypes, etc. displayed without their maker.
Semi-intermediate referrals These referrals have a responsible gatekeeper that can assist the researcher.	**Organization** Formal organization (e.g. company, agency, non-profit, school)
	Event Conference, seminar, fair, etc.
Pure intermediate referrals These referrals cannot be used directly: a researcher-driven sample must be obtained next.	**Mass media** Mass-broadcasted one-way communication (newspaper, TV, radio, company website).
	Index Searchable index of things, people and their personal information[16] (e.g. census, health care, and tax records, databases, search engines)
	Field Professional field or domain[17] (e.g. superconductors, banking, public health care)
	Location A meeting place where people hang out, a subway station, a gallery, etc.

The basic metaphor of pyramiding is finding one's steps up a pyramid to reach the top lead user(s).[18] To date, pyramiding and broadcasting have been combined both in parallel (Hienerth et al., 2007) and sequence (Keinz & Prügl, 2010), and multiple starting points have been used for pyramiding (Poetz & Prügl, 2010, p. 910). To take these experiments further **publication III** introduces more encompassing combinatory search that uses several referral types and several search methods to overcome constraints in referral types that become available during a search. We call this search approach *mountaineering*, because it is foremost multiple method hill-climbing, a way of "traversing upwards" towards those people, who have the sought-after characteristics (von Hippel et al., 2009), but not limited to pyramiding only. The basic idea is thus to purposefully combine the referral types and search methods listed in Table 2

[16] Poetz and Prügl (2010) mention also 'literature' that we would place under Index in network search terms.

[17] In Poetz and Prügl (2010) also 'profession' and 'technology'.

[18] One of the earliest illustrations of such a lead user search was the networking approach (von Hippel et al., 1999, p. 50). To be precise, the figure presents an approach with two search methods (snowball and pyramid sampling) and two referral types (person, field). The search methods are explained in Publication III, Table 2 and the referral types in Table 2.

and Publication III, Table 2 in order to get at the lead users step by step. This can take place via multiple routes in parallel but emphasizing those referrals and search methods that are most promising in a given moment. Such concurrent integrative search approach can be started with many given starting points and methods and can keep several search chains alive simultaneously, in so much that they do not jeopardize each other, for instance through same people being contacted repeatedly or by several means (see Figure 9).

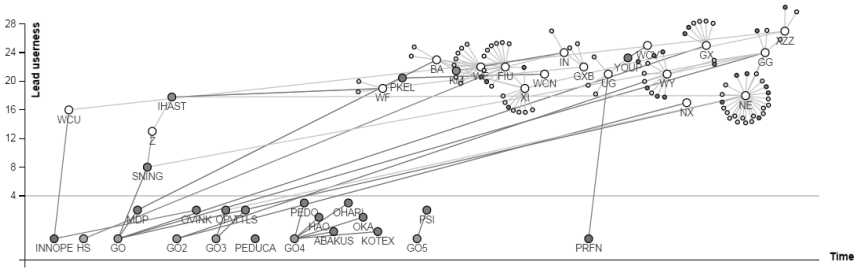

Figure 9. *Publication III, Figure 11:* The final stage of the web service lead user search. (The referral types and search methods map to different-colored circles and lines: persons as white circles and light-blue lines as snowball and pyramid sampling, for example.) (Hyysalo et al., 2015)

Objective 2) was to gain more understanding on and alternative means for transferring (lead) user knowledge. It has been treated especially in section 2.4.2 and in **publications IV** (Helminen, Ainoa, & Mäkinen, 2015), **V** (Helminen, Mäkinen, & Holopainen, 2016), and **VI** (Hyysalo et al., 2014).

The idea of a user innovation toolkit is to transfer the users' use-specific "sticky" information to manufacturers by providing users with a possibility to "prototype" their ideas. By restricting the available solution space and by offering a module library, the user information is created in a format that speaks the same language with that on the manufacturer side, but by not making it difficult for the user to produce. According to the user innovation literature, the solution space must be limited in order to prevent users from developing a solution that the developer side cannot produce (von Hippel & Katz, 2002; von Hippel, 2001). On the other hand, it is assumed that users make use of the offered solution space and that toolkits that offer a large solution space allow substantial innovations (Franke & Piller, 2004). The role of the module library is to provide users with existing modules, so that they do not need to start designing from scratch (von Hippel & Katz, 2002; von Hippel, 2001). The above arguments were examined regarding the solution space and the module library with the help of three toolkits in the context of a shopping center where the combination of limited/unlimited solution space and typical/extended module library varies (**publication IV**). This study suggests that limiting the solution space is not necessarily as important as stated in the previous literature on user innovation toolkits. It appears that offering the users unlimited solution space does not automatically lead users to take advantage of it, nor does it mean that if they do, they will come up with substantial innovations. This was seen in the case of

Toolkit 1[19]. The role of the module library is also not as straightforward as assumed. Even though users were offered an extended module library (Toolkits 2[20] and 3[21]), not many non-shopping-related special blocks were found in their designs. In the case of Toolkit 3, it was seen, however, that even if the extended module library failed to enrich the users' designs as such, it worked as inspiration when users exploited the unlimited solution space.

A physical modelling approach called collaborative physical modeling (CPM) can be used to reveal the different stakeholder interpretations of a service and to extract these interpretations in a format that can be easily shared and compared, thus facilitating user-developer communication (**publication V**). The CPM process flow consists of six main phases: preparation, warm-up, model building, disassembling, grouping, and analysis. To demonstrate the use of this method, CPM is used in three differing cases. The study recapitulates the well-rehearsed fact that the worlds of the developer and the user are fundamentally different. The developer sees a product concept as something that could be produced while the user sees it as something that could be used or consumed (Engeström & Escalante, 1996; Hyysalo, 2009a, 2010).

With the help of the three cases, where CPM was used for analyzing and existing service and for generating new service concepts, we present a proof of concept for utilizing a purposefully simple and inexpensive physical modeling approach, extendable to different types of service development situations, to reveal the different stakeholder interpretations of a service and to extract these interpretations in a format that can be easily shared and compared. The cases illustrate how by modifying the workshop setting, CPM becomes a method that is extendable to address different types of service development situations from analyzing an existing service to generating new service concepts. Moving from analyzing to generating, the method was enhanced with a pre-module: a futures module in the case of developers and 'ordinary' users, and a trigger module in the case of lead users.

Publication VI reports on experiences of drawing from both user innovation research and participatory design (PD) to compile a workshop arrangement that enables transferring the lead user knowledge in the case of maker space planning for the year 2020. We saw that the complementary elements offered by user innovation research and PD did play out well in the current case, offering a proof-of-concept that some purposeful cross-breeding from these traditions can be achieved.

[19] In Toolkit 1, the solution space was unlimited, which means that users were provided with blank blocks that they could develop into any imaginable element in their design. The module library of Toolkit 1 was "typical," i.e., only shopping-related blocks that are generally found in Finnish shopping centers were offered.

[20] In Toolkit 2, the solution space was limited, i.e., no blank blocks were offered, but on the other hand, the module library was extended and comprised of non-shopping-related elements (special blocks) that are usually not found in Finnish shopping centers.

[21] Toolkit 3 was a combination of Toolkits 1 and 2 and provided the user with both unlimited solution space (i.e., blank blocks) and an extended module library (i.e., shopping-related and non-shopping-related blocks).

Objective 3) was to explore the factors that challenge the adoption of the LU method in an organization. It has been treated especially in section 2.5 and in **Publication VII** (Helminen, Mäkinen, & Hyysalo, n.d.)**.**

Despite its advantages and its solid academic backing, the LU method appears to have gained far less ground as an everyday approach among companies than traditional methods. The implementation of the LU method was studied in two organizations (**publication VII**). The evidence from the two cases is that NIH, loss of control, or the loss of professional identity gain at best limited support as factors in employees' willingness to adopt the LU method, but further adoption steps may have been challenged by a lack of adapting or re-innovating it for an organizations' specific practices. The effect of staff turnover featured in both cases where the operational level skill to conduct the LU method was lost (cf. Olson & Bakke, 2001). What comes to the effort of carrying out the LU method, we come to the interpretation that the LU method was seen as unsuited for small projects but beyond this the amount of effort is relative to the given context and needs, and requires further explanation rather than being an explanatory variable as such.

In both cases we saw that knowledge of the method transferred only partially to persons that were not involved in the actual legwork but were mere observers. The needed knowledge was thus sticky, that is to say, difficult and costly to transfer with the reliability needed for conducting it into the next in-house LU project. Our data implies that easier-to-transfer methods become part of the method toolbox in an organization more easily. At Broadco, for example, "design probes" (Mattelmäki, 2006) entered the organization from outside in 2003 and were routinized as part of its audience research repertoire – frequently referred to as a flexible tool for different projects. We thus find that the sticky information characteristics of the LU method contributed to the lack of it being re-applied in the studied organizations.

6. Discussion

6.1 Theoretical Contributions

Literature on user innovation has been building up since the 1970's (von Hippel, 1976, 1978a, 1978b), the core concept 'lead user' entering the stage at 1986 (von Hippel, 1986). Despite the rich body of research, some related concepts have remained vague. The framework in **publication II** provides means of determining "the field" and "analogous fields" (and eventually makes it easier to find potential lead users). Through explanatory real world references, complementing concepts of *situational value & situational lead user* and *positional value & positional lead user* are developed.[22] Also the concepts of *"intrinsic" value* and *intended value* are explained.

Often lead-userness is associated with the high performance level of a user. This unnecessarily limits the scope of where lead users could be identified, as also the low-performance users can be seen as lead users (**publication I**). It is important not to draw too strong parallels between this and the Universal design approach[23]. The philosophy of the latter is that when products and environments are developed for the disabled, they may also serve the able-bodied. The idea behind the low-performance lead users is that the product is still being developed for the large mass market, and not a niche, but that the low-performance lead users are likely to have already found solutions for the needs that will soon be faced among the masses. What is fundamentally different in these two cases is that when a product is being developed specifically for the disabled market, the end result very often stands out from the other offerings[24]. If low-performance users (not necessarily just disabled users) are seen as lead users, this will boost the development of the products for the large target market, but as a "bonus" also produce products that the niche low-performance users will feel comfortable using as they are not stigmatizing.

Identification of lead users has repeatedly been found to be the key challenge when companies try to benefit from lead users' potential. Literature has provided a range of methods and approaches for their identification (see section 2.4.1 for a review) as well as pursued comparisons and simulations for

[22] Recent work by Schweisfurth, Herstatt, and Raasch also contributes to clarifying the dimensions of lead-userness by introducing the term 'embedded lead user' meaning company employees that are also users of the company's products (Schweisfurth & Herstatt, 2014, 2015; Schweisfurth & Raasch, 2015).

[23] 'Universal design' as termed in the US, 'Design for all' as termed in Europe (especially in Nordic countries), and 'Inclusive design' in the UK.

[24] Managing the stigma of assistive products has been studied for instance by Jacobson (2014).

establishing the efficiency and efficacy between different identification methods (e.g., Piller & Walcher, 2006; Poetz & Prügl, 2010; Stockstrom et al., 2012; von Hippel et al., 2009). Thus far, different identification strategies have been seen as alternatives of which to choose from, and attention has not been paid to the fact that not all identification methods are applicable to all referral types (**publication III**). Pyramiding and snowball search, for instance, are directly applicable only to immediate referrals, whereas other referral types require additional sampling steps. **Publication III** organizes the terminology and concepts regarding different lead user identification methods, both *respondent-assisted* and *researcher-driven* by sampling logic, as well as the full range of referral types identified thus far. Table 3 presents how *immediate*, *semi-immediate*, *semi-intermediate*, and *pure intermediate* referral types correspond to different identification methods.

Table 3. *Publication III, Table 3:* Referral types and applicable methods. (Hyysalo et al., 2015)

REFERRAL TYPE		RESPONDENT-ASSISTED SAMPLING METHODS Nominated sampling	COMPLETE ENUMERATION METHODS		RESEARCHER-DRIVEN SAMPLING METHODS	RESPONDENT-ASSISTED SAMPLING METHODS Self-nomination to research action
		Pyramid search Snowball search	Screening by survey	Screening by solution content analysis	Purposive, quota, and probabilistic sampling	Broadcasting, idea competitions, virtual stock markets
Immediate	Person	Yes	yes	no	yes	Yes
Semi-immediate	CMC	Yes, delay and uncertainty in response	No, response rate is unlikely to produce screening	yes	yes	Yes
	Solution		no	yes	yes	No, requires link to person
Semi-intermediate	Organization	Additional step	Yes	no	yes	Yes
	Event	Additional step	Yes	Yes, if solutions on display	yes	Yes
Pure intermediate	Mass media	May require research driven sampling step(s).	no	Yes, if solutions on display	yes	Yes
	Index		no	Yes, if solutions on display	yes	yes
	Field	Requires research driven sampling step(s).	Yes,	Yes, if solutions on display	yes	yes
	Location		Yes	Yes, if solutions on display	Yes	yes

Looking at the four cases, the most productive search strategy appears to vary significantly from one case to another as well as with regard to the phase of the particular case. The mix of a domain expert–broadcasting–pyramiding search strategy used in the web service case would have been less productive in the heat

pump and wood pellet searches where we could opportunistically use large Internet forums by first drawing researcher-driven samples and then screening these by content, followed by pyramiding. Screening by content (Internet or other communities of interest) can be effective, particularly if there is a self-nominated subsection of the population active regarding the sought search attribute. Otherwise, a researcher-driven sampling strategy would be needed targeting the sweet spots for the information and people searched for. Similarly, the known downside of link-tracing strategies in missing isolates (Atkinson & Flint, 2001; van Meter, 1990) can be compensated by using multiple starting points as we did in all of our searches.[25]

Our cases demonstrate how capitalizing on different strengths of different identification methods can help overcome referral type limitations. This is in contrast to the current literature that has concentrated on comparing and choosing between methods but has left the possibilities for systematically combining different methods under-explored. Discussion similar to our case has recently emerged in the field of human–computer interaction — a field where the debate on choosing the "best" method for some specified context has prevailed for the past decades. Woolrych et al. (2011) argue that only very few comparative research studies investigate methods as they are mostly used in practice: as combinations of methods and their components.

The last step of the LU method – the concept design – is typically organized as a workshop arrangement where both company representatives and the identified lead users are present (Churchill et al., 2009; Hienerth et al., 2007; Lüthje & Herstatt, 2004). If, as it seems, lead user workshops are the prevailing best practice in transferring lead user knowledge to the company, it is remarkable how thin the literature on the content of this practice is. The lead user literature has remained an island with little cross-breed with neighbors such as human-centered and participatory design where there is a large amount of research concentrating on studying and developing workshops and the like. Various physical representations, for example, have long been used to support design activities considering physical features, the context of use, socio-technical systems and services (Hillgren, Seravalli, & Emilson, 2011), experiences (Buchenau & Suri, 2000), social interaction (Kurvinen, Koskinen, & Battarbee, 2008), or software (Budde, Kautz, Kuhlenkamp, & Züllighoven, 1992). Collaborative design again features a large family of techniques and methods that take place in workshops and utilize representations of work and technology to translate information and understanding between developers and users (Bødker et al., 2004; J. M. Greenbaum & Kyng, 1991; Muller & Kuhn, 1993). This dissertation indicates that the content of the LU workshops could benefit from collaborative and participatory techniques (**publications V and VI**). It also contributes to the existing literature on user innovation toolkits and proposes that the roles of the solution space and the module library might in fact be interrelated (**publication IV**). This can be interpreted so that creating functional and efficient user

[25] Figure 9 relating to the web service search shows a lead user being found very late in the process and not connected to the initial chains.

innovation toolkits is more complicated than assumed in the literature and creating one might be too risky (or even impossible) a task in most product development cases.

The LU method is typically run as a project, and project outcomes have been evaluated successful in most studies. The research so far has concentrated on the project-level, exploring individual LU projects and ceasing data-gathering at the end of the project, thus concluding at recommending the LU method. Nevertheless, the method remains unknown to most companies – conducting a LU project is not easy. This is not difficult to believe, when concepts and means for lead user identification have so far been presented in an incomplete and unclear manner (Objective 1 of this dissertation) and, on the other hand, only sketchy instructions on how to run the lead user workshop are available in the literature (Objective 2).

Previous literature and the two cases studied (Broadco and Softco) indicate that the LU method use is difficult to sustain in producer organizations. This goes even for organizations (such as Broadco) that have a record of routinizing several user research methods into their toolbox and would thus be likely to adopt new tools and techniques (Nijssen & Frambach, 2000). It was found that instead of general resistance to user ideas or new ways of working or the cost and time required by the LU method, the case analyses point to the difficulty of transferring and retaining the knowledge of how to conduct a LU project. It appears that the LU method features skill components that are more costly and difficult (i.e. "sticky") to transmit among employees than the adopter organizations were prepared for. Rather ironically, it is the same phenomenon that user innovation research has identified as one of the key reasons for why users hold solution and trend information and why lead users should be utilized in the first place.

Overall, this dissertation drills down to the core of the LU method: how it is carried out in practice. The documents of the good results that companies can achieve by utilizing the LU method have left factors that challenge its adoption in organizations unattended in academic research. These challenges stem from the ways the LU method is conducted in reality: how the lead users are identified and how the lead user knowledge is transferred.

6.2 Managerial Implications

Understanding user needs is essential for companies to thrive in today's competitive environment. But how are user needs identified? And are these the needs of the right users? For long, designers and engineers have monopolized the development of new products. Nowadays, lead users have been recognized as users that are loaded with potential to generate novel solutions for needs that are not yet common among the masses. Lead users face needs months or years before they become general in the marketplace and lead users are also positioned to benefit significantly, if these needs are met. A lead user can be an

actual user, like the one biker who thought first it would be a good idea to ride a bicycle down a mountain and started fixing his equipment accordingly. It could be a group of users, such as blind or deaf mobile phone users (**publication I**). A lead user can also be an entirely different field of industry, as were the military aircrafts in the case of the antilock braking systems commonly used in cars. The challenge of the companies is not only to open up to the possibility that a competitive solution might be developed *outside the company*, but that it could be developed to meet a need that is identified *outside the target market* of the product under development (see **publication I**). If companies concentrate solely on the needs of the users in the target market, they very possibly miss insights from the lead users. In addition, the value of lead users is not only in their insights but their leading-edge status might make them also opinion leaders in the market (Morrison, Roberts, & Midgley, 2004, 2000; Schreier et al., 2007; Urban & von Hippel, 1988).

A framework presented in **publication II** enables to see beyond the intended value of a product and the corresponding consummation chain. A product is always part of a net of crossing consummation chains in the user's life, and in user's point of view it cannot be seen as unconnected (see case examples in **publication V**). Recognizing the inevitable crossing points of different consummation chains and value systems opens up for the possibility to identify not only *lead users* and *situational lead users*, but also *positional lead users*.

Collaborative physical modeling approach (**publication V**) brings relief to managers who understand the need for involving (lead) users in (product or) service development but who are constantly bound by limited resources be it personnel, time, or money. This low-cost, time-efficient and easy-to-adopt physical modeling approach can be extended to address differing service development situations before jumping into more complicated and resource-intensive methods. Later on CPM could easily be coupled with service blueprinting, for example.

When companies are seeking to benefit from lead users, it is important to take note of the skill needed to carry out the LU method in practice – support at the management level is not enough (**publication VII**). The method requires an operational level person as a change agent to guarantee the organization's ability to reapply the method after the pilot project. This heightens the risk that the skill and expertise will be lost through staff turnover. The method transfer can be augmented through having several of the adopter organization's staff members take part in a "hands on" way in the pilot project. Another way to tackle the stickiness of the LU method is to buy the competence from outside as an expert service, project by project, when needed. In this way, however, the potential of building a longer lasting relationship with the identified lead users is compromised.

6.3 Avenues for Future Research

The present study highlights the complexity of real-life lead user identification processes and indicates that the chain length that has been used in pyramiding

simulations (Stockstrom et al., 2012; von Hippel et al., 2009) may not be the only viable measure in network searches were different methods are combined. The cases in **publication III** indicate that the search can proceed with relatively little effort even when the chain is long, while sometimes short chains can become prolonged and take immense effort to accomplish. Therefore both invested working time as well as calendar time of the identification process could be considered as alternative measures in future research.

The particular characteristics of lead users include that the primary driver for their actions is to find a solution to a specific and often critical need. They do not care how the need is met, as long as it is met. Often they create a solution by themselves out of whatever resources they have at hand. This leads us to ponder how motivated they are in fact to participate in a workshop with company representatives and other lead users and to work in collaboration, and if we can even assume that workshop practices that are used with "regular" users are suitable when working with lead users. This calls for research on comparisons between lead users and other user groups with respect to different means and practices for transferring user knowledge.

As future work regarding user innovation toolkits we suggest testing the hypotheses formulated in **publication IV** quantitatively in different contexts ranging from product to service design. Looking into the relationship of the module library and the solution space benefits not only the development of user innovation toolkits but also other methods and techniques commonly used by designers. Our experiences encourage designers to systematically study the role and interrelations of the elements in the methods that are used for transferring sticky information between the user and the designer.

Herstatt and Schweisfurth (2014, p. 11) identify the following question as one of key questions for future research: Which organizational mechanisms can be used to make user innovations useful for companies? The insights from this dissertation lead to approach this question from another angle: How could the LU method be packaged or developed into an approach that can be applied piecemeal, in order to facilitate an organization's ability to adopt it? Or should we go as far as packaging it into an expert service that is aimed at being bought from outside and not applied by members of the organization? To better address these questions longitudinal research on organizations where the LU method has been adopted, meaning its use has been continued after the pilot project, is desperately needed. None have emerged so far.

Overall, referring back to the research directions pointed out by Lilien et al (2002, p. 1056) in the beginning of this dissertation (p. 12–13), it is safe to say that the method development for lead user identification (direction 2) has been given much more attention than the methods to obtain information from lead users (direction 3), where there is still room to learn from neighboring disciplines such as human-centered and participatory design, for example. Organizational aspects (directions 1 and 4) on the other hand continue to require in-depth studies, which was confirmed in the current dissertation.

References

Alam, I. (2002). An exploratory investigation of user involvement in new service development. *Journal of the Academy of Marketing Science*, *30*(3), 250–261.

Amaratunga, D., & Baldry, D. (2001). Case study methodology as a means of theory building: performance measurement in facilities management organisations. *Work Study*, *50*(3), 95–105.

Armstrong, A., & Hagel, J. (1996). The real value of on-line communities. *Harvard Business Review*, *74*(3), 134–141.

Atkinson, R., & Flint, J. (2001). Accessing hidden and hard-to-reach populations: Snowball Research Strategies. *Social Research Update*, (33).

Bakewell, C., & Mitchell, V.-W. (2003). Generation Y female consumer decision-making styles. *International Journal of Retail & Distribution Management*, *31*(2), 95–106.

Baldwin, C., Hienerth, C., & von Hippel, E. (2006). How user innovations become commercial products: A theoretical investigation and case study. *Research Policy*, *35*, 1291–1313.

Beck, K., Beedle, M., van Bennekum, A., Cockburn, A., Cunningham, W., Fowler, M., … Thomas, D. (2001). Manifesto for Agile Software Development. Retrieved September 15, 2015, from http://agilemanifesto.org/

Belz, F.-M., & Baumbach, W. (2010). Netnography as a method of lead user identification. *Creativity and Innovation Management*, *19*(3), 304–313.

Berkhout, A. J., Hartmann, D., van der Duin, P., & Ortt, R. (2006). Innovating the innovation process. *International Journal of Technology Management*, *34*(3/4), 390–404.

Berkhout, A. J., & van der Duin, P. A. (2007). New ways of innovation: an application of the cyclic innovation model to the mobile telecom industry. *International Journal of Technology Management*, *40*(4), 294.

Beyer, H., & Holtzblatt, K. (1998). *Contextual design: defining customer-centered systems*. San Francisco, USA: Morgan Kaufmann Publishers.

Beyer, H., & Holtzblatt, K. (1999). Contextual design. *Interactions*, *6*(1), 32–42.

Bilgram, V., Brem, A., & Voigt, K.-I. (2008). User-centric innovations in new product development — Systematic identification of lead users harnessing interactive and collaborative online-tools. *International Journal of Innovation Management*, *12*(3), 419–458.

Bitner, M. J., Ostrom, A. L., & Morgan, F. N. (2008). Service blueprinting: A practical technique for service innovation. *California Management Review*, *50*(3), 66–95.

Boddy, C. (2004). From brand image research to teaching assessment: using a projective technique borrowed from marketing research to aid an understanding of teaching effectiveness. *Quality Assurance in Education*, *12*(2), 94–105.

Boddy, C. (2005). Projective techniques in market research: valueless subjectivity or insightful reality? A look at the evidence for the usefulness, realiability and validity of projective techniques in market research. *International Journal of Market Research*, *47*(3), 239–254.

Bogers, M., Afuah, A., & Bastian, B. (2010). Users as innovators: A review, critique,

and future research directions. *Journal of Management*, *36*(4), 857–875.

Bogers, M., & West, J. (2012). Managing Distributed Innovation: Strategic Utilization of Open and User Innovation. *Creativity and Innovation Management*, *21*(1), 61–75. doi:10.1111/j.1467-8691.2011.00622.x

Botero, A., & Hyysalo, S. (2013). Ageing together: Steps towards evolutionary co-design in everyday practices. *CoDesign*, *9*(1), 37–54.

Brady, T., Rush, H., Hobday, M., Davies, A., Probert, D., & Banerjee, S. (1997). Tools for technology management: An academic perspective. *Technovation*, *17*(8), 417–426.

Bragge, J., Tuunanen, T., & Marttiin, P. (2009). Inviting Lead-users from Virtual Communities to Co-create Innovative IS Services in a Structured Groupware Environment. *Service Science*, *1*(4), 241–255.

Brandt, E., & Messeter, J. (2004). Facilitating collaboration through design games. In *Proceedings of Participatory Design Conference 2004* (pp. 121–131). July 27-31, Toronto, Canada: ACM Press.

Brody, H. (1996). The web maestro: An interview with Tim Berners-Lee. *Technology Review*, *99*(5), 32–40.

Brown, B. A. T., Sellen, A. J., & O'Hara, K. P. (2000). A Diary Study of Information Capture in Working Life. In *Proceedings of the SIGCHI conference on human factors in computing systems* (Vol. 2, pp. 438–445). April 1–6, 2000, The Hague, The Netherlands.

Brown, J. (2002). A Resource guide for hosting conversations that matter at The World Café. Retrieved September 15, 2014, from http://www.meadowlark.co/world_cafe_resource_guide.pdf

Bryman, A. (1984). The debate about quantitative and qualitative research: a question of method or epistemology? *The British Journal of Scoiology*, *35*(1), 75–92. Retrieved from http://usir.salford.ac.uk/9875/

Buchenau, M., & Suri, J. F. (2000). Experience prototyping. In *Proceedings of DIS '00* (pp. 424–433). Brooklyn, New York: ACM.

Budde, R., Kautz, K., Kuhlenkamp, K., & Züllighoven, H. (1992). What is prototyping? *Information Technology & People*, *6*(2), 89–95.

Buur, J., & Matthews, B. (2008). Participatory innovation. *International Journal of Innovation Management*, *12*(3), 255–273.

Bødker, K., Kensing, F., & Simonsen, J. (2004). *Participatory IT design: Designing for business and workplace realities*. Cambridge, MA, USA: MIT Press.

Castellion, G., & Markham, S. K. (2013). Perspective: New product failure rates: Influence of Argumentum ad populum and self-interest. *Journal of Product Innovation Management*, *30*(5), 976–979.

Chatterji, A. K., & Fabrizio, K. (2012). How do product users influence corporate invention? *Organization Science*, *23*(4), 971–987.

Chesbrough, H. (2003). *Open innovation: The new imperative for creating and profiting from technology*. Boston, MA, USA: Harvard Business School Press.

Chesbrough, H., & Bogers, M. (2014). Explicating open innovation: Clarifying an emerging paradigm for understanding innovation. In H. Chesbrough, W. Vanhaverbeke, & J. West (Eds.), *New frontiers in open innovation* (pp. 3–28). Oxford: Oxford University Press.

Chesbrough, H., Vanhaverbeke, W., & West, J. (Eds.). (2006). *Open innovation: Researching a new paradigm*. New York, NY, USA: Oxford University Press.

Churchill, J., von Hippel, E., & Sonnack, M. (2009). *Lead User Project Handbook: A practical guide for lead user project teams*. Retrieved from http://web.mit.edu/people/evhippel/Lead User Project Handbook (Full Version).pdf

Cooper, R. G. (1990). Stage-Gate Systems: A New Tool for Managing New Products. *Business Horizons*, (May-June), 44–54.

Cooper, R. G., & Kleinschmidt, E. J. (1986). An investigation into the new product process: Steps, deficiencies, and impact. *Journal of Product Innovation Management*, *3*(2), 71–85.

Crawford, C. M. (1977). Marketing research and the new product failure rate. *Journal of Marketing*, *41*(2), 51–61.

Creswell, J. W., & Miller, D. L. (2000). Determining validity in qualitative inquiry. *Theory into Practice*, *39*(3), 37–41.

Dahlsten, F. (2003). Avoiding the customer satisfaction rut. *MIT Sloan Management Review*, *44*(4), 73–78.

de Jong, J. (2011). *Uitvinders in Nederland (Inventors in the Netherlands)*. Zoetermeer: EIM.

Denzin, N. K. (1989). *The research act: A theoretical introduction to sociological methods* (3rd ed.). Englewood Cliffs, NJ: Prentice Hall.

Denzin, N. K. (2001). *Interpretive interactionism* (2nd ed.). Thousand Oaks, CA: SAGE Publications, Inc.

Denzin, N. K., & Lincoln, Y. S. (2000). *Handbook of Qualitative Research* (2nd ed.).

Droge, C., Stanko, M. A., & Pollitte, W. A. (2010). Lead users and early adopters on the web: The role of new technology product blogs. *Journal of Product Innovation Management*, *27*(1), 66–82.

Eisenhardt, K. M. (1989). Building theories from case study research. *Academy of Management Review*, *14*(4), 532–550.

Eisenhart, M. A., & Howe, K. R. (1992). Validity in educational research. In M. D. LeCompte, W. L. Millroy, & J. Preissle (Eds.), *The handbook of qualitative research in education* (pp. 643–680). San Diego: Academic Press.

Engeström, Y., & Escalante, V. (1996). Mundane tool or object of affection? The rise and fall of the Postal Buddy. In B. A. Nardi (Ed.), *Context and consciousness: Activity theory and human–computer interaction* (pp. 325–374). Cambridge, MA, USA: MIT Press.

Enos, J. L. (1962). *Petroleum progress and profits: A history if process innovation*. Cambridge, MA, USA: MIT Press.

Ernst, M., Brem, A., & Voigt, K.-I. (2013). Innovation management, lead-users, and social media – introduction of a conceptual framework for integrating social media tools in lead-user management. In M. R. Olivas-Luján & T. Bondarouk (Eds.), *Social Media in Strategic Management* (pp. 169–195). Bingley, UK: Emerald Group Publishing Limited.

Flick, U. (2009). *An introduction to qualitative research* (4th ed.). London: SAGE.

Flint, D. J. (2002). Compressing new product success-to-success cycle time: Deep customer value understanding and idea generation. *Industrial Marketing Management*, *31*(4), 305–315.

Fotopoulos, C., & Psomas, E. (2009). The use of quality management tools and techniques in ISO 9001:2000 certified companies: the Greek case. *International Journal of Productivity and Performance Management*, *58*(6), 564–580.

Frambach, R. T., & Schillewaert, N. (2002). Organizational innovation adoption: a multi-level framework of determinants and opportunities for future research. *Journal of Business Research*, *55*(2), 163–176.

Franke, N., Lettl, C., Roiser, S., & Tuertscher, P. (2013). "Does god play dice?" Randomness vs . deterministic explanations of idea originality in crowdsourcing. In *Proceedings of DRUID 2013*. June 17-19, Barcelona, Spain.

Franke, N., & Piller, F. T. (2003). Key Research Issues in User Interaction with Configuration Toolkits in a Mass Customization System: The Foundation of the Idtown User Design Project. *International Journal of Technology Management*, *26*(5/6), 578–599.

Franke, N., & Piller, F. T. (2004). Value Creation by Toolkits for User Innovation and Design: The Case of the Watch Market. *Journal of Product Innovation*

Management, *21*(6), 401–415.

Franke, N., & Shah, S. K. (2003). How communities support innovative activities: an exploration of assistance and sharing among end-users. *Research Policy*, *32*, 157–178.

Franke, N., & von Hippel, E. (2003). Satisfying heterogeneous user needs via innovation toolkits: the case of Apache security software. *Research Policy*, *32*(7), 1199–1215.

Franke, N., von Hippel, E., & Schreier, M. (2006). Finding commercially attractive user innovations: A test of lead-user theory. *Journal of Product Innovation Management*, *23*(4), 301–315.

Franz, R., & Wolkinger, T. (2003). Customer integration with virtual communities. Case study: the online community of the largest regional newspaper in Austria. In *Proceedings of the 36th Annual Hawaii International Conference on System Sciences (HICSS'03)*. IEEE.

Freeman, C. (1968). Chemical process plant: Innovation and the world market. *National Institute Economic Review*, *45*, 29–51.

Gassmann, O., Enkel, E., & Chesbrough, H. (2010). The future of open innovation. *R&D Management*, *40*(3), 213–221. Retrieved from http://doi.wiley.com/10.1111/j.1467-9310.2010.00605.x

Gaver, B., Dunne, T., & Pacenti, E. (1999). Cultural Probes. *Interactions*, *6*(1), 21–29.

Glaser, B. G., & Strauss, A. L. (1967). *The discovery of grounded theory: strategies for qualitative research*. New York: Aldine de Gruyter.

Gobo, G. (2004). Sampling, representativeness and generalizability. In C. Seale, G. Gobo, J. F. Gubrium, & D. Silverman (Eds.), *Qualitative Research Practice* (pp. 435–456). London: Sage Publications.

Goodman, L. A. (1961). Snowball Sampling. *Annals of Mathematical Statistics*, *32*(1), 148–170.

Greenbaum, J. M., & Kyng, M. (Eds.). (1991). *Design at work: cooperative design of computer systems*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Habicht, H., Oliveira, P., & Shcherbatiuk, V. (2013). User Innovators: When Patients Set Out to Help Themselves and End Up Helping Many. *Die Unternehmung*, *66*(3), 277–294. Retrieved from http://ssrn.com/abstract=2144325

Hannan, M. T., & Freeman, J. (1984). Structural inertia and organizational change. *American Sociological Review*, *49*(2), 149–164.

Hannukainen, P., & Hölttä-Otto, K. (2006). Identifying customer needs - Disabled persons as lead users. In *Proceedings of IDETC/CIE 2006, 18th International Conference on Design Theory and Methodology (DTM)*. September 10-13, Philadelphia, Pennsylvania, USA: ASME 2006 International Design Engineering Technical Conferences & Computers and Information in Engineering Conference.

Hauser, J. R., & Clausing, D. (1988). The House of Quality. *Harvard Business Review*, *66*(3), 63–73.

Helminen, P., Ainoa, J., & Mäkinen, S. (2015). Designing user innovation toolkits: exploring the interrelation between solution space and module library. *International Journal of Design Creativity and Innovation*. doi:10.1080/21650349.2015.1043351

Helminen, P., Mäkinen, S., & Holopainen, M. (2016). Better user-developer communication in service development by collaborative physical modelling. *International Journal of Services and Operations Management*, *23*(2), 169–186.

Helminen, P., Mäkinen, S., & Hyysalo, S. (n.d.). Organisational adoption of the lead user method: a follow-up study on intentions versus actions. *International Journal of Business Excellence*, *x*(x).

Henderson, A., & Kyng, M. (1991). There's no place like home: Continuing design in use. In J. Greenbaum & M. Kyng (Eds.), *Design at work: Cooperative design of computer systems* (pp. 219–240). Hillsdale, NJ, USA: Lawrence Erlbaum Associates.

Herstatt, C., & Schweisfurth, T. (2014). *The intellectual pillars of user innovation: a co-citation analysis*. Working Paper, Technologie- und Innovationsmanagement, Technische Universität Hamburg-Harburg, No. 87. Retrieved from http://hdl.handle.net/10419/102302

Herstatt, C., & von Hippel, E. (1992). From experience: Developing new product concepts via the lead user method: A case study in a "low-tech" field. *Journal of Product Innovation Management*, *9*(3), 213–221.

Hienerth, C. (2006). The commercialization of user innovations: the development of the rodeo kayak industry. *R&D Management*, *36*(3), 273–294.

Hienerth, C., Keinz, P., & Lettl, C. (2011). Exploring the nature and implementation process of user-centric business models. *Long Range Planning*, *44*(5-6), 344–374.

Hienerth, C., & Lettl, C. (2011). Exploring how peer communities enable lead user innovations to become standard equipment in the industry: Community pull effects. *Journal of Product Innovation Management*, *28*(S1), 175–195.

Hienerth, C., Pötz, M., & von Hippel, E. (2007). Exploring key characteristics of lead user workshop participants: Who contributes best to the generation of truly novel solutions? In *Proceedings of DRUID 2007*. June 18-20, Copenhagen, Denmark.

Hienerth, C., von Hippel, E., & Berg Jensen, M. (2014). User community vs. producer innovation development efficiency: A first empirical study. *Research Policy*, *43*(1), 190–201.

Hillgren, P.-A., Seravalli, A., & Emilson, A. (2011). Prototyping and infrastructuring in design for social innovation. *CoDesign*, *7*(3-4), 169–183.

Hinsch, M. E., Stockstrom, C., & Lüthje, C. (2014). User innovation in techniques: A case study analysis in the field of medical devices. *Creativity and Innovation Management*, *23*(4), 484–494.

Hyysalo, S. (2003). Some problems in the traditional approaches to predicting the use of a technology-driven invention. *Innovation*, *16*(2).

Hyysalo, S. (2009a). *Käyttäjä tuotekehityksessä: Tieto, tutkimus, menetelmät*. Helsinki: TaiK.

Hyysalo, S. (2009b). User innovation and everyday practices: micro-innovation in sports industry development. *R&D Management*, *39*(3), 247–258.

Hyysalo, S. (2010). *Health technology development and use: From practice-bound imagination to evolving impacts*. *New York*. New York, NY, USA: Routledge.

Hyysalo, S., Helminen, P., Mäkinen, S., Johnson, M., Juntunen, J. K., & Freeman, S. (2015). Intermediate search elements and method combination in lead-user searches. *International Journal of Innovation Management*, *19*(1).

Hyysalo, S., Johnson, M., & Juntunen, J. K. (n.d.). Consumer innovation in sustainable energy technologies: Suboptimal diffusion channels spur creativity. *Journal of Cleaner Production*, *in review*.

Hyysalo, S., Juntunen, J. K., & Freeman, S. (2013a). Internet forums and the rise of the inventive energy user. *Science and Technology Studies*, *26*(1), 25–51.

Hyysalo, S., Juntunen, J. K., & Freeman, S. (2013b). User innovation in sustainable home energy technologies. *Energy Policy*, *55*, 490–500.

Hyysalo, S., Kohtala, C., Helminen, P., Mäkinen, S., Miettinen, V., & Muurinen, L. (2014). Collaborative futuring with and by makers. *CoDesign*, *10*(3-4), 209–228.

Hyysalo, S., Repo, P., Timonen, P., Hakkarainen, L., & Heiskanen, E. (2016). Diversity and change of user driven innovation modes in companies. *International Journal of Innovation Management*, *20*(2). doi:10.1142/S1363919616500237

Hyysalo, S., & Usenyuk, S. (2015). The user dominated technology era: Dynamics of dispersed peer-innovation. *Research Policy*, *44*(3), 560–576.

International Organization for Standardization. (2010). ISO 9241-210: Ergonomics of human-system interaction — Part 210: Human-centred design for interactive

systems. Retrieved September 25, 2015, from https://www.iso.org/obp/ui/#iso:std:52075:en

INUSE Research Group. (2015). Codesign approaches. Retrieved June 26, 2015, from http://codesign.inuse.fi/approaches

Jacobson, S. (2014). *Personalised assistive products: Managing stigma and expressing the self*. Helsinki: Doctoral dissertation, Aalto University School of Arts, Design and Architecture.

Jeppesen, L. B., & Frederiksen, L. (2006). Why do users contribute to firm-hosted user communities? The case of computer-controlled music instruments. *Organization Science*, *17*(1), 45–63.

Jeppesen, L. B., & Lakhani, K. R. (2010). Marginality and problem-solving effectiveness in broadcast search. *Organization Science*, *21*(5), 1016–1033.

Jin, D., Chai, K.-H., & Tan, K.-C. (2012). Organizational adoption of new service development tools. *Managing Service Quality*, *22*(3), 233–259.

Johnson, M. (2013). *How social media changes user-centred design: Cumulative and strategic user involvement with respect to developer-user social distance*. Helsinki, Finland: Doctoral dissertation, Aalto University, Department of Computer Science and Engineering.

Johnson, M., Mozaffar, H., Campagnolo, G. M., Hyysalo, S., Pollock, N., & Williams, R. (2014). The managed prosumer: evolving knowledge strategies in the design of information infrastructures. *Information, Communication & Society*, *17*(7), 795–813.

Juntunen, J. K. (2014). *Prosuming energy – User innovation and new energy communities in renewable micro-generation*. Helsinki, Finland: Doctoral dissertation, Aalto University, Department of Management Studies.

Kankainen, A., Vaajakallio, K., Kantola, V., & Mattelmäki, T. (2012). Storytelling Group – a co-design method for service design. *Behaviour & Information Technology*, *31*(3), 221–230.

Kaulio, M. A. (1998). Customer, consumer and user involvement in product development: A framework and a review of selected methods. *Total Quality Management*, *9*(1), 141–149.

Keinz, P., Hienerth, C., & Lettl, C. (2012). Designing the organization for user innovation. *Journal of Organization Design*, *1*(3), 20–36.

Keinz, P., & Prügl, R. (2010). A user community-based approach to leveraging technological competences: An exploratory case study of a technology start-up from MIT. *Creativity and Innovation Management*, *19*(3), 269–289.

Kirk, J., & Miller, M. L. (1986). *Reliability and validity in qualitative research*. Newbury Park, CA, USA: SAGE Publications.

Kline, S. J., & Rosenberg, N. (1986). An overview of innovation. In R. Landau & N. Rosenberg (Eds.), *The Positive Sum Strategy: Harnessing Technology for Economic Growth* (pp. 275–305). doi:10.1108/14601069810368485

Kohtala, C. (2013). Shaping sustainability in fab labs. In *Proceedings of Participatory Innovation Conference 2013*. June 18-20, Lahti, Finland.

Kohtala, C. (2015). Addressing sustainability in research on distributed production: an integrated literature review. *Journal of Cleaner Production*, *106*, 654–668.

Kohtala, C., & Hyysalo, S. (2015). Anticipated environmental sustainability of personal fabrication. *Journal of Cleaner Production*, *99*, 333–344.

Koskela, K., Näkki, P., & Pikkarainen, M. (2009). Towards a framework for lead user driven innovation in software intensive companies. *The Proceedings of The XX ISPIM Conference*.

Kotro, T. (2005). *Hobbyist knowing in product development: desirable objects and passion for sports in Suunto Corporation*. Doctoral dissertation, University of Arts and Design Helsinki.

Kotro, T. (2007). User orientation through experience: A study of hobbyist knowing in

product development. *Human Technology*, *3*(2), 154–166.

Kozinets, R. V. (1998). On netnography: Initial reflections on consumer research investigations of cyberculture. *Advances in Consumer Research*, *25*(1), 366–371.

Kozinets, R. V. (2010). *Netnography: Doing ethnographic research online*. London: Sage.

Kratzer, J., Lettl, C., Franke, N., & Gloor, P. A. (2015). The social network position of lead users. *Journal of Product Innovation Management*. doi:10.1111/jpim.12291

Kristensson, P., & Magnusson, P. R. (2010). Tuning Users' Innovativeness During Ideation. *Creativity and Innovation Management*, *19*(2), 147–159.

Kristensson, P., Magnusson, P. R., & Matthing, J. (2002). Users as a hidden resource for creativity: Findings from an experimental study on user involvement. *Creativity and Innovation Management*, *11*(1), 55–61.

Kurvinen, E., Koskinen, I., & Battarbee, K. (2008). Prototyping social interaction. *Design Issues*, *24*(3), 46–57.

Kuusisto, J., de Jong, J. P. J., Gault, F., Raasch, C., & von Hippel, E. (2013). *Consumer innovation in Finland: Incidence, diffusion and policy implications*.

Lakhani, K. R. (2006). *Broadcast search in problem solving: Attracting solutions from the periphery*. *MIT Sloan School of Management working paper*.

Lehnen, J., Ehls, D., & Herstatt, C. (2014). *Implementation of lead users into management practice: A literature review of publications in business press*. Working Paper, Technologie- und Innovationsmanagement, Technische Universität Hamburg- Harburg, No. 78. Retrieved from http://hdl.handle.net/10419/92405

Leonard-Barton, D. (1992). Core capabilities and core rigidities: A paradox in managing new product development. *Strategic Management Journal*, *13*(Summer), 111–125.

Lettl, C. (2005). The emergence of radically new health care technologies: inventive users as innovation networkers. *Technology and Health Care : Official Journal of the European Society for Engineering and Medicine*, *13*(3), 169–83. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/15990420

Lettl, C., Herstatt, C., & Gemuenden, H. G. (2006). Users' contributions to radical innovation: evidence from four cases in the field of medical equipment technology. *R&D Management*, *36*(3), 251–272.

Lilien, G. L., Morrison, P. D., Searls, K., Sonnack, M., & von Hippel, E. (2002). Performance assessment of the lead user idea-generation process for new product development. *Management Science*, *48*(8), 1042–1059.

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. Newbury Park, CA, USA: Sage Publications.

Lundvall, B.-Å. (1985). *Product Innovation and User-Producer Interaction*. Aalborg: Aalborg Universitetsforlag.

Lundvall, B.-Å. (1988). Innovation as an interactive process - from user-producer interaction to national systems of innovation. In G. Dosi, C. Freeman, R. Nelson, G. Silverberg, & L. Soete (Eds.), *Technical Change and Economic Theory* (pp. 349–367). London: Printer.

Lüthje, C. (2000). *Kundenorientierung im Innovationsprozess: Eine Untersuchung der Kunden-Hersteller-Interaktion in Konsumgütermärkten*. Wiesbaden: Gabler.

Lüthje, C. (2003). Customers as co-inventors: An empirical analysis of the antecedents of customer-driven innovations in the field of medical equipment. In *Proceedings of the 32th EMAC Conference*. Glasgow.

Lüthje, C. (2004). Characteristics of innovating users in a consumer goods field: An empirical study of sport-related product consumers. *Technovation*, *24*(9), 683–695.

Lüthje, C., & Herstatt, C. (2004). The lead user method: an outline of empirical

findings and issues for future research. *R&D Management*, *34*(5), 553–568.

Lüthje, C., Herstatt, C., & von Hippel, E. (2005). User-innovators and "local" information: The case of mountain biking. *Research Policy*, *34*, 951–965.

Magnusson, P. R. (2003). Benefits of involving users in service innovation. *European Journal of Innovation Management*, *6*(4), 228–238.

Magnusson, P. R., Matthing, J., & Kristensson, P. (2003). Managing user involvement in service innovation: Experiments with innovating end users. *Journal of Service Research*, *6*(2), 111–124.

Maguire, M. (2001). Methods to support human-centred design. *International Journal of Human-Computer Studies*, *55*(4), 587–634.

Mattelmäki, T. (2006). *Design Probes*. Doctoral dissertation, University of Arts and Design Helsinki.

Matthing, J., Sandén, B., & Edvardsson, B. (2004). New service development: learning from and with customers. *International Journal of Service Industry Management*, *15*(5), 479–498.

Mayring, P. (2007). On generalization in qualitatively oriented research. *Forum Qualitative Sozialforschung / Forum: Qualitative Social Research*, *8*(3), Art. 26.

Mitchell, R., & Buur, J. (2010). Tangible Business Model Sketches to Support Participatory Innovation. In *Proceedings of DESIRE'10* (pp. 29–33). August 16-17, Aarhus, Denmark.

Moon, J. Y., & Sproull, L. (2000). Essence of distributed work: The case of Linux Kernel. *First Monday*, *5*(11). Retrieved from http://firstmonday.org/ojs/index.php/fm/article/view/801/710

Morrison, P. D., Roberts, J. H., & Midgley, D. F. (2000). Opinion leadership amongst leading edge users. *Australasian Marketing Journal (AMJ)*, *8*(1), 5–14.

Morrison, P. D., Roberts, J. H., & Midgley, D. F. (2004). The nature of lead users and measurement of leading edge status. *Research Policy*, *33*(2), 351–362.

Morrison, P. D., Roberts, J. H., & von Hippel, E. (2000). Determinants of user innovation and innovation sharing in a local market. *Management Science*, *46*(12), 1513–1527.

Muller, M. J., & Kuhn, S. (1993). Participatory Design. *Communications of the ACM*, *36*(4), 24–28.

Muniz, A. M., & O'Guinn, T. C. (2001). Brand community. *Journal of Consumer Research*, *27*(4), 412–432.

Nambisan, S. (2002). Designing virtual customer environments for new product development: Toward a theory. *The Academy of Management Review*, *27*(3), 392.

Newman, M. E. J. (2003). The structure and function of complex networks. *SIAM Review*, *45*(2), 167–256.

Nijssen, E. J., & Frambach, R. T. (2000). Determinants of the adoption of new product development tools by industrial firms. *Industrial Marketing Management*, *29*(2), 121–131.

Normann, R. (2001). *Reframing Business: When the map changes the landscape*. Chichester: Wiley.

Ogawa, S., & Pongtanalert, K. (2011). Visualizing invisible innovation continent: Evidence from global consumer innovation surveys. *Available at SSRN*. doi:10.2139/ssrn.1876186

Oliveira, P., & von Hippel, E. (2011). Users as service innovators: The case of banking services. *Research Policy*, *40*(6), 806–818.

Olson, E. L., & Bakke, G. (2001). Implementing the lead user method in a high technology firm: A longitudinal study of intentions versus actions. *Journal of Product Innovation Management*, *18*(6), 388–395.

Page, A. L. (1993). Assessing new product development practices and performance:

Establishing crucial norms. *Journal of Product Innovation Management*, *10*(4), 273–290.

Pajo, S., Verhaegen, P., Vandevenne, D., & Duflou, J. R. (2013). Analysis of automatic online lead user identification.

Pajo, S., Verhaegen, P., Vandevenne, D., & Duflou, J. R. (2014). Lead user identification through twitter: Case study for camera lens products. In M. Laakso & K. Ekman (Eds.), *Proceedings of NordDesign 2014* (pp. 294–302). August 27-29, Espoo, Finland.

Pals, N., Steen, M. G. D., Langley, D. J., & Kort, J. (2008). Three approaches to take the user perspective into account during new product design. *International Journal of Innovation Management*, *12*(3), 275–294.

Patton, M. Q. (2002). *Qualitative research & evaluation methods* (3rd ed.). Thousand Oaks, CA: Sage Publications, Inc.

Perry, J., Macken, E., Scott, N., & McKinley, J. L. (1997). Disability, inability and cyberspace. In B. Friedman (Ed.), *Human Values and the Design of Computer Technology* (pp. 65–89). CSLI Publications & Cambridge University Press.

Piller, F. T. (2015). Mass Customization. Retrieved July 2, 2015, from http://frankpiller.com/mass-customization/

Piller, F. T., & Walcher, D. (2006). Toolkits for idea competitions: a novel method to integrate users in new product development. *R&D Management*, *36*(3), 307–318.

Piller, F. T., & West, J. (2014). Firms, users, and innovation: An interactive model of coupled open innovation. In H. Chesbrough, W. Vanhaverbeke, & J. West (Eds.), *New frontiers in open innovation* (pp. 29–49). Oxford: Oxford University Press.

Pine, B. J. (1993). *Mass Customization: The New Frontier in Business Competition*. Boston, MA, USA: Harvard Business School Press.

Poetz, M. K., & Prügl, R. (2010). Crossing domain-specific boundaries in search of innovation: Exploring the potential of pyramiding. *Journal of Product Innovation Management*, *27*, 897–914.

Poetz, M. K., & Schreier, M. (2012). The value of crowdsourcing: Can users really compete with professionals in generating new product ideas? *Journal of Product Innovation Management*, *29*(2), 245–256.

Polar. (2007). Polar Electro Celebrates 30 Years of Innovation. Retrieved July 14, 2015, from http://www.polar.com/en/about_polar/press_room/press_releases/30

Polar. (2015). About Polar. Retrieved July 14, 2015, from http://www.polarheart.co.nz/content/aboutpolar.html

Power, M. R., & Power, D. (2004). Everyone here speaks TXT: deaf people using SMS in Australia and the rest of the world. *Journal of Deaf Studies and Deaf Education*, *9*(3), 333–343. doi:10.1093/deafed/enh042

Prahalad, C. K., & Ramaswamy, V. (2004). *The Future of Competition: Co-Creating Unique Value With Customers*. Boston, MA: Harvard Business Review Press.

Raasch, C., Herstatt, C., & Lock, P. (2008). The Dynamics of User Innovation: Drivers and Impediments of Innovation Activities. *International Journal of Innovation Management*, *12*(03), 377–398.

Ratcliffe, J. W. (1983). Notions of validity in qualitative research methodology. *Science Communication*, *5*(2), 147–167.

Riggs, W., & von Hippel, E. (1994). Incentives to innovate and the sources of innovation: the case of scientific instruments. *Research Policy*, *23*, 459–469.

Ritchie, J., & Lewis, J. (Eds.). (2003). *Qualitative research practice: A guide for social science students and researchers*. London: Sage Publications.

Rogers, E. M. (1962). *Diffusion of innovations*. New York: Free Press.

Rogers, E. M. (1995). *Diffusion of innovations* (4th ed.). New York: Free Press.

Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.). New York: Free Press.

Rogers, E. M., & Shoemaker, F. (1971). *Communication of innovations: A cross-cultural approach*. New York, NY, USA: Free Press.

Rothwell, R. (1994). *Towards the fifth-generation innovation process*. *International Marketing Review* (Vol. 11).

Schmuckler, M. (2001). What is ecological validity? A dimensional analysis. *Infancy*, *2*(4), 419–436.

Schreier, M., Oberhauser, S., & Prügl, R. (2007). Lead users and the adoption and diffusion of new products: Insights from two extreme sports communities. *Marketing Letters*, *18*(1-2), 15–30.

Schuler, D., & Namioka, A. (Eds.). (1993). *Participatory design: Principles and practices*. Hillsdale, NJ, USA: Lawrence Erlbaum Associates, Inc.

Schweisfurth, T. G., & Herstatt, C. (2014). How internal users contribute to corporate product innovation: the case of embedded users. *R&D Management*. doi:10.1111/radm.12103

Schweisfurth, T. G., & Herstatt, C. (2015). Embedded (lead) users as catalysts to product diffusion. *Creativity and Innovation Management*. doi:10.1111/caim.12106

Schweisfurth, T. G., & Raasch, C. (2015). Embedded lead users—The benefits of employing users for corporate innovation. *Research Policy*, *44*(1), 168–180.

Shah, S. K. (2000). *Sources and Patterns of Innovation in a Consumer Products Field: Innovations in Sporting Equipment*. *MIT Sloan Working Paper #4105*.

Shah, S. K., & Tripsas, M. (2007). The accidental entrepreneur: The emergent and collective process of user entrepreneurship. *Strategic Entrepreneurship Journal*, *1*(1-2), 123–140.

Shank, G. D. (2006). *Qualitative research: A personal skills approach* (2nd ed.). Upper Saddle River, NJ: Pearson Merrill Prentice Hall.

Skiba, F., & Herstatt, C. (2009). Users as sources for radical service innovations: opportunities from collaboration with service lead users. *International Journal of Services Technology and Management*, *12*(3), 317–337.

Slater, S. F. (2001). Market orientation at the beginning of a new millennium. *Managing Service Quality: An International Journal*, *11*(4), 230–233.

Smith, A. (1776). *An inquiry into the nature and causes of the wealth of nations, Vol. 1 of 3*. Dublin: Eighteenth Century Collections Online. Gale. Aalto University. 28 May 2015. Retrieved from http://find.galegroup.com/ecco/infomark.do?&source=gale&prodId=ECCO&userGroupName=heluni&tabID=T001&docId=CW104122318&type=multipage&contentSet=ECCOArticles&version=1.0&docLevel=FASCIMILE

Sohlenius, G. (1992). Concurrent engineering. *Annals of the CIRP*, *41*(2), 645–655.

Spann, M., Ernst, H., Skiera, B., & Soll, J. H. (2009). Identification of lead users for consumer products via Virtual Stock Markets. *Journal of Product Innovation Management*, *26*(3), 322–335.

Statistics Finland. (2009). *Televiestintä 2008 (Telecommunication 2008)*. Retrieved from http://www.stat.fi/til/tvie/2008/tvie_2008_2009-06-09_fi.pdf

Stockstrom, C., Goduscheit, R. C., Jørgensen, J., & Lüthje, C. (2012). Identification of individuals with special qualities - Assessing the performance of pyramiding search. In *Proceedings of DRUID 2012*. June 19-21, Copenhagen, Denmark.

Strauss, A. L., & Corbin, J. (1998). *Basics of Qualitative Research: Grounded Theory Procedures and Techniques* (2nd ed.). Thousand Oaks, CA: SAGE Publications, Inc.

Sudman, S. (1985). Efficient screening methods for the sampling of geographically clustered special populations. *Journal of Marketing Research*, *22*(1), 20–29.

Sundbo, J., & Toivonen, M. (2011). Introduction. In J. Sundbo & M. Toivonen (Eds.), *User-based innovation in services* (pp. 1–21). Cheltenham, UK: Edward Elgar.

Taylor, S. J., & Bogdan, R. (1984). *Introduction to qualitative research methods* (2nd ed.). New York: John Wiley.

The Standish Group. (2013). *Chaos Manifesto 2013: Think Big, Act Small*. The Standish Group International. Retrieved from http://www.versionone.com/assets/img/files/ChaosManifesto2013.pdf

Tietz, R., Morrison, P. D., Lüthje, C., & Herstatt, C. (2005). The process of user-innovation: a case study in a consumer goods setting. *International Journal of Product Development*, *2*(4), 321–338.

Torrance, E. P. (1975). Sociodrama as a creative problem-solving approach to studying the future. *The Journal of Creative Behavior*, *9*(3), 182–195.

Trott, P., & Hartmann, D. (2009). Why "Open Innovation" is old wine in new bottles. *International Journal of Innovation Management*, *13*(4), 715–736.

Tuarob, S., & Tucker, C. S. (2015). Automated discovery of lead users and latent product features by mining large scale social media networks. *Journal of Mechanical Design*, *137*(July). doi:10.1115/1.4030049

Tuulenmäki, A., & Helminen, P. (2009). Lead users of positional value. In *Proceedings of 8th European Academy of Design Conference* (pp. 453–458). April 1-3, Aberdeen, Scotland.

Tuunanen, T., Bragge, J., Häivälä, J., Hui, W., & Virtanen, V. H. (2011). A Method for Recruitment of Lead users from Virtual Communities to Innovate IT Enabled Services for Consumers in Global Markets. *Pacific Asia Journal of the Association for Information Systems*, *3*(2), 31–56.

Ulrich, K. T., & Eppinger, S. D. (1995). *Product design and development*. New York: McGraw-Hill.

Urban, G. L., & von Hippel, E. (1988). Lead user analyses for the development of new industrial products. *Management Science*, *34*(5), 569–582.

Utterback, J. M. (1996). *Mastering the dynamics of innovation*. Boston: Harvard Business School Press.

Vaajakallio, K. (2012). *Design games as a tool, a mindset and a structure*. Helsinki, Finland: Doctoral dissertation, Aalto University School of Arts, Design and Architecture.

Van de Ven, A. H., Polley, D. E., Garud, R., & Venkataraman, S. (1999). *The innovation journey*. New York: Oxford University Press.

van der Boor, P., Oliveira, P., & Veloso, F. (2014). Users as innovators in developing countries: The global sources of innovation and diffusion in mobile banking services. *Research Policy*.

van Meter, K. M. (1990). Methodological and design issues: Techniques for assessing the representatives of snowball samples. In E. Y. Lambert (Ed.), *NIDA Research Monograph 98 "The Collection and Interpretation of Data from Hidden Populations"* (pp. 31–43).

Van Slyke, C., Comunale, C. L., & Belanger, F. (2002). Gender differences in perceptions of web-based shopping. *Communications of the ACM*, *45*(7), 82–86.

Welch, S. (1975). Sampling by referral in a dispersed population. *The Public Opinion Quarterly*, *39*(2), 237–245.

West, J., Salter, A., Vanhaverbeke, W., & Chesbrough, H. (2014). Open innovation: The next decade. *Research Policy*, *43*(5), 805–811.

White, M., & Marsh, E. (2006). Content analysis: A flexible methodology. *Library Trends*, *55*(1), 22–45. Retrieved from http://hdl.handle.net/2142/3670\nhttp://muse.jhu.edu/journals/lib/summary/v055/55.1white.html

Wikipedia. (2015). Polar Electro. Retrieved July 14, 2015, from https://en.wikipedia.org/wiki/Polar_Electro

Williams, R. L., & Cothrel, J. (2000). Four smart ways to run online communities. *Sloan Management Review*, *41*(4), 81–91.

von Hippel, E. (1976). The dominant role of users in the scientific instrument innovation process. *Research Policy*, *5*, 212–239.

von Hippel, E. (1978a). A customer-active paradigm for industrial product idea generation. *Research Policy*, *7*(3), 240–266.

von Hippel, E. (1978b). Successful industrial products from customer ideas. *Journal of Marketing*, *42*(1), 39.

von Hippel, E. (1986). *Lead users: A source of novel product concepts*. *Management Science*.

von Hippel, E. (1988). *The Sources of Innovation*. New York, NY, USA: Oxford University Press.

von Hippel, E. (1994). "Sticky information" and the locus of problem solving: Implications for innovation. *Management Science*, *40*(4), 429–439.

von Hippel, E. (1998). Economics of product development by users: The impact of "sticky" local information. *Management Science*, *44*(5), 629–644.

von Hippel, E. (2001). PERSPECTIVE: User toolkits for innovation. *Journal of Product Innovation Management*, *18*(4), 247–257.

von Hippel, E. (2005). *Democratizing innovation*. Cambridge, Massachusetts, USA: MIT Press.

von Hippel, E. (2007). Horizontal innovation networks - by and for users. *Industrial and Corporate Change*, *16*(2), 293–315.

von Hippel, E., de Jong, J. P. J., & Flowers, S. (2012). Comparing business and household dector innovation in consumer products: Findings from a representative study in the United Kingdom. *Management Science*, *58*(9), 1669–1681.

von Hippel, E., Franke, N., & Prügl, R. (2009). Pyramiding: Efficient search for rare subjects. *Research Policy*, *38*(9), 1397–1406.

von Hippel, E., & Katz, R. (2002). Shifting innovation to users via toolkits. *Management Science*, *48*(7), 821–833.

von Hippel, E., Thomke, S., & Sonnack, M. (1999). Creating breakthroughs at 3M. *Harvard Business Review*, *77*(September-October), 47–57.

Woolrych, A., Hornbæk, K., Frøkjær, E., & Cockton, G. (2011). Ingredients and meals rather than recipes: A proposal for research that does not treat usability evaluation methods as indivisible wholes. *International Journal of Human-Computer Interaction*, *27*(10), 940–970.

Voss, A., Hartswood, M., Procter, R., Rouncefield, M., Slack, R., & Büscher, M. (Eds.). (2009). *Configuring user-designer relations: Interdisciplinary perspectives*. London, UK: Springer.

Yin, R. K. (1994). *Case study research: Design and methods* (Vol. 5). Thousand Oaks, CA, USA: Sage Publications.

Äijälä, E. (2007). *You Could Have It So Much Better. Matkapuhelimien personointi ja massaräätälöinti (Personification and Mass Tailoring of Mobile Phones)*. Helsinki, Finland: Master's thesis, University of Arts and Design Helsinki.

Aalto-DD 165/2016

ISBN 978-952-60-6974-6 (printed)
ISBN 978-952-60-6973-9 (pdf)
ISSN-L 1799-4934
ISSN 1799-4934 (printed)
ISSN 1799-4942 (pdf)

Aalto University
School of Engineering
Department of Engineering Design and Production
www.aalto.fi

BUSINESS + ECONOMY

ART + DESIGN + ARCHITECTURE

SCIENCE + TECHNOLOGY

CROSSOVER

DOCTORAL DISSERTATIONS