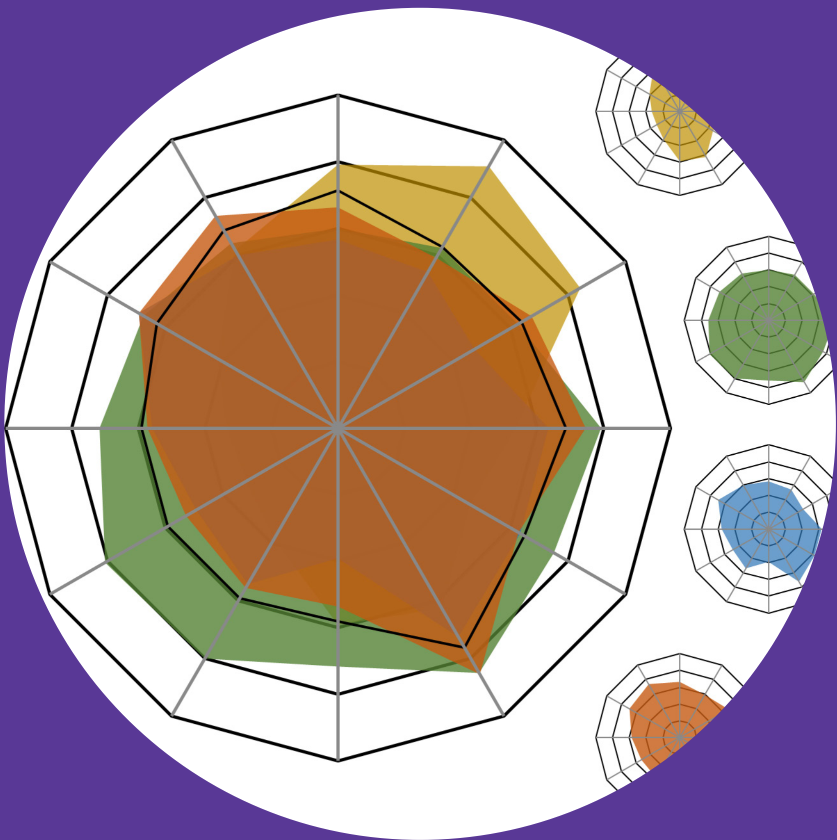
Department of Conputer Science

User-Centered Design Competencies

Construction of a Competency Model

Mika P. Nieminen



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User-Centered Design Competencies

Construction of a Competency Model

Mika P. Nieminen

A doctoral dissertation completed for the degree of Doctor of Science (Technology) to be defended, with the permission of the Aalto University School of Science, at a public examination held at the lecture hall T2 of the school on 9 April 2015 at noon.

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Abstract

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Abstract

User-Centered Design (UCD) has become an established practice for designing new and better products and services. These products and services should have good usability, elicit positive user experience, and thereby help people enjoy using them for both work and play. UCD has evolved from its origins in basing a design on users' wants and needs, to increasingly engaging more stakeholders in the design process. Managing user involvement and design team composition requires a solid understanding of the participants' competencies, i.e. their knowledge, skills and abilities, in order to use their strengths in the best possible way. What are the necessary UCD competencies? How can these UCD competencies be measured or assessed? How can the use of a competency model help UCD projects?

This thesis introduces competencies and competency models in order to lay a theoretical foundation for the development of the UCD Competency Model. The proposed model is based on seminal works of User-Centered Design literature and on experience gained from the processual and methodological developments described in the published papers (Publications I-VIII). It describes twelve of the most relevant competencies for UCD in the four categories of User Strengths, Soft Skills, Designer Strengths, and Hard Skills. The model provides tools to assess and visualize each participant's expertise in each competency in order to form a picture of the entire project team's strengths and potential gaps in their resources.

The UCD Competency Model was validated with 24 industry practitioners of User-Centered Design with a total of 261 years of work experience. Based on the quantitative analyses (means, deviations, reliability checks, exploratory factor analysis and correlations) and qualitative analyses (text condensation, affinity diagrams and card sorting) of the questionnaire data, the UCD Competency Model is shown to include the most relevant aspects of UCD, to be statistically reliable and valid, and to be able to reliably differentiate project participants with respect to appropriate competency levels.

Keywords User-Centered Design, user involvement, competencies, competency models

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Tiivistelmä

Käyttäjäkeskeisestä suunnittelusta on tullut yleisesti hyväksytty tapa suunnitella parempia uusia tuotteita ja palveluita. Tuotteiden ja palveluiden tulisi olla käytettävyydeltään hyviä, tuottaa positiivinen käyttäjäkokemus ja siten houkutella ihmiset käyttämään niitä sekä kotona että työtehtävissään. Käyttäjäkeskeinen suunnittelu on kehittynyt käyttäjien halujen ja tarpeiden ymmärtämisestä kohti kaikkien osapuolien yhä vahvempaa osallistumista suunnitteluprosessiin. Käyttäjien osallistamisen ja suunnittelutiimien kokoonpanojen hallinta vaatii sen jäsenten kompetenssien eli osaamisalueiden, tietojen, taitojen ja kykyjen, syvällistä ymmärtämistä. Näin kaikkien osallisten vahvuudet saadaan hyödynnetyksi parhaalla mahdollisella tavalla. Työ etsii vastauksia kysymyksiin: Mitkä ovat käyttäjäkeskeisen suunnittelun tärkeimmät kompetenssit? Kuinka näitä kompetensseja voidaan mitata tai arvioida? Kuinka kompetenssimallia voi hyödyttää käyttäjäkeskeisen suunnittelun projekteissa?

Kompetenssien ja kompetenssimallien teoria luo työssä perustan käyttäjäkeskeisen suunnittelun kompetenssimallin kehitykselle. Malli pohjautuu käyttäjäkeskeisen suunnittelun kirjallisuuteen ja väitöstyöhön kuuluvissa artikkeleissa (I-VIII) julkaistuihin tuloksiin suunnitteluprosessien ja menetelmien tutkimuksesta. Se kuvaa 12 käyttäjäkeskeisen suunnittelun merkittävintä kompetenssia jakaen ne neljään luokkaan käyttäjien vahvuudet, luontaiset taidot (soft skills), suunnittelijoiden vahvuudet ja opitut taidot (hard skills). Malli tarjoaa työvälineen hahmottaa kaikkien projektiin osallistuvien tietoja ja taitoja sekä mahdollisia puutteita heidän osaamisessaan.

Kehitettyä käyttäjäkeskeisen suunnittelun kompetenssimallia arvioivat 24 teollisuudessa toimivaa käyttäjäkeskeisen suunnittelun ammattilaista, joilla oli yhteensä 261 vuoden työkokemus. Kyselystä saatujen vastausten tilastollisen (keskiarvot, hajonnat, reliabiliteettitarkistukset, faktorianalyysi ja korrelaatiot) ja laadullisen (aineiston tiivistäminen, affiniteettidiagrammit ja korttilajittelu) analyysin perusteella käyttäjäkeskeisen suunnittelun kompetenssimalli sisältää käyttäjäkeskeisen suunnittelun tärkeimmät elementit, se on tilastollisesti luotettava ja sisällöltään perusteltu, ja sen avulla voidaan erotella suunnitteluprojektien osallistujat eri kompetenssitasoille.

Avainsanat Käyttäjäkeskeinen suunnittelu, käyttäjien osallistaminen, kompetenssit, kompetenssimallit

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The writing of this thesis has been an undertaking of epic proportions. Not only did it take 19 years to complete, it also needed several drastic realignments to reach its final form. This task would not have been possible without those around me either giving their aid willingly or at least not hindering the progress on purpose.

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I would also like to thank professor Martti Mäntylä for hiring me way back in ‘94 and getting me started on my journey… and our former department head professor Heikki Saikkonen for putting a stop to it by not letting me linger upon the topic as long as I would have liked to, and thus actually getting this thesis done. Also my warmest thanks to my extraordinarily capable pre-examiners professor Froukje Sleeswijk Visser and Dr. Mark Robinson for their valuable insights in finalizing this thesis, and professor Jacob Buur for agreeing to act as my official opponent.

Additionally, I would like to thank my distinguished co-authors in order of appearance – Petri Mannonen, Johanna Kaipio (née Viitanen), Mari Tyllinen, Mikael Runonen and Marko Nieminen – for the many late nights while making the very last changes at ridiculous past-midnight hours. Without your efforts, and the customary extension of deadlines, many of our heroic deeds would have been left untold.

I would like to thank all the other current or past members of the STRATUS research group. First and foremost Sirpa Riihiaho, thank you for everything in the past twenty years. Also starring Sampo, Jussi, Tapio, Katrine, Aqdas, Aman, Sami, Vennu, Sakari, Mikael, Elina, Kalle, Marjaana, … and all the guest stars like Vexi, Timo, Kaisa, Saku and Nick… Outside STRATUS I would like to thank professor Matti Vartiainen (and his team) for the many and very interesting projects during the past years and for freely given support whenever I needed it. Also a very big “thank you” to ALL the people in the companies and research partners with whom I have had the pleasure to work in my past projects, especially Liu Jianbing at BRCUSE in Beijing for having me over and providing several weeks of much needed time to work on this thesis.

I would like to thank my parents Jukka and Kaija Nieminen and my brother Timo for… well, being there. Everyone else harassed me semi-regularly with questions about when the thesis is going to be finished, you never did. Well, it’s finished now. Look mom, I wrote the final book!

Also my thanks to my parents-in-law Matti and Niina Tiikkainen for the use of their summer cottage for my solitary writing marathons, and for the too many times taking care of the girls when both parents were physically or mentally elsewhere.

Last but not least, I would like to thank my wife Eija and our children Eero, Saara and Laura for keeping me balanced on the edge of sanity thereby making this work possible. Sorry for all the tantrums and absences, I’ll do better from now on. Really.

Lohja, February 2015

Mika P. Nieminen

List of Publications

This thesis is based on the following publications, which are referred to in the text by their Roman numeral, or collectively as Publications.

I Nieminen, M.P. and Mannonen, P. Capturing the Mobile and Distributed Work for Concept Development using Photograph Probes. Proceedings of the IASTED International Conference on Human Computer Interaction (IASTED-HCI 2005), Phoenix, USA. ACTA Press, Anaheim, CA, USA. 2005. 191-196.

II Nieminen, M.P. and Mannonen, P. User-Centered Product Concept Development. In International Encyclopedia of Ergonomics and Human Factors (2nd edition). CRC Press, Boca Raton, FL, USA. 2006. 1728-1732.

III Nieminen, M. P., Mannonen, P. and Viitanen, J. International Remote Usability Evaluation: the Bliss of not Being There. Proceedings of the 2nd international conference on Usability and internationalization (UI-HCII'07), Peking, China. Nuray Aykin (Ed.). Springer-Verlag, Heidelberg, Germany. 2007. 388-397.

IV Nieminen, M.P. and Viitanen, J. Time Machine: Creating a Mixed Reality Experience for Children. Proceedings of the Third IASTED International Conference on Human Computer Interaction (IASTED-HCI 2008), Innsbruck, Austria. ACTA Press, Anaheim, CA, USA. 2008. 14-23.

V Nieminen, M. P. and Tyllinen, M. Concept Development with Real Users: Involving Customers in Creative Problem Solving. Proceedings of the 1st International Conference on Human Centered Design, San Diego, USA. Springer-Verlag, Heidelberg, Germany. 2009. 869-878.

VI Nieminen M.P. By the People, for the People: Can People Really Design Their Own Information Systems? Proceedings of the 3th IASDR World Conference on Design Research (IASDR 2009), Seoul, Korea. 2009. 1715-1724.

VII Nieminen, M.P., Runonen, M., Nieminen, M. and Tyllinen, M. Designer Experience: Exploring Ways to Design in Experience. Proceedings of the 2011 Annual Conference on Human Factors in Computing Systems (CHI '11), Vancouver, Canada. ACM, New York, NY, USA. 2011. 2449-2452.

VIII Nieminen, M.P. and Runonen M. Designer Experience - Designing in Experience. Proceedings of the 4th World Conference on Design Research (IASDR 2011). Delft, the Netherlands. 2011. 9 pp.

Summary of the Publications and Author's Contribution

I. Capturing Mobile and Distributed Work with Photograph Probes

This paper describes a user research method based on mobile knowledge workers self-documenting their work environments and practices with digital cameras. The method and its use was a derivative from an earlier short paper by Mannonen, Kuoppala and Nieminen (Mannonen et al., 2003). Main findings include that photograph probes can explicate users' insights and offer designers/researchers a more detailed picture of users' everyday activities. Also we discovered some necessary safety considerations to improve the method for future use.

Mr. Nieminen was the primary author of the paper. He was responsible for formalizing the method description and applying it in the context of mobile and distributed work.

II. User-Centered Product Concept Development

This publication is a short book chapter describing a user-centered concept development process suitable for technology driven new product design. It outlines the five phases of Project commitment, User and technology research, Innovation sprint, Iterative concept creation and validation, and Project assessment with their respective deliverables.

Mr. Nieminen was the primary author of the publication. He developed the process from the previous version by Nieminen, Mannonen and Turkki (Nieminen et al., 2004) by redefining the phases and deliverables. The process is outlined in this doctoral dissertation, while its development has already been described in detail in Mr. Nieminen's Licentiate thesis (Nieminen, 2006).

III. International Remote Usability Evaluation: the Bliss of not Being There

This paper describes the design and execution of a remote usability test that was conducted during the implementation of a pan-European web portal for vocational counseling. In the project we enforced a clear division of labor between the usability team and the local project partners at six European countries. Centrally designed usability tests were simultaneously conducted in several languages.

The main findings suggest what materials and training are necessary to enable local subject matter specialists to run tests in their local language and to report the relevant results to the usability team in English. We found clear differences between the practices of experienced usability specialists and those of fast-track trained novice usability testers. We argue that these distinctions were not detrimental to the process since the results of both groups strongly supported each other.

Mr. Nieminen was the primary author of this paper. He designed the test procedure used in the project, was a member of the evaluation team in Finland, and conducted the training sessions with the remote test teams in Austria.

IV. Time Machine: Creating a Mixed Reality Experience for Children

This paper describes an iterative design project spanning four different project teams that eventually produced a mixed reality demonstrator for a science center. It identifies the common challenges of design: Dynamic context of use, special considerations towards the user group, and the use of new emerging technology. The findings show consecutive iterative design cycles to be supported by a unified design process and shared project coordination to enable fluent knowledge transfer. The use of concrete high fidelity prototypes can be costly, but it is necessary to illustrate the potential of not-yet-existing technologies.

Mr. Nieminen was the primary author of the paper. He was responsible for the overall structure and writing of the paper, supervised all the reported case studies, and led the formulation of the conclusions.

V. Concept Development with Real Users: Involving Customers in Creative Problem Solving

This paper describes idea generation activities in a user-centered concept development project when creating a new Enterprise Resource Planning (ERP) system. With the help of detailed statistics about the ideas produced, we show that various creative problem solving methods enable real end-users to generate ideas to improve their own ERP system. The results show consistent success in using the various methods, and a remarkably high percentage of users' new ideas were selected for further evaluation by the developers of the system.

Mr. Nieminen was the primary author of the paper. He planned and led the writing process and was in charge of the qualitative analysis and conclusions.

VI. By the People, for the People: Can People Really Design Their Own Information Systems?

This paper describes a year in a design project; the objective of this project was to create a concept for a next generation Enterprise Resource Planning (ERP) system. Over the course of the project, the existing system's users were encouraged to specify their needs and requirements, to create new designs to remove unsolved problems, and to evaluate and enhance a prototype of the new design. The goal was to enable people who were unfamiliar with information system (IS) design to improve their current work processes and tools and to produce new creative design solutions for future releases of their information system. The users were encouraged to become active participants in creating contents for the new design artifacts, while the designers' roles became more editorial. The seven guidelines for design science in information systems research are used as an analysis framework to recount the various aspects of the user-generated artifacts and user involvement. In the end the potential and observed success of information systems designed by their users are outlined.

Mr. Nieminen was the sole author of this publication.

VII. Designer Experience: Exploring Ways to Design in Experience

A provocative workshop abstract eliciting position papers for a one-day workshop at CHI2011 conference. This coined the term Designer Experience as a new design paradigm for performing design activities in the future user's experiential system.

Mr. Nieminen was the primary author of the paper and the main organizer of the workshop. He was responsible for the planning and organizing the writing process and chaired the workshop.

VIII. Designer Experience - Designing in Experience

This paper introduces a new paradigm for performing user-centered product or service design on an experiential level. Designer Experience refers to design activity that takes place within an experiential system similar to the one that the eventual product or service will be used in. We discuss the various aspects of Designer Experience and suggest ways to invoke it. A case study regarding the representation of users' contextual systems to designers is presented. Our experiences with the UCD Holodeck system acted both as an inspiration for the definition of Designer Experience and as a validation in order to illustrate one potential path towards Designer Experience.

Mr. Nieminen was the primary author of the paper. He was responsible for the definition and terminology relating to Designer Experience and he designed and supervised the validation tests and their analysis.

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Prologue

Thomas Young (1773-1829) is often acclaimed as "the last man who knew everything" for being the last person to master virtually all scientific knowledge of his time[1]. He contributed seminal works in the fields of physics, especially the wave theory of light, vision and color theory, archeology, and languages. Thomas Young interpreted the hieroglyphs in the Rosetta Stone and was an avid contributor to the Encyclopedia Britannica with 63 entries (Robinson, 2006).

Unfortunately the reign of polymaths, or persons fluent in practically all relevant fields of knowledge, ended during the 19th century. At that point even the contents of a well-defined compartment of knowledge such as mathematics had become too vast to comprehend fully (Boyer, 1959). This forced specialization and necessitated the involvement of multiple experts from different disciplines[2] to solve complex problems. Hail, the birth of multidisciplinary group work.

In the context of this thesis and in the field of user-centered design (UCD), the inability to know everything about everything calls for a better understanding of the different skills and knowledge (i.e. competencies) of the main two players in the UCD game: The users and the designers. The asymmetries in the knowledge bases and competencies of these two stakeholders (and others), and the ability to utilize their respective strengths in full, govern the success of any design effort. In order to take advantage of the new technologies and embedding the new products firmly in to use, users and designers are inescapably bound together (Voss et al., 2009, p. 1) – and luckily both parties know it (Olsson, 2004).

"No man is an island, entire of itself; every man is a piece of the continent, a part of the main"

John Donne[3]

[1] Other often cited last all-knowers include Athanasius Kircher (1602-1680) (Findlen, 2004) and Joseph Leidy (1823-1891) (Warren, 1998) or more ancient figures like Aristotle (384-322BC) (Kharbe, 2009, p. 185) or Leonardo da Vinci (1452-1519) (Burguete and Lam, 2008, p. 34).

[2] A discipline refers to a field of study and research that provides knowledge (Denning and Frailey, 2011).

[3] In "Devotions Upon Emergent Occasions, and several steps in my Sickness" Mediation XVII by the 17th-century metaphysical poet John Donne, originally published 1624, quote from 1959 version (Donne, 1959, p. 108).

1 Introduction

User-Centered Design (UCD) has become the de facto standard for designing new and better products and services (Mao et al., 2005). These products should have good usability[4], elicit positive user experience[5], and thereby help people enjoy using them for both work and play.

Making the products' future users part of the design process has become commonplace over the past few decades. At the same time the level of user involvement has increased and become more diverse. While at the same time critical voices have cautioned about the challenges (Norman, 2005; Webb, 1996) and on the lack of demonstrable benefits (Ives and Olson, 1984) in designing with users, in general the design community agrees on the utility of UCD, while still a few questions remain (Marti and Bannon, 2009). Who are these users that should participate in the development of new products, systems and services? How and when exactly should they be involved? UCD requires more user involvement competence (Lettl, 2007) or explicit skills in working with non-designer colleagues.

The principles and guidelines for UCD should point out clear areas of expertise and suitable phases in the design process to engage the right users. These key dimensions of design can be used to map skill, knowledge, or resource deficiencies, so that a design project may systematically identify their competency needs in a timely manner and augment their resources in order to achieve the best possible outcome.

1.1 Scope

This dissertation focuses on illuminating the necessary competencies within User-Centered Design during the early stages of product development, often called concept development (Ulrich and Eppinger, 1995) or concept design

[4] ISO 9241-11 "The extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use." (ISO - International Organization for Standardization, 1998)
[5] ISO 9241-210 "a person's perceptions and responses that result from the use or anticipated use of a product, system or service." (ISO - International Organization for Standardization, 2010a)

(Keinonen and Jääskö, 2003). It focuses on the collaboration between designers and users on their joint effort to create a better product, service or system.

Both the cited literature and the empirical evidence found in the listed Publications mainly cover the field of designing information systems or technology and software-intensive products (Brown, 2012). The theoretical framework of this thesis is that of User-Centered Design (UCD) focusing on the practicalities of involving end-users and other stakeholders in design processes. May contain traces of design research (Hevner et al., 2004).

This thesis suggests a structured model and a classification of the competencies vital to successful user involvement in the UCD process. It adopts and adapts the framework and vocabulary of competency models, more commonly used in HR[6] functions for assessing the requirements of a job or an organizational unit (Shippmann et al., 2000), to multidisciplinary UCD projects. The proposed UCD Competency Model enables analysis and reflection on each stakeholder's strengths and weaknesses so as to better achieve the joint goal. It also proposes approaches to remedy potential competency shortages in some of the dimensions.

1.2 Goal and Contribution

The goal of this thesis is to give the practitioners of User-Centered Design a simple and effective tool to plan, execute and reflect on their design projects by leveraging the available stakeholder know-how in a best possible way. The competency approach offers tools and vocabulary to assess and develop the skills of the people active in design projects, but both traditional and recently-formulated competency models have concentrated on catering to individual persons or job roles (for examples see Ho and Frampton, 2010), or entire industries such as information technology (SFIA Foundation, 2011) or software engineering (Ardis et al., 2014). This work seeks to collect and refocus the competencies to support the design team as the unit of interest. The presented UCD Competency Model describes the key dimensions of collaborative UCD projects and claims that the identified competencies and defined competency levels help to identify potential gaps in the resources of design teams. This thesis proposes the UCD Competency Model to be used as selection criteria for building better multidisciplinary design teams, and as an object of conversation for continuing discussion on user involved design. For a more detailed account of contributions, see section 7.2 Contribution.

[6] Human Resources

This thesis seeks to answer the following research questions:

- What are the necessary competencies for User-Centered Design?
- How can these competencies be measured?
- How can the proposed competency model be used to aid UCD projects?

2 The Role of Users in User-Centered Design

In this chapter the key fundaments and principles of user involvement in design are recounted in order to identify the underlying themes and classifications. These source statements are underlined in the text and also included as Appendix 1: Source Statements. In the following chapter they are used in conjunction with the empirical evidence from the Publications to formulate the UCD Competency Model.

This thesis does not seek to define User-Centered Design, design involving users, or any of the other innumerable variations thereupon. Arguing whether usability is a sub-category of user experience or whether co-design is the non-political wing of participatory design or the son of User-Centered Design (Rizzo, 2010) is irrelevant to this thesis[7], this thesis instead embraces the various approaches that appreciate active involvement of actual users in the design of their future products and services. Some boundaries for this work can be found from the map of design research or the landscape of human-centered design (research) by Sanders and Stappers (see Figure 1), where they differentiate participatory design from user-centered design based on the role of the users involved in the design (Sanders, 2006, 2008; Sanders and Stappers, 2008). This thesis considers the interplay of users and designers (and other stakeholders) within the confines of this landscape. Sanders also makes the distinction between the designer-as-expert (research-led) and user-as-expert (design-led) halves of the topography (Sanders, 2006). This underlines the necessity or opportunity to utilize the various competencies of the stakeholders in a design project as selection criteria for both design activities and participants.

[7] The author assumes the stance to use the term co-design as an umbrella for all variants of collaborative, co-operative, concurrent, human-centered, participatory, socio-technical and community design among others (Scrivener, 2005) across the whole span of a design process (Sanders and Stappers, 2008).

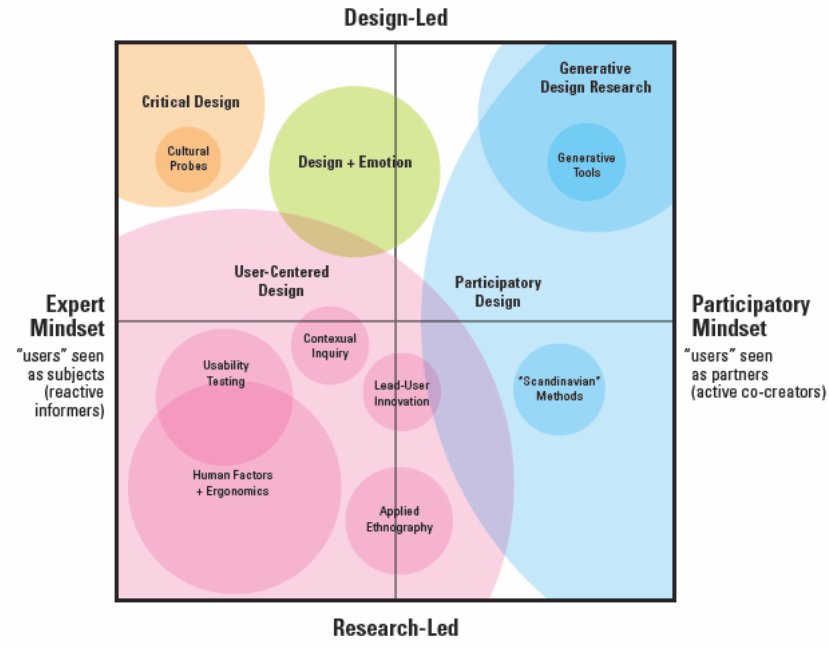


Figure 1. Map of design research – research types (Sanders, 2008).

Because many facets of design are strongly related to the then-current phase in the design process and the methodology used, a description for a product concept design process is given in section 2.3 (Publication II) and used as a reference point to further clarify the temporal and logical relationships between the tasks and the people performing them.

2.1 Foundations of User-Centered Design

While the term User-Centered Design was coined by Norman and Draper (1986) to underline the necessity for a product to serve the needs of the users, the core principles of UCD were established by the work of Gould and Lewis (1985) a few years earlier. They rightfully claimed that designing usable systems requires early focus on users, empirical "hands-on" measurements, and iterative design.

Gould, Boies and Lewis (1991) later elaborate on their own rules by emphasizing the need to act out the design for usability principles as a process, and by adding a fourth rule of "integrated design". With integrated design the authors reached towards strategic usability (Bloomer et al., 1997; Rosenbaum et al., 2000) and more holistic design when they demand the development of all relevant aspects in parallel such as the user interface, documentation and support services. They further stress the necessity to have the entire process under one management. These principles were also the foundation for the development of the ISO 13407 standard Human-centered design processes for interactive systems (ISO -

International Organization for Standardization, 1999), "to provide authoritative guidance on how to achieve usability by incorporating user-centered design activities throughout the life cycle of interactive computer-based systems" (Bevan, 1999). ISO 13407 emphasizes the need to ensure appropriate allocation of function between users and technology and the need for multidisciplinary design teams explicitly demanding a variety of skills. The depicted process proposes understanding the context of use as the basis for specifying user and organizational needs, and calls for iterative design in producing design solutions and evaluating them against requirements. After a decade the standard was augmented with user experience to the standard ISO 9241-210 Human-centred design for interactive systems (2010a).

Gulliksen et al. (2003) argue that user-centered systems design lacks a clear definition and that principles presented by Gould et al. (1997) and ISO 13407 (1999) do not sufficiently maintain the UCD approach in projects or organizations. Standards do not specify exact details (to permit design flexibility), but rather define generic principles. Therefore, they are authoritative statements of good practice and not very useful to demonstrate conformance (Bevan, 2001). The augmented list of 12 key principles by Gulliksen et al. further emphasizes the clarity and adaptability of used process and methods, simplicity and concrete nature of the design artifacts, and wide-ranging multidisciplinary attitude and skill set and leadership by an experienced usability expert (Gulliksen et al., 2003).

A more pragmatic take on the key principles of UCD can be found in the design heuristics of Nielsen and Molich (1990), tailored towards evaluating or designing user interfaces – a cornerstone of usability engineering (Nielsen, 1993).

In the context of software and user interface design education, Seffah and Andreevskaia (Seffah, 2003; Seffah and Andreevskaia, 2003) identified three groups of necessary skills. They called for prerequisite skills including the foundations of development methodologies and processes, specific skills that are in strong relation to the subject domain technology, and a human-centric approach for the design and most importantly generic skills or "soft skills" that include the communication and social skills necessary to work in a multidisciplinary organization and effectively communicate its results to all stakeholders. Lewis and Bonollo (2002) report almost exact same list of competences for industrial designers with an emphasis on the negotiation aspects in designer-client situations and the acceptance of professional responsibility. McGill (2008) provides supporting evidence from the field of game development by reporting a strong need for communication and interpersonal skills, claiming they form fully 24% of all the qualities sought in a software designer.

A workshop organized by Tom Dayton (Dayton et al., 1993) at the CHI'92 conference produced a list of universal UCD attributes or "skills needed by user-centered design practitioners in real software environments". They organized UCD requisites into three groups: knowledge, skills, and attributes harder to acquire. Knowledge includes understanding the basic HCI literature, standards and guidelines, and the ability to use common methodology for research, analysis, usability testing and experimenting, prototyping, and user interface design. Skills comprise project and time management skills, commitment to users, sufficient understanding of the development and implementations technologies, and teamwork skills such as negotiation, facilitation and communication skills in general. Attributes harder to acquire are tenacity, flexibility, empathy, willingness to be a generalist, and having the right attitude[8].

2.2 Evolution of User Involvement in Design

Nearly three decades after the conception of User-Centered Design, Marti and Bannon (2009) refer to the principles described by Gulliksen et al. (2003) and herald the "near consensus on the importance of UCD and on the ways in which it can be achieved". Meanwhile dissident voices argue that the linking of success to user participation is inconclusive (Ives and Olson, 1984). More knowledge is required on the exact ways, how, and when users can and should participate in the design process (Marti and Bannon, 2009). Kaulio (1998), citing Eason (1992), describes the role and degree of user involvement in UCD with three categories: design *for* users, design *with* users, and design *by* users. In the following sections user involvement is discussed from a few additional points of view based on Figure 2.

[8] In the words of the iconic industrial designer Henry Dreyfuss "[Designer] accepts the responsibility of his position as liaison linking management, engineering, and the consumer and cooperates with all three." (Dreyfuss, 1955)

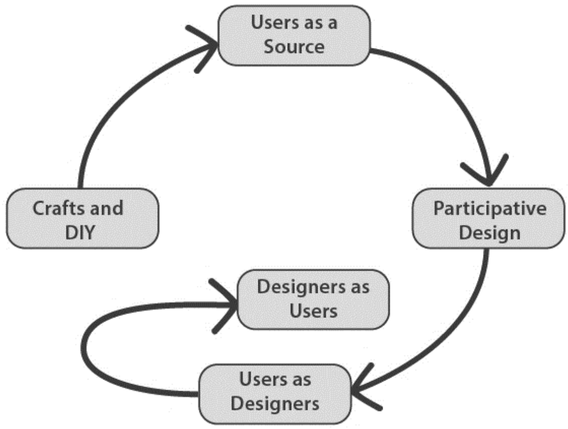


Figure 2. Evolution of user involvement.

2.2.1 Pre-industrial Crafters and Do-It-Yourself

Throughout human history, before the era of UCD, earlier forms of product designs have been based on necessity and craft. Technological invention and innovation in the preindustrial economy are poorly understood due to the small-scale anonymous innovations dominant to that era (Epstein, 1998). People made their own tools and trinkets from available materials or bartered them from neighbors or passing travelers. If a shepherd required a hooked stick to rescue runaway sheep from a stream, he found a suitable material (a branch) and molded it (with a knife and twine) into the necessary shape to perform the needed function. A craft refers to a set of practices shared by a community of practice, but it has no special social status (Denning and Frailey, 2011). This knowledge was then passed among the practitioners (shepherds and villagers) so that also others could make or trade similar products. The utility and need for a product was immediate and very personal, while it was often burdened by limited generalizability. This led to the formation of a trade or an organized group of practitioners, such as a guild or labor union (Denning and Frailey, 2011). Since the 14th century the apprenticeships was the most important means for controlling and distributing occupational training in what we now call design and crafts (Wallis, 2008), eventually formalized in England with the Statute of Artificers[9] in 1562 that formalized the length and terms of an apprenticeship (Dunlop, 1911).

In the scope of information technology and (user-centered) design of software systems, this is comparable to the early or middle 20th century when

[9] 5 Eliz. c. 4.

mathematicians and physicists built their own computing machines and found their own proprietary ways to make use of them. Now in this time of smartphones and tablet computers it is sobering to remind ourselves of how short the history of computers and information technology really is[10].

2.2.2 Users as Inactive Information Sources

The original focus of User-Centered Design in the early days[11] was not to include the people in the design process as active participants (Marti and Bannon, 2009). Enough user-centeredness could be injected into the process by allowing the designer/researcher to <u>observe the users</u> in their real environments (Beyer and Holtzblatt, 1998) or in simulated contexts of use, for instance in a usability lab (Nielsen, 1993). The users could <u>act as an information source</u> by means of questionnaires, interviews and observations (Hackos and Redish, 1998). The users' contributions were then given a life as a product by the designers. After a product (or more often a product concept) was ready, the users could validate its design (in a usability test), thus adding their voice to the final design. The users were involved in the process and they could voice their opinions, but in the end it was always designers who made the decisions.

2.2.3 Users as Active Participants and Design Team Members

In order to give users an active voice in the design of their own products, the User-Centered Design sought more participatory and user-inclusive approaches. The Scandinavian tradition of active user involvement in the design of their information systems, termed participatory design (PD) (Bødker et al., 2004; Ehn, 1993; Voss et al., 2009), has roots deeply set in workers' unions and democratization of the workplace. Törpel et al. (2009) list the main issues of PD as <u>expertise</u> on workers' own work as a design resource, sustainable <u>innovation</u>, <u>multiple viewpoints</u>, <u>interplay</u> between work practices, technology, organizational and other aspects of the environment, <u>context</u>, authentic <u>experience</u>, <u>hands-on methods</u> and activity, <u>empowerment</u> of marginalized societal groups, and <u>reflection</u>. Gulliksen et al. (1999) state that PD is no longer as tightly coupled to the democratization of workplaces as in its beginnings and that PD has become a subset of UCD, but at the same time they make a counterclaim as to whether a participation by management in design reviews can be seen as truly user-centered.

[10] The first commercially mass produced computer UNIVAC 1 was sold to U.S. Census Bureau in 1951 (Gray, 2001). Until 1970's computer enthusiasts had to build their own computers from the scratch or use assembly kits like MITS Altair 8800 launched in 1975, only after which started the era of the personal computer with Commodore PET 1977 followed shortly by Apple II (Matthews, 2003).
[11] Late 1970s and through 1980s.

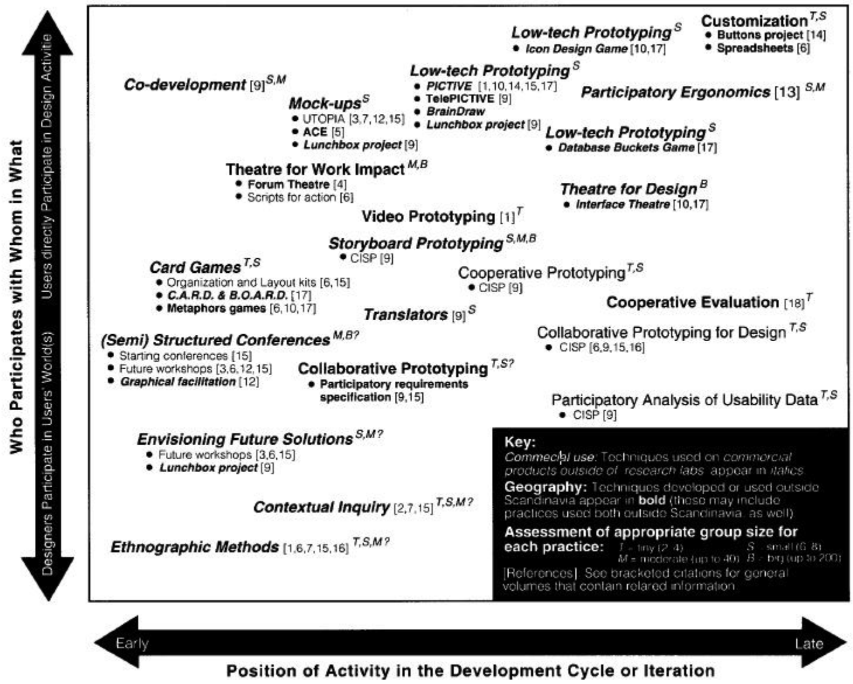


Figure 3. Taxonomy for PD practices (Muller et al., 1993).

Muller, Wildman and White (1993) propose a taxonomy for participatory design practices based on the position of activity in the development cycle or iteration, the mode of participation (i.e. designers participating in users' world(s) versus users directly participating in design activity), and the group size. Figure 3 depicts their taxonomy and a plethora of methods and projects positioned to it.

PD's origins in the context of waged labor presumes a clear definition of actor groups and their organizational dependencies, and suggests design (and research) by interventions organized as a project, and therefore this approach may not work in fluid non-traditional work or non-work contexts (Voss et al., 2009, p. 25).

Co-design (or: codesign) and participatory design are often used as synonyms (at least in the Nordic countries), but Mattelmäki and Sleeswijk Visser (2011) note that co-design "carries perhaps a bit lighter weight on the political attitude but builds on the same mindset and tools". They also find co-design to share with PD the same agenda[12] of empowering people and an experience-driven mindset. Co-design is inherently a set of tools for collaborative engagement, i.e.

[12] Citing the three layers of design research methods: instrument, competence and agenda by Keinonen (Keinonen, 2009a) where he dissects the methods to tools, the necessary skill to use them and the prevalent mindset.

instruments, and competence by the future users to utilize their experiences and creativity for design.

Another way to classify the interplay of users and designers is to concentrate on the nature of their actions. Keinonen (2009b) recognizes the different kinds of contributions from both designers and users. His Design Contribution Square positions UCD practices based on the inactive, reactive, or proactive contributions of the users and the designers (see Figure 4). Silent design (Gorb and Dumas, 1987) refers to design without explicit participation of design professionals and Keinonen extends it to include design practice based on preset guidelines and standards or tools and processes mediated by design proposals. Reflective design takes place without users' direct active participation. Designers contrast their existing knowledge to available user data and thereby create new concepts. Suitable methods for mediating inactive user knowledge to reflective design are affinity diagrams (Beyer and Holtzblatt, 1998), card sorting (Hudson, 2012), scenarios (Carroll, 2000), personas (Cooper, 1999), and rich media presentations[13]. Keinonen argues that with the use of more formal user representations such as hierarchical task analysis (Stanton, 2006), GOMS (John and Kieras, 1996) or the many models of contextual design (Beyer and Holtzblatt, 1998), the designer's contribution becomes more reactive. If users participate fully in the design effort the process turns into codesign. While many earlier described design approaches can also be applied to codesign, Keinonen also suggests the use of collaborative design games (Brandt, 2006), context mapping approaches (Sleeswijk Visser et al., 2005), and different kinds of construction kits (Mattelmäki and Lehtonen, 2006).

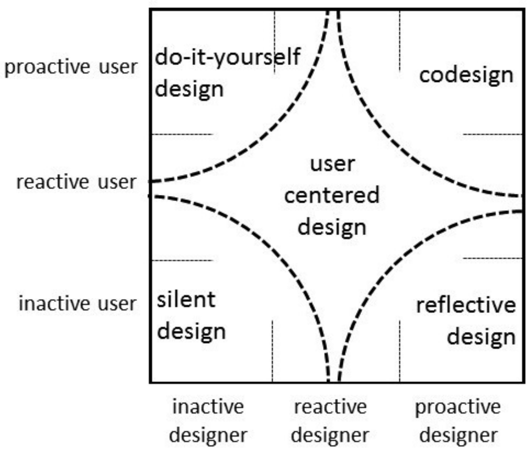


Figure 4. Design contribution square (Keinonen, 2009b).

[13] One example of this kind of mediation of user research as a multimedia experience is the UCD Holodeck (Karvonen, 2010) also depicted in Publication VIII.

Marti and Bannon (2009) claim that researchers in HCI are more prone to earlier user involvement than is customary for professional design teams, where users are only involved at specific stages, for instance requirement elicitation or assessment.

2.2.4 Users as Designers

It seems that with just a few evolutionary steps, user-involved product design is now heading back to do-it-yourself design (cf. Figure 4 for proactive users with inactive designers in the DCS (Keinonen, 2009b)). Current IT ecosystems thrive on user generated content in the form of digital media e.g. pictures, videos, blogs, status updates, and increasingly better means to consume or create such content. The internet, smart phones, and tablet computers form an attractive platform for new digital product and service design for ordinary people. This kind of use, tailoring, and completion of "unfinished" products is often referred to as meta-design or end-user development (Fischer et al., 2004). Application development can be performed with modest programming skills with the aid of free software development kits (SDK), authoring tools, or meta-programming/scripting tools that are in fact apps for making apps, such as the MIT App Inventor ("MIT App Inventor," 2014) for Android devices. Users driven to solve everyday problems are provided the tools to do so, and if their foresight meets the needs of the larger public, these emerging lead users (von Hippel, 1986) have ample means to disseminate their products and even benefit financially. All relevant operating systems and computing platforms have adopted application store or market concepts similar to those of Apple's App Store, providing a dissemination path for both professionally and privately developed software applications in exchange for a percentage of the sales price[14].

User participation in product design has in many ways passed the kind of simple tinkering that solves an annoying everyday problem. Nowadays, if designing a product or programming an app is not your strength, you can harness the power of social media to help you envision the product through crowdsourcing (Leimeister et al., 2009), and enable the development by collecting the necessary funding through crowdfunding (Belleflamme et al., 2014). Even

[14] Apple Inc. App Store https://itunes.apple.com/us/genre/ios/id36?mt=8
Google play https://play.google.com/store
Microsoft Store (earlier Windows Marketplace) http://www.microsoftstore.com
Windows Store http://www.windowsstore.com
Windows Phone Store http://www.windowsphone.com/store
Amazon Appstore http://www.amazon.com/appstore
Nokia Store: http://store.ovi.com/

manufacturing your unique design is now possible by means of affordable 3D printers and the requisite open source software suites.

2.2.5 Designers as Users

In some cases, involving users to a design effort is impossible, undesirable or impractical due to time constraints, technological complexity, personal attributes or geographical distance. For instance, the design of consumer products is often technology and market driven and thus the involvement of users in early stages is difficult. The users may be incapable of contributing to the innovation process due to existing functional fixations, inability to evaluate concepts without an existing reference product, or the high technological complexities involved (Lettl, 2007). Users find it difficult to make sense of new emerging technologies and finding appropriate uses for them. Users' ability to participate in the design effort may be hindered by temporary or permanent impairment (Marti and Bannon, 2009). Often they may belong to a restrictive user group (for instance children see (Scaife and Rogers, 1999) and Publication IV) or cannot participate fully due to geographical distance (Lettl, 2007). Under such circumstances it may be preferable to either simulate or mediate the user involvement.

In Publication VII a question is raised as to whether the experiences of future users can be made available to designers at the time of the design. The term future user is borrowed from Redström (2006) to emphasize the paradox of designing a product for a user when the user comes into existence only after the use of the product. A new design paradigm called Designer Experience (DX) is introduced to describe the designer's immersion in the future users' experiential system in order to glimpse the "irrational, non-deterministic side of the user". As an introduction for a one-day workshop, Publication VII organized the problem space for Designer Experience into three themes on the existence and feasibility of DX, on ways to invoke DX, and on future research topics and uses of DX. The authors described the level of intimacy, i.e. the depth of knowledge the designers can have on the future users of their products, as a continuum that starts from "knowing about people" and ranges up to "thinking like the future users" and "experiencing like the future users" in relation to the various aspects of the experiential system.

In Publication VIII the Designer Experience is defined in more detail as a holistic approach to enable design activity in the experiential level by means of explicit iterative switching of the designer and user roles. The five main aspects of DX are identified as the following: Physical context which includes both concrete physical environments and actors and their virtual representations;

Social context which describes the interactions between the various stakeholders, including also design related collaborations such as participatory design or co-design (Sleeswijk Visser et al., 2005); Culture in its very broadest definition, from the group's basic assumptions to values and behavioral patterns (Schein, 1984), to shared language and vocabulary (Williams, 1985) that enable communication and interaction; cognitive processing outlining the users' perceptive and cognitive potential and limitations; and lastly the psychological concerns in the form of expressed needs, attitudes and desires or dreams, emotions, personal values and motivations that are often more difficult to study including the psychological needs (Ryan, 1995; Sheldon et al., 2001). These aspects are not independent of each other (Wright et al., 2006) and the designers always leverage their own past memories, experiences and knowledge (Woo, 2007). The aspects of DX can be used to bring the designers closer to their future users, especially useful if there is no direct access to the people or their contexts.

2.3 User-Centered Concept Design Process

This chapter describes a generic user-centered concept design process that is to be used as a scaffolding to position the methods and observations from the included articles. The process itself is originally described in Publication II and then later used and referred to in Publications I, IV, V and VI. The development of the process and the suggested methods for each phase are described in more detail in the author's Licentiate thesis (Nieminen, 2006).

In many of the Publications the author refers to the act of creating new product concepts as the process of concept development. Without going into past discussion (Nieminen, 2006) or presenting arguments on the matter, for the sake of clarity this thesis uses the term concept design as an umbrella for all activities leading to the creation of new products or services. These include conceptual design (French, 1998), concept management (Chakravarthy et al., 2001) and product concept design (Kankainen, 2003; Keinonen and Jääskö, 2003) to name a few.

The following user-centered concept design process is founded on the works of Ulrich and Eppinger (1995) on product design and development, ISO standards for human-centric systems design (ISO - International Organization for Standardization, 2010a, 1999), and prior art by Kankainen (2003). The following Figure 5 depicts the process phases on a timeline with their relative durations and resource consumption, which mostly comprises person-hours expended. The process is defined to be iterative within each phase, and when necessary, it transforms the final Assessment deliverables to redefine a new Commitment phase for a full iteration of the process.

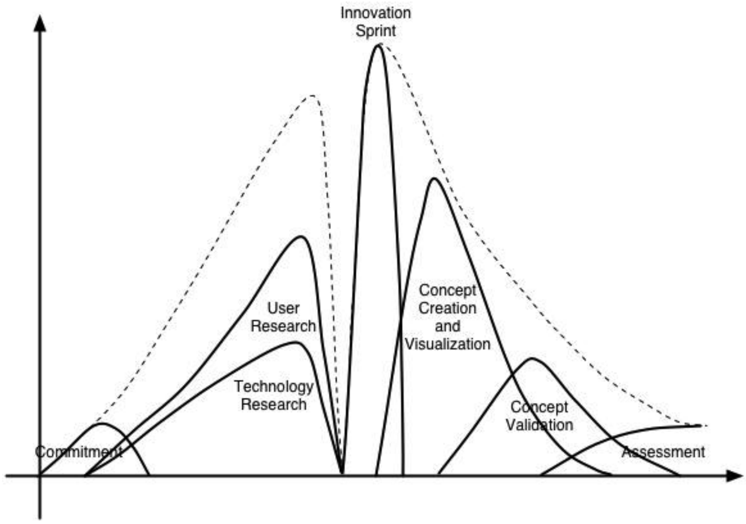


Figure 5. User-centered concepts design process (Publication II).

The following Table 1 briefly summarizes each phase of the process and their main deliverables. For more details please see (Nieminen, 2006).

Table 1. Summary of the user-centered concept design process (Publication II).

Project Commitment	**User and Technology Research**	**Innovation Sprint**	**Concept Creation and Validation**	**Project Assessment**
Define user group and context	Select research methods	Generate ideas	Select and combine	Evaluate concepts against requirements
Select technology framework	Conduct user and technology research	Be creative	Visualize	Collect customer feedback
Schedule the project	Analyze data	Do not criticize	Validate	Prioritize concepts and propose future steps
		Outcomes		
Design brief	User tasks and needs description	Hundreds of ideas	Validated concept candidates	Final concepts
	Technology trends and possibilities			Project documentation

The user-centered concept design process outlined here has three distinctive layers of design activity, each with flavors particular to them (see Publication VI and (Nieminen, 2006)). As can be seen in Figure 6, the heart of the process is the creative process for manifesting the new product ideas, which is enclosed in systematic user-centric phases of user and technology research and concept creation and validation. All of the above are embedded in a shell of project management. The gray arrow depicts iteration within the process so that all these layers are visited several times, but in a fixed, "orderly" manner.

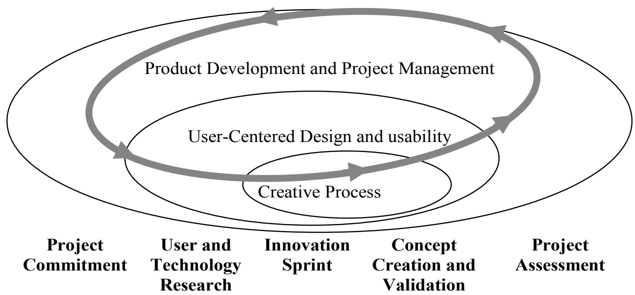


Figure 6. User-centered concept design as a nested iterative process (Publication VI and (Nieminen, 2006)).

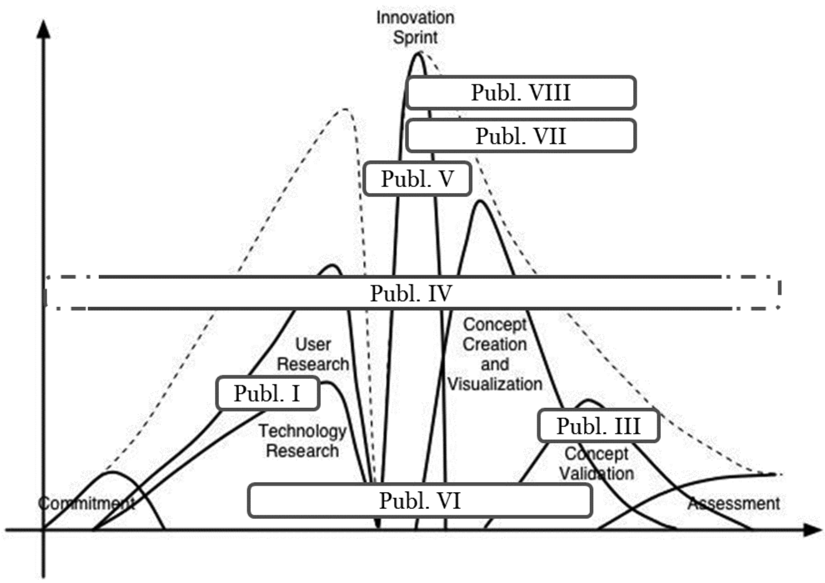


Figure 7. Relationship of the publications to the process (adapted from Publication II).

Figure 7 overlays the methods and case studies presented in the Publications I-VIII onto their respective places in the process. Publication IV depicts three instances of the whole process.

3 Competency Approach to User-Centered Design

In this chapter the theory behind competencies and competency models in general are explored. It provides a motivation to approach UCD from a competency point of view and further discusses the various competencies and competency model by means of examples from engineering design.

3.1 Definitions – or, a Quick Word from the Language Police

> *"Competency is an underlying characteristic of an individual that is causally related to criterion-referenced effective and/or superior performance" (Spencer and Spencer, 1993, p. 9).*
>
> *Competence is "a demonstrated ability to apply knowledge, skills and attitudes for achieving observable results" (CEN European Committee for Standardization, 2010).*
>
> *"A competency is a measurable human capability that is required for effective performance. A competency may be comprised of knowledge, a single skill or ability, a personal characteristic, or a cluster of two or more of these attributes." (Marrelli et al., 2005)*

In the literature and in common speech, the terms competence (pl. competencies[15]) and competency (pl. competences) are used almost as synonyms (Le Deist and Winterton, 2005; Rowe, 1995; Teodorescu, 2006). According to Le Deist and Winterton (2005) "competence" refers to functional and "competency" to behavioural areas, and McConnell (2001) underlines that "competence refers to an individual's capacity to perform job responsibilities" while "competency focuses on an individual's actual performance in a particular situation", i.e. what people can do and how well they do it (Rowe, 1995). These definitions seem to differ from the earlier and much more cited definition by Spencer and Spencer (1993, p. 9) and Boyatzis (1982) citing Klemp (1980). Teodorescu (2006) agrees that the literal meanings of the terms are basically

[15] Plural forms based on Rowe (1995), Merriam-Webster claims plural of competency to be competencies (Merriam-Webster Dictionary, 2013), while Oxford dictionary heralds competence as a mass noun with no plural form and a synonym for competency (Oxford Dictionaries, 2013).

the same but that the theoretical versus practical nuance is carried over to the competency and competence models as well. She claims that competency models describe skills, knowledge and job attributes, while competence models define processes and best practices specifically targeted to produce valuable results without excessively costly behavior[16].

In this thesis the author uses the term competency (pl. competencies) to describe characteristics, ability, and necessary resources to complete a desired task in an excellent manner. Competence is the result of realizing a competency in a competent manner. So, competency is the theoretical potential and competence is its realization. This is in line with the criticism towards overly generic and transferrable competencies[17] and in favor of the integrated conception of competency theory that demands that "competence incorporates knowledge, skills and attitudes displayed in the context of a carefully chosen set of realistic occupational tasks or elements which are of an appropriate level of generality" (Hager, 1995).

The choice of terminology to use when discussing the referred works has largely been left to the original authors, including spelling differences between British or American spelling for instance "behaviour" vs. "behavior".

3.2 Motivation for Competency-based User-Centered Design

The main uses for competencies and competency models include:

- Identification and clarification of required skills, knowledge and characteristics (Lucia and Lepsinger, 1999, p. 33).
- Planning and development of educational programs or vocational training to improve individual job performance and organizational effectiveness (Markus et al., 2005).
- Improve recruitment and employee selection practices (Cook, 2004),
- Performance management and to create a common language to facilitate dialog on strategic and HR issues (Sparrow, 1995).

In short, competencies and competency models can be used to effectively communicate and manage participants' own actions (Green, 1999, p. xiii).

[16] Referring to the definition of human competence as a function of worthy performance by Gilbert (2007, pp. 17–18)
[17] Hager condemns Klemp's (1988) claim "that very successful performers in a range of jobs were distinguished by the following general attributes: diagnostic thinking, conceptualisation, systematic thinking, influence skills, sensitivity to others, ability to use informal processes, confidence, initiative and persistence" (Hager, 1995).

The design of information systems (IS) requires a special set of knowledge and skills, as has been noted by the Curriculum guidelines shown in Figure 8 from the Association for Computing Machinery (ACM) (Topi et al., 2010). The ACM details three categories that include factual IS design and implementation capabilities, foundational "soft-skills" relating to leadership, negotiation, collaboration, and communication skills. The third necessary body of knowledge and skills is the fundamentals of the domain for which the information system is designed.

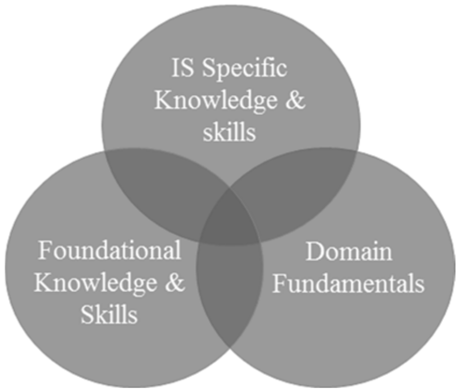


Figure 8. ACM IS 2010 curriculum guidelines (Topi et al., 2010).

In the early seventies, the design theorist Horst Rittel (1971) outlined the requirements necessary for design education. He claimed that design education should expose typical difficulties in design as clearly as possible and then proceed to solve them one difficulty at a time. The emphasis on the knowledge of "present technologies" should be deemphasized in favor of the principles underlying the technologies. The vast amounts of factual knowledge should be taught as relationships among the variables of design, context, and performance, and should be used to mesh many disciplines into one. Design education should take note "how cultural, social, economic and political factors influence design and how these factors themselves can become subject to design". Most of all Rittel claims that advanced design education should be based on real design problems instead of mock-up projects as "design problems are notoriously ill-behaving"[18].

This thesis does not suggest that "user-centered designer" is a singular job role that could be assessed completely through a unified set of competencies or a single competency model. It does aim to provide a framework in which the process to be used and the selection of actors and methods can be tailored to fit the task at hand with the aid of a manageable number of options and easily

[18] This of course is a nod towards Rittel's seminal work with Webber on the wicked problems (Rittel and Webber, 1984).

applied criteria. The competency approach was selected since the analysis of work task performance and the consideration of different roles in different organizational cultures in conjunction with non-task performance related issues resonate very well with the complex richness found in user involvement in UCD practices. The author fully agrees with the notion by Hoge et al. (2005) that performing most tasks requires the use of several competencies simultaneously or in sequence.

3.3 Competencies and Competency models

Markus et al. (2005) groups competency definitions into three distinct approaches: educational standards, behavioural repertoires, and organizational competencies. The educational approach defines competency based on knowledge, skills, and attitudes or expected [work] outcomes (Fletcher, 2001). In a way, competence is here described by the minimum levels of actions, behavior or outcomes, with different levels of mastery defined by statements (Burke et al., 1974). The psychological approach argues that competencies defined as motives and personality traits (i.e. behavioral repertoires) are better indicators of success (McClelland, 1973). Competencies are seen as “a generic body of knowledge, motives, traits, self images, and social roles and skills that are causally related to superior or effective performance in the job” (McClelland and Boyatzis, 1980). The organizational or business approach is based on Hamel and Prahalad’s work on definitions of “Core Competencies[19]” and “Capabilities” as the outcome of an organization’s collective learning (Hamel and Prahalad, 1989), and this suggests a need to define higher level future-oriented organizational competencies (Sparrow, 1995).

Marrelli et al. (Hoge et al., 2005; Marrelli et al., 2005) describe competency by its elements: Knowledge, Skill, Ability, and Personal characteristics – KSAP for short. Knowledge includes the information, facts and principles necessary to complete a task successfully (Mirabile, 1997) and it is acquired through learning and experience. Skill is a mental or physical capacity to perform tasks with a specified outcome, while Ability extends skill to perform with a wide range of possible outcomes (Marrelli, 1998). Personal characteristics such as attitudes, values and traits include emotional or personality components. Both knowledge and skills range from concrete tasks, for instance filling in a form, to more abstract ones like facilitating a team meeting (Lucia and Lepsinger, 1999).

[19] Prahalad and Hamel describe three tests to identify core competences: core competence provides potential access to wide variety of markets, core competence should make a significant contribution to the perceived customer benefit of the end product, and core competences should be difficult to imitate by competitors (possibly via a complex harmonization of individual technologies and production skills) (Prahalad and Hamel, 1990).

Competency models are collections of functional or behavioral competencies required to perform a certain job. They promote desired organizational values and core competences by rewarding preferred behaviors (Markus et al., 2005). The models organize the competencies into a hierarchy with unique descriptors and criteria. The number of groups in a model depends on the complexity of the work and the culture and values of the organization in which it takes place (Ho and Frampton, 2010). Usually this results in a single role competency model having eight to sixteen competencies (Shippmann et al., 2000), while Mansfield (1996) advocates "10-20 traits or skills, each with a definition and a list of specific behaviors that describe what effective performers do and how to achieve effective results". Spencer and Spencer (1993) suggest avoiding long laundry lists of competences as they are less useful than focused lists of the most essential competencies. They propose five to nine competencies as a good rule of thumb, quoting Miller's (1956) "7 plus or minus 2" rule, as this amount of competencies seem to manifest naturally from the limits of human information processing. Bartram (2005) supports this by comparing the Great Eight competencies to the Big Five factors finding the eight factor solution to function as a better predictor.

McLaughlin et al. (2012) claim the Iceberg Model of Competencies (Spencer and Spencer, 1993) is one of the most used model to illustrate competences. It details the characteristics of competencies into five categories: motives, traits, self-concept, knowledge, and skill. The name of the model reflects the hidden nature of the underlying motives and traits that are also more difficult to develop. Ho and Frampton (2010) offer us an illustration of this by mapping the competencies of an IT architect to the Iceberg Model in Figure 9.

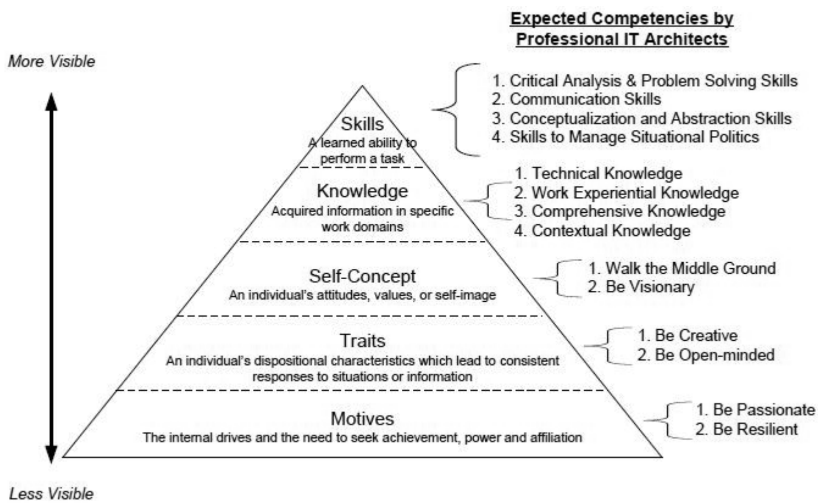


Figure 9. Competencies for IT architect mapped to Iceberg Model (Ho and Frampton, 2010).

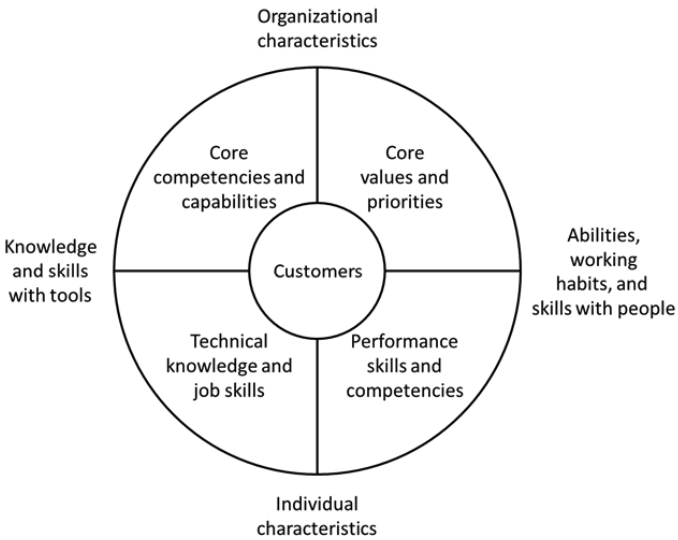


Figure 10. The competency scope, linking organizational and individual characteristics (Green, 1999).

Green (1999) introduces the competency scope, depicted in Figure 10, that organizes the competencies based on level and type. Level described how organizations can be effective in the market, such as leveraging a core competence (Prahalad and Hamel, 1990) or a company value, or how an individual can be effective in doing a particular task. Type, on the other hand, segregates the competencies into hard skills of knowledge and work procedural skills; and to soft skills such as values and priorities, personal abilities, and social skills.

Models designed for selection and educational purposes describe technical competencies in terms of skills and knowledge, while behavioural repertoires and organizational competencies are typically described at a higher level (Markus et al., 2005). Green (1999, p. 7) suggest that when describing competencies one should use behavioral language, i.e. state what has been done, what is being done, or what needs to be done to do the work right, so as to avoid misunderstandings. For instance to define a competence called "Excellence" one can avoid confusion or misinterpretations by describing what a person says or does when performing in an excellent way.

> *"Regardless of approach, a competency model should provide an operational definition for each competency and subcompetency, together with measurable or observable performance indicators or standards against which to evaluate individuals" (Markus et al., 2005).*

A competency should be measurable and provide rating anchors for ratings of high, average and low performance to make the competency system both acceptable and representative (Green, 1999, p. 17). Marrelli et al. (2005) point out the necessity of considering legal implications when using competency models for employment situations, exhibiting a higher need for robust validation.

The competency approach promises performance benefits via the causal or instrumental relationship between competencies and both individual job performance (Boyatzis, 1982) and organizational performance (Hamel and Prahalad, 1989). Other expected benefits include improved recruitment and selection practices, improved individual and organizational development, improved performance management, and improved communications on strategic or HR issues (Sparrow, 1995). Competencies are also context-specific, which implies that some competencies are more important for certain jobs than others (Ho and Frampton, 2010).

When defining competencies there is always a tradeoff between universality and specificity (Stuart, 1983). Competencies express themselves in unique mixes of task specific and shared elements and "the paradox is that the more universally true any given list of competencies is, the less immediately useful it is to any particular choice about how to act and behave in a specific situation" (Burgoyne, 1990). This observation implies that competency models are always incomplete (Hayes et al., 2000). At the same time competence models assume that individual workers' outputs can be aggregated to represent the organization (Borman and Motowidlo, 1997).

Writing from an industrial and organizational psychology perspective, O'Reilly and Chatman (1986) distinguish between the in-role behaviors required in the job and prosocial behaviors which are not specifically fixed to a particular role. Motowildo et al. (1997) identify the two aspects of overall job performance as task performance and contextual performance, where in essence the contextual performance is the overhead from the necessary socialization, application and effort needed to facilitate task performance, i.e. the application of the technical and task knowledge (Borman et al., 2003). Motowildo et al. (1997) also suggest that the activities involved in task performance most likely vary between roles, while those involved in contextual performance are often similar.

Ruuska and Vartiainen (2003) claim that individuals and groups must be able to integrate their competences in order to achieve their intended goals. These kinds of collective competences, or team competences (Crawford, 2000; Frame, 2003), emphasize interaction and communication and they are based on the shared understanding of the project teams (Schein, 1993). Collective competences are context-dependent since they can only be learned by participating in a collective activity of the group as a whole (Cook and Yanow, 1993). This context-dependency of competencies is partially due to their tacit dimension (Polanyi, 2009), where learning takes place while focusing on something else.

Robinson et al. (2005) reviewed literature on engineering design competencies ((Leiper and Khan, 1999); (Turley and Bieman, 1995); (Edum-Fotwe and McCaffer, 2000) and (Duncan, 1991)) and identified the main competency themes to include role-specific technical competencies; competencies indicating a high level of motivation; the use of intelligence to solve problems and make decisions; teamwork; the management and leadership of others; communication; planning and management of projects and resources; innovation; and strategic awareness of the wider business and customer context. For ten years in the future they predict six competency groups for design engineering: personal attributes, project management, cognitive strategies, cognitive abilities, technical ability, and communication.

Robinson et al. (2005) citing the ethnographic studies by Baird et al. (2000) note the importance of non-technical skills such as planning, prioritization and awareness of other people's dependencies. "[Design engineers] engage in complex thought processes when evaluating long-term implications alongside more immediate outcomes, before then prioritizing work accordingly" (Robinson et al., 2005). Hales and Gooch (2004, pp. 66–67) found that only 47% of the engineering design effort belonged to steps in design process, while the remaining time was spent in general activities of "planning work, reviewing/reporting, cost estimating, information retrieval, social contact, and helping others".

Figure 11 shows the Eye of Competence, from the International Project Management Association (Caupin et al., 2006). It structures 46 identified project management competence elements into technical, behavioural, and contextual competences that describe 20, 15 and 11 elements, respectively.

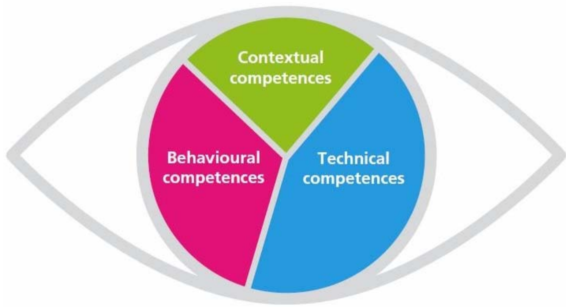


Figure 11. The eye of competence (Caupin et al., 2006).

Derro and Williams (2009) go into even more detail when describing the behavioral competencies of systems engineers at NASA or the "the art of systems engineering" with five themes: leadership skills, attitudes and attributes, communication, problem solving and systems thinking, and technical acumen (see Figure 12).

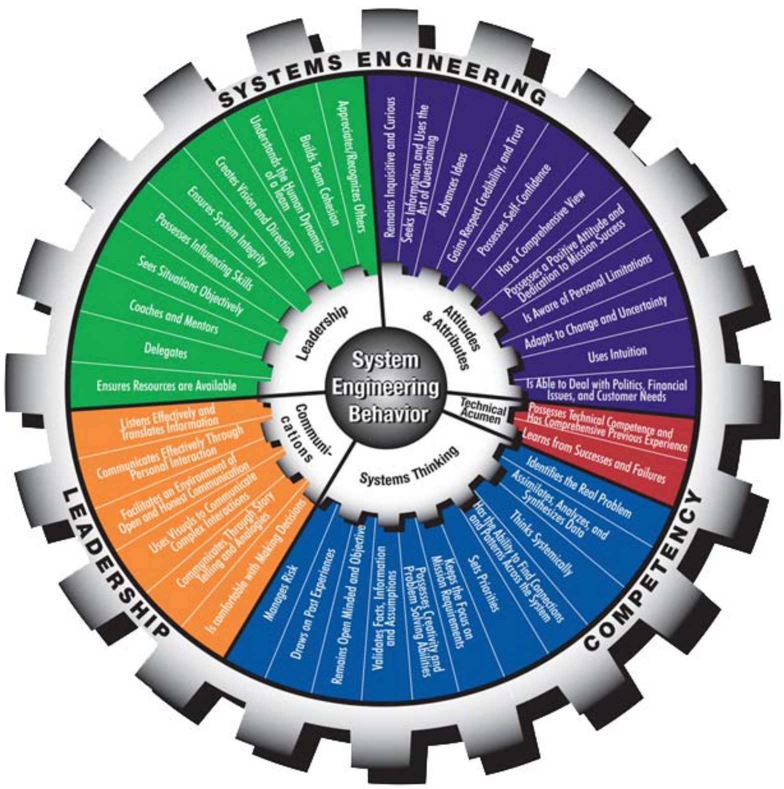


Figure 12. Behavioral competencies of highly regarded systems engineers at NASA (Derro and Williams, 2009).

Ruuska and Vartiainen (2003) identified seven major areas of project competences as project management, leadership, communication and interaction, knowledge management, interest groups, technology, processes and procedures, and customer competence.

3.4 Ways to Build Competency Models

Spencer and Spencer (1993) outline three analysis steps and four validation steps for identifying competencies and building a competency model based on the Behavioral Event Interviews (BEI), surveys, panels, expert systems, and observations. The final competency model (a competency codebook) is to include precise definitions of each competency with scoring rules.

The process of defining broad competency models[20] starts by defining the intended population to be described by the competency model, and proceeds by using literature sources, pre-existing competency models, and existing experience in developing the models. These models often require additional assessment and development tools to support the real-world application of the models. An obvious drawback of broad competency models is their inability to directly describe any specific job. (Mansfield, 1996)

Marrelli et al. (2005) propose a seven-step process for developing a competency model summarized in Table 2.

[20] Competency models that apply to larger audiences than singular job roles.

Table 2. Seven steps to develop a competency model, adapted from (Marrelli et al., 2005).

Defining the Objectives	Why to develop a competency model, what is the unit of analysis and timeframe are and how to apply the model
Obtain the Support of a Sponsor	What resources are needed and how to ensure the cooperation of all stakeholders
Develop and Implement a Communication and Education Plan	How to manage the participation of the committed, compliant and resistant stakeholders[21] during the process
Plan the Methodology	Collect data from multiple groups, while focusing on high performers[22] with strong analytical and verbal abilities, but ensure a representative sample of the entire population. When selecting a data collection method[23] consider its validity, reliability, efficiency, practicality and acceptance to the stakeholders.
Identify the Competencies and Create the Competency Model	Create a broad job definition. Identify specific competencies. Organized the competencies into a framework and provide them with descriptions to form the competency model. Review the draft model with subject matter experts. Develop examples for each competency for at least three levels of proficiency.
Apply the Competency Model	Use the competencies to select, develop, manage, reward, and compensate employees.
Evaluate and Update the Competency Model	Competency modeling is a continuous process. Establish a schedule for future reviews.

Sherman et al. (2007) promote using grounded theory methodology (Corbin and Strauss, 1990; Glaser and Strauss, 1967; Strauss and Corbin, 1994) to analyze their interviews. Langdon and Marrelli (2002) claim that any job model can be described with the six elements of behavior[24] using the Language of Work. Other approaches for competency identification and construction of competency models include process-driven approaches, outputs-driven approaches, invented approaches, trends-driven approaches, and work responsibilities-driven approaches (Rothwell and Lindholm, 1999). The construction of the UCD competency Model, described in the next chapter, is

[21] Committed stakeholders are willing participants and provide data, funding and motivate others to support the study. Compliant will follows instructions, but do not volunteer extra support. Active resistant stakeholders oppose or hinder the study. Passive resisters undermine the study while appearing to comply with it (Lucia and Lepsinger, 1999).

[22] Not surprisingly, people with excellent job performance provide most accurate data about competencies needed for excellent performance (Gilbert, 2007; Kelley and Caplan, 1993).

[23] Suggested methods include: Literature review, focus groups, structured interviews, BEIs, surveys, observations and work logs (Marrelli et al., 2005).

[24] Inputs, conditions, process steps, outputs, consequences and feedback (Langdon and Marrelli, 2002).

tightly coupled to the UCD processes, while it also includes some of the task or work responsibility related aspects from the UCD practices.

4 Construction of a UCD Competency Model

In this chapter the canons of UCD and empirical evidence from the author's Publications are sourced to construct a generic competency model for User-Centered Design. The structure of the competency model and steps to validate it are discussed prior to describing the analysis of the validation study (Chapter 5) and final UCD Competency Model (Chapter 6).

All the presented competency theories and models in the previous chapter have several points in common. They emphasize the relevance of both technical and non-technical skills, and they acknowledge the necessity of involving all connected interest groups and the importance of motivation and fluent communication and collaboration among stakeholders.

The goal of the UCD Competency Model is to include the most important competencies necessary for a successful UCD projects and provide a framework to reflect on the strength of the various stakeholders in them. The following sections outline the process of constructing the model in seven steps as shown in Figure 13:

1. Source Statement Collection (Systematic Text Condensation)

2. Initial Dimension Definition (Closed Card Sorting)

3. Categorization of Dimensions (Dimension-Specific Affinity Diagram Formation)

4. Definition of UCD Competency Areas (Cross-Dimensional Affinity Diagram Formation)

5. Definition of initial UCD Competencies (Adjacent Category Analysis)

6. Parallel Definition of Competency and Level Descriptions and

7. UCD Competency Model

The analysis proceeded through three different layers depending on the nature of the handled data starting with source data, condensing it to dimensions of UCD and finally to UCD competencies. While moving on each layer the analysis process transforms the data either towards more abstract or more concrete representations.

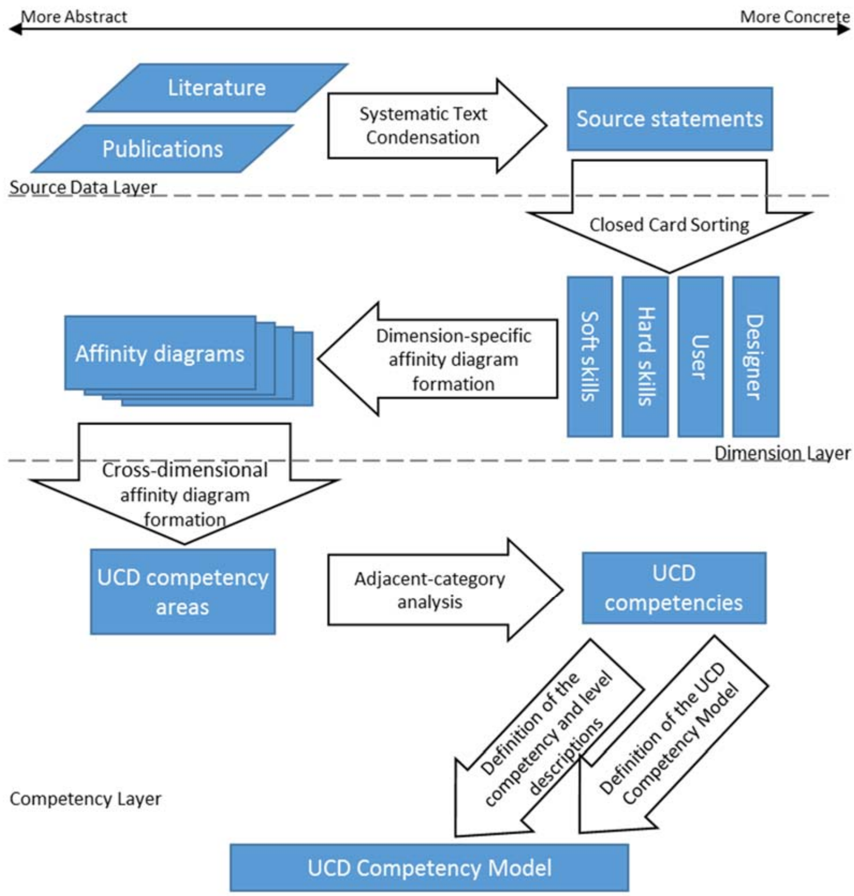


Figure 13. The development of the UCD Competency Model, three abstraction layers.

4.1 Sources for the UCD Competencies

The source data for the analysis of the UCD competencies and for the formation of the UCD Competency Model is derived from seminal UCD literature and from the experiences and observations recounted in the author's Publications. These include for instance the commonly agreed upon principles of UCD such as early focus on users, empirical measurements and iterative design (Gould and Lewis, 1985), or adaptability of design processes and methods and leadership by an experienced usability experts (Gulliksen et al., 2003) to name a few. These observations or source statements about the practices of UCD and user involvement are included in abbreviated form as Appendix 1: Source Statements. They are also underlined when present in the previous chapters of this thesis.

The analysis of the Publications was done by starting with an overview of an article, identifying and sorting its meaningful units that are then condensed using a flexible coding system. In the last the coded materials are synthesized to descriptions and concepts. Afterwards this way of qualitative analysis was noted to follow the characteristics of a Systematic Text Condensation (STC) (Malterud, 2012).

4.2 Overall Structure for the UCD Competency Model

The overall structure for the UCD Competency Model is based on the underlying theory described in section 3.3 Competencies and Competency models. The construction of the model was launched by choosing the key axes to reflect the main two themes of the envisioned model.

1. Skills and competences that could be tied to a work specific role of the participant, and

2. More generic abilities and skills that do not directly contribute to any singular role[25].

The roles of the key participants were outlined as designers and users, while the non-role specific competences were further divided into hard and soft skills. These selections, paying homage in structure to Green's Competency Scope (Green, 1999), defined the main dimensions as these:

Designer (developer, engineer, researcher)

Active and responsible stakeholder in a design process. Has specialized education and work experience in multidisciplinary design[26] and/or research[27]. Represents the design and development organization in the process and may manifest/leverage core competences (Prahalad and Hamel, 1990) during the process.

User (end-user, corporate professional[28] or consultant)

Collaborator in the design process to a variable degree. Brings to the table vast reservoirs of contextual and subject domain knowledge, may divulge

[25] However these non-role dependent competences are of crucial importance to the overall performance of the design task.
[26] User-Centered {software, product, service, industrial} design.
[27] Psychology, social-psychology, sociology, cognitive and neurosciences.
[28] Often from management, Human Resources or other business units such as marketing and sales or services.

tacit knowledge (Publication IV, V and VI). Depending on activities, may be equal team member with the designers, but cannot be held accountable for the overall results (Publication VII and VIII).

Hard skills

Knowledge and practices acquired by formal education or training, or a resource or an enabler mediated by use of the same. May require or grant a license or certificate. Corresponds mainly to the Knowledge and Skill components of competency (Marrelli et al., 2005) or the top layers of the Competency Iceberg (Spencer and Spencer, 1993).

Soft skills

Personal abilities, values and affinities. Social skills in collaboration and communication[29]. Changes in soft skills are most likely to occur in group processes. Soft skills populate the lower half of the Competency Iceberg (Spencer and Spencer, 1993) or the attitude and personal characteristics components (Marrelli et al., 2005).

The qualitative analysis of the source data layer statements was conducted using the well-known and proven methods of closed card sorting (Hudson, 2012) to pigeonhole the materials to the above four dimensions. Some of the source statements were included in several dimensions.

4.3 Dimensions of User-Centered Design

Next an affinity diagram process (Beyer and Holtzblatt, 1998) was used to group the statements within their own dimensions and provide them with summative higher level titles. An example of a dimension layer affinity diagram for the *User Strengths* is shown in Figure 14.

[29] Importance of collaboration and communication skills is further emphasized because "In engineering design most design representations are directed inwards towards people with the same competency, but in order to engage in dialogue with other groups, design suggestions has to have a richness that makes it possible to span the gap between the concerns of different groups" (Binder et al., 1999). Studies (Kovanen et al., 2013; McPherson et al., 2001) show that communication and interaction patterns are influenced by similarity of sex, age, race, or education, a phenomena known as homophily.

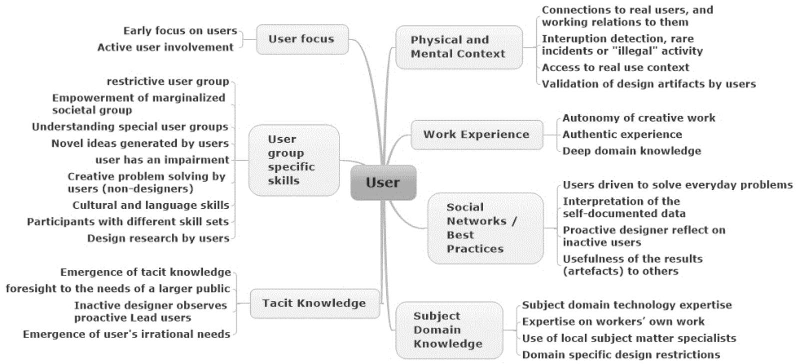


Figure 14. Affinity Diagram for the User Strengths dimension.

The final condensed result of this process, combining all the dimension layer affinity diagrams into a single model. This categorization depicting the identified competency areas is shown in Figure 15.

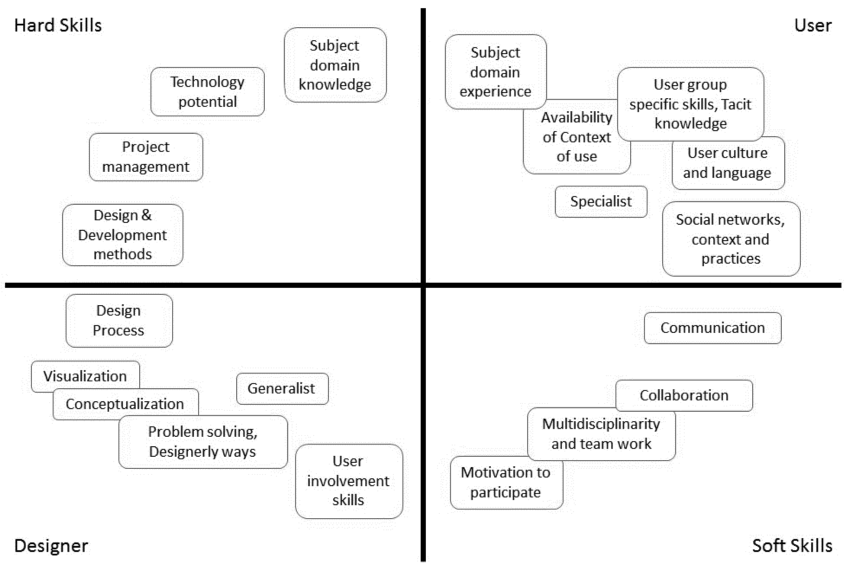


Figure 15. Affinity diagram depicting the high level UCD Competency areas in the selected four dimensions.

4.4 Competencies of User-Centered Design

The adjacent categories of the final affinity diagram were further condensed and renamed to transform them to titles for the competencies. The competencies relating to User Cultures and Social Practices were combined together, while Multidisciplinarity was joined with Collaboration. The core early stage design activities of Conceptualization and Visualization were united. The motivation competency was retitled to include Ambition to further explicate its intrinsic aspects. This process led to the first set of 14 UCD competencies depicted in Figure 16, shown with two example data sets.

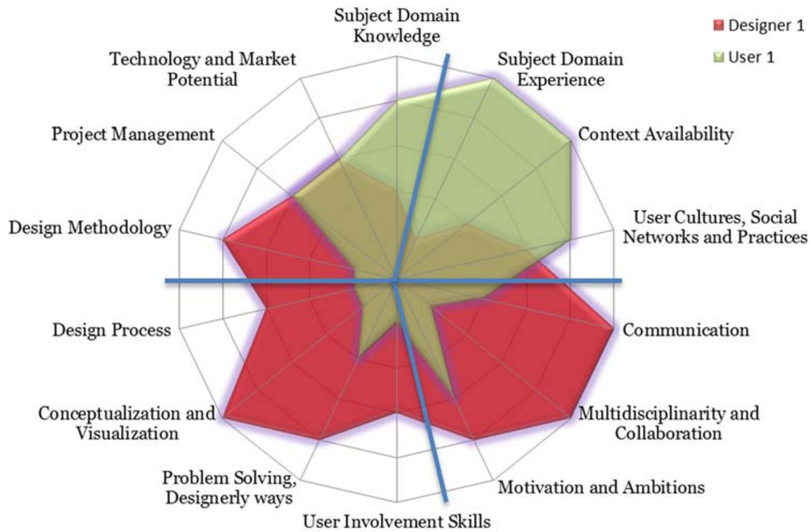


Figure 16. UCD Competencies prior description and competency level definitions.

4.5 User-Centered Design Competency Model

During the parallel definition of both the descriptions and competency levels and the definition of the final model some of the competencies were merged. It was chosen to form a single hard competency to include both design processes and methods, leading to the set of the 12 competencies in the final UCD Competency Model shown in Figure 17. This version of the visualization was also used as an example included in the validation questionnaire. Based on feedback from the pilot testers, additional smaller radar graphs for each separate role were added to make it easier to visualize the overlapping profiles.

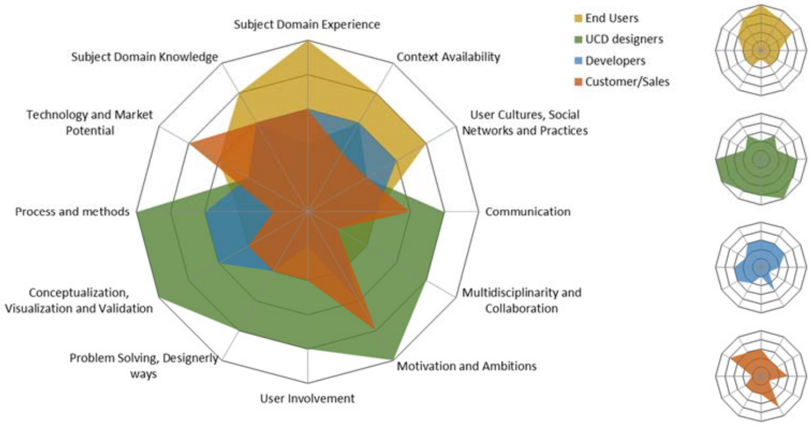


Figure 17. The UCD Competency Model.

The competencies are described in detail in chapter 6. UCD Competency Model. A brief outline of the model is presented here to support the reader's understanding of the validation process and its results that are described in the following sections. After each competency, the abbreviation that will be used for it is given in parentheses.

- Subject Domain Experience (SDE): (Tacit) knowledge, crafts and skills gained by (long) experience.
- Context Availability (CA): Access to real context of use, may be restricted or difficult to arrange.
- User Cultures, Social Networks and Practices (USP): Each user groups have their own language and culture that can be difficult to grasp and utilize in a design project.
- Communication (C): Well-functioning and democratic communications are the most time consuming and critical part of design work.
- Multidisciplinarity and Collaboration (MC): Multiple points of view increase the eventual impact of design.
- Motivation and Ambitions (MA): Intrinsic motivation, self-improvement, professional ambitions, competitive salary, and manageable workload create solid design conditions.
- User Involvement (UI): Capabilities in selecting the right users and working with them effectively.

- Problem solving and Designerly ways (PSD): Attitude and determination towards designing a change for the better and having the means to realize it in a responsible manner.

- Conceptualization, Visualization and Validation (CVV): Skills in creating product concepts, prototyping and testing.

- Process and Methods (PM): Process, management and methodological excellence and the skills to adapt them.

- Technology and Market Potential (TMP): Awareness of advances in available technologies and relevant trends at target markets.

- Subject Domain Knowledge (SDK): Knowledge and skills gained by education and certification.

4.6 Validation of the UCD Competency Model

The UCD Competency Model presented in this thesis was constructed based on literary sources through several analysis steps. The model, as a working hypothesis, was then presented to a group of UCD practitioners to be validated through a questionnaire. The primary purpose of this validation was not to collect additional source materials to build the model, but to test the proposed model for its validity and reliability, and to make such amendments to the model that were deemed necessary by the participated UCD practitioners. The following sections describe the set goals for the validation, measures taken to validate the model including the selection of the participants and the validation process.

4.6.1 Of Validity and Reliability

Term validity refers to the extent to which any measuring instrument measures what it claims to measure (Carmines and Zeller, 1979, p. 17) and that the instrument predicts something useful (Cook, 2004, p. 206). Table 3 lists the common types of validity, after which the assessment of content validity, construct validity and criterion validity within this thesis are discussed in more detail.

Table 3. Types of validity (Cook, 2004).

Faith validity	Person providing the instrument seems plausible. Validity is based on appearance and trust.
Face validity	The instrument seems plausible. It seems to ask the right questions and is acceptable to the people using it.
Content validity	The instrument seems plausible to experts. People competent in the topic have reviewed or built the used instrument.
Construct validity	The instrument measures something meaningful.
Criterion validity	The instrument predicts the chosen criterion, most often future performance.
Rational validity	Experts can make a fairly accurate estimate of the instrument's predictive validity and can suggest a test to be used.
Factorial validity	The instrument measures a phenomenon through number of separate factors.
Synthetic validity	The instrument synthesizes separate validity tests to predict a compound validity.

Content validity is based on evaluation by a group of experts competent in the topic area. In this thesis number of UCD practitioners[30] voiced their agreement or disagreement to proposed statements and reviewed the UCD Competency Model, the competency descriptions and level criteria with regards to completeness, clarity and importance.

Construct validity is assessed by examining the groupings and structure of the model through performed exploratory factor analysis and by comparing the identified competencies to the "most important success factor for a UCD project" provided by the practitioners.

Criterion validity is more difficult to measure and often requires more substantial input from a large number of people (Cook, 2004, p. 209). Criterion validity has several sub types that may be considered. Predictive validity measures if the instrument predicts who *will* be productive in the future, also referred to as follow-up validity since current measurements predict future results. Concurrent validity claims the instrument predicts who *is* more productive at the moment, also known as present-employee validity, because it uses instrument and criterion data collected at the same time. With retrospective validity the past instrument measurements are used predict present productivity, also called shelf research, due to the fact that the instrument data has been collected in advance and used to predict some new unanticipated criterion. In this thesis the criterion validity is discussed by describing a potential longitudinal study as part of the future work that may

[30] The selection criteria for these experts is discussed in the following section.

provide more concrete answers on the predictive properties of the UCD Competency Model.

Reliability refers to the consistency that a measuring procedure yields the same results on repeated trials (Carmines and Zeller, 1979, p. 11). Inter-rater reliability covers the consistency in performing the same measurement by different raters, whereas test-retest reliability tackles the consistency of taking the same measurement twice (Cook, 2004, p. 98). The internal consistency of a measurement can be evaluated using alpha coefficients, also called split half reliability. The most commonly used of these is the Cronbach's alpha, which is used in section 5.1.2 to analyze the ratings provided by the UCD practitioners. Viswesvaran, Ones and Schmidt (1996) reported a fairly poor inter-rater reliability 0,52 when supervisors assessed their employees, but also showed that peer ratings by the employees themselves to be even lower at 0,42. Rothstein (1990) showed that the length of acquaintance does increase the supervisor's inter-rater reliability to 0,60, but it takes 20 years.

4.6.2 Participant Selection Criteria

The UCD Competency Model is intended to be used by a project manager or a lead designer in a UCD project. For the validation study the selection of participants was set two ground rules:

1. More than 3 years of work experience in User-Centered Design.
2. Has participated in a project with active user involvement within the past 12 months.

These limitations were to assure that all participants are practicing UCD professionals with several projects under their belts and that they would readily have a project at hand to which they could try the proposed UCD Competency Model. The three year work experience threshold was chosen to capitalize on the linear increase of work knowledge and performance during the first five years of their careers (Schmidt et al., 1986). During the study three participants were disqualified based on the set preconditions. At this stage it was decided to focus the study to UCD practitioners in Finland using existing contact forums. Making the model and study in English was hoped to down play potential translation problems when relaying the results and to keep the door ajar for attracting larger audiences in the future. The original goal was to attract 20-40 responses to the questionnaire[31].

[31] When preparing the validation study there was no plans to perform a factor analysis, which was later found to require a substantially larger data set.

4.6.3 Validation Questionnaire Study in Practice

The validity of the UCD competency model was assured by means of an online questionnaire. The participants were approached in early March 2014 using three somewhat overlapping mediums. First the invitation was posted to the Aalto Usability Network[32] blog (Aalto Usability Network, 2013). Secondly the questionnaire was promoted by sending an invitation to the members of SIGCHI Finland[33]. Thirdly the invitation was sent as a personal email to 63 people[34] working in the UCD field in Finland. The survey targeted design professionals with a minimum of three years of work experience and who had involved users in their design projects during the last 12 months. The launch page for the questionnaire is included in the Appendix 2: UCD Competency Model Questionnaire.

Before its launch the questionnaire was piloted with three prospective designers, who first individually and independently filled in the questionnaire and then were interviewed in a facilitated walkthrough of the model and the questionnaire. This led to minor changes in both the competency and competency level descriptions, namely that the descriptions were modified to enable a better fit with the evaluation of multiple participant groups (end users, UCD designers, developers, and business owners were used as examples). Some of the questionnaire questions were simplified and a few spelling mistakes were corrected.

The questionnaire consisted of two documents:

- A PDF document that included a two-page guide explaining how to participate in the study and the UCD Competency Model.
- An Excel document that was used to fill in the competency levels for the participants of the chosen reference project, and in a separate tab (sheet) the actual questionnaire.

The guide first introduced the UCD Competency Model and its uses in identifying potential gaps in skills and competencies in user-involved design projects. The participants were asked to apply the model to one of their recent projects and to evaluate the competencies of their project's participants. The actual questionnaire asked their work experience in years, their level of

[32] Aalto Usability Network (AUN) is a LinkedIn group managed by the Strategic Usability Research Group STRATUS (STRATUS, 2013). AUN is an online community with almost four hundred registered members (394 on 3.3.2014) from roughly 250 companies or academic institutions working in the field of User-Centered Design and usability in Finland.

[33] SIGCHI Finland is the local chapter of the ACM Special Interest Group for Human-Computer, www.sigchi.fi. At the time of the questionnaire the member's mailing list included 485 recipients.

[34] Of which two bounced as unreachable.

education and current work role. The participants were asked to evaluate the overall structure of the model for both correctness and completeness, the clarity of each competency description, and the utility of the described levels of competency levels descriptions. Open-ended questions asked the participants to suggest modifications and additions to the listed competencies and to propose ways they could benefit from using such a model. The full questionnaire form is included as Appendix 2: UCD Competency Model Questionnaire.

The survey was originally promoted to AUN and SIGCHI Finland members with a short introductory blog post or an email pointing to the Questionnaire launch page, while a separate reminder was sent one week later. After the first two weeks the questionnaire had attracted a staggering two (2) responses, at which point the invitation was sent out as a personal email. During the following two weeks another 21 contributions were received. So altogether, the survey was held open for four weeks during which it received 23 responses. The last of the three pilot users was also included in the questionnaire data set because the questionnaire used was essentially the same[35] as the publicly used final version and the pilot user fulfilled the other requirements. This led to the final data set of 24 responses.

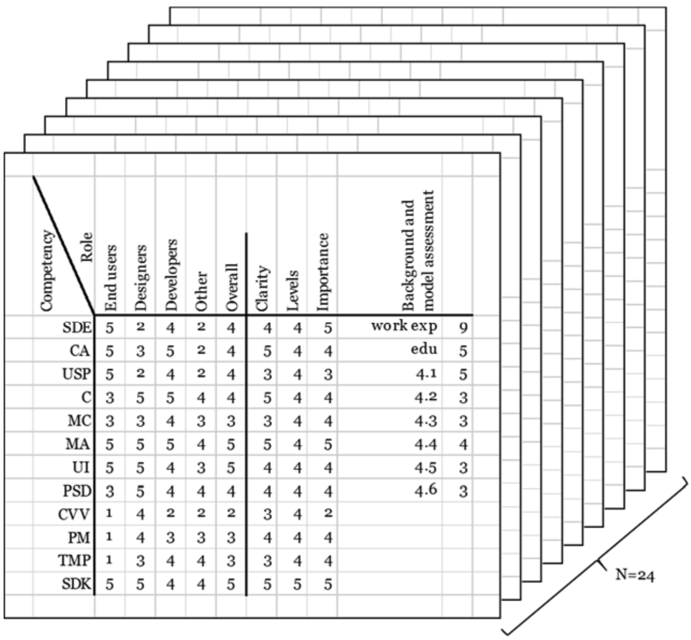
[35] Only minor typographic errors were corrected, and the overall rating for whole project team was added.

5 Analysis of the Questionnaire Data

This chapter presents both a qualitative and a quantitative analysis of the questionnaire data. It also illustrates the hypotheses guiding the analysis to validate the correctness, coverage and reliability of the UCD Competency Model. The last section outlines the suggested modification to the model.

5.1 Quantitative Analysis of the Questionnaire Data

In the questionnaire the participants applied the UCD Competency Model to one of their recent projects and evaluated the competency levels of the project participants. Additionally, they submitted brief background information about themselves (work experience in years and level of education) and evaluated the model both as a whole (questions 4.x) and each competency individually for the clarity of its description, level of discrimination, and importance. The quantitative questionnaire data are depicted in Figure 18.



Competency \ Role	End users	Designers	Developers	Other	Overall	Clarity	Levels	Importance	Background and model assessment	
SDE	5	2	4	2	4	4	4	5	work exp	9
CA	5	3	5	2	4	5	4	4	edu	5
USP	5	2	4	2	4	3	4	3	4.1	5
C	3	5	5	4	4	5	4	4	4.2	3
MC	3	3	4	3	3	3	4	4	4.3	3
MA	5	5	5	4	5	5	4	5	4.4	4
UI	5	5	4	3	5	4	4	4	4.5	3
PSD	3	5	4	4	4	4	4	4	4.6	3
CVV	1	4	2	2	2	3	4	2		
PM	1	4	3	3	3	4	4	4		
TMP	1	3	4	4	3	3	4	4		
SDK	5	5	4	4	5	5	5	5		

Figure 18. The quantitative questionnaire data (N=24).

5.1.1 Handling Missing Data

In the data set of 24 responses, one response was missing six (6) values from the "End users" role, representing 4% of the data set. Because the values are subjective ratings of other people's competencies, we may consider them as statistically random inside each variable. In this case, based on Roth (1994) and Tsikriktsis (2005), the missing data should be imputed using the Hot-Deck missing data technique (MDT). Others have suggested more complex methods such as maximum likelihood (ML) and Bayesian multiple imputation (MI) (Schafer and Graham, 2002). Hot-Deck method imputes the missing data with an actual score from a similar case in the same data set (Roth, 1994). In this analysis the median value of each competency data set for End users role was used.

5.1.2 Reliability and Discrimination of the UCD Competency Model

The internal consistency or half split reliability of the UCD Competency Model was assessed by calculating Cronbach's alpha for each of the evaluated roles and competency evaluations for clarity, level discrimination and importance (shown in Table 4). In all cases the calculations include all 12 competency ratings containing the stated N number of ratings. Cronbach's alpha is a reliability coefficient that demonstrates the internal consistency of a group. Nunnally (1978), even though Lance et al (2006) claims he is very often misquoted, states that a reliability coefficient larger than 0.70 is sufficient when using a scale in the early stages of research. As a general rule, reliability of 0.80 or higher should be used as a minimum (Carmines and Zeller, 1979) at least for well-established fields or basic research. From the Table 4 we can see that both the "Designers" and "Developers" have sufficient values, while "End Users" and "Others" are below this threshold. In many of the unveiled reference projects, the end users participation did not extend to actual co-design activities and the study could not collect sufficient background data regarding users to be able to categorize them in more precision. The "Others" group included people from marketing and sales, customer business owners, management, external consultants and researchers. It can be argued that the larger variations within these participant groups, both in the contents of their work roles and in the level of involvement in the evaluated projects, explain the lower consistency in their competency ratings.

Table 4. Cronbach's Alpha reliability coefficients (N=24, except N=22 for Others and N=21 for Overall).

Coefficient	End Users	Designers	Developers	Others	Overall	Clarity	Levels	Importance
Cronbach's Alpha	,576	,737	,771	,661	,812	,855	,876	,612

The discrimination[36] properties of the UCD Competency Model were evaluated by looking at the rating frequencies, i.e. how widely the different competency level ratings were used to rate the different competencies for different roles, including the overall rating for all roles. Rating frequencies over all respondents are shown in Table 5. The N=115 refers to the overall number of ratings provided by the participants, when three participants did not provide ratings for the overall category and two participants only defined and rated three roles.

Table 5. Frequencies of all the given competency ratings (N=115).

Level	SDE	CA	USP	C	MC	MA	UI	PSD	CVV	PM	TMP	SDK
1	14	8	9	4	9	0	16	14	20	17	7	12
2	18	26	21	18	23	9	35	28	29	25	26	15
3	28	34	38	37	38	36	33	41	34	41	41	36
4	26	17	26	42	36	38	16	23	26	32	31	34
5	29	30	21	14	9	32	15	9	6	0	10	18
Mean	3,33	3,30	3,25	3,38	3,11	3,81	2,82	2,87	2,73	2,77	3,10	3,27
Standard deviation	1,34	1,27	1,18	1,01	1,07	0,94	1,23	1,11	1,15	1,02	1,04	1,19

Table 5 highlights two competency level ratings that were never used. In order to detect potential outliers, or "observations that appear to deviate markedly from the other members of the sample" (Grubbs, 1969), the means[37] and standard deviations for the ratings for each competency were calculated and can be seen in Table 5. The standard deviation of all the means of the competencies was 0,31, while mean of the whole ratings data set was 3,14. Even though the ratings do not conform to normal distributions, only one of the competencies'

[36] In this context discrimination refers to competencies' ability to differentiate the participants to appropriate levels.
[37] Throughout this thesis statistical term mean refers to arithmetic mean calculated as the sum of the values of data points divided by the number of data points.

means, “Motivation and Ambitions” (3,81), differed significantly[38] from the overall mean having a distance of 2,11 standard deviations.

5.1.3 Validity of the UCD Competency Model

Content validity of the competencies included in the model were assessed based on the respondents’ opinions regarding the competencies and by performing an exploratory factor analysis on the competency ratings.

The subjective importance of each competency in relation to respondents’ reference projects, expressed as “Importance to your project”, was asked using a five-point scale (5: Very important, 3: Neutral, 1: Very unimportant). Means for each competency with 95% confidence values are depicted in Figure 19.

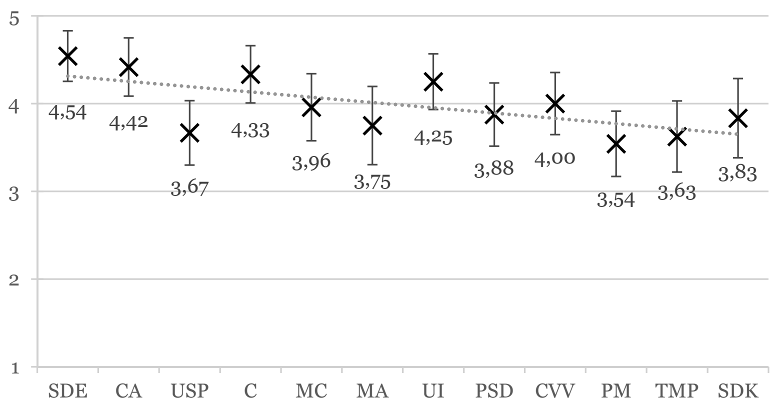


Figure 19. Importance of the competencies, linear trendline (N=24).

The slightly downwards trend in the competency scores is evident in all the evaluation metrics and can be contributed to the order-effect bias (Perreault, 1975) as all the respondents evaluated the competencies in the same order or changes in the individual evaluator behavior due to large number of consecutive evaluations. In case of re-evaluating the same subject this effect is called “regression to the mean”, which states that in successive related but not perfectly correlated tests (in our case the consecutive evaluation of 12 competencies), the following test scores “move” or regresses towards the mean or average score (Barnett et al., 2005).

The means for the clarity of the competency descriptions had a more equal trendline as shown in Figure 20. The only notable exceptions are the first competency of “Subject Domain Experience” that had a noticeably lower value

[38] Often used criteria for identifying outliers is to pick out value if its distance from the sample mean is more than two sample standard deviations (Wilcox, 2010, p. 32).

and “Motivation and Ambitions” that had a higher mean. The low value for SDE is most likely due to it being the first competency that all participants evaluated and at that time they were not yet familiar with the structure of the model and thus could not fully relate to the nature of the descriptions. The apparent higher score for MA may also relate to the relative brevity of its description.

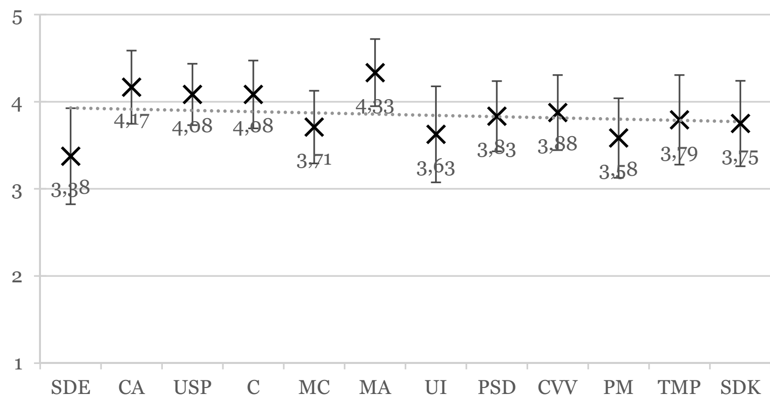


Figure 20. Clarity of competency descriptions, linear trendline (N=24).

The respondents’ were asked to rate the utility of the competency levels, i.e. to give their opinion about the competency levels’ ability to “differentiate skill levels appropriately”. Based on Figure 21 we may observe that while the mean ratings for the level’s utility are all well above neutral, two of the competencies – “Process and Methods” and “Subject Domain Knowledge” – have lower level utility ratings and may therefore require amendments to their level descriptions.

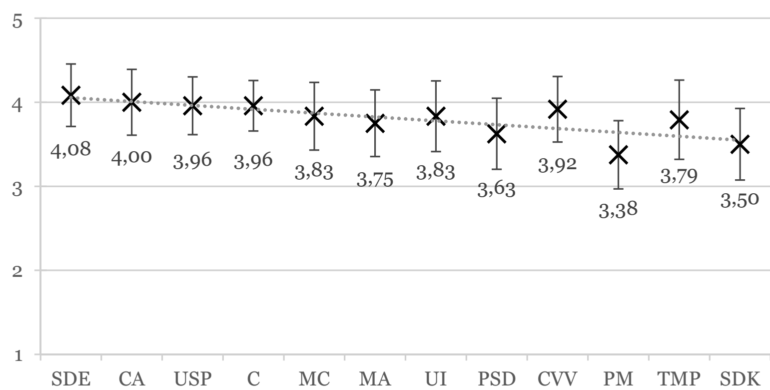


Figure 21. Utility of the competency levels, linear trendline (N=24).

The completeness of the model as a whole, or its construct validity, was studied by eliciting respondents' agreement to a statement "The UCD Competency Model includes the most relevant aspects of UCD", again using a five-point scale (5: I strongly agree, 3: Neutral, 1: I strongly disagree). The mean for the completeness of the model was 4,21, with a quite low standard deviation of 0,59. None of the respondents disagreed with the statement and only two (2) respondents gave a neutral answer, thus 22 respondents out of 24 (92%) agreed or strongly agreed that the model includes the most relevant UCD competencies (see also Table 8).

A more statistical view of the model's construct validity was reached by performing exploratory factor analysis (EFA) for the competencies of different roles. As all the respondents belonged to the "Designers" role, it was fair to assume that their responses about their own role's competencies would yield the most accurate picture of the interconnectedness of the competencies. It has been shown that people with excellent job performance provide most accurate data about the competencies needed for excellent performance (Gilbert, 2007; Kelley and Caplan, 1993).

A principal component analysis (PCA) with a Varimax (orthogonal) rotation of the 12 competency ratings for the "Designers" role was conducted based on the 24 responses. The Kaiser-Meyer-Olkin measure of sampling adequacy suggested that the sample was borderline (KMO=.499), due to the small sample size, but still potentially suitable for factoring. Bartlett's test of sphericity suggests with high statistical significance (sig. < 0,001) that the correlation matrix was not an identity matrix (containing random values) and that in that respect, performing a factor analysis is feasible.

Table 6. Rotated component matrix for "Designer" role competencies.

	Component			
	1	2	3	4
CA	,852			
SDE	,852			
USP	,812			
MA	,655			
C		,827		
MC		,701		
UI		,685		
PSD			,885	
SDK			,712	
CVV			,547	
TMP				,859
PM				,731

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
Rotation converged in 7 iterations.

For the four factors chosen with initial Eigenvalues > 1, the cumulative Eigenvalues explain 71,556% of the variance, which is very high for new non-validated questionnaire. For humanities studies, the explained cumulative variance is commonly as low as 50-60%. The often recommended value of more than 75% variance explained is questioned when the measure is used in applied psychological studies (Henson and Roberts, 2006). The rotated component matrix is shown in Table 6. Excluding factor loadings of less than 0,53, the analysis produces a simple four-factor solution including all competencies with very high component loadings. The relationships between the results of the factor analysis and the UCD Competency Model are illustrated in Figure 22 and Table 7. 2-tailed Pearson correlations for the competencies.

Factor 1 (CA + SDE + USP + MA)
Average loading ,793; variance explained 28,084%; Cronbach's alpha ,805.
Factor 1 covers all three of the context and user related competencies in addition to the Motivation and Ambitions. This factor was labeled "User strengths and motivation".

Factor 2 (C + MC + UI)
Average loading ,738; variance explained 19,846%; Cronbach's alpha ,648.
Factor 2 very clearly covers the social aspect of interpersonal collaboration and communication. This factor was labeled "Social aspects".

Factor 3 (PSD + SDK + CVV)
Average loading ,715; variance explained 14,068%; Cronbach's alpha ,613. Factor 3 includes both the designer and subject domain knowledge components and the factor was labeled "Professional knowledge and practices".

Factor 4 (TMP + PM)
Average loading ,795; variance explained 9,557%; Cronbach's alpha ,576. Factor 4 includes the hard skills relating to processes, use methodologies and technology and market insight. This factor was labeled "Design project insights".

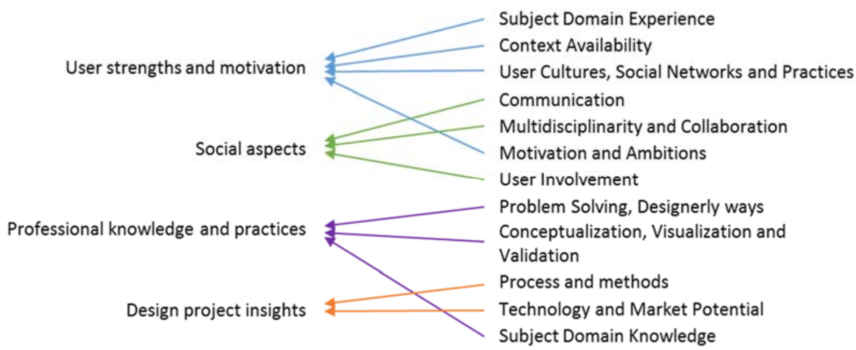


Figure 22. Factor analysis vs. UCD Competency Model

The construct validity of the competencies included in the UCD Competency Model is argued based on the following observations:

- All 12 competencies are included in the four factors extracted in the EFA with high cut-out value (,53).
- The four factors form coherent and easily describable groups with meaningful labels that are not contradictory with the categories in the model.
- All extracted factors have an average factor loading > ,7 with low deviations.

These results suggest that all of the competencies are necessary and contribute curiously equally to the whole of the model.

Table 7. 2-tailed Pearson correlations for the competencies.

	SDE	CA	USP	C	MC	MA	UI	PSD	CVV	PM	TMP	SDK
SDE	1	,646**	,618**	,130	-,230	,386	,071	,100	-,045	,048	,068	,504*
CA	,646**	1	,738**	,006	-,062	,490*	,116	,151	-,210	,306	,300	,407*
USP	,618**	,738**	1	,060	-,068	,361	,049	0,000	-,156	,177	,327	,245
C	,130	,006	,060	1	,284	-,112	,499*	,243	,409*	,398	-,038	,191
MC	-,230	-,062	-,068	,284	1	-,097	,371	-,062	,267	,220	,078	-,176
MA	,386	,490*	,361	-,112	-,097	1	,116	,197	-,022	-,047	-,017	,584**
UI	,071	,116	,049	,499*	,371	,116	1	,399	,262	,243	,213	,136
PSD	,100	,151	0,000	,243	-,062	,197	,399	1	,418*	,089	,316	,566**
CVV	-,045	-,210	-,156	,409*	,267	-,022	,262	,418*	1	-,189	-,032	,191
PM	,048	,306	,177	,398	,220	-,047	,243	,089	-,189	1	,429*	,058
TMP	,068	,300	,327	-,038	,078	-,017	,213	,316	-,032	,429*	1	,196
SDK	,504*	,407*	,245	,191	-,176	,584**	,136	,566**	,191	,058	,196	1

Significant correlations are highlighted and marked with asterisks, * $p<,05$ ** $p<,01$

5.1.4 Correlations in the Questionnaire Assessment

In the questionnaire, respondents revealed their work experience in years. Their agreed or disagreed on a five-point scale with statements about

a) does the model include most relevant UCD competencies,

b) the ease of filling in the questionnaire,

c) whether it took too long to fill in,

d) if they thought they could use it to identify gaps in their project's resources, and

e) that the model can help justify a higher degree of user involvement.

The final question in this block asked if they think they will

f) try out the model in the future.

Response frequencies for the above statements are presented in Table 8.

Table 8. Questionnaire response frequencies regarding the model and its usage (N=24).

Statement (code)	1	2	3	4	5	Mean
Has most relevant competencies (a)	0	0	2	15	7	4,21
Was easy to fill in (b)	4	11	2	4	3	2,63
Did not take too long (c)	1	4	7	10	2	3,33
Identify gaps in the resources (d)	0	4	7	10	3	3,5
Help justify user involvement (e)	4	2	7	10	1	3,08
Try the model in the future (f)	2	4	8	6	4	3,25

Pearson 2-tailed correlations were calculated for the respondents' work experience and the response frequencies shown in Table 8. Unsurprisingly, there was a highly significant correlation between willingness to use the model in the future and its ability to identify gaps in resources (r_{df}=,549, p=,005) and between willingness to use it and its helpfulness in justifying user involvement (r_{ef}=,606, p=,002). Significant correlations were also found between identifying gaps and justifying user involvement (r_{de}=,476, p=,019), and between having all the most relevant UCD elements and the ease of filling out the questionnaire (r_{ab}=,443, p=,030). These correlations indicate that designers are willing to use the model to find resource gaps, that it can help them justify more user involvement, and that people who feel the model includes the most relevant aspects of UCD also find the model easy to use[39].

The respondents' work experience in years correlated with only one other statement. It had a significant negative correlation to the model helping to identify gaps in project's resources (r=-,477, p=,018). This suggests that in this aspect, the model is best suited for design professionals with 12 years or less work experience, and that more experienced designers have other practices to assess the project's resource needs, or perhaps they do it intuitively without any explicit tools.

5.2 Qualitative Analysis of the Questionnaire Data

In the validating questionnaire the respondents were able to give free form feedback and comments on the UCD Competency Model in several ways. The following sections give a summary of their responses. In the questionnaire the respondents were asked the following direct open-ended questions:

- What are the most important success factors for a UCD project?
- What important competencies are missing? Is there a skill or knowledge that does not fit in any of the described competencies?
- Is there a competency that seems unnecessary? Should some competencies be changed or removed?
- The instructions and the questionnaire were in English, which might not be your native language. Did it make it difficult to use the model? Are there any specific terms that should be clarified?
- How could you benefit from the UCD Competency Model? How and when would you use it?

In addition the participants were given a chance to comment on each competency when they filled in the numeric ratings for the clarity of descriptions, utility of competency levels, and competency's importance to their project.

5.2.1 Overall Assessment of the UCD Competency Model

The given responses for the most important success factors for a UCD project were sorted to groups using the open-ended card sorting (Hudson, 2012). The

[39] At the same time we must note that the easiness to fill out the model was the only statement to receive a negative average (<3). The reason for this are outlined in the following chapters.

resulting groups are shown in Table 9 with the number of respondents that mentioned them and the corresponding competencies in the UCD Competency Model. All of the stated success factors could be fitted into the competencies included in the model, thus presenting evidence of the construct validity of the UCD Competency Model since two different measurements of the same competency domain are converging.

Table 9. Most important success factors for a UCD project.

Success Factor	#	**Competencies**
Access to users	14	UI, SDE, CA
Skilled (multidisciplinary) personnel	14	PSD, CVV, MC
Process and methodological skills (including implementation)	13	PM, CVV
Communication and collaboration between all stakeholders	11	C, MC, UI
Motivation and commitment	7	MA
Attitude and respect	7	PSD, UI
Organizational support including reasonable budget	4	MA, PM
UCD activities early in the project	3	PM
Defined design goals	3	PM, TMP
Following (UI) design trends	1	TMP

In the questionnaire, multiple respondents requested additional competencies to be included to the model. Most of the suggestions were unique to each respondent[40] and only a few received several mentions. Many of the suggested features had been intentionally left outside the model, because it focuses on the early stages of design practices in the concept design phases and did not seek to cover the business side of running a successful design company. Among most sought-after additions were more attention to design business in the form of understanding the business side of design, cost-benefit analysis, budgeting and marketing skills, all of which can be handled in the "Technology and Market Potential" competency. Also more details on the management of people, projects and products were wished for[41]. Suggestions regarding iterative development and agile collaboration between design and development are assumed evident in the "Process and Methods" and "Multidisciplinarity and Collaboration" competencies, respectively.

[40] Such as IT procurement, visual design, personality assessment and more interestingly work environment as an enabler for collaboration.
[41] Many of the modification requests seem to stem from confusing the distinction of a design project activity and a design process competency. This led to asking for more project management activities, when the model covers this with "Process and Methods" competency.

Some respondents argued that “Subject Domain Experience” and “Subject Domain Knowledge” could be combined or that the distinction between them should be made clearer. Likewise the allocation of “Communication” and “Collaboration” to different competencies was questioned.

Clearly however the most commented part of the model was the role of End Users. In particular it was felt difficult to apply the model or evaluate the competencies of all the participants if they were not involved in all phases of the project. Most often users did not take part to design activities directly, or developers did not have any direct contacts with users or their context of use. In a sense this is one of the main reasons why this model has been developed; everyone is assumed not to excel in all fields, but acknowledging the differences in participants’ capabilities helps to remove, or at least alleviate, problems arising from mismatched skills and knowledge asymmetries. If (or when) members of a specific role are not active in some competency area, consideration of their capabilities on that topic may prove that they should indeed partake in that particular activity.

75% of the respondents did not voice any problems with having the model in English. The remaining 25% cited some problems with terms; especially the terms “Subject Domain” and “Multidisciplinary” were seen as problematic and too “scientific”, respectively. This indicates the maturity of the UCD terminology in English as a working language.

5.2.2 Benefits and Uses for the UCD Competency Model

The respondents saw the model as a tool to assist in setting up a project team or analyzing its composition. It offered a medium to communicate and justify the necessity of including parties from multiple disciplines in a design project. The visual representation was seen especially useful for “sales presentations” when outlining the necessary capabilities to clients. Most respondents wanted to use the model at either at the beginning of a new project (immediately after a project kick-off) or when entering a new phase in a project. The preferred use was to assess progress or to track changes in resource needs. The model was also seen useful in visualizing the resources required when ramping up UCD functions in a new organization.

Concerns about the benefits and uses of the model included that the evaluation of project partners might have a negative impact on the dynamics of the teams, or that “management would have to be first educated and persuaded of potential benefits” so as not to misinterpret the resulting model. One respondent criticized that the model does not provide enough “practical guidance to pick appropriate methods". Admittedly, the model only seeks at a general level to raise the awareness of the need to be able to choose and adapt the methodology to be used and the people involved in their execution.

5.2.3 Assessment of Individual Competencies

In this section, the additional comments regarding each of the competencies are summarized as a basis for required modifications. Each section starts with a direct quote from a respondent.

Subject Domain Experience
"Defining what the domain is can be challenging."

The respondents voiced some comments regarding the difference between "Subject Domain Experience" and "Subject Domain Knowledge" and also about the fact that they are at opposite ends of the model. The distinction between competency gained by experience or by education is based on the model's separate themes for Hard Skills, which covers the theoretical knowledge contrasting Soft Skills, or expertise arising from the context of use of the target of design and its users' background. The UCD Competency Model has been constructed in a manner such that all adjacent competencies are related to each other[42], but as SDE and SDK are tightly interconnected to each other, their relation should have been explained more clearly. Several respondents pointed out a source of ambiguity, in that the term "Subject Domain" can also refer to the professional domains of the designers, developers and other stakeholders in addition to that of the designed products' or services' intended users'.

Context Availability
"Clear and good description."

The respondents were generally happy with this competency description and agreed that while in most cases users have better access to the context of use, they often lack the necessary analytical approach to assess its challenges – a skill found with designers and developers.

[42] Therefore, no matter which of the competencies is the starting point, if the model is traversed in the given order two related topics will be separated by all the rest.

User Cultures, Social Networks and Practices

"Isn't the point of [user] research to find this out?"

It was correctly pointed out that this competency overlaps somewhat with the "Subject Domain Experience" of a user group's specific tacit knowledge, but on a personal level. Some practices are so deeply rooted to the professions that they are indistinguishable from personal experiences.

Communication

"Very important skill."

The question with "Communication" competency was: with whom? Different user groups communicate in a different manner with each other, and if the users are not tightly coupled in a co-design process they may not feel the need to be active in their dealings with the designers.

Multidisciplinarity and Collaboration

"Multi-disciplanary [sic] is probably the corner stone of getting anything done."

With this competency the respondents clearly wanted to score the whole project team as one entity instead of each role (End Users, Designers, Developers, and Others) separately. Most project teams are so small that having designers with more three different disciplines is very rare.

Motivation and Ambitions

"There were some conflicting aspects to the definition [dedicated time vs. personal interests]."

Motivation was described as an individual not a group attribute, and also motivation changes during a project. In consultancy companies designers are assigned to projects based on whoever is available, so the motivation is not for specific projects but towards the profession in general. This guarantees the availability of personnel for a project, but does not necessary promote or demand more personal interest.

User Involvement
"Same as above."[43]

The "User Involvement" competency was seen difficult to grade for End Users. Also it was argued that its grading would make more sense for the project team or all of its individual members as a whole rather than for each role separately.

Problem Solving, Designerly ways
"[Not] everyone in the project team should act as designer[s]."

Respondents were hesitant in scoring "End Users" when they did not take part in design tasks. Visual/interaction design was considered out-of-scope for users and developers, while features and functional requirements were often the result of a collaborative effort between all groups. Two respondents argued against the role of documentation in the level definitions[44].

Conceptualization, Visualization and Validation
"Iterativity should be highlighted in this context."

Respondents disliked the unintentional innuendo in the level descriptions that highly visual presentations are better than low fidelity prototypes or text narratives. Also the term "highly visual marketing packages" was frowned upon. The iterative nature of the activities covered in this competency should be emphasized.

Process and methods
"Do methods refer to UCD methods or methods in general?"

It seemed unclear to the respondents that this competency covered processes and methods for both design and project management. A request for stronger focus on agile methods was voiced.

Technology and Market Potential
"Really a must, if [one] wants to produce something that is ahead or in front of the curve."

Respondents would have liked to score this competency separately for technology potential and market potential. It was pointed out that the general public and technology companies may value the same technology trends in a very different way.

[43] Not relevant for end users [who] were not active in the design phase (pointing to the "Multidisciplinarity and Collaboration" competency).
[44] Contrary to Crabtree et al. (1997) claiming that design engineers use 23,5% of their time working on documentation.

Subject Domain Knowledge
"Why this is separate from Subject Domain Experience?"

This drew comments similar to those for "Subject Domain Experience". What is the domain and how do these competencies differ from each other? In some cases formal training is irrelevant, if domain knowledge is primarily acquired in a master and apprentice manner[45].

5.3 Modifications to the UCD Competency Model

This section counts the modifications that were made to the final version of the UCD Competency Model based on the validation questionnaire. Most of the suggested changes to the model required more precise wordings of the competency and competency level descriptions. The following sections outline the most substantial additions and changes to the model. The modified parts in the model introduced in the following chapter are marked with underline, while the initial version used for the validation questionnaire is included as Appendix 3: UCD Competency Model, Initial Version Used in the Validation.

5.3.1 Modifications to the Competency Descriptions

Some of the competencies are shared by the entire project group and making individual ratings for different roles can be challenging. For this reason the guidance to apply the model was changed to suggest using only the overall grade of the whole project team for some of the competencies, while still allowing the ability to assign separate scores if a distinction between project participants can be made. Adding yet another radar graph to the visualization would make it even more difficult to read, so the choice was made to change the descriptions to propose using the same score for all roles. The *collective competencies* that are by nature characteristic of the entire project team are "Communication", "Multidisciplinarity and Collaboration", and "User Involvement".

Subject Domain was explicitly defined as the domain of expertise of the target users of the design project. For example, if in designing a better accountancy system the subject domain is accounting or if one is trying to make a new vocational counselling portal (as was the case in the project described in Publication III), the subject domain might be vocational career planning or online self-improvement.

[45] See (Beyer and Holtzblatt, 1998), one respondent gave an example of a Polynesian aboriginal as a master diver without formal training.

5.3.2 Modifications to the Competency Level Descriptions

The “Process and Methods” competency did not receive any level 5 ratings even though more than half of the designers had over ten years of work experience and graduate degrees in design or engineering. Based on a few informal comments surrounding the validation questionnaire, this can partially be explained by respondents’ false modesty towards their own competence, also known as the Dunning-Kruger effect (Kruger and Dunning, 1999). It states that due to the connection between competence and metacognitive skills, the incompetent overestimate their competence[46] while those competent underestimate their ability[47] as much as 20% below their actual performance. This competency had a lower level utility rating (3,38) by the respondents. Kruger and Dunning (1999) also showed that training in the competence in question also increases the metacognitive skills that are necessary to accurately assess its existence in others and themselves. This would imply that recurring use of the UCD Competency Model will correct this bias, and therefore the competency descriptions were left unchanged.

[46] People who do not know, do not know that they do not know.
[47] People who know also know that they do not know everything.

6 UCD Competency Model

This chapter gives detailed instructions on how to apply the UCD Competency Model and then a detailed description of the model itself. The additions and modification to the initial version used in the validation are marked with underline[48].

The UCD Competency Model outlines the most important competencies necessary for a successful user-involved design project. It visualizes the strengths that users, designers and other stakeholders can bring to the table when together working on a design project. The primary uses for the model are to identify gaps in a design team's skills and competencies so that additional resources, people or training, can be applied if necessary, and to further motivate increased stakeholder participation to the design process.

The UCD Competency Model for a project is created by filling in the competency ratings in a spreadsheet, and then using this information to reflect on the stakeholders' competency asymmetries by examining the graphical profiles that are drawn for each participant.

6.1 Contents of the UCD Competency Model

In the UCD Competency Model, the competencies are described in a consistent manner. Each competency has an expressive title and a short description. The model defines three levels of expertise for each competency and includes remarks regarding any necessary variations between different roles within a design team. The levels are designated as low (1), medium (3) and high (5) on a scale from 1 to 5. Values 2 and 4 provide necessary additional flexibility to rate any given competency in-between the three key levels. The levels are defined so that all participants meet at least the low level (can operate in a task under guidance), the medium level is sufficient to independently apply previously learnt practices to common tasks and the high level is for superior performers capable of adopting existing and inventing new practices. The level descriptions

[48] Excluding minor corrections to wording or grammar.

are cumulative so that, for example, level 3 includes the attributes at level 1, while level 5 includes the contents of both level 3 and level 1.

Each competency also presents a rationale section that provides additional links to literature or Publications extending the views presented in chapters 2 and 3. These rationale sections are not intended to be included in the model when it is distributed to practitioners[49] and likewise they were not included in the UCD Competency Model Questionnaire during its validation.

The order in which the competences are described is based on Figure 17 (see page 39). It starts from the top and then proceeds clockwise throughout the four dimensions of User Strengths, Soft Skills, Designer Strengths, and Hard Skills. The abbreviations used for the competencies are shown in parentheses after their titles and they are used in tables and figures when necessary.

6.1.1 Filling in the UCD Competency Model

The process begins with selecting a design project that is about to begin[50] or a past project in order to retrospectively analyze it. Before starting the scoring, consider the project's (potential) participants and group them by discipline or role. Most often these roles will include UCD/UX designers, participating end users, development engineers, customer representatives or business owners, and so on. This grouping is necessary in order to decrease the impossibly large amount of scoring necessary if every participant were evaluated individually. Depending on the complexity of the project, three to five groups can be used effectively. In very small projects, individual groups may include only a few people or even just a single person.

After defining the groups, the practitioner (the person building the model) evaluates the skills, knowledge and abilities of the groups using the 12 competencies on a five-point scale. At this point the practitioner should read through each competency and competency level description and fill in a score for each group. In case of larger project teams it might be feasible to have several project managers or lead designers to fill in the model to gain better inter-rater reliability by comparing and merging their individual assessments in using the UCD Competency Model to plan and ponder their project teams.

Although typically all stakeholders in a project do not work on all aspects of UCD, a score should be based on his or her *potential* in each competency regardless of whether he or she is currently planned to participate in a certain

[49] Whom are generally looking for a practical "Getting Started" guide for considering competencies in their User-Centered Design projects rather than scientific justification.
[50] Or in the beginning of a new phase or iteration in the project.

activity (or had participated in a task, in the case of a past project). Some of the competencies for some of the groups must be considered on a hypothesis that "If a group X had to perform specific tasks, what level of competency would they demonstrate?"

It should also be noted that some of the competencies are by nature characteristic of the entire project team and they can be rated either using a single value for all participants or separate values if a distinction can be made. These *collective competencies* are "Communication", "Multidisciplinarity and Collaboration", and "User Involvement".

6.1.2 Interpreting the UCD Competency Model

The UCD Competency Model is a broad competency model targeting project team level competencies of all the participants in a UCD project. As projects and their stakeholders come in all shapes and sizes, the ultimate burden of making sense of the results is placed upon the person using the model. This includes the decision on when to use or update the model, with the three options being: at the start of a project, during the project when transitioning to the next phase, or between design iterations[51]. The participant visual profiles that are generated, visualized as radar graphs, are layered semi-transparently on top of each other so that the differences in competency levels can be compared in much the same manner as inspecting see-through tracings on a light table. This makes it easier to locate gaps in competencies, provides guidance on the preferred composition of the team, and helps prioritize ownership and expertise within tasks.

While it is not possible to suggest a universal minimum level for any of the competencies, the data from the study's 24 projects does suggest that for all competencies, the project teams seem to reach an average scores of 3.5 or higher. For each competency the highest values should be at level four or five. If a certain project phase's participants do not reach the upper values, the remedies include realigning current personnel, committing additional persons to these tasks, or updating the team's competencies by training. Especially the early stage design activities can be super-charged with a well-timed injection of new methods or knowledge that can be relatively fast and easy to adopt. The severity of these corrective measures must be decided on a case by case basis depending on the project and its phase.

[51] Publication IV and (Nieminen, 2006, p. 21) suggests not jumping back to earlier phases in the design process, but instead realigning the project assessment as the new project commitment and iterating the whole process. This way the order of the phases (research, analysis, concept creation and validation) remains unchanged. Don Norman (Redenbaugh et al., 2014) recently referred to this as TOM (Observe, Make, Test).

6.2 User Strengths

User Strengths competencies are characterized by including items, actors and concepts belonging to the users' immediate surroundings. These include experiential knowledge gained from work tasks or extended use, context of use as a resource for design, and embedded user cultures, networks and practices.

6.2.1 Subject Domain Experience (SDE)

Subject Domain Experience refers to the specialized skills and knowledge that can only be gained through personal experience Subject Domain" refers to the domain of expertise of the target users of the design project. It includes all those not-by-the-book, non-traditional work practices that eventually emerge in every field, or the snowboarding tricks learned by a serious hobbyist. Whether they include appropriated use of tools, adapted work practices, or hidden shortcuts through company regulations, this valuable expertise is often hidden from view as tacit knowledge embedded with the most experienced members of the subject domain. What makes the utilization of this competency problematic is that its availability may be hidden: if you do not have it you may never know of its existence, and if you have it you might not be able to tell anyone of its existence due to its tacit nature.

Please note: The last competency in this model is Subject Domain Knowledge, which includes knowledge gained by formal education or training and certification aspects of the users' subject domain.

Key concepts: subject domain experience, (work) practices, tacit knowledge.

Competency levels

Table 10. Competency levels for Subject Domain Experience.

Competency level	Description	Remarks
Low **1**	No relevant subject domain history. Newly appointed employee with less than six months of work experience, often covering only a single entry level job role (determined by education and subject domain). Novice user of a product or service, recently started hobbyist.	In the role of a Designer this is one of his or her first projects in this subject domain.
Medium **3**	Less than three years of relevant experience. May have previous experience at other (entry level) job role and has understanding of both the practical tasks and overall processes. Hobbyist with good or average skills of the subject domain.	
High **5**	More than five years of relevant work experience from several job roles. Includes opportunities for everyday problem solving and work practice development. May provide on-the-job training to new workers and have some management or leadership experience. Committed semi-pro hobbyist with excellent skills, driven to develop her skills on the subject matter. Is considered as an authority or expert of her field.	For jobs of greater complexity and/or autonomy and discretion the experience requirement for the highest level may be 10 years or more.

Rationale

Measuring work experience based on seniority or tenure, or in years spent on the job, is an often-used approach (Quiñones et al., 1995) with well-defined legal foundations for recruitment and rewarding practices (Gordon and Johnson, 1982). Schmidt, Hunter and Outerbridge (1986) conducted a study using path analysis on the impact of job experience to acquisition of job knowledge and performance. Their studies indicate that job experience has a strong correlation to accumulation of job knowledge[52] and thereby a strong indirect effect on

[52] This is supported by Sternberg and Frensch (1992): experienced surgeon extracts more knowledge when observing a new medical procedure than a non-experienced medical student. Similar results were found by Atman et al. regarding different level engineering students (Atman et al., 1999) and when comparing student to experienced practitioners.

performance. For jobs at intermediate levels of complexity they claim that job experience is most influential during the first five years, while with jobs of greater complexity and/or autonomy and discretion the positive effect of job experience may extend beyond five years. Other studies show that acquiring expert performance requires at least ten years of deliberate practice (Ericsson et al., 1993) or more precisely 10 000 hours of practice to master any trait regardless of the subject domain (Gladwell, 2008). Quiñones, Ford and Teachout (1995) add that work experience is not only about time spent in the job, but also the number of times the relevant tasks have been performed.

When the subject domain relevant to the design is not work-related, for instance an extreme sport such as scuba diving or skydiving, the user is an enthusiast of that field who starts as a novice hobbyist and can through acquired experience become an expert of her subject area and a potential lead user (von Hippel, 1986).

The value of extended work experience is also illustrated in Publications V and VI, where the employees of one project partner, working in manufacturing as welders and metal workers, contributed to the redesign of an Enterprise Resource Planning (ERP) system. Their participation in the idea generation phase produced feature requests well-grounded in the practicalities of everyday work, even though the welders themselves directly used only a very small portion of the system that was developed. Similarly, years of experience in acquiring exhibition pieces for popularizing science, done by the designers and exhibition managers at a science center (depicted in Publication IV), expedited the iterative design process by scoping and focusing the design on those areas that most often pose difficulties during exhibit construction. Both of these examples indicate the necessity to include not only the actual end-users of a design but also the people above and below them – in these examples, the people managing a science fair, and the metal workers realizing the plans devised with the ERP, respectively.

6.2.2 Context Availability (CA)

Context of use is an important factor in User-Centered Design. Use of products or services is often situated and tightly coupled with the time, location and other contextual factors surrounding the actual use. Understanding the context is necessary when scoping new design projects, during user research, and when evaluating the design. The access to real context may be hindered by several factors such as geographically remote locations (global design project), security (construction sites or factories), privacy and confidentiality issues (homes, hospitals or banks), or irregular occurrence of use (emergency services). In all cases some of the users have the context available to them even though the designers may only have very limited access to it. Unfortunately these privileged users are not always available.

Key concepts: access to actual context of use, environment or system.

Competency levels

Table 11. Competency levels for Context Availability.

Competency level	Description	Remarks
Low **1**	Group member has no access to the real context of use. Contextual facts must be attained in retrospect via second hand reports, logs or media recordings.	Utility of user involvement is severely compromised.
Medium **3**	Limited or supervised access to context of use. The context is available upon arrangement or on predetermined occasions. Normal tasks can easily be observed, but irregular interruptions are missed.	Applies if unobserved events can be afterwards reproduced for further study.
High **5**	Full access to context of work. Either the context has unrestricted access e.g. a public place or the participant can gain access rights by agreement, certification or collaboration. In case of random events or otherwise temporally challenging tasks the participant is either the first-tier actor onsite or can be invited to participate at a moment's notice.	Applies if unobserved events can be afterwards accurately reproduced **in their real context of use** for further study.

Rationale

The necessity of Context Availability is evident in UCD based on its well-established standards (ISO - International Organization for Standardization, 2010a) and widely used methodological approaches, such as the Contextual Design (Beyer and Holtzblatt, 1998). The elusive nature of context was particularly visible during the study of mobile knowledge workers reported in Publication I. The sporadic nature of the mobile, even nomadic, workforce was tackled with the development and use of an accurate self-documenting method called photograph probes. Under the instruction to take pictures of "Spaces, equipment, and activities relating to my work", this method provided the researchers a rich telling of users' daily tasks including glimpses into more difficult to capture environments while working at home, public places, customer premises, or in transit. The photographs and subsequent debriefing interviews unearthed previously invisible challenges relating to appropriate and safe use of ICT tools, plurality of working environments, and even obvious blind spots in corporate security policies.

Publication III describes a geographically challenged design process that included usability testing in several European countries and in different languages. The meaningful recruitment and involvement of local users was made possible only by utilizing the partners present at the location and allowing them to mediate the steps using their own language and customs.

Publication VII and VIII describe another way to tackle context availability by reproducing the context of use for design; see the earlier discussion in section 2.2.5.

6.2.3 User cultures, Social networks and Practices (USP)

Understanding the future users of a product or a service can be difficult to an outside observer, especially if the user group exhibit behavior or language (either unknown terminology or foreign language) only accessible to a member of that closely knit community. Common practices and naming of items are often products of informal social networks and can differ in ways that are beyond recognition to others. An inside informant is necessary to make sense of these types of user cultures. Examples of such practices and their names include "one ring", a teenager slang term for calling a friend and letting the phone ring just once before hanging up, or "ten-four", when a police officer acknowledges a message as received and understood. The same cultural interpretations are necessary when designing for users and contexts of other cultures.

Key concepts: Subject domain terminology (Jargon), special user groups, cultural differences.

Competency levels

Table 12. Competency levels for User cultures, Social networks and Practices.

Competency level	Description	Remarks
Low **1**	Group member has no prior knowledge of the target sub-culture or its practices. Members of the relevant practices are not directly involved in the design process. The available information is based on literature, third party informants, common knowledge or hearsay.	Design based on American television shows or stereotypical caricatures of users.
Medium **3**	Some prior experience with the target culture's practices and has direct contacts to the members of the practice. Can on demand interact with the users/practitioners during the design process.	If designing medical equipment, the design team can consult medical doctors to demonstrate the interactions among the practitioners.
High **5**	Group includes members of the target sub-culture. Relevant practices are internal to the group and members may invite even wider audiences on demand.	For example the group includes (employs) medical doctors. A designer can have medical training and experience, or a doctor has become competent in design practices.

Rationale

Terminology and jargon that are used in work or design, creating reliance on common language and vocabulary, can be considered as a second language for collaboration. In the context of language education and proficiency it is divided into two types based on the primary use of the language. Basic interpersonal communicative skills (BICS) refer to conversational fluency in normal social situations, while cognitive academic language proficiency (CALP) refers to a person's ability to understand and express abstract concepts and ideas outside their immediate contextual framework (Cummins, 2008). Whereas BICS is acquired naturally, CALP is the direct result of formal schooling. In reference to use of language in user communities, these become more mixed as often the context of use is social even though the content is subject matter driven. Some linguistic skills are presumed universal, while individual differences appear to be unrelated to cognitive or academic skills such as oral fluency (Cummins, 1980).

Acknowledging cultural differences becomes especially relevant when a product is designed for users speaking several languages, or when the design collaboration process includes people of different cultures and languages[53]. One example of such a situation is the cross-European usability engineering project described in Publication III. Cultural differences manifest themselves in "values and attitudes, social relationships, communication styles, visual preferences, and cognitive styles" and they also affects the methodology available to the design task (Plocher et al., 2012, p. 162). Language influences thinking and can affect people's impressions and memories of other individuals, changing them to match cultural stereotypes (Hoffman et al., 1986).

6.3 Soft Skills

Soft Skills competencies include those design and team work traits that are heavily influenced by personal aptitudes such as communication and collaboration skills, multidisciplinary attitude and motivation. Of course these skills can be honed by training, but they are mainly based on intrinsic abilities.

6.3.1 Communication (C)

Communication is claimed to be the most time consuming and essential part of design work. Working communication practices enables effective team work and it opens the design process to information sharing among all participating stakeholders. Communication skills enable the delivery of an understandable and relevant message to others, but also requires willingness to participate in a dialog to form common ground when opinions differ. All participants should feel empowered and have the means to initiate communication at any given time. Part of the challenge is to pass through the communication barriers set by multidisciplinary teams and various user cultures or languages.

Collective Competency: This competency should be evaluated for the entire project team as a whole, and you may use the overall grade for all roles. If a distinction between project participants can be made then feel free to grade them separately.

Key concepts: Communication skills, low threshold to initiate dialog.

[53] Clarke (1991) paying homage to Anselm Strauss' concept of "social worlds or arenas" describes the various communities formed and united by either geographic location (areal organizational fields) or functional domain (functional field models).

Competency levels

Table 13. Competency levels for Communication.

Competency level	Description	Remarks
Low **1**	Group members are not engaged in direct dialog with other participants and all information exchange is handled by prepared documents or facts are based on assumption or hearsay.	This is often the case if participation is management driven or if the design team is fragmented either due to geography or lack of social connections.
Medium **3**	Key participants in the design process have been identified and there are communication channels available to reach them. Dialogs are still most often initiated either outwards from group members or towards group members.	
High **5**	All parties are actively and continuously participating in dialogs on a personal level. Group members feel confident they can reach out to any other participants, and similarly are available and open for all contacts.	Well-functioning, democratic and sincerely bidirectional communications practices.

Rationale

Good communication skills are essential for effective design and engineering work (Darling and Dannels, 2003). White and Leifer (1986) claim that in engineering, intra-team communication is the most important success factor during the strategic planning phase. Other studies show that engineers spend up to 80% of their work time communicating information (Pinelli et al., 1995). Communication can be seen as a separate competence and its effect as an interpersonal soft skill that creates trust between participants and relieves anxiety (Duffy et al., 2004).

In the context of interaction designers, Arvola and Artman (2008) claim that that simply having technical skills to create original and creative products must be augmented with learning the practices of design communication “by mastering the articulation of envisioned future use”.

6.3.2 Multidisciplinarity and Collaboration (MC)

Multidisciplinary approach is one of the cornerstones of User-Centered Design. Understanding the human aspects of a complex design task requires expertise from several fields. Multiple points of view increase the impact of the design.

Connecting people of different backgrounds requires willingness to collaborate and venture outside the comfort zone of one's own expertise.

Collective Competency: This competency should be evaluated for the entire project team as a whole, and you may use the overall grade for all roles. If a distinction between project participants can be made then feel free to grade them separately.

Key concepts: Multidisciplinarity, collaboration.

Competency levels

Table 14. Competency levels for Multidisciplinarity and Collaboration.

Competency level	Description	Remarks
Low **1**	Group is solely populated by experts of a single discipline, for instance the engineers of the subject field domain.	No established connections to tap into wider expertise from other fields.
Medium **3**	A very few group members can access and utilize other disciplines in a trans-disciplinary manner, i.e. specialties are mixed and generalized on need to know basis. The number of different disciplines is three or less.	For instance, a single UCD specialist or consultant participates in the design process with limited support from known experts from other fields, often among her colleagues.
High **5**	Group has a permanent attendance from specialists from three or more relevant disciplines. Adequate tools and resources for collaboration are budgeted for all project phases.	The multidisciplinary UCD approach is built-in to the project, including a pre-approved budget for unanticipated tasks.

Rationale

Multidisciplinary approach is a key factor for the impact and effectiveness of a UCD project, even though practitioners do not have a clear definition for it (Vredenburg et al., 2002). The terms multidisciplinary, interdisciplinary and transdisciplinary are often used as synonyms due to the lack of clear definitions (Choi and Pak, 2006). Multidisciplinary refers to collaboration among different fields in an additive rather than integrative manner, where the individual disciplines are not changed and their relationship is transitory, whereas interdisciplinary means the synthesis of two or more disciplines forming a new entity (Klein, 1990, pp. 56, 66). Transdisciplinary on the other hand takes a holistic approach to combining and expanding specialists' knowledge and roles to the other disciplines (Choi and Pak, 2006).

A multidisciplinary team has the advantage of wielding the separate expertise of several fields, with the added burden of connecting the separate bodies of knowledge through collaboration. The interdisciplinary approach forms a new integrated field, while a transdisciplinary team mixes their individual bodies of knowledge and skills to learn and adapt from each other.

Publication III describes a usability testing case with the transdisciplinary approach where in this instance, Austrian vocational counsellors facilitated a usability evaluation of a web site based on a prepared manual preceded by a one-day crash course in usability testing. At a later stage the same vocational counselors exhibited multidisciplinarity when reflecting on the results of the tests to improve the design.

Designers are increasingly working in a socially collaborative manner (40% of their total working hours), even in their technical tasks of which 25% were performed in collaboration (Robinson, 2012). Contrary to common assumptions, more senior design engineers do not spend less time asking questions and more time answering questions than their junior colleagues (Robinson, 2010).

6.3.3 Motivation and Ambitions (MA)

Motivation of the participants in a design project is crucial to its success. Motivation can arise from personal interest towards the subject of the project, satisfaction gained from good utilization of one's abilities, or potential to learn new things (and thus, for instance, gain career advantage through self-improvement). Unfortunately participation in a project is not always "voluntary". Additional duties are often simply piled on top of current tasks, and sometimes it is not clear to the person why she is chosen for a certain project.

Key concepts: Motivation, willingness, learning, ambition.

Competency levels

Table 15. Competency levels for Motivation and Ambitions.

Competency level	Description	Remarks
Low **1**	Group members are forced to join a design project on a moment's notice with no or cursory relevance to their current assignments. The participation is "in addition to other duties" with no removal of other tasks or additional compensation. With non-work related topics the members are picked at random and are not given a real opportunity to decline to participate (e.g. opinion polls at street corners).	From the perspective of the designers this is a project where their personal strengths are not utilized properly. They participate as a generic UCD person in a generic project, sometimes on a temporary basis. No personal attachment to the subject matter.
Medium **3**	The project is assigned with group members knowledgeable on the relevant fields who are willing to share their expertise. The users may have some doubts on the project or its UCD approach. Members agree to participate in addition to other duties. Non-work related users are approached in advance about their participation, and their participation in the study/project is conditional on their suitability and demonstrated interest.	Designers' motivation is based on professional skill. Well-tried practices are performed adequately.
High **5**	Participants are chosen among those group members actively seeking to join the project. The task aligns well within their current duties and professional and personal interests. Participation is enabled by additional compensation and/or other duties are removed or scaled down to make time for the project and to legitimize it inside the organization. A user sees advantage in learning new skills and is convinced him or her can make a difference by participating.	For instance, a designer is driven by the subject matter or the methodology that is used to immerse his or herself in the project. The designer strives to improve and develop current practices and learn from the project. Motivation carries the designer over the not-too-heavy work load.

Rationale

In "A theory of human motivation" Maslow (1943) describes man as "a perpetually wanting animal" who seeks to satisfy hierarchically arranged basic needs of physiological, safety, love, esteem, and self-actualization. Most evident in group work settings are the last two, involving self-esteem, sense of achievement, respect and prestige, or a need to do what one is competent in.

Motivation is often divided to intrinsic motivation, where something is done because it is interesting or enjoyable, and extrinsic motivation, where an act is propelled by the separate outcome it leads to. Intrinsic motivation is claimed to promote high-quality learning and creativity. (Ryan and Deci, 2000a) Intrinsic motivation is critical in jobs with high task ambiguity and with difficult to measure concepts such as quality of work (Kreps, 1997). Psychologists, sociologists and human resource management experts emphasize the role of intrinsic motivation in social interactions. They caution that "explicit incentives may, in the long run, undermine the person's confidence in their own abilities or in the value of the rewarded task." (Bénabou and Tirole, 2003) The self-determination theory states that social-contextual events (for instance feedback, communications or rewards) that cause feelings of competence during an action enhance intrinsic motivation, but only if accompanied by a sense of autonomy i.e. that the behavior is self-determined (Ryan and Deci, 2000b).

Kouprie and Sleeswijk Visser (2009) found that designers are motivated by their personal connection with the users (empathy), their own emotional states and commitment to the project. They also claim that the willingness of an individual designer to empathize with users can spread to the whole team through discussions.

6.4 Designer Strengths

Designer Strengths competencies are characterized by the UCD's core values: user involvement, designerly ways of solving design problems, and professional skills in defining, visualizing and testing new solutions.

6.4.1 User Involvement (UI)

Working with end users and other stakeholders is one of the core principles of UCD. User involvement is about identifying and engaging the right people at the right time in the design process, and having the right interaction methods to foster their participation and creativity. Selecting suitable users is dependent on the phase of the process, such as idea generation, development or testing, with variable requirements or opportunities for merging the users' and designers' skills. The interaction repertoire that can be utilized includes the level of personal interaction, number of users, temporal extent of the involvement, and the social and professional competencies of the people working with the users.

<u>Collective Competency: This competency should be evaluated for the entire project team as a whole, and you may use the overall grade for all roles. If a distinction between project participants can be made then feel free to grade them separately.</u>

Key concepts: User involvement skills, user selection, interaction with users, being a user.

Competency levels

Table 16. Competency levels for User Involvement.

Competency level	Description	Remarks
Low **1**	Only a few users are involved and their selection is based solely on availability or they are picked by management. A group member may feel powerless to influence the selection. Group members have no training and limited experience in facilitation or group work. May lack relevant social skills for effective collaboration.	
Medium **3**	An adequate number of users is selected using valid criteria from a large enough population. The participants responsible for interaction with the users are moderately experienced interviewers and facilitators. Users have sufficient group work skills.	Often UCD consultancies maintain their own user and expert pools, or outsource the recruiting to other companies.
High **5**	The available user population is large enough to enable tailoring the user selection criteria and methods for a specific project. The facilitators have good people skills and several years of experience in collaborative design practices. Participants have received or will receive training in interacting with people[54]. Well-defined facilitation practices and collaboration methods are used.	

Rationale

Lettl (2007) defines user involvement competence in two dimensions: Firstly a subjective component that considers knowledge about the characteristics of users[55], and secondly the interaction that describes how user involvement takes place. He further claims that the benefits from user involvement include acquisition of radical innovation, faster development times at a lower cost,

[54] These include important skills such as daring to approach people and the ability and willingness to really listen to others.

[55] Lettl discusses what he calls Inventive users that are close but not quite the same as von Hippel's lead users (von Hippel, 1986).

better product performance, increased use friendliness, and improvement to the quality of the company's design decisions. From a corporate perspective, user involvement needs to be integrated in all areas of corporate life as part of an organizational strategy (Damodaran, 1996), while from a user perspective the appropriate level of user involvement before and after a collaborative activity needs to be managed. The use of different work packages is suggested in order to widen the temporal extent of user involvement in creative problem solving processes (van der Lugt and Sleeswijk Visser, 2005).

Finding appropriate users to be involved in co-design activities is often limited by the specific subject domain to a select few employees at the participating companies (Publication V and VI). Sometimes remote involvement is an acceptable alternative to reach wider audiences, thus making the internet[56] and social media an excellent recruitment channel (Ståhlbröst et al., 2013) or participation medium for distributed innovation and co-design (Näkki and Koskela-Huotari, 2012).

6.4.2 Problem Solving, Designerly ways (PSD)

User-Centered Design is essentially an attempt to understand users and propose new solutions to improve their lives. Creating new products and services requires problem solving and thinking "outside the box". An essential part of design is to look at things from different perspectives or from a distance. Design as a practice is characterized by an attitude and a determination to introduce change for the better, and have the necessary means to realize it, in a responsible manner.

Key concepts: Creative problem solving, design thinking, design ethics.

[56] While often useful internet recruitment has its flaws; Koo and skinner (2005) report a 0,24 % success ratio (5 out of 2109) when soliciting study participants using email.

Competency levels

Table 17. Competency levels for Problem Solving, Designerly ways.

Competency level	Description	Remarks
Low **1**	No experience in creative problem solving using any established method or practice. Problem solving happens by freeform brainstorming without any facilitation. Proposed changes are often incremental and the documentation of design solutions and design decisions is done in an ad hoc manner.	Design decisions are given "as is" and tracing them back to original data is difficult.
Medium **3**	A few basic methods for problem solving and analytical thinking are used based on earlier experiences. Decisions are documented mostly as functional statements or user requirements.	Traceability of design decisions can be obtained from appropriate documentation.
High **5**	A group member can select the best suited problem solving methods for the participating team. They make use of some defined analytical framework to make sure the design problems are reviewed from all relevant perspectives. Design decisions and their future implications can be justified based on a well-structured and unified understanding that reaches beyond the original problem or design space.	The use of multiple or non-conventional methods and variable points of view can promote the emergence of radical innovations i.e. solutions that are not evidently available and may be disruptive to existing solutions.

Rationale

User-Centered design is founded on absorbing knowledge about users and creating understanding of their lives in order to assist them in their various problems through the design of new solutions. Studies show (Robinson, 2012, 2010) that design engineers spend 20% of their working time understanding information and over 18% in problem solving, and in another categorization over 19% in creating solutions.

Creativity continuum (McFadzean, 2001, 1999) classifies all creative problem solving methods into three groups – paradigm-preserving, paradigm-stretching, and paradigm-breaking – based on their interactions with the problem boundaries. Paradigm-preserving methods like brainstorming do not force the participants to change their own perspectives, thus leaving the problem boundaries unchanged. Paradigm-stretching methods introduce unrelated stimuli and forced association to the problem solving, thereby encouraging participants to stretch their existing paradigms. This can make some participants feel uncomfortable. Paradigm-breaking techniques call for high degrees of cohesion and trust in the group as they demand the development of new relationships between existing or new problem elements, and also they express the outcomes in modes other than verbally or in writing, for instance role playing or dreaming the solution.

The second part of this competency "Designerly ways" pays homage to Nigel Cross' works on defining the design as a coherent discipline, to understand the "artificial world" (Cross, 2001, 1982). He argues that as a result of their education, designers solve ill-defined problems by synthesis using a solution-focused strategy where "all the necessary information is [not], or ever can be, available to the problem-solver". The solution is reached through active, constructive and inventive patterns by the designer's own efforts. The most experienced designers tend to assume a systemic view to a design problem, frame the problem to suit their own design strategy, and look for "first principles"[57] when coming up with a novel solution (Cross and Cross, 1998). Successful design behavior derives from adequate problem scoping and prioritization criteria rather than from extensive problem analysis (Cross, 2004).

6.4.3 Conceptualization, Visualization and Validation (CVV)

New designs must be defined, given a concrete form, and evaluated to find the best available solution. The ideas and features behind a new product must be refined to concepts that describes the full extent of the design. Its form and contents are explored using various visualization techniques ranging from paper and pen sketching to 3D modeling or even cinematic/dramatic depictions. These artifacts are used to test the design internally within the design team, and more importantly with the users and other stakeholders using a plurality of usability or user experience evaluation methods.

Key concepts: Conceptualization, visualization, concept validation.

[57] An approach where the current accepted solutions are challenged and the design is taken back to the basics of the problem, often inspired by stimuli from nature.

Competency levels

Table 18. Competency levels for Conceptualization, Visualization and Validation.

Competency level	Description	Remarks
Low **1**	Concept Novice: Conceptualization is done in an ad hoc manner with no real documentation. Produced concept definitions are mostly very brief text descriptions that describe the expected features through their functionality. Low visualization skills make communicating the concepts to others difficult and leaves unwanted space for individual interpretations. No ongoing policy, practice or skill for testing the new designs with "outsiders".	The concepts can appear as fragmented collections of requirements with conflicting and ambiguous meanings.
Medium **3**	Competent Conceptualist: Conceptualization is done using well-proven methods and with sufficient documentation to depict considered alternatives. Concepts are visualized by text narratives, some visual depictions, or low fidelity prototypes. Concept validation is mostly handled within the group and is driven by the need to influence the customer or management.	
High **5**	Concept Master: Concepts describe not only the design at hand but also its implications for existing or emerging practices. Concepts are well-grounded in facts and understanding the users' needs and the design rationale[58] is made visible to others. Each concept is visualized using several well-suited methods, thus enabling more flexibility when presenting and validating the concepts with both their future users and other relevant parties in several iterations.	The concepts are factually accurate, coherently focused, and (when appropriate) highly visual marketing packages made to support decision making.

Rationale

Publication II describes a design process suitable for development of new product concepts. With small variations in the terminology, almost all design processes include the following design activities[59]:

[58] "Design rationales … include not only the reasons behind a design decision but also the justification for it, the other alternatives considered, the tradeoffs evaluated, and the argumentation that led to the decision." (Lee, 1997).

[59] For more details see the author's licentiate thesis (Nieminen, 2006).

- User research and idea generation enables conceptualization i.e. the formation of new ideas to product or service concepts based on factual user understanding with extrapolation, selection, combination and refinement of ideas from an adequately large pool of alternatives[60].

- Visualization to give the new product a form or a detailed enough description, so that is can be communicated to its future users or other stakeholders such as company management or client representatives.

- Validation to test the concept candidates to collect the necessary information to improve between iterations and to justify the final design.

Customary methods for user research includes observations, interviews, surveys or questionnaires augmented with more design oriented tools such as cultural or design probes (Gaver et al., 1999; Mattelmäki, 2006), photograph probes (Publication I), or generative methods such as collaging or Make Tools (Stappers and Sanders, 2003). Data collection is followed by a plurality of quantitative and qualitative analysis methods, such as affinity diagrams (Beyer and Holtzblatt, 1998), personas (Cooper, 1999), task analysis methods (Hackos and Redish, 1998), or analytical approaches such as grounded theory (Strauss and Corbin, 1994), for condensing the data so as to inspire idea generation and conceptualization.

The most often used visualization methods include scenarios (Carroll, 2000), storyboards (Landay and Myers, 1996) and mood boards (Lucero, 2012), paper prototypes (Säde et al., 1998), low or high fidelity functional prototypes (Kankainen, 2003), roleplaying (Iacucci et al., 2000), dramatic enactments (Mehto et al., 2006), or short movie clips.

Concept validation methodology borrows heavily from traditional usability testing (Nielsen, 1993) with tools such as thinking aloud, laboratory testing, pluralistic walkthroughs, structured or semi-structured interviews, and focus groups, but the primary goal is different. Instead of finding usability problems to fix based on actual use of a product, concept validation allows the designers to confirm the correctness of their understanding or the users' needs and relevant contextual actors (Publication II). The feedback from validation is used to reassemble the concepts devised, even if they are sometimes self-contradictory, into new ones, thus combining the new knowledge for

[60] Studies show that the creation of different alternative solution during a design process needs to be balanced: too few alternatives fixate the designers to concrete solutions too early, while excessive expansion of the search space waste the designers' time on managing the different variants instead of carefully evaluating and modifying the best alternatives (Fricke, 1996).

redesigning and refining the final concepts in an iterative manner (Publication IV).

6.5 Hard Skills

Hard Skills competencies are gained mainly by training and education. These include the ability to choose and execute suitable processes and methods, a necessary understanding of the available technologies and market potential, and lastly the knowledge portion of the subject domain expertise. This finalizes the UCD Competency Model circle and ties it to Subject Domain Experience.

6.5.1 Process and Methods (PM)

Managing a design process requires a holistic view of its many aspects and phases in an iterative fashion. For a successful outcome the right things need to be done in the right order with dedication and rigor. The whole is larger than the sum of its parts. The design process used and its activities can rely on predefined models, but often tailoring and modifications are needed to suit a specific need. Like any goal-oriented activity, design projects require management and leadership to utilize the available resources in a best possible way.

Key concepts: Selection of design process and methodology, project management, tailoring and adaptation.

Competency levels

Table 19. Competency levels for Process and Methods.

Competency level	Description	Remarks
Low **1**	The group's design efforts are guided by uninformative deadlines with no overarching process. Most tasks and used methods are selected and applied by the participants without guidance or control. Learning new practices is not actively encouraged. Project management and leadership is either missing or authoritative and retrospective.	Path of least resistance. In cases of consumer products, active participation in design by the general public is often missing.
Medium **3**	The group's design efforts rely on a predefined design process and a set of commonly used methods. Some adaptation of the methods used is evident but not systematic. Document templates or methods portfolios are used to support the design tasks. Project management is mostly based on the manager's personal skills and choices.	User participation may rely on facilitation by design professionals.
High **5**	A correct design process can be selected to leverage its group members' skills and the individual project's needs. Good methodological vocabulary allows adaptation from a large set of tools and development of new methodology. Project management is professional, transparent and timely, and it seeks to empower all stakeholders on all levels.	

Rationale

Utilizing the right UCD processes and methods at the right time is challenging due to the great diversity of methods available (Bevan and Ferre, 2010). Selection of the process and methods to be used depends on the practitioner's level of expertise, the project phase, and the availability of resources such as limitations in time frame or access to users. Ferre, Juristo and Moreno (Ferre et al., 2005) suggest selecting the UCD method to be used based on activity groups, as shown in Table 20.

Table 20. UCD Methods classified by activity groups (Ferre et al., 2005).

Kind of activity			Method
Requirements	Requirements Elicitation and Analysis		Card Sorting
			Competitive Analysis
			Affinity Diagrams
			Contextual Inquiry
			JEM (Joint Essential Modeling)
			Ethnographical Observation
		User Analysis	Personas
			Structured User Role Model
			User Profiles
		Task Analysis	Essential Use Cases
			Task Scenarios
			HTA (Hierarchical Task Analysis)
		Develop Product Concept	Scenarios and storyboards
			Visual Brainstorming
		Prototyping	Paper Prototyping
	Requirement Specification		Usability Specifications
	Requirements Validation		Inspections
			Heuristic Evaluation
			Collaborative Inspections
			Cognitive Walkthrough
			Pluralistic Walkthrough
Design	Interaction Design		Menu-Selection Trees
			Interface State Transition Diagrams
			Product Style Guide
			Navigation Maps
			Interface Content Model
			Impact Analysis
			Organizing Help by Use Cases
Usability Evaluation	Expert Evaluation		Inspections
			Heuristic Evaluation
			Collaborative Inspections
			Cognitive Walkthrough
			Pluralistic Walkthrough
	Usability Testing		Thinking Aloud
			Post-Test Information
			Performance Measurement
			Laboratory Usability Testing
	Follow-Up Studies of Installed		User Feedback
			Questionnaires, Interviews and Surveys
			Logging Actual Use

Other approaches to facilitate selection are to classify the methods by intrinsic properties[61], Human Centred Design (HCD) activities[62], and Human System processes or to use specific selection tools such as the Usability Planner (Ferre et al., 2010) that recommend methods based on the design life cycle stage, business benefits or potential risks. There are also web sites such as UsabilityNet (UsabilityNet, 2012) or All about UX (All About UX, 2013) that provide guidance on method selection.

[61] (ISO - International Organization for Standardization, 2010b)
[62] (ISO - International Organization for Standardization, 2010a)

6.5.2 Technology and Market Potential (TMP)

Successful product and service design requires a good grasp of current and emerging trends in technology, business opportunities and user practices. Either user behavior drives the development of new technologies or new technology enables and promotes new usage patterns. Business intelligence is often used to describe activities that methodologically search competitive advantage from trends, technology potential and risks, competitive products, and weak signals from markets. A good example that combines technology, new usages and market potential over the last 30 years in integrated circuits; incremental advances in material and manufacturing technologies have created a new category, "the personal computer", and more recently "the smart phone". These in turn have driven other technical innovations such as display and battery technologies in order to meet customers' demands for smaller, faster, brighter, greener, or even more flexible cell phones.

Key concepts: Technology potential, feasibility, market potential, trends, business intelligence.

Competency levels

Table 21. Competency levels for Technology and Market Potential.

Competency level	Description	Remarks
Low **1**	The group has no organized technology or market research. Members do not demonstrate personal interests outside common work and consumer products. Information comes from popular media sources (television, papers, books, the Internet), and friends and colleagues.	
Medium **3**	Group members follow a few key fields of technology on a semi-permanent basis and are somewhat knowledgeable about the ongoing trends in them. Can reflect on potential business implications. Information sources include technical, scientific or trade magazines and blogs. Personal interests align and contribute to the deeper understanding of the key fields.	"Jack of all trades, master of none."
High **5**	Systematic collection of information on the key fields and those related to them. Coordination of group level knowledge acquisition (dedicated focus areas). Actively analyzing technology and market knowledge in relation to new business opportunities and has defined practices for disseminating it.	Systematic multidisciplinary coordinated effort. Working reward system for innovations.

Rationale

Donald Norman declared war on User-Centered Design and design research at the 2009 IASDR conference in Seoul, South Korea[63]. In his keynote speech, later published as (Norman, 2010), he argued that a UCD approach is bound to produce small, yet essential incremental improvements and that all new, novel or radical innovations are born through advances in technology. Further elaboration by Norman and Verganti (2013) claimed that changes in technology or meaning drive the innovations beyond the limits of User-Centered approaches. Their argument emphasizes the necessity either to turn to new emerging technologies or to force fundamental change in the meaning of things in order to create radical innovations that lead to new product categories or services that change our world (see Figure 23). This importance of technology

[63] The author was attending to present Publication VI.

prowess is include in the user-centered concept design process that is described in Publication II and its predecessors (Nieminen, 2006; Nieminen et al., 2004). The importance of understanding market potential is evident, it being the prerequisite to the third criterion for successful radical inventions (Dahlin and Behrens, 2005): for an invention to be successful, it must be adopted i.e. approved by users and markets. Most often the cause for failure with a new innovative product is a timing issue, coming to the market too early or too late[64].

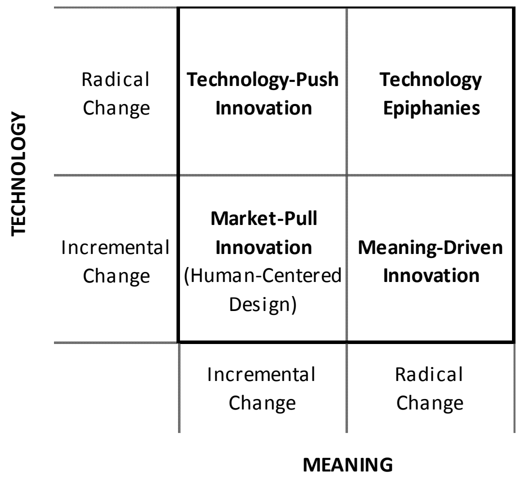


Figure 23. The two dimensions and four types of innovation (Norman and Verganti, 2013).

6.5.3 Subject Domain Knowledge (SDK)

Subject Domain Knowledge includes the hard skills and knowledge gained through formal education and training. "Subject Domain" refers to the domain of expertise of the target users of the design project. In many cases this knowledge is demonstrated with a degree or certification. Design problems relating to a specialized field can become so complex that advanced background knowledge and understanding is required about the foundations and theories involved therein. Subject Domain Knowledge may be required to be able to enter otherwise restricted areas or take part in regulated activities. A good example of Subject Domain Knowledge is the theoretical and practical training needed to become an airplane pilot or a medical doctor. In both cases permission to practice requires certification and a license granted by an accredited authority. The same applies to hobbies such as scuba diving or parachuting although with a little less scrutiny. Practices founded on formal procedures, rules or laws require often Subject Domain Knowledge. The main

[64] Examples include such notable failures as Apple Newton, one of the first smart pen-based computers decades before its time, and Microsoft Xbox Kinect as the late arrival to the motion sensing gaming (Norman and Verganti, 2013).

difference between Subject Domain Experience and Subject Domain Knowledge competencies is that in most cases the knowledge is readily available to parties outside the domain too: Even laymen may read medical text books, while they are definitely not allowed to treat patients.

Key concepts: Education, vocational training, certifications, theoretical background.

Competency levels

Table 22. Competency levels for Subject Domain Knowledge.

Competency level	Description	Remarks
Low **1**	Novice: Insufficient Subject Domain Knowledge. Either no formal training for the subject domain or performing tasks beyond existing education or certification. May benefit from knowledge transfer from other subject domains.	Designer joining a project in a completely unfamiliar field. First time scuba diver entering a course.
Medium **3**	Subject domain specialist: Has the appropriate education and certifications to perform all relevant tasks within the specified subject domain.	Designer working in the field matching her education, or has received additional training in the new field. Certified scuba diver.
High **5**	Subject domain expert: Has superior knowledge of the subject domain with additional insights on its relations to the neighboring fields. Can teach or even certify others.	Subject domain professional with relevant background in other fields such as product design, or a design professional with strong supporting subject domain knowledge. Certified scuba instructor with additional first-aid training.

Rationale

Knowledge about a specific subject domain can be brought to a design project either by the designers mastering the application field or by attaining it from the other stakeholders such as the end users or subject domain experts. While in most disciplines the required deep knowledge is available to outside parties, in the form of text books or open access courses, the time to acquire it often exceeds the time allotted for the completion of a design project. For instance, the average time required to become a medical doctor in Finland is 6.42 years (Hetemäki et al., 2014).

Gulliksen and Sandblad (1995) argue that detailed domain knowledge is essential for designing end user interfaces. Likewise Shaft and Vessey (1995) illustrate the importance of domain knowledge in computer programming in their studies with software designers with or without detailed grasp of a specific application area, and further presume it to have even larger effect on other development tasks.

Publications V and VI describe a project where a subject matter specialist participated in evaluating the results of facilitated end-user idea generation workshops, and thus enabling designers unfamiliar with the domain to proceed with the best possible concept candidates when developing a new enterprise resource planning system (ERP).

7 Conclusions and Discussion

This chapter revisits the research questions outlined in the beginning of this thesis, addresses its contribution and the relevance of this work, and discusses the strengths and weaknesses of the research. The chapter is finalized with a look at things undone and possible future work.

7.1 Research Questions Revisited

In this section the research questions are revisited.

What are the necessary competencies for User-Centered Design?

The UCD Competency Model defined the most relevant competencies for User-Centered Design as follows, for more detailed descriptions see chapter 6. UCD Competency Model.

- Subject Domain Experience: (Tacit) knowledge, crafts and skills gained by (long) experience.
- Context Availability: Access to real context of use, may be restricted or difficult to arrange.
- User Cultures, Social Networks and Practices: Each user group has its own language and culture that can be difficult to grasp and utilize in a design project.
- Communication: Well-functioning and democratic communications are the most time consuming and critical part of design work.
- Multidisciplinarity and Collaboration: Multiple points of view increase the eventual impact of design.
- Motivation and Ambitions: Intrinsic motivation, self-improvement, professional ambitions, competitive salary, and manageable workload create solid design conditions.

- User Involvement: Capabilities in selecting the right users and working with them effectively.

- Problem solving and Designerly ways: Attitude and determination towards designing a change for the better and having the means to realize it in a responsible manner.

- Conceptualization, Visualization and Validation: Skills in creating product concepts, prototyping and testing.

- Process and Methods: Process, management and methodological excellence and the skills to adapt them.

- Technology and Market Potential: Awareness of advances in available technologies and relevant trends at target markets.

- Subject Domain Knowledge: Knowledge and skills gained by education and certification.

This categorization is derived from seminal UCD literature and the author's Publications and it is validated by the responses of UCD practitioners working in the industry designing products, services and information systems. Their accounts of the success factors for UCD projects fit into the proposed model and the statistical analysis of the practitioners' assessments of their project participants' competencies support this claim. 92% of the designers who tried the model agreed that it contains the most relevant User-Centered Design competencies, while two voted neutral none disagreed with the statement.

How can these competencies be measured?

The theories presented regarding competencies and competency models suggest that competencies should be defined by describing the activities included in them, and propose assessing them using three to five competency levels along with suitable examples. The use of a five-point scale seems to be most common. The proposed UCD Competency Model has been constructed according to these guidelines.

The main challenge for applying the model was the large number of ratings necessary to cover the various participants and roles included in the design projects, which made evaluating the competencies quite laborious. The use of a group level assessment led to minor difficulties in evaluating some of the competencies because a few of them are inherently shared among all project participants. This was solved by changing the guidance on rating these collective competencies to prefer the same competency level for the whole team unless individual distinctions could be made.

It should be pointed out that since the UCD Competency Model is a broad competency model (Mansfield, 1996), it has to work on a higher abstraction level to include the whole of UCD practices rather than a single job role. This forces the descriptions and competency level criteria to be more generic, and some would argue even vague. The approach that has been chosen relies on interpretation by the applying practitioner to give the model its full meaning. Every project is different and every designer has his or her individual preferences regarding work practices, but within the confines of their own ways of designing, the practitioners can form the necessary subjective interpretations of what each competency means for them.

How can the proposed model be used to aid UCD projects?

The suggested uses of "identifying gaps in project resourcing" and "using the model to justify user involvement" are linked together with statistical significance and both correlate with high significance to practitioners' willingness to use the model in the future. Four respondents out of 24 disagreed with the statement "I think I can use the model to identify gaps in the resources of my project", while 13 agreed with it.

The visualization of the competency levels using overlapping semi-transparent radar graphs was appreciated by the practitioners that tried out the model[65]. The initial design driver for selecting this design to visualize the competencies was to enable looking the competency profiles of various participants "against the light", like one would examine competing design tracings on a light table. This enables quick discovery of the competencies that a project team lacks and acts as a motivation to invite more people to join the project team. Likewise if some participants demonstrate abilities in competencies that are currently underutilized, they should be engaged in additional project phases or activities. These considerations were voiced by several of the practitioners and they saw the model as a way to organize their own thoughts about their projects firstly to themselves and secondly as a tool for dialog with other stakeholders (often mentioning company management and clients) about competency needs in projects.

The UCD Competency Model is intended to be used at the beginning of a project to assess its special requirements. Since UCD projects include several different

[65] Based on pilot testing prior to the questionnaire, additional smaller radar graphs for each role were added to make each of them more readable.

phases requiring very different skills sets[66], it is advisable to revisit the competencies at phase transitions during a design project[67]. The respondents also suggested that the model to be used to analyze past projects or when introducing UCD practices to new organizations.

There was also a significant reverse correlation between work experience and the model's ability to help find gaps in project's resources. This indicates that some of the more experienced designers seem to trust their own abilities and current practices in managing resourcing without the assistance of the proposed model. This is partially explained by the dual processing model of decision-making (Djulbegovic et al., 2012) that describes the two competing decision-making strategies as intuitive and analytical. The effectiveness of intuitive decision-making, at least on non-decomposable tasks, is shown to be greatly increased by a high level of domain expertise, while the analytical approach yields almost identical results regardless of expertise level (Dane et al., 2012).

7.2 Contribution

The contribution to new knowledge and the relevance of this thesis is twofold. First is the practical utility of the competency model that has been developed, considered from the perspective of its potential future users in industry, and all the implications thereof. Second is the new scientific knowledge provided by the research, presented in this thesis and the attendant Publications.

7.2.1 Practitioner Perspective

The common uses for competency models are listed in section 3.2 to identify required skills and knowledge, plan and develop training, improve recruitment and manage performance (Cook, 2004; Lucia and Lepsinger, 1999; Markus et al., 2005; Sparrow, 1995).

92% of the practicing designers who tried the model agreed that it contains the most relevant User-Centered Design competencies, which clearly proves the content validity of the UCD Competency Model. The following Table 23 and Figure 24 show the average competency profiles for the participants in the UCD projects, based on the responses of the 24 participants in the validation questionnaire. The black line shows the average of the respondent's estimates for their project group's overall competencies.

[66] Publication VI makes the distinction between the analytical frame of mind needed for user and technology research and the innovative and creating mindset necessary during ideation and concept creation surrounded in a shell of project management and corporate strategy.
[67] Publication II depicts one way of defining different process phases.

Table 23. Average competency profiles for the participants in UCD projects.

		End Users	UCD designers	Developers	Others	Overall
User Strengths	SDE	3,96	3,00	2,83	3,32	3,57
	CA	4,54	3,13	2,71	2,95	3,14
	USP	4,21	3,13	2,38	3,36	3,19
Soft Skills	C	2,67	3,96	3,17	3,73	3,43
	MC	2,29	3,75	3,17	3,14	3,24
	MA	3,13	4,25	3,63	4,27	3,81
Designer Strengths	UI	2,96	3,58	1,96	2,68	2,90
	PSD	1,92	4,00	2,71	2,77	2,95
	CVV	1,58	4,04	2,46	2,64	2,95
Hard Skills	PM	1,67	3,58	2,79	2,86	2,95
	TMP	2,08	3,38	3,46	3,45	3,14
	SDK	3,08	3,21	3,00	3,68	3,43

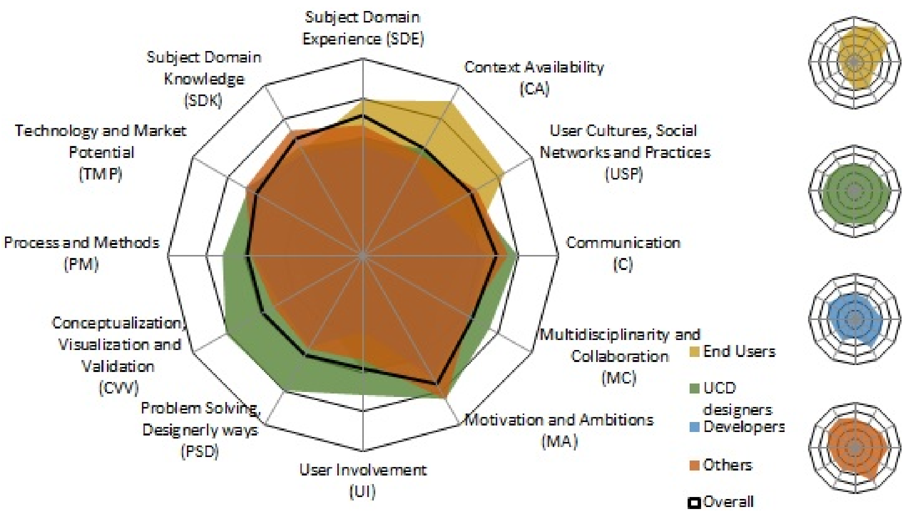


Figure 24. Average competency profiles for the participants in UCD projects.

The average profiles describe the **Designers** as multitalented generalists with at least sufficient capabilities in practically all the UCD competencies and notably favoring the lower half of the model. The **Users** profile is distinctly light bulb shaped and leaning rightwards. As expected it emphasizes the User Strengths yet it has another peak showing high motivation and group work skills necessary for involvement in the design process. **Developers** show up as generalists tightly coupled to projects. They possess unique assets in technology but otherwise do not match Designers in any other dimension. Their lack of direct contacts to users or their contexts is evident. The group **Others** included customer representatives, corporate and project management, and people from marketing and sales departments. Their talents lie in their understanding of technology and market potential and they express well-developed communication skills.

42% of the respondents agreed or strongly agreed that they will use the model in the future, while 33% remained neutral. 25% of the respondents disagreed or strongly disagreed about trying the model in the future. The most stated reason in the open answers for not using the model was that it takes too long to apply. This is supported by the point that 21% disagreed or strongly disagreed with the statement “Filling out the model did not take too long”.

The significant negative correlation between work experience and using the model to identify gaps in project resources suggest that the model is most suited for designers with less than 12 years of work experience[68].

7.2.2 Academic Perspective

In the following list, processual and methodological advances in scientific knowledge at the time of their writing are provided for each Publication:

- A new and then novel method of photograph probes is introduced in Publication I (2005), a focused continuation of cultural probes (Gaver et al., 1999) reaching towards design probes (Mattelmäki, 2006) and collaborative construction of mood boards (Lucero and Vaajakallio, 2008).

- Publication II (2006) defines a concept design process emphasizing the necessity of understanding and uncovering the technological potential of design when working with new emerging technologies, an approach currently advocated (and verbosely so) by Don Norman (2010; Norman and Verganti, 2013).

- Publication III (2007) outlines a participatory usability evaluation activity, in which subject domain specialists were trained and equipped to perform remote usability tests on behalf of a web site design team.

- Publication IV (2008) underlines the need for a unified design process under shared project management for iterative and consecutive concept design projects.

- Publications V (2009) and VI (2009) depict the innovation potential found in end users and company employees that can be harnessed via suitable selection of methods used, involving the right people, and

[68] Even though the highest positive response came from the third most experienced designer with 19 years of work history.

providing them adequate facilitation. A fluent way of interacting with users is also referred to as user involvement competence (Lettl, 2007).

- Sometimes the design team does not have access to the users or their context of use, or the design work is distributed geographically. Publications VII (2011) and VIII (2011) elucidate a new design paradigm called Designer Experience (DX) in which designers try to perform their design tasks while "artificially" immersed in the users' experiences.

The competency model for User-Centered Design developed herein offers a novel new look at the competencies and key dimensions of user-involved design practices. While there have been several attempts to define the principles for User-Centered Design practices (Gulliksen et al., 2003) or standards for them (ISO - International Organization for Standardization, 2010a) or to offer taxonomies for design education (Friedman, 2012), to the author's knowledge this is the first attempt to describe the key competencies for a field of practice on a project team level with a measurable and practical tool.

The model is certain to be found flawed in its details and as-is it will not suit all fields of UCD, but as a theoretical construct it can kindle academic discussion and debate and act as a good starting point for further modifications that can better cater to the completeness sought by the theorists or to the rough and ready practicality needed by people wading in the UCD trenches. The model can be expanded with new competencies or the existing ones can be subdivided to better reflect the endless complexities of UCD; the model can be reduced further to gain an even simpler, possibly more efficient and practical tool.

7.2.3 The Past and Present of the UCD Competency Model

The first ideas for the UCD Competency Model were conceived during the writing of the Publication V in late 2008. For personal reasons[69] the topic was left on the back burner for several years, to resurface in 2011 as a tentative radar graph visualization of users' and designers' knowledge and skill asymmetries; this rekindled the goal of creating a practical tool to bring out the best in all the participants in a UCD process. It took another two years to realize that what the author originally referred to as knowledge and skill asymmetries were cannily similar to the concept of competency as it is used in HR, career development, and educational planning. In living up to the past practices of UCD, namely adapting methodologies from neighboring sciences, the author adopted the competencies and strived to make them serve the purpose.

[69] The author's second daughter Laura was born in January 2008 and during spring 2008 the author was on a leave of absence building the family's new home.

Although the development of the model took time, it seems to have emerged at a potentially opportune moment. In parallel to my work, the SFIA Foundation (2011) has launched the Skills Framework for the Information Age in the UK. This is a very broad competency model for the entire IT industry and in its 5th version it finally included four UCD related competencies under a human factors subcategory. Within the final stages of this work during spring 2014, several attempts at defining the necessary knowledge base, competencies or education for design have materialized. The Software Engineering Competency Model (SWECOM) (Ardis et al., 2014) is currently undergoing final review and comment. It categorizes the necessary software engineering elements, shown in Figure 25, to five groups with competency levels ranging from entry level technician to senior software engineer.

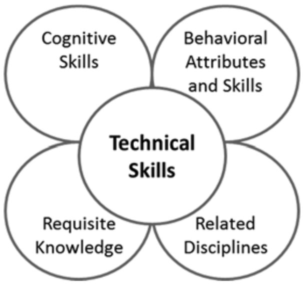


Figure 25. The elements of SWECOM

In January 2014 the Norman Nielsen Group published a comprehensive report on the future educational demands for User Experience Careers, discussing both the hard and soft skills that are needed (Farrell and Nielsen, 2014). In a recent paper Gray (2014) described the evolution of design competence from an educational perspective and identified the following similar competence elements for UX practice: Tool/Representational Knowledge, Dealing with Complexity, Vocabulary/Language/Communication, Design Leadership, Internal/External Upskilling, Reconciling Corporate Reality/Culture, and Designerly Identity.

The increasing importance of cognitive and social skills is underlined by a study (Weinberger, 2014) that compared high school graduates from the 70's and 90's while controlling for a combination of technical and social skills. Its results showed a clear shift in employer's hiring practices towards preferring multitalented employees. Over the last twenty years those with high cognitive and social skills had acquired a seven percentage-point salary premium over employees with only technical skills.

7.3 Strengths and Weaknesses of the Research

The UCD Competency Model was constructed mostly by using literature sources by a single researcher. While the author fully trusts that the combined knowledge of the UCD community from the past 30 years is a solid enough foundation for the model with adequate triangulation, most theories cited assume the competency models to be built by teams of people. This creates a strong potential for selection bias during the initial development of the model. Robust validation is assumed to have picked out the worst outliers, but the fact remains that the structure of the model is affected by a common source bias, implicit theories, and illusory correlations (Podsakoff et al., 2003).

The validation procedure may have also been affected by sampling bias, as a large portion of the respondents came from the author's professional social network. The structure of the validation questionnaire was such that all respondents browsed through the competency model in the same order, and this caused a modest order bias clearly visible as descending trendlines in the ratings means presented in section 5.1.3.

7.4 Unaddressed Issues and Future Work

While the validation study did, up to a point, prove the content and construct validity of the developed model, it did leave some questions unanswered:

1. Are the identified competencies really competencies? The study did not gather performance data to be able to prove that the UCD Competency Model can predict the performance and success of UCD projects.

2. Are these the right competencies? The number of the collected ratings samples was not large enough to support reliable factor analysis and dimension reduction of the proposed 12 competencies in order to form a more concise model with fewer competencies.

3. How does the competency approach integrate to everyday UCD practices? The integration of a competency model based approach to the everyday activities and tools of a UCD practitioner needs to be studied in more detail.

The future research in a form of a longitudinal case study, combining collection of more competency ratings using the current competency model and in-depth interview and observation data, should be performed to assess these matters. This study should use the current model to iteratively measure the changes in team competencies, observe and record the best and worst design practices for performance data and investigate the adoption of a competency based approach on all levels of the design activities from ways to improve user involvement in everyday practices to strategic usability[70] and decision-making of the top management.

7.4.1 Are these Really Competencies?

The definitions of a competency demands that it describes or predicts effective or superior performance (Marrelli et al., 2005; Spencer and Spencer, 1993, p. 9). This demands the verification of the causal relationship between the higher competency ratings in the UCD Competency Model and measurable success in the UCD projects. The identification of relevant performance metrics for UCD projects would not be a trivial task. These performance metrics would need to compare the design practices to the profitability of the design business in themes such as HR spending, revenue, customer or user satisfaction, ability to attract new customers and even impact to the brand of the company or product. Correlating the performance data to the observed competency levels would confirm the criterion validity of the competency model. Since many of the participants in the validation study showed interest in using the model such a follow-up study would seem feasible, but would require strong commitment also at the corporate level.

7.4.2 Are these the Right Competencies?

The extent of the UCD Competency Model with its numerous competency ratings made its quite time consuming to use. One option would be to develop a more concise competency model. Gathering a substantially larger ratings data set with the current model would enable a reliable refactoring of the competencies to gain potentially simpler yet reliable model. The adequate sample size for effective factor analysis is suggested to have subjects-to-variables (STV) ratio of 10:1 (Nunnally, 1978, p. 421) or at least 300 samples (Comrey and Lee, 1992). General consensus is that larger sample size is always better, because it minimizes errors, maximizes accuracy and increases the generalizability of the results (Osborne and Costello, 2004). Although, empirical tests have shown that STV or sample size have only a small influence on factor stability (Arrindell and Ende, 1985).

Besides the size and complexity of the model there is also the scope of UCD in which it is applied. For this thesis it was decided to develop a broad competency model to cover the early stages of User-Centered Design. Comparative studies

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[70] Strategic usability embeds good design and engineering to corporate business strategy and decision-making by merging the usability and business goals (Rosenbaum et al., 2000)

are needed to determine whether several more role or job description specific competency models would be more effective.

7.4.3 How Does the Competency Approach Integrate to Everyday UCD practices?

A longitudinal case study following the daily practices of a design teams is needed to verify the actual use cases for competency models in UCD.

How long does it take to use it?

Applying the model to a project is something of a heavy task. From the validation questionnaire's open comments one can conclude that the model's usability[71] is acceptable in light of its effectiveness and satisfaction, but poor in efficiency. The time needed to construct the model is of course individual to every practitioner and project. Unofficially[72] the respondents reported times between of 40 minutes and 4 hours. Since first-time use of the model requires a comprehensive one-time reading and interpretation of the competencies and their level descriptions, it is fair to assume that the effort needed to apply it to succeeding cases would be greatly reduced. This needs to be verified by following design teams while they apply the model iteratively in their project(s). This would also be a great opportunity to gather the necessary performance information, mentioned in the previous section.

Who should use it?

The UCD Competency Model has been developed to be used by the project managers or lead designers to assess the competencies of their entire extended teams. In the validation study this worked as expected, but of course other options are available. Added inter-rater reliability could be gained if two or *more persons would use the model* and their results were then compared and merged. The model could be used as a *self-assessment tool*, so that all participants could rate themselves and all other project participants. This would propose an additional expense in spent working hours and could have a negative impact on the team spirit or the self-esteem of the participants. The most problematic stakeholder groups are the corporate top management and end users, because both groups often participate in the design projects for short periods of time. Company managements may wish the competency approach to integrate smoothly to the company's existing processes and tools, whereas the end users may need to be coaxed to participate, for instance by gamification of the UCD Competency Model.

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[71] Defined as effectiveness, efficiency and satisfaction in the ISO 9241-11 standard (ISO - International Organization for Standardization, 1998)

[72] The time taken to apply the model was not asked in the questionnaire, but some respondents volunteered it in their emails when returning the filled forms.

How to use it?

Respondents criticized the arrangement wherein the UCD Competency Model was described in a separate document and the scores were entered to a separate spreadsheet. When preparing the questionnaire, several options for implementing it as a web survey were explored where all the data would be in one place, but no suitable solution could be found. In none of the alternatives found, including Google Drive and Webropol[73], was it possible to generate the desired graphs in parallel with the rating tasks. In the future, using the model and having it generally accepted by the UCD practitioners it does have to be readily available as a web resource or as a part of other project management tools. Even accessing the UCD Competency Model as an outsourced cloud-based service might be an attractive choice to some companies or practitioners.

When to use it?

The longitudinal case study can also provide more details about when the model can and should be used. The validated hypothesis was to fill in the UCD Competency Model in the beginning of a project or at the start of a new project phase. How separate these assessments should be, or should the model be incrementally updated as soon as a change in the team composition happens? Using the model as a self-assessment tool, as suggested earlier, further blurs the line when the model should be used.

[73] Google Drive offers several spreadsheet and forms applications that can be used to implement online surveys, available at drive.google.com. Webrobol is a Finnish online service for creating and managing online questionnaires, www.webropol.fi.

Epilogue

This thesis has gone to great lengths to outline the various skills and knowledge needed to create new products or services while making the best possible use of the competencies of all involved actors. An intricate construct called the UCD Competency Model was proposed to help visualize the complex and amorphous aspects of User-Centered Design. In many ways though it all boils down simply to understanding people and design. We can agree that people are hard to quantify, but luckily design is such a very simple, uncomplicated and clear concept. In the words of Paul Ralph and Yair Wand (2009):

> *Design: (noun) a specification of an object, manifested by some agent, intended to accomplish goals, in a particular environment, using a set of primitive components, satisfying a set of requirements, subject to some constraints.*

I myself would rather go with Douglas Adams (1987):

> *"Of course I will explain to you again why the trip to the Bahamas was so vitally necessary" said Dirk Gently soothingly. "Nothing could give me greater pleasure. I believe, as you know, Mrs Sauskind, in the fundamental interconnectedness of all things."*

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Appendix 1: Source Statements

Source data i.e. the collected UCD statements from the literature and author's Publications (excluding Publication IX) in abbreviated notation.

<u>Literature based statements:</u>
Early focus on users
Empirical "hands-on" measurements
Iterative design
Design for usability principles as a process
"Integrated design"
Whole process under one management
Appropriate allocation of function
Multidisciplinary design teams
Variety of skills
User focus
Active user involvement
Evolutionary systems development
Simple design representations
Prototyping
Evaluate use in context
Explicit and conscious design activities
A professional attitude
Usability champion
Holistic design
Processes customization
A user-centered attitude
Foundations of development methodologies and processes
Subject domain technology expertise
Human-centric approach
Communication skills
Social skills
Negotiation skills
Acceptance of professional responsibility
Interpersonal skills

Expertise on workers' own work

Interplay between work practices, technology, organizational and other aspects of the environment

Context of use

Authentic experience

Hands-on methods and activity

Empowerment of marginalized societal group

Reflection on all aspects of use and design

Position of activity in the development cycle or iteration

Mode of participation

Design group size

Mediated design via standards, guidelines and heuristics

Inactive designer observes proactive Lead users

Proactive designer reflect on inactive users

Distance between social practices and system functionality

Autonomy of creative work

Users driven to solve everyday problems

Foresight to the needs of a larger public

Make sense of new emerging technologies

User has an impairment

Restrictive user group

Project and time management

Development and implementations technologies

Observe the users

Users as an information source

Innovation

Multiple points of view

Shared understanding

Tacit dimension of knowledge

Motivation

Strategic awareness

Cognitive strategies and abilities

Importance of non-technical skills

Social contact

Helping others

Interest groups

Customer competence

Publication based statements:	Publication
Context availability (restricted or dynamic)	P1
Rich and holistic description of activities an locations	P1
Deep domain knowledge	P1
Interpretation of the self-documented data	P1
Interruption detection, rare incidents or "illegal" activity	P1
Memory and conversation aid	P1
Emergence of tacit knowledge	P1
Usefulness of the results (artefacts) to others	P1
Well-defined design/development process	P2
Iterative design (within phases and overall)	P2
Changes in mindsets between different phases	P2
Dynamic team composition	P2
Participants with different skill sets	P2
Use of local subject matter specialists	P3
Cultural and language skills	P3
Connections to real users, and working relations to them	P3
Geographical location or proximity	P3
Providing training	P3
Need for Instructions and supporting tools	P3
Understanding special user groups	P4
Access to real use context	P4
Making use of technological potential	P4
Iterative design	P4
Use of formalized design process to enable knowledge transfer	P4
Cumulative knowledge through consecutive projects	P4
Centralized coordination or project management	P4
Use of Prototypes (to make evaluations concrete)	P4
Domain specific design restrictions	P4
Creative problem solving by users (non-designers)	P5
Facilitation of formal methods	P5
Novel ideas generated by users	P5
Selection of suitable method to match participants needs	P5
Selection of participants to design activities	P5
Use of several different types of methods	P5
Selection and rating of user generated product ideas	P5
Documentation of user generated requirements	P6
Prototype development (design artifact creation)	P6
Design process facilitation	P6
Validation of design artifacts by users	P6
Design research by users	P6

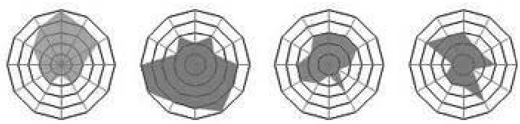
New "social" design skills: Listen, learn, adapt	P6
Ethical considerations of design (impact of design)	P7
Designing for users, not designing users	P7
Design based on real or simulated experiences	P7
Emergence of user's irrational needs	P7
Design for future users	P8
Predict products' impact on future users	P8
Reproducing users' context of use	P8
Invoking experiences to inspire design	P8
Predicting future use of a product (appropriation)	P8

Appendix 2: UCD Competency Model Questionnaire

Launch Page for the Questionnaire in English and Finnish.

UCD Competency Model Questionnaire

Welcome to the UCD Competency Model Questionnaire!



This questionnaire reflects on the User-Centered Design (UCD) as a multidisciplinary collaboration between people from different fields. This is especially relevant when involving end users to design tasks. What are the most important competencies of UCD, how various knowledge and skills are distributed among the participants and how this fragmentation of competencies should be managed in UCD projects? This study is part of my doctoral thesis work, to be published during 2014.

In order to participate to this study you must:

- Have minimum of three years of experience in UCD.
- Have participated to a project in the last 12 months that had active user involvement. It is easiest if your reference project has recently ended or is just about to end.
- Have approximately 45 minutes of time to ponder the knowledge and skills of those involved in your project.

All complete answers will enter a lottery for a tasty Easter basket or a donation of 50€ to the New Children's Hospital, the lucky winner may choose.

Please, complete the questionnaire as soon as possible, preferably **no later than end of March**. Feel free to share this invitation to any of your colleagues that you see fit.

The questionnaire has two parts:

1. Choose your own reference project and evaluate the competencies of its participants using the UCD Competency Model.
2. Questionnaire about the UCD Competency Model in order to finalize it and to support the analysis of the collected data.

All stakeholders in a project do not naturally work on all the aspects of UCD, so you may have to think about their competencies on the lines of "If they had to perform specific tasks to what level of competency would they rate?".

Below you will find the needed two documents:

1. Study Guide + UCD Competency Model (pdf) on how to participate to this study (2 pages) and the description of the UCD Competency Model (13 pages). PDF still has the earlier DL date 16.3. but the study is active until 31.3.2014
2. UCD Competency Model + Questionnaire (Excel document) to evaluate the competencies of the participants in your project, including the actual questionnaire on a separate sheet.

After you have applied the model to you project and filled out the questionnaire, please save the Excel file and return it to mika.nieminen@aalto.fi. Please include "ucdcm questionnaire" on the subject.

All responses are treated confidentially and handled anonymously.

Thank you for your contribution,

Mika P. Nieminen, Aalto University Strategic Usability Research Group

Tervetuloa Käyttäjäkeskeisen suunnittelun kompetenssimallin pariin!

Tämän kyselyn tarkoituksena on peilata käyttäjäkeskeisen suunnittelun tapaa yhdistää usean osaamisalueen toimijat yhteiseen suunnittelutehtävään, ennen kaikkea varsinaisten käyttäjien ottaminen mukaan suunnitteluun. Sitä mitkä ovat käyttäjäkeskeisen suunnittelun tärkeimmät osaamisalueet, miten tiedot ja taidot jakautuvat eri osapuolien välille ja kuinka tällainen kompetenssien hajautuneisuus tulisi huomioida suunnitteluprojekteissa? Tämä tutkimus on osa tulevaa tohtorinväitöskirjaani.

Osallistuaksesi kyselyyn tulee sinulla olla:

- Vähintään kolmen vuoden työkokemus käyttäjäkeskeisestä suunnittelusta tai tuotekehityksestä.
- Olet ollut mukana viimeisen vuoden aikana projektissa, jossa käyttäjillä oli aktiivinen rooli. Kyselyyn vastaaminen on helpointa jos projekti on juuri loppunut tai ainakin loppumaisillaan.
- noin 45 minuuttia aikaa pohdiskella projektiisi osallistuneiden tahojen tietoja ja taitoja.

Sekä malli että kysely ovat englanninkielisiä.

Kaikkien vastanneiden kesken arvotaan pääsiäisherkkukori tai 50€ lahjoitus Uuden Lastensairaalan hyväksi voittajan valinnan mukaan.

Toivoisin vastauksia ennemmin kuin myöhemmin, mielellään maaliskuun loppuun mennessä. Voit jakaa tätä kutsu eteenpäin.

Kyselyssä on kaksi osaa:

1. Valitsemasi referenssiprojektin eri toimijoiden kompetenssien arviointi mallia soveltaen.
2. Kysely itse käyttäjäkeskeisen suunnittelun kompetenssimallista sen loppuunsaattamiseksi ja edellisessä kohdassa kerätyn aineiston analyysin tueksi.

Kaikki osapuolet eivät tietenkään luontaisesti toimi kaikilla käyttäjäkeskeisen suunnittelun osa-alueilla, joten joudut kenties miettimään heidän kyvykkyyttään tyyliin "Jos hänen olisi pakko, niin mille tasolle hän sijoittuisivat".

Kyselyyn osallistumiseen tarvitaan kahta dokumenttia:

1. Study Guide + UCD Competency Model (pdf), opas joka kertoo kuinka voit osallistua tähän tutkimukseen (2 sivua) ja kuvaa Käyttäjäkeskeisen suunnittelun kompetenssimallin (13 sivua). PDF:ssä on edelleen vanha palautuspäivämäärä 16.3., mutta kysely on auki 31.3.2014 asti.
2. UCD Competency Model + Questionnaire (Excel document), johon syötät arviosi projektisi osallistujien kyvyistä, sisältäen omalla välilehdellään varsinaisen kyselyn.

Kun olet soveltanut mallia omaan projektiisi ja täyttänyt kyselyosuuden tallenna Excel-tiedosto ja palauta se sähköpostilla osoitteeseen mika.nieminen@aalto.fi. Kirjoita viestin otsikoksi "ucdcm questionnaire"

Kaikkia vastauksia käsitellään luottamuksellisesti ja nimettöminä.

Kiitokset osallistumisesta,

Mika P. Nieminen, Aalto-yliopiston Strategisen käytettävyyden tutkimusryhmä

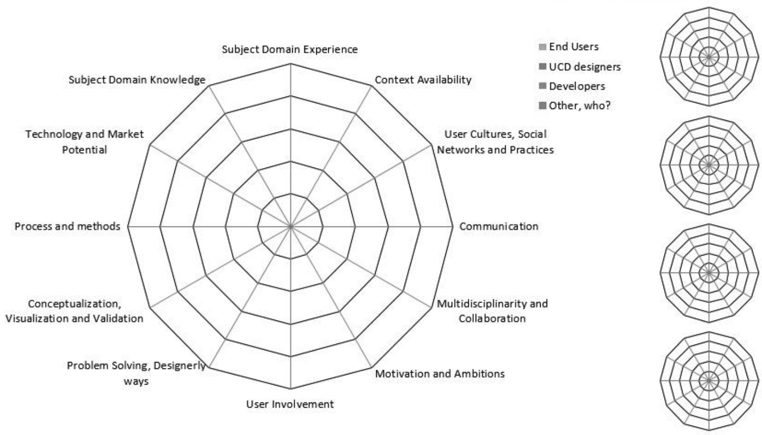
UCD Competency Model Questionnaire Excel Spreadsheet

UCD Competency Model & Questionnaire

Project description:
(providing name for the project is of course optional)

"Designing a new web service for managing customer reservations, Animal hostel Pirs-Katti"

		End Users	UCD designers	Developers	Other, who?	Overall for whole project team
User strengths	Subject Domain Experience					
	Context Availability					
	User Cultures, Social Networks and Practices					
Soft Skills	Communication					
	Multidisciplinarity and Collaboration					
	Motivation and Ambitions					
Designer strengths	User Involvement					
	Problem Solving, Designerly ways					
	Conceptualization, Visualization and Validation					
Hard Skills	Process and methods					
	Technology and Market Potential					
	Subject Domain Knowledge					



UCD Competency Model Questionnaire

Your reference project: "Designing a new web service for managing customer reservations, Animal hostel Pirs-Katti"
(from the previous sheet)

1. Work experience with User-Centred Design (UCD) in years (e.g. "4,5" for four and a half years)
   1.1 Describe your current work role in a few word

2. Highest level of education you have completed (select from the list)
   2.1 From what discipline is you education?

3. What are the most important success factors for a UCD project? Name at least three.

4. Consider the UCD Competency Model as a whole and rate the following statements (5: I strongly agree - 3: Neutral - 1: I strongly disagree)
   4.1 The UCD Competency Model includes the most relevant aspects of UCD
   4.2 Filling out the model was easy
   4.3 Filling out the model did not take too long
   4.4 I think I can use the model to identify gaps in the resources of my project
   4.5 I think the model can help me justify involving users more in my projects
   4.6 I think I will try this tool in the future

5. Browser the competency descriptions again and consider the following attributes for each competency and rate them to the table below (5: Very clear/very important - 3: Neutral - 1: Very unclear/very unimportant)
   *The clarity of each competency description.
   *The utility of the described competency levels, ie. do they differentiate skill levels appropriately.
   *Importance to your project.

		Clarity of the competency description	Utility of the competency levels	Importance to your project	Additional comments regarding the competency (optional)
User strengths	Subject Domain Experience				
	Context Availability				
	User Cultures, Social Networks and Practices				
Soft Skills	Communication				
	Multidisciplinarity and Collaboration				
	Motivation and Ambitions				
Designer strengths	User Involvement				
	Problem Solving, Designerly ways				
	Conceptualization, Visualization and Validation				
Hard Skills	Process and methods				
	Technology and Market Potential				
	Subject Domain Knowledge				

6. What important competencies are missing? Is there a skill or knowledge that does not fit in any of the described competencies?

7. Is there a competency that seems unnecessary? Should some competencies be changed or removed?

8. How could you benefit from the UCD Competency Model? How and when would you use it?

9. When rating the competency levels for a group role, did you use the persons' average or best-in-group value for the competencies? Why?

10. The instructions and the questionnaire were in English, which might not be your native language. Did it make it difficult to use the model? Any specific terms that should be clarified?

11. Anything else that comes to mind now that you have reached the end of this questionnaire?

May I contact you if additional information is needed during the analysis?

Do you want to be informed with an email when the results of this study are available?

Now please save this Excel file and return it back to mika.nieminen@aalto.fi. Please include "ucdcm questionnaire" on the subject.
Thank you again for your valuable contribution!

Instructions to Fill in the UCD Competency Model Questionnaire

UCD Competency Model Questionnaire

Dear reader, thank you for participating in this study. I truly appreciate your input to my research.

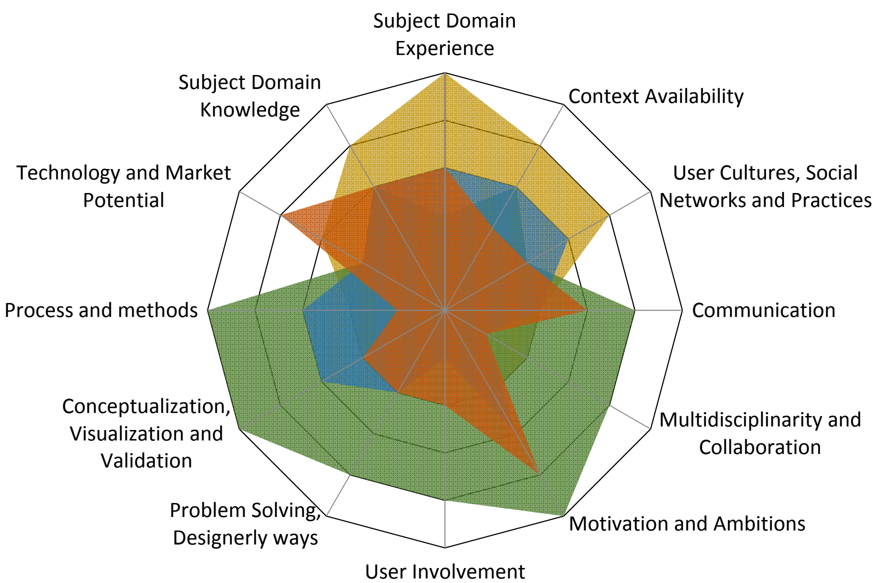
In order to participate to this study you must:

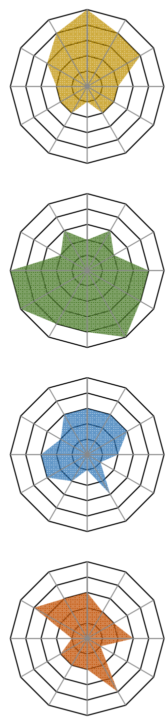
- Have more than three (3) years of experience in User-Centered Design
- Have participated in a project within the past year that had active user involvement (in a quite broad sense).
- Have approximately 45 minutes of time to ponder the knowledge and skills of those involved in your project.

Please, complete the questionnaire as soon as possible, preferably no later than March 16th. Feel free to share this invitation to any of your colleagues that you see fit. **All complete answers will enter a lottery for a tasty Easter basket or a donation of 50€ to the New Children's Hospital**, the lucky winner may choose.

In order to successfully complete this questionnaire you must follow the instructions in this document and in parallel fill in the required values to the accompanying Excel spreadsheet. I suggest you either print out this document and open the spreadsheet on your screen, or open and position these two documents side-by-side on your screen.

This document contains the instructions for applying the UCD Competency Model, while the Excel is used to fill in the values for each competency and build the radar graph. The actual questionnaire is located on a separate sheet in the Excel, but you only need to fill it out after you have applied the model to your reference project. After you have applied the UCD Competency Model and completed the questionnaire part, save the Excel file and return it back to mika.nieminen@aalto.fi. Filling in any identifiable information is optional, all responses are treated **confidentially** and handled **anonymously**.





Instructions for applying the UCD Competency Model

The UCD Competency Model outlines the most important competencies necessary for a successful user involved design project. It was built to visualize the strengths that users, designers and other stakeholders can bring to the table when together working on a design project. Additionally to the strengths of the users and designers the model has separate sections for hard and soft skills, i.e. skills gained through education or training, or more based on personal skills or characteristics. Primary uses for the model are to identify gaps in a design team's skills and competencies, so that additional resources, people or training, can be applied and to motivate increased user participation to the design process.

The collaboration between the designers and users includes, but is not limited to, participation to user and market studies, all forms of ideation or problem solving sessions, collaborative or participatory design activities, and validation of concepts or testing the final designs with users. Whenever a person external to the core design team, or user as a member of that team, contributes to the design work it becomes within the scope of this study.

In the spreadsheet, please only enter text or values to the colored fields. Other fields are locked.

In order to apply the model for this questionnaire, please follow these steps:

1. Select a reference project from the past 12 months that you have been involved and that has had active user participation. It is easiest if your reference project has recently ended or is just about to end. Describe the project with a few words, for instance "Designing a new web service for managing customer reservations, Animal hostel Pirs-Katti", you may optionally fill in the name of the project if you like.
   Estimated time spent on this task: 2 minutes.

2. Consider the key participants in your project and group them based on a discipline or a role (referred to as a **group** or **group members** in the competency descriptions). For this study one of the groups should be **End users**. Other groups could be UCD designers, development engineers, customer representatives/business owners, marketing & sales and so on. For efficient use of the model in this study do not create more than 3-4 groups. Give your groups descriptive titles on the top row of the colored table.
   Estimated time spent on this task: 3 minutes.

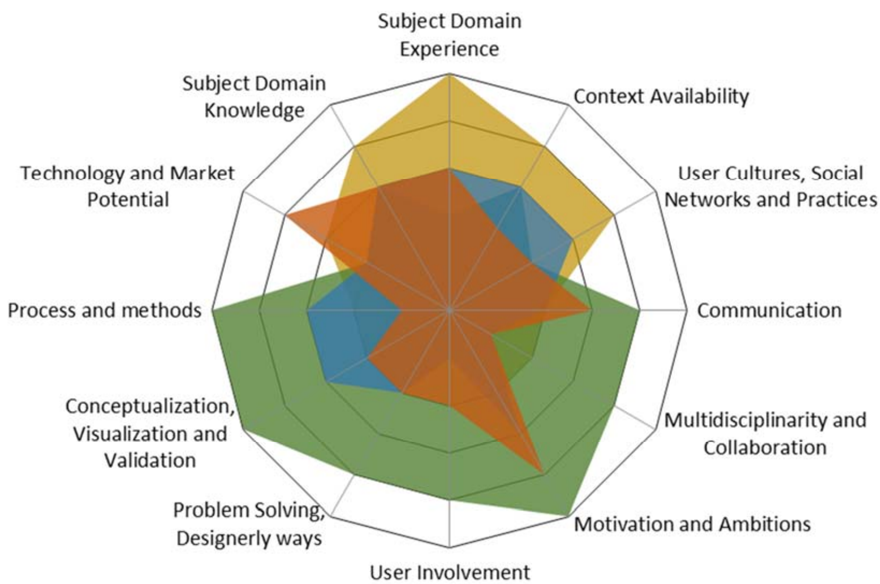
3. Go through all 12 competencies (described in the next pages) one by one and for each rate on which level do each of the participants in your project belong to (1-5). Also provide a value for the team's overall level of competency. Each competency has a short introduction and descriptions for low, medium and high competency levels. All stakeholders in a project do not naturally work on all the aspects of UCD, so you may have to think about their competencies on the lines of "If they had to perform specific tasks to what level of competency would they rate?".
   Estimated time spent on this task: for three groups 30 minutes.

While you are rating your project's competencies a graph is drawn below to show your ratings for each competency and role. When all competencies have a value for every role the model is finished and you may move to the questionnaire part by selecting the "Questionnaire" sheet at the bottom of your excel window.

The questionnaire has altogether 11 questions, just keep scrolling down until you reach the end. After you have completed the questionnaire, please save the excel sheet and return it to mika.nieminen@aalto.fi. Thank you again for you contribution!

Appendix 3: UCD Competency Model, Initial Version Used in the Validation

UCD Competency Model



User strengths	Subject Domain Experience	**Designer strengths**	User Involvement
	Context Availability		Problem Solving, Designerly ways
	User Cultures, Social Networks and Practices		Conceptualization, Visualization and Validation
Soft Skills	Communication	**Hard Skills**	Process and methods
	Multidisciplinarity and Collaboration		Technology and Market Potential
	Motivation and Ambitions		Subject Domain Knowledge

Subject Domain Experience

Subject Domain Experience refers to the specialized skills and knowledge that can only be gained through personal experience. It includes all those not-by-the-book, non-traditional work practices that eventually emerge at every field, or the snowboarding tricks learned by a serious hobbyist. Whether they include appropriated use of tools, adapted work practices or hidden short cuts through company regulations, this valuable expertise is often hidden from view as tacit knowledge embedded to the most experienced members of the subject domain. What makes the utilization of this competency problematic is that its availability may be hidden: if you do not have it you may never know of its existence, and if you have it you might not be able to tell anyone of its existence due to its tacit nature.

Key concepts: subject domain experience, (work) practices, tacit knowledge

Competency level	Description	Remarks
Low **1**	No relevant subject domain history. Newly appointed employee of less than six months of work experience, often covering only a single entry level job role (determined by education and subject domain). Novice user of a product or service, recently started hobbyist.	In the role of a Designer this is one of her first projects in this subject domain.
Medium **3**	Less than three years of relevant experience. May have previous experience at other (entry level) job role and has understanding of both the practical tasks and overall processes. Hobbyist with good or average skills of the subject domain.	
High **5**	More than five years of relevant work experience from several job roles. Includes opportunities for everyday problem solving and work practice development. May provide on-the-job training to new workers and have some management or leadership experience. Committed semi-pro hobbyist with excellent skills, driven to develop her skills on the subject matter. Is considered as an authority or expert of her field.	For jobs of greater complexity and/or autonomy and discretion the experience requirement for the highest level may be 10 years or more.

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Context Availability

Context of use is an important factor in User-Centered Design. Use of products or services is often situated and tightly coupled with the time, location and other contextual factors surrounding the actual use. Understanding the context is necessary when scoping new design projects, during user research and when evaluating the finished design. The access to real context may be hindered by several factors such as geographically remote locations (global design project), security (construction sites or factories), privacy and confidentiality issues (homes, hospitals or banks) or irregular occurrence of use (emergency services). In all cases some of the users have the context available to them even though the designers may only have very limited access. Unfortunately, these privileged users are not always available.

Key concepts: access to actual context of use or environment

Competency level	Description	Remarks
Low **1**	Group member has no access to the real context of use. Contextual facts must be attained in retrospect via second hand reports, logs or media recordings.	Utility of user involvement is severely compromised.
Medium **3**	Limited or supervised access to context of use. The context is available upon arrangement or on predetermined occasions. Normal tasks can easily be observed, but irregular interruptions are missed.	Applies if unobserved events can be afterwards reproduced for further study.
High **5**	Full access to context of work. Either the context has unrestricted access e.g. public place or the participant can gain access rights by agreement, certification or collaboration. In case of random events or otherwise temporally challenging tasks the participant is either the first-tier actor onsite or can be invited to participate at a moment's notice.	Applies if unobserved events can be afterwards accurately reproduced **in their real context of use** for further study.

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User Cultures, Social Networks and Practices

Understanding the future users of a product or a service can be difficult to an outside observer, especially if the user group exhibit behavior or language (either unknown terminology or foreign language) only accessible to a member of that closely knit community. Common practices and naming of items are often products of informal social networks and can differ beyond recognition to others. Inside informant is necessary to make sense of these kinds of user cultures. Examples of such practices and their names include "one ring", a teenager slang term for calling another and letting the phone ring just once before hanging up, or "ten-four", when a police officer acknowledges a message received and understood. Same cultural interpretations are necessary when designing for foreign users and contexts.

Key concepts: Subject domain terminology (Jargon), special user groups, cultural differences

Competency level	Description	Remarks
Low **1**	Group member has no prior knowledge of the target sub-culture or its practices. Members of the relevant practices are not directly involved to the design process. The available information is based on literature, third party informants, common knowledge or hearsay.	Design based on American television shows or stereotypical caricatures of the users.
Medium **3**	Some prior experience on the target culture's practices and has direct contacts to the members of the practice. Can on demand interact with the users/practitioners during the design process.	If designing medical equipment the design team can consult medical doctors to illustrate the interactions among the practitioners.
High **5**	Group includes members of the target sub-culture. Relevant practices are internal to the group and members may invite even wider audiences on demand.	E.g. the group includes (employs) medical doctors. A designer can have also medical training and experience, or a doctor has become competent in design practices.

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Communication

Communication is claimed to be the most time consuming and essential part of design work. Working communication practices enables effective team work and it opens the design process to information sharing among all participating stakeholders. Communication skills enable the delivery of an understandable and relevant message to others, but also requires willingness to participate in a dialog to form a common ground when opinions differ. All participants should feel empowered and have means to initiate communication at any given time. Part of the challenge is to pass through the communication barriers set by multidisciplinary teams and various user cultures or languages.

Key concepts: Communication skills, low threshold to initiate dialog

Competency level	Description	Remarks
Low **1**	Group members are not engaged in direct dialog with other participants and all information exchange is handled by prepared documents or facts are based on assumption or hearsay.	Often the case if participation is management driven or the design team is fragmented either due to geography or lack of social connections.
Medium **3**	Key participants in the design process have been identified and there are available communication channels to reach them. Dialogs are still most often initiated either outwards from group members or towards group members.	
High **5**	All parties are actively and continuously participating in dialog on a personal level. Group members feel confident they can reach out to any other participants, and similarly are available and open for all contacts.	Well-functioning, democratic and sincerely bidirectional communications practices.

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Multidisciplinarity and Collaboration

Multidisciplinary approach is one of the corner stones of User-Centered Design. Understanding the human aspects of a complex design task requires expertise from several fields. Multiple points of view increase the impact of the design. Connecting people of different backgrounds requires willingness to collaborate and venture outside the comfort zone of one's own expertize.

Key concepts: Multidisciplinarity, collaboration

Competency level	Description	Remarks
Low **1**	Group is solely populated by experts of a single discipline, for instance the engineers of the subject field domain.	No established connections to tap into wider expertise from other fields.
Medium **3**	A very few group members can access and utilize other disciplines in a transdisciplinary manner, i.e. specialties are mixed and generalized on need to know basis. Number of different disciplines three or less.	For instance, a singular UCD specialist or consultant participates in the design process with limited support from known experts from other fields, often among her colleagues.
High **5**	Group has a permanent attendance from specialists from three or more relevant disciplines. Adequate tools and resources for collaboration are budgeted for all project phases.	Multidisciplinary UCD approach is built-in to the project with preapproved budget for also unanticipated tasks.

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Motivation and Ambitions

Motivation of the participants in a design project is crucial to its success. Motivation can arise from personal interest towards the subject of the project, satisfaction gained from good utilization of one's abilities or potential to learn new things (and thus, for instance, gain career advantage through self-improvement). Unfortunately participation to a project is not always "voluntary". Additional duties are often simply piled on top of current tasks, and sometimes it is not clear to the person why she is chosen for a certain project.

Key concepts: Motivation, learning, ambition

Competency level	Description	Remarks
Low **1**	Group members are forced to join a design project on a moment's notice with no or cursory relevance to their current assignments. The participation is "in addition to other duties" with no removal of other tasks or additional compensation. With non-work related topics the members are picked at random and are not given a real opportunity to decline to participate (e.g. opinion polls at street corners).	From the perspective of the designers this is a project, where their personal strengths are not utilized properly. They participate as a generic UCD person in a generic project, sometimes on a temporary basis. No personal attachment to the subject matter.
Medium **3**	The project is assigned with group members knowledgeable on the relevant fields who are willing to share their expertize. The users may have some doubts on the project or its UCD approach. Members agree to participate in addition to other duties. Non-work related users are approached in advance about their participation, and they participation to the study/project is conditional on their suitability and demonstrated interest.	Designers' motivation is based on professional skill. Well-tried practices are performed adequately.
High **5**	Participants are chosen among those group members actively seeking to join the project. The task aligns well within their current duties and professional and personal interests. Participation is enabled by additional compensation and/or other duties are removed or scaled down to make time for the project and to legitimize it inside the organization. User see advantage in learning new skills and is convinced to be able to make a difference with her participation.	For instance, a designer is driven by the subject matter or used methodology to immerse into the project. She thrives to improve and develop current practices and learn from the project. Motivation carries her over the not-too-heavy work load.

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User Involvement

Working with end users and other stakeholders is one of the core principles of UCD. User involvement is about identifying and engaging the right people at the right time during the design process, and having the right interaction methods to foster their participation and creativity. Selecting suitable users is dependent on the phase of the process, such as idea generation, development or testing, with variable requirements or opportunities for merging the users' and designers' skills. The utilized interaction repertoire includes the level of personal interaction, number of users, temporal extent of the involvement and the social and professional competencies of the people working with the users.

Key concepts: User involvement skills, user selection, interaction with users, being a user

Competency level	Description	Remarks
Low **1**	Only a few users are involved and their selection is based solely on availability or they are picked by the management. Group member may feel powerless to influence the selection. Group members have no training and limited experience in facilitation or group work. May lack relevant social skills for effective collaboration.	
Medium **3**	Adequate number of users are selected using a valid criteria from a large enough population. The participants responsible for interaction with the users are moderately experiences interviewers and facilitators. Users have sufficient group work skills.	Often UCD consultancies maintain their own user and expert pools, or outsource the recruiting to other companies.
High **5**	Available user population is large enough to enable tailoring the user selection criteria and methods for a specific project. The facilitators have good people skills and several years of experience in collaborative design practices. Participants have received or will receive training for interacting with people. Well-defined facilitation practices and collaboration methods are used.	

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Problem Solving, Designerly ways

User-Centered Design is essentially an attempt to understand the users and propose new solutions to improve their lives. Creating new products and services requires problem solving, thinking outside the box. Essential part of design is to look at things from different perspectives or from a distance. Design as a practice is characterized by an attitude and determination towards introducing a change for the better, and having the necessary means to realize it, responsibly.

Key concepts: Creative problem solving, design thinking, design ethics

Competency level	Description	Remarks
Low **1**	No experience in creative problem solving using any established method or practice. Problem solving happens by freeform brainstorming without any facilitation. Proposed changes are often incremental and the documentation of design solutions and design decisions is done in an ad hoc manner.	Design decisions are given "as is" and tracing them back to original data is difficult.
Medium **3**	A few basic methods for problem solving and analytical thinking are used based on earlier experiences. Decisions are documented mostly as functional statements or user requirements.	Traceability of design decisions can be obtained from appropriate documentation.
High **5**	Group member can select the best suited problem solving methods for the participating team. They make use of some defined analytical framework to make sure the design problems are reviewed from all relevant perspectives. Design decisions and their future implications can be justified based on well-structured and unified understanding that reaches beyond original problem/design space.	The use of multiple or nonconventional methods and variable points of view can promote emergence of radical innovations i.e. solutions that are not evidently available and may be disruptive to the existing solutions.

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Conceptualization, Visualization and Validation

New designs must be defined, given a concrete form and evaluated to find the best available solution. The ideas and features behind a new product must be refined to concepts that describes the full extent of the design. Its form and contents are explored using various visualization techniques from paper and pen sketching to 3D modeling or even cinematic/dramatic depictions. These artifacts are used to test the design internally within the design team, and more importantly with the users and other stakeholders using plurality of usability or user experience evaluation methods.

Key concepts: Conceptualization, visualization, concept validation

Competency level	Description	Remarks
Low **1**	Concept novice: Conceptualization is done in an ad hoc manner with no real documentation. Produced concept definitions are mostly very brief text descriptions that describe the expected features through their functionality. Low visualization skills make communicating the concepts to others difficult and leave unwanted space for individual interpretations. No ongoing policy, practice or skill for testing the new designs with "outsiders".	The concepts can appear as fragmented collections of requirements with conflicting and ambiguous meanings.
Medium **3**	Competent conceptualist: Conceptualization is done using a well-proven methods with sufficient documentation to depict considered alternatives. Concepts are visualized by text narratives, some visual depictions or low fidelity prototypes. Concept validation is mostly handled within the group and is driven by the need to influence the customer or management.	
High **5**	Concept Master: Conceptualizations describes, not only the design at hand, but also its implications to existing or emerging practices. Concepts are well-grounded to facts and understanding the users' needs and the design rationale[74] is made visible to others. Each concept is visualized using several well-suited methods, thus enabling more flexibility when presenting and validating the concepts with both their future users and other relevant parties.	The concepts are factually accurate, coherently focused and highly visual marketing packages made to support decision making.

[74] "Design rationales … include not only the reasons behind a design decision but also the justification for it, the other alternatives considered, the tradeoffs evaluated, and the argumentation that led to the decision." Lee, J., 1997. Design rationale systems: understanding the issues. IEEE Expert 12, 78–85.

User strengths	Subject Domain Experience	**Designer strengths**	User Involvement
	Context Availability		Problem Solving, Designerly ways
	User Cultures, Social Networks and Practices		Conceptualization, Visualization and Validation
Soft Skills	Communication	**Hard Skills**	Process and methods
	Multidisciplinarity and Collaboration		Technology and Market Potential
	Motivation and Ambitions		Subject Domain Knowledge

Process and Methods

Managing a design process requires a holistic view to its many aspect and phases in an iterative fashion. For a successful outcome the right things need to be done in the right order with dedication and rigor. The whole is larger than the sum of its parts. Used design process and its activities can rely on predefined models, but often tailoring and modifications are needed to suit a specific need. Similarly to any goal-oriented activity, design projects require management and leadership to utilize the available resources in a best possible way.

Key concepts: Selection of design process and methodology, project management, tailoring and adaptation

Competency level	Description	Remarks
Low **1**	Group's design efforts are guided by uninformative deadlines with no overarching process. Most tasks and used methods are selected and applied by the participants without guidance or control. Learning new practices is not actively encouraged. Project management and leadership is either missing or authoritative and retrospective.	Path of least resistance. In case of consumer products active participation to design by the general public is often missing.
Medium **3**	Group's design efforts rely on a predefined design process and a set of commonly used methods. Some adaptation of the used methods is evident, but not systematic. Document templates or methods portfolios are used to support the design tasks. Project management is mostly based on the manager's personal skills and choices.	User participation may rely on facilitation by design professionals.
High **5**	A correct design process can be selected to leverage its group members' skills and the individual project's needs. Good methodological vocabulary allows adaptation from a large set of tools and development of new methodology. Project management is professional, transparent and timely, and it seeks to empower all stakeholders.	

User strengths	Subject Domain Experience	**Designer strengths**	User Involvement
	Context Availability		Problem Solving, Designerly ways
	User Cultures, Social Networks and Practices		Conceptualization, Visualization and Validation
Soft Skills	Communication	**Hard Skills**	Process and methods
	Multidisciplinarity and Collaboration		Technology and Market Potential
	Motivation and Ambitions		Subject Domain Knowledge

Technology and Market Potential

Successful product and service design requires a good grasp on current and emerging trends in technology, business opportunities and user practices. Either user behavior drives the development of new technologies or new technology enables and promotes new usage patterns. Business intelligence is often used to describe activities that methodologically search competitive advantage from trends, technology potential and risks, competitive products and weak signals from the markets. Good example combining technology, new usages and market potential is the last 30 years in integrated circuits; incremental advances in material and manufacturing technologies have created a new category "the personal computer", and more recently "the smart phone". These in their part have driven other technical innovations such as display and battery technologies in order to fulfil customers' demand for smaller, faster, brighter, greener or more flexible cell phones.

Key concepts: Technology potential, feasibility, market potential, trends, business intelligence

Competency level	Description	Remarks
Low **1**	Group has no organized technology or market research. Members do not demonstrate personal interests outside common work and consumer products. Information comes from popular media sources (television, papers, books, internet), and friends and colleagues.	
Medium **3**	Group members follow a few key fields of technology on a semi-permanent basis and are somewhat knowledgeable with the ongoing trends in them. Can reflect on potential business implications. Information sources include technical, scientific or trade magazines. Personal interests align and contribute to the deeper understanding of the key fields.	"Jack of all trades, master of none."
High **5**	Systematic collection of information on the key fields and those related to them. Coordination of group level knowledge acquisition (dedicated focus areas). Actively analyzing technology and market knowledge in relation to new business opportunities and has defined practices for disseminating it.	Systematic multidisciplinary coordinated effort. Working reward system for innovations.

User strengths	Subject Domain Experience	**Designer strengths**	User Involvement
	Context Availability		Problem Solving, Designerly ways
	User Cultures, Social Networks and Practices		Conceptualization, Visualization and Validation
Soft Skills	Communication	**Hard Skills**	Process and methods
	Multidisciplinarity and Collaboration		Technology and Market Potential
	Motivation and Ambitions		Subject Domain Knowledge

Subject Domain Knowledge

Subject Domain Knowledge refers to the hard skills and knowledge gained through formal education and training. In many cases this knowledge is demonstrated with a degree or certification. Design problems relating to a specialized field can become so complex that advanced background knowledge and understanding is required about the foundations and theories involved therein. Subject Domain Knowledge may be required to be able to enter otherwise restricted areas or take part in regulated activities. Good example of Subject Domain Knowledge is the theoretical and practical training needed to become an airplane pilot or a medical doctor. In both cases requires certification and a license granted by an accredited authority. Same applies to hobbies such as scuba diving or parachuting with a little less scrutiny. Practices founded on formal procedures, rules or laws require often Subject Domain Knowledge.

Key concepts: Education, vocational training, certifications, theoretical background

Competency level	Description	Remarks
Low **1**	Novice: Insufficient Subject Domain Knowledge. Either no formal training for the subject domain or performing tasks beyond existing education or certification. May benefit from knowledge transfer from other subject domains.	First time scuba diver entering a course. Designer joining a project in a completely unfamiliar field.
Medium **3**	Subject domain specialist: Has the appropriate education and certifications to perform all relevant tasks within the specified subject domain.	Certified scuba diver. Designer working in the field matching her education, or has received additional training in the new field.
High **5**	Subject domain expert: Has superior knowledge of the subject domain with additional insights on its relations to the neighboring fields. Can teach or even certify others.	Certified scuba instructor with additional first-aid training. Subject domain professional with relevant background in other fields such as product design or a design professional with strong supporting subject domain knowledge.

Publications

I	Capturing Mobile and Distributed Work for Concept Development Using Photograph Probes
II	User-Centered Product Concept Development
III	International Remote Usability Evaluation: the Bliss of Not Being There
IV	Time Machine: Creating a Mixed Reality Experience for Children
V	Concept Development with Real Users: Involving Customers in Creative Problem Solving
VI	By the people, for the people: Can People Really Design Their Own Information Systems?
VII	Designer Experience: Exploring Ways to Design in Experience
VIII	Designer Experience - Designing in Experience

User-Centered Design (UCD) has become an established practice for designing new and better products and services. It has evolved from its origins in basing a design on users' wants and needs, to increasingly engaging more stakeholders in the design process. Managing user involvement and design team composition requires a solid understanding of the participants' competencies, i.e. their knowledge, skills and abilities, in order to use their strengths in the best possible way.

By reading this thesis you may find out:
What are the most relevant UCD competencies?
How can these UCD competencies be measured or assessed?
How can a competency approach help UCD projects?

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