HELSINKI UNIVERSITY OF TECHNOLOGY

Faculty of Electronics, Communications and Automation

Kati Kuusinen

Integrating Human-Centered Design into Product Development Process

Thesis submitted in partial fulfillment of the requirements of the degree of Master of Science in Technology.

Tampere, 28.5.2009

Supervisor: Adj. Prof. Timo Korhonen, Helsinki University of Technology

Instructors: Pasi Köppä, M.Sc., Metso Automation,
Jarmo Palviainen, M.Sc., Tampere University of Technology

HELSINKI UNIVERSITY OF TECHNOLOGY **ABSTRACT OF THE MASTER'S THESIS**

Author:	Kati Kuusinen	
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Instructors:	M. Sc. Pasi Köppä, M.Sc. Jarmo Palviainen	

The need for usable systems is growing constantly. Internationalization of products and companies brings new demands for usability. Efficiency and productivity are key issues in the business world. At the same time user experience has risen to a more important role.

A way to integrate human-centered design into an existing product development process of an organization was developed in this master's thesis. A usability maturity assessment, participant observation and interviews were executed in this thesis. With the results obtained with these methods and the cognizance gained in the literature review, a process model for product development was created. The model was tested in a pilot project and it was developed further based on the feedback gained from a survey and interviews after the pilot project.

The process emphasizes the early phase design and involvement of the actual users. The process model divides the product development projects into three categories according to the importance of usability. The usability work methods vary in each category.

The process model created in this thesis has been implemented in the target organization. The change is being supported by training and communication. A central usability group is controlling the compliance with the process. All the usability work outside the development projects is part of the responsibility of the central usability group.

Keywords: Usability, Human-centered design, strategic usability, product development, organizational management

TEKNILLINEN KORKEAKOULU **DIPLOMITYÖN TIIVISTELMÄ**

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Tarve käytettäville tuotteille kasvaa jatkuvasti. Kansainvälistyminen asettaa haasteensa tuotesuunnittelulle. Työkäyttöön tarkoitettujen järjestelmien tehokkuusvaatimukset ovat nousseet. Samalla myös käyttäjäkokemukseen on alettu kiinnittää enemmän huomiota.

Tässä työssä kehitettiin tapa sulauttaa käyttäjäkeskeinen kehitysprosessi yrityksen olemassa olevaan tuotekehitysprosessiin. Yrityksessä toteutettiin käytettävyyden kypsyysarviointi, haastatteluja sekä osallistuva havainnointijakso. Näiden menetelmien avulla saatujen tulosten sekä kirjallisuuslähteiden perusteella luotiin uusi tuotekehityksen prosessimalli, jota testattiin pilottiprojektissa. Projektin osallistujat vastasivat kyselyyn ja heitä haastateltiin. Prosessimallia kehitettiin pilottiprojektista saadun palautteen perusteella.

Ehdotettu prosessi painottaa alkupään suunnittelua ja käyttäjän osallistuttamista tuotekehitykseen. Prosessimalli jakaa tuotekehitysprojektit kolmeen tasoon niiden käytettävyyskriittisyyden suhteen. Eri tasoilla suunnittelutyötä tehdään erilaisia käytettävyyttä parantavia menetelmiä hyödyntäen.

Tässä diplomityössä ehdotettu prosessimalli on otettu käyttöön kohdeyrityksessä. Muutoksen pysyvyyttä tuetaan koulutuksin, tiedotuksin, ja varmistamalla johdon tuki. Prosessin noudattamista valvoo keskeinen käytettävyysryhmä, jonka vastuulla on tuotekehitysprojektien ulkopuolinen käytettävyystyö.

Avainsanat: Käyttäjäkeskeinen tuotekehitys, Käytettävyys, Strateginen käytettävyys, Organisaatiojohtaminen, Tuotekehitysprosessi

Acknowledgements

This master's thesis was conducted in cooperation with Metso Automation and the Unit of Human-Centered Technology (IHTE) in Tampere University of Technology (TUT).

The job offer was so interesting I moved from Espoo to Tampere for this thesis work. I had worked in Metso Automation Helsinki for six years in software development. Now I could continue my work with Metso Corporation in TUT. I got a challenge to evolve product development work in Metso Automation.

I want to thank the Metso Automation product development organization and especially Pasi Köppä and Hannu Paunonen for this interesting research topic and guidance during this work. Many thanks to the pilot project group, the interviewees and the people who read and commented my work. I also thank the IHTE group, especially Jarmo Palviainen for the guidance and encourage during the thesis work and Jari Varsaluoma, Jani Sundström, Sari Kujala and Kaisa Väänänen-Vainio-Mattila for their help. I also want to thank the HUT people, Timo Korhonen for supervising my work and Miia Martinsuo for introducing literature of management and development processes.

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Tampere May 28, 2009

Kati Kuusinen

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List of Names and Acronyms

CI	Contextual Inquiry
CMM	Capability Maturity Model
DNA	Dynamic Network of Applications
HCD	Human-Centered Design
HCI	Human-Computer Interaction
HUT	Helsinki University of Technology
IHTE	Unit of Human-Centered Technology
ISO	The International Organization for Standardization
MS	Microsoft
QMMG	Quality Management Maturity Grid
SPICE	Software Process Improvement Capability Determination
SQL	Structured Query Language
TEKES	Finnish Funding Agency for Technology and Innovation
TQM	Total Quality Management
TR	Technical Report
TRUMP	Trial Usability Maturity Process
TUT	Tampere University of Technology
UCD	User-Centered Design
UCM	Usability Capability Maturity
UI	User Interface
UMA	Usability Maturity Assessment
UMM	Usability Maturity Model
UMM-P	Usability Maturity Model - Processes
UX	User Experience

Key Definitions

Action research	A research method that is often used to improve practice. The phases are identifying the problem, planning, acting, observing, and reflecting. [Järvinen & Järvinen 2004; Kumar 2005]
Capability Maturity Model for Software	A reference model for evaluating software process maturity. It is intended to help software organizations to improve the maturity of their software processes. It is developed by the Software engineering Institute. [Herbsleb et al.1997; Paulk 1993]
Change	Developing or development work towards something new. The outcome is different from the earlier and the earlier is replaced by the new one. [Russell-Jones 1995]
Change management	Maintaining a continuous change and managing radical change or leading a planned change and an increasing change in an organization [Apilo et al. 2007]
Consumer	A customer who is also a user [Magnusson 2003]
Context of use	Users, tasks, equipment (hardware, software and materials), and the physical and social environments in which a product is used [ISO 9241-11:1998, definition 3.5]
Control room	A dedicated place for viewing and controlling the processes, the operator´s control place [Paunonen, 1997]
Competitive advantage	Occurs whenever a business is able to sustain an edge over its rivals by attracting customers and defending itself against competitive forces. [Cook & Hunsaker 2001]
Customer	A private individual or a company that makes the decision to purchase a product or service.
Development	The translation of research findings or other knowledge into a plan or design for new, modified, or improved products, processes, and services [Juran & Godfrey 1998]
Front End of Innovation	The phases of an innovation process that precedes the systematic product development made in projects. [Apilo et al. 2007]
Human-centered design	The attitudes and approaches (principles and techniques) used for developing usable systems [Karat 1997]
Human-centered design integration	The actions to embed HCD into the current product development process of an organization.

Immediate process control	An activity of an organization to control the process in an on-line cycle. Involves for example monitoring the process, performing changes and reacting to disturbances. [Paunonen 1997]
Innovation	1. An economic realization of an idea. 2. The process of putting an invention to commercial use.
Iteration	Design work that involves correction, feedback or interdependencies and is done in cycles. [Unger & Eppinger 2002]
Operator	A person taking care of immediate process control [Paunonen 1997]
Organizational Change	Moving of an organization toward a desired future state [Tushman & Anderson 2004]
Process	A sequence of steps that transforms a set of inputs into a set of outputs. [Ulrich & Eppinger 2003] A set of functions and equipment performing production [Paunonen 1997]
Product	A device that provides a service that enhances human experience [Cagan & Vogel 2002]
Product Development Process	The sequence of steps or activities which an enterprise employs to conceive, design and commercialize a product [Ulrich & Eppinger 2003]. The systematic part of innovation process that is made in projects and starts after front end of innovation [Apilo et al. 2007].
Prototype	A demonstrator to be created to represent the product built for testing and experimentation [Ketola 2002]
Quality	A degree to which a set of inherent characteristic fulfils requirements [ISO 9000:2000]
Requirement	A need or expectation that is stated, generally implied or obligatory [ISO 9000:2000]
Service	An activity that enhances human experience [Cagan & Vogel, 2002]
Situation awareness	It refers to an operator's state of knowledge of the relevant aspects of a dynamic environment with which a person is interacting. [Sheridan 2002]

Strategic usability	Embedding usability engineering in the organizational processes, culture, and product roadmaps [Rosenbaum et al. 2000]. Usability work supports the overall business objectives of the organization [Bloomer et al. 1997].
Style guide	A style guide is a collection of good practices and organizational practices in interface design [TRUMP 2008]
Sustainability	When new ways of working and improved outcomes become the norm [Buchanan et al. 2005]. Making an innovation routine until it reaches obsolescence [Greenhalgh et al. 2004].
Usability	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 9241-11:1998, definition 3.1; ISO 13407:1999]
Usability Maturity Model	A reference model that is used to measure the capability of a development process to generate usable outcome. [Kuutti et al. 1998]
Usability method	Method supporting human-centered design used for the purpose of increasing the usability of a product or a system [ISO TR 16982:2002, definition 3.4]
User	Individual interacting with the system [ISO 13407: 1999, definition 2.8]
User Experience	All aspects a person has when interacting with a system [Tullis & Albert 2008]. People's felt experience with technology [McCarthy & Wright 2004]. Non-utilitarian aspects of human-technology interaction, shifting the focus to user affect and sensation [Law et al. 2008].
User-centered design	A design approach to product development that focuses the user of the system being created. [Veryzer & Mozota 2005]
User need	User needs refer to problems that hinder users in achieving their goals, or opportunities to improve the likelihood of users' achieving their goals. An important factor affecting on user needs is the context of use. [Kujala 2002]
User requirement	Any function, constraint, or other property that is required in order to satisfy user needs. User requirements are elicited from users and described from the user and customer point of view. [Kujala 2002]

1. Introduction

This master's thesis has been done in a TEKES-funded project called KASTE that aims to establish and develop good automation design practices that take cognizance of all user groups. The purpose of the KASTE project is to assert human-centered methods as a part of multifunctional machinery automation product development. The participants of the TEKES funded KASTE project are Tampere University of technology, Metso Automation, Metso Minerals, John Deere, Kone, and Kalmar.

This thesis has been done for Metso Automation. The objective of this thesis is to develop and improve the product and service creation process of Metso Automation so that it would systematically result into usable products and services. The meaning is to formalize the state of human-centered design in the way that the work would be official and controlled. The aim is to integrate and establish human-centered design into the product and service creation process. Integrating human-centered design into a product development process is a change process in the organization and it takes time and demands internalizing new methods and a new approach of work.

The research method used in this master's thesis is action research. The method was selected because the research conducted in this thesis endeavors to change the product development organization and its ways of working.

1.1. Research Problem

The research questions are

1. Why should a product development process support human-centered design?
2. What does human-centered design mean in a product development process?
3. What is the present state of the application of human-centered design approach in the product development process and practicalities in Metso Automation?
4. How should the present product development process be changed in order to support human-centered design?
5. How the change can be realized?

The first two research questions are inherently more general and they are answered in the theoretical part of this master's thesis based on the literature. The first question is answered particularly in the chapter five but also in the chapter two of this thesis. The second question is answered in the chapter two. The third research question concerns the product development in Metso Automation particularly and it is answered in the research part of this thesis, in the chapters six and eight. The fourth research question depends partly on the third question and it also has a theoretical background. It is discussed through the thesis, particularly in the chapters five, eight and two. The fifth question is also discussed in theory and applied in the case of Metso Automation. The fifth question is answered particularly in the chapters four and eight.

1.2. The Structure of the Thesis

Chapters 2 - 5 form the literature review part of this master's thesis. Chapter 2 discusses human-centered design and usability in general. Chapter 3 is about industrial product development, product development processes and innovating in product development. Chapter 4 is an insight into organizational and change management. And chapter 5 collects up the theory in the viewpoint of integrating human-centered design into product development.

Chapters 6, 7 and 8 establish the experimental part of this thesis. Chapter 6 is about the context and background of the thesis work. It represents the Metso Automation's Tampere location, its business field, customers and users, and the product development organization. Chapter 7 introduces the research methods used during the thesis work. Chapter 8 describes the results and conclusions of the research conducted in this thesis.

2. Human-Centered Design

This chapter describes the concepts of usability and user experience, UX and the principles of human-centered design, HCD. It also represents the most salient standards in the field of human-centered design.

2.1. Usability and User Experience

Usability is a part of system acceptability. It is a quality attribute that evaluates the subjective level of how well the specified users are able to achieve their specified goals. It also refers to the methods that are used to improve the ease of use when producing products or services. It is easy to learn how to use a usable system and it is efficient to use when learned. Its use is easy to recall after long time of not using the system. The users do not make errors when using the system and they are satisfied with the system and using it. [Nielsen 1993; ISO 9241-11:1998]

ISO 9241-11 defines that usability is about effectiveness, efficiency, and satisfaction. Effectiveness tells if the users are able to achieve their goals with the system. Efficiency is about the effort that is required to complete the task and it can often be measured in duration. Satisfaction is a subjective attribute of how the users feel about the system.

Current research weights more hedonic attributes and user experience (UX), which refers to all aspects a person has when interacting with a system [Tullis & Albert 2008]. Hedonic or experiential aspects are for example pleasure, fun, presence, emotionality and aesthetics. Usability can be seen as the interaction between human and system, user cognition and performance (fig 2-1). Functionality is a technical issue referring solely on the product, and user experience refers to the individual’s personal experience or relationship with the system or product. [McNamara & Kirakowski 2006; Tullis & Albert 2008; Law et al. 2008] The figure 2-1 presents usability as the interaction between human and system in a specified context. Context or environment of use is represented with the green oval and usability with the yellow triangle. UX is represented by the white thought balloon and functionality with the gray one.

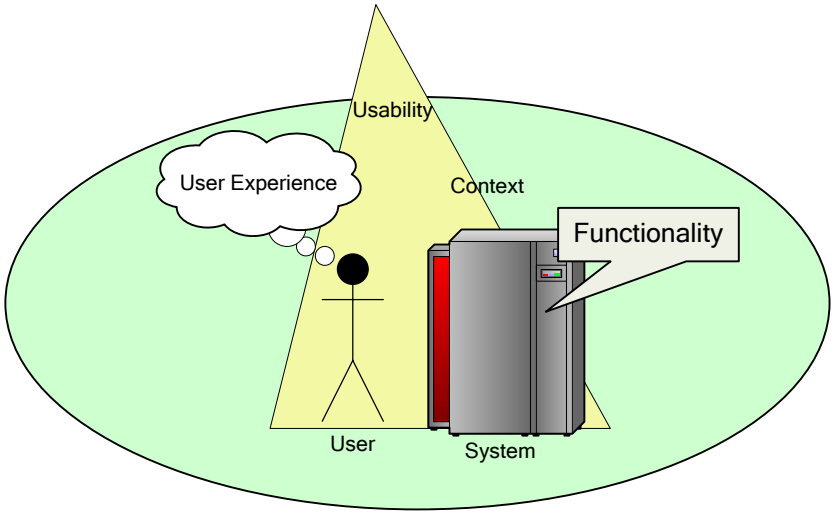

Figure 2-1 Usability and User Experience

To fit for the use, the product or service has to be both usable and functional. If the product is utile, it does what the users need it to do and the users are able to reach their goals with it. For example in the case of regular fixed-line telephone; if it is utile, it has the functionality needed to make and receive calls. If it is usable, the user can easily make and receive calls with it. To be practically accepted, the product or service has also to be available at reasonable price and it has to be compatible with other devices. [Nielsen, 1993; ISO 13407] Usability and utility can be seen as overlapping concepts since ISO 13407 comprises effectiveness and efficiency. The concept of usability has been developing during the last decades and the boundaries between usability, utility, user experience and functionality are not clear. There are divergent interpretations that define the concepts differently.

The significance of usability is growing constantly. In many cases the product or service is not acceptable if it is not usable. The users refuse to use it and they select a replacement instead. Nowadays the product and service markets for consumers are so wide that the users can select the products they prefer. In the work context the development of the awareness of the usability importance is a bit slower since the users are not usually allowed to select the purchased products and systems themselves. Nevertheless the decision makers in companies are also getting more aware of the positive impacts that usability has on effectiveness and productivity. Increasingly the users are participating in the purchase decisions. People have a stronger sense that the technology is for humans and they are not willing to adapt to using difficult technology.

Also the business requirements for efficiency are higher than before. The technology will be more invisible so that the user does not have to know how the system operates or what happens inside the machine. The technology has become a part of the everyday life and no designer should rely on the user's technical expertise. A designer or engineer is a technical specialist; the user is an expert in some other field.

The products and services should be usable so that they would support the natural characteristics of the human user. That leads to fewer errors, more pleasant using, and to efficiency and satisfaction when using the product or service. Many accidents have happened because of human error, that is to say – because of poor usability. Usability supports the activities, decisions and physiology of human. Therefore the users are able to concentrate to their actual job. In a usable product, the ergonomics are well designed; the user does not have to crane, bend, squint, or memorize long lists or sequences. Also the layout is well designed; the user does not accidentally press wrong button or leave required fields unfilled.

2.2. Human-Centered Design

To constantly produce acceptable and usable products or services, their development needs to be based on HCD and the developers have to know how to exploit the HCD methods. In practice, usable products are not originated accidentally, usability is not based on a common sense and it is not a matter of opinion. Whereas a database system will not be designed well without database experts and good practices, the quality of use is not generally achieved without usability experts and good practices.

HCD is a process that in principle leads to usable systems. Usability can be considered as a quality factor. Quality or usability cannot be added to a system but they can be achieved by investing into the development work continuously. An appropriate development process or life cycle is needed to produce high quality high usability products or services.

In the HCD the users and other stakeholders are in an important role and an actual user participates in the design process [ISO 13407:1999]. HCD focuses on making usable interactive systems. It combines technology, ergonomics and human factors. Special

attention is paid to human health, safety and performance and it also takes into account human capabilities, skills, limitations and needs. Human or user-centered design appreciates human as is and it abbreviates that designing should concentrate on the human and their needs. [ISO 13407:1999] While user-centered design emphasizes the actual user of a system, human-centered design concentrates also on the other persons the system is influencing, the stakeholders [Gulliksen 2008]. These concepts are often used as synonyms [Jokela et al. 2003]. Design that pays attention to the user directs to increased productivity, better quality of work, drop in support and training costs, and improve in user satisfaction [ISO 13407:1999].

HCD answers to the question "who are the users of our design and what is the problem we are trying to solve for them?" That may be seen as the question in product development and in business operations on the whole. What do the customers want and what they are willing to pay to get it? Can we answer to the customer's problem better than the rivals? In many cases the product development has been about trying to think up what the users or customers might want and then to develop a product just to see what is wrong with it, why does it not sell. In HCD the users' work, context and desires are examined and the developers process the users' needs into a marketable product. In the HCD the users give inspiration and hints to the developers who try to find out the essentials of the user needs. The users are the experts in their own field. The developers have to do the actual design work from the snippets they get from the users. Generally it is not productive for a developer to ask the users how they would design the system. It is important to keep in mind that a user is not a developer more than a developer is a user. The developer's job is to examine the suggestions the user makes and then to evaluate them in the terms of the requirements of the activity [Norman 2005].

2.2.1. Human-Centered Design and Usability Standards

Standards relating to usability and HCD can be divided into different categories depending on their primary concern. Bevan [2001] divides standards into four categories as follows:

1. The use of the product (effectiveness, efficiency, and satisfaction in a particular context of use)
2. The user interface and interaction
3. The process used to develop the product
4. The capability of an organization to apply HCD

When the purpose is to develop usable products, all the categories of standards are undergone. Standards belonging to the first category define the concept of usability, user, and the context of use. They concern the quality of use. The second category handles the product quality; user interface and interaction and how they should be realized in a usable product or service. This master's thesis concentrates on the standards in the third and the fourth category since they discuss the process of making usable products and services. The third category deals with process quality and the fourth with the organizational capability. Process quality is discussed later in this chapter and the organizational capability is discussed further in the chapter 5 "Integrating HCD with Product Development".

Usability and HCD standards can be categorized also differently, but the basic idea remains the same. In the UsabilityNet site the standards are divided into three categories; standards affecting product development process, standards that define the use of a product and standards that concern the design of interaction and user interface. Also categorization into two classes, standards defining the product and standards defining the process has been used. [UsabilityNet 2008]

2.2.2. Human-Centered Design Process

The main standard in usability area concerning product development process is ISO 13407 "Human-centered design processes for interactive systems" [UsabilityNet 2008]. The standard gives principles and recommendations of product development. It describes a process on HCD activities for the life cycle of interactive computer-based systems. The standard is aimed at process managers and it focuses on planning and management of HCD. The standard provides guidance on HCD activities throughout the life cycle of interactive computer-based systems. HCD requires multidisciplinary

approach, since it concerns human factors and ergonomics knowledge, and techniques with the objective of enhancing effectiveness and efficiency, improving human working conditions, and preventing possible harmful effects of use on human health, safety, and performance. The main idea is to help in developing products that are most suitable for human use. [ISO 13407:1999, UsabilityNet 2008]

ISO 13407 standard identifies four basic principles of HCD:

- Appropriate task allocation between the user and the system
- Active involvement of users
- Iteration of design systems, and
- Using multi-disciplinary design teams

Practicing these principles leads to identification of the following four HCD activities that help to build systems fulfilling user needs (fig. 2-2):

- Understand and specify the context of use
- Specify the user and organizational requirements
- Produce designs and prototypes
- Carry out user-based assessment [ISO 13407:1999]

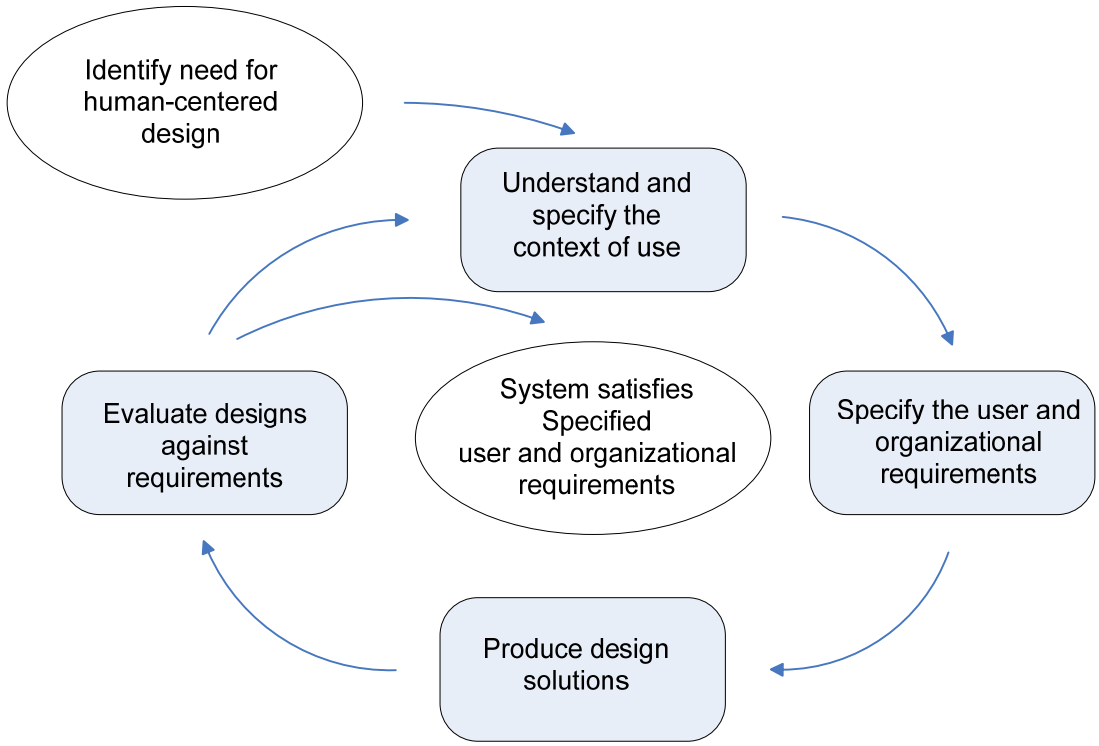

Figure 2-2 Standardized Human-Centered Design Process [ISO 13407:1999]

The activities of the ISO 13407 HCD process presented in the figure 2-2 are fulfilled iteratively and the cycle is repeated until the particular usability objectives have been reached. The process starts with identifying the need for HCD; when the fact that the system needs to be usable is understood. The spark for HCD can derive for example from positive or negative feedback, from a development idea, from customers or users or from the finding that the competitors have better products or that the product support costs are too high. Understanding and specifying the context of use is the first step in developing usable products. Understanding who the users are, what are their needs and tasks, and what kind of context they operate in, helps the developers to create more usable products that fit the users' needs. If this information is not readily available it should be collected. The information should be confirmed by the users and documented carefully for future use. If the project is about enhancing or upgrading an existing system or product, the data might already be available, but its validity should be checked because the user groups might just be apparently similar or the data may be old dated. [ISO 13407:1999]

After acquiring the understanding of the context of use, the requirements are specified. If the context is not well defined, the requirements gathering is difficult and it is hard to be comprehensive because the requirements are based on the user's needs and the task. The requirements consist of user and organizational requirements that include for example safety and health requirements, users' jobs and task allocation, and work design. They should define much more than just the simple human-computer interaction or the user-interface. The requirements should go deep and detailed into the user needs and tasks. [ISO 13407:1999]

The HCD process is iterative and if in any phase the designers realize that they need more information about some other activity to fulfill the activity in the making, they can return to it. Designs and prototypes are produced when the background information is available. Designs are evaluated against requirements and if they do not meet the requirements, the design work will be continued iteratively. Design work is based on the context of use analysis outcome. One idea in making prototypes is to make it easier to communicate the design ideas to the users and get their feedback in the early phase. [ISO 13407:1999]

Evaluation is an essential part of all stages in the system life cycle. The previous versions of a system or the versions of competitor products can be evaluated before starting to develop a new version of a system. The prototypes should be evaluated between the iteration cycles to find the weaknesses in the design in the early phase. It will be relatively inexpensive to fix faults if they are found during prototyping. If users find them after launch, the fixes will be very expensive and time consuming.

Independently of the selected design process, the human-centered approach is characterized by the following: active user involvement and clear understanding of user and task requirements, allocation of user and system tasks, the iteration of design solutions and multi-disciplinary design. [ISO 13407:1999] The users should actively involve with development through the whole product life cycle. The users are experts in their work, ways of action, context of use and the task. User involvement helps to collect the user and task requirements since the designer cannot think like the user.

In the definition of the EU TRUMP-project [TRUMP 2008], HCD process has at the minimum three phases, which are stakeholder meeting, evaluating early design concepts from a user perspective and testing the usability of prototypes with real users. TRUMP recommends a bit more covering process, which is described in the Table 2-1. In the KASTE project in which this thesis is done, the usability maturity assessment and the system life cycle are based on the TRUMP process. The TRUMP process is based on international standards and the principles of HCD. The TRUMP is a project that has raised the usability maturity of large organizations and it distributes its knowledge to others to achieve similar results. The name TRUMP comes from the words TRial, Usability, Maturity and Process. The goal of the EU TRUMP project was to integrate usability methods into existing product development processes and to increase usability awareness in organizational cultures to increase the quality of products and systems. Its methods were applied in trial projects. The results of the project were judged very valuable and cost effective and the methods are incorporated into the product development processes of the organizations that attended the trial projects. [TRUMP 2008; Bevan & Bogomolni 2000]

Table 2-1 ISO 13407 and TRUMP process [Bevan & Bogomolni 2000]

<table>
<tr><th colspan="6">ISO 13407 Process</th></tr>
<tr><td>Plan project</td><td>Specify the context of use</td><td>Specify the requirements</td><td>Produce design solutions</td><td colspan="2">Evaluate designs</td></tr>
<tr><th colspan="6">TRUMP Lifecycle</th></tr>
<tr><td colspan="2">Feasibility</td><td>Requirements</td><td>Design</td><td>Implement</td><td>Release</td></tr>
<tr><td>1. Stakeholder meeting</td><td>2. Context of use
3. Scenarios</td><td>4. Evaluate existing system
5. Usability requirements</td><td>6. Prototyping
7. Style guide</td><td>8. Evaluation
9. Usability testing</td><td>10. Collect feedback</td></tr>
</table>

The methods that the TRUMP project recommends are numbered in the table above and they are described more closely in the following chapters. There are also other methods available but usually their function is rather similar. The TRUMP process is relatively well instructed and it covers the product development process in full. Maguire [2001] and UsabilityNet have fairly comprehensive mapping of HCD methods.

2.2.3. Human-Centered Design Methods

A standard concerning HCD process ISO/TR 16982:2002 "Ergonomics of human-system interaction – Usability methods supporting human-centered design" provides information about different widely used HCD methods and how to use them to support HCD as described in the standard ISO 13407. The methods help to develop systems that meet the usability goals of a HCD process. They also help to define the usability goals for a system. [ISO/TR 16982:2002; Bevan 2001]

ISO/TR 16982 divides the methods into design and evaluation methods in terms of their function. The design methods focus on gaining a better understanding of the user and the context that relates the tasks for which the system is being created. The objective is to gather data about the user's capabilities, knowledge and limitations. The evaluation methods measure the quality of the design or a prototype against user's preferences. Many methods can be used for both purposes. [ISO/TR 16982:2002] In this thesis the author uses division into four categories described in the ISO 13407 (fig. 2-2).

2.2.3.1. Data Gathering Methods

These methods can be applied to understand and specify the context of use. Their purpose is to acquire data about the potential users, their tasks and context of use.

Stakeholder Meeting

A stakeholder meeting is typically a half-day gathering where people who are interested in business objectives and intended users and usage encounter. The goal of the meeting is to collect information, separate usability objectives from business objectives and commit to the usability work. The stakeholder meeting brings together relevant people

and helps to form a common vision. It also helps to identify the factors that relate to the use of the system before the design work begins. [TRUMP 2008; UsabilityNet 2008] In a stakeholder meeting also the role of HCD in the project can be discussed; how much usability work will be invested in making the system. The importance of usability for the system is analyzed in the meeting and based on the importance the scope of the usability work is agreed.

At least a business manager, a project manager and user representatives should attend the stakeholder meeting. Other participants could be from marketing, development, support and training. Different stakeholders can give different points of view in the usability area. In the meeting the objectives of the system and the users and their tasks are discussed. The usability goals and metrics are set and it will be decided how to determine that the project has been successful. A usability goal can be for example that the system is considered successful if 90 percent of the intended users can perform a certain task without errors in one minute and their overall satisfaction of the system is at least 6 on average on a scale to 1-8. Also existing or competitor systems can be analyzed in the meeting. [UsabilityNet 2008; Jokela 2003]

Observing

Observing real people in authentic situations and context is one widely used method to find out and understand the diverse needs people have. Observation is a field study where the investigator watches users as they work. It can give the observer an understanding of the user's work. It is a method that may also uncover people's emotions, motivations and goals when used together with master-apprentice approach or interviewing (described below). [ISO/TR 16982 2002; UsabilityNet 2008]

Interviewing

In HCD, interviewing is a method where an interviewer asks questions from an informant to discover facts and opinions held by the users or potential users of a system. It is a challenging method since it requires planning the questions and analyzing the gathered data that is often unstructured. The interviewer must be deliberate not to prompt the interviewee. [UsabilityNet 2008; ISO/TR 16982:2002]

Contextual inquiry (CI) is a special type of interview where a user is interviewed in the context when he or she is doing their task. A contextual inquiry session is started with traditional interview, which is later switched to a master-apprentice relation. The interviewer tells the user what they want to learn. The interviewer observes the user and asks questions of the interviewee's task like an apprentice trying to learn the master's work. It is important to time the questions so that they would not disrupt the user's work. In the final phase the interviewer should summarize what they learned during the CI and let the user correct the possible misunderstandings. [UsabilityNet 2008]

The CI session should be interpreted in a group within 48 hours after the interviewing. The interviewer and some designers should attend, preferably also other stakeholders. The group is needed to make the interpretation more accurate and valid. The early findings are discussed informally in the interpretation session. The interpretation session aims at capturing the user and organization profiles which can lead to work models. [Holtzblatt et al. 2005]

User Surveys and Questionnaires

Survey is a means to get quantitative data since it is a straightforward way to get answers from a large number of people. In a survey the questions are represented in the exactly same form to every respondent. The surveys can usually be analyzed statistically and thus the data can be considered objective. Survey questions need to be carefully prepared and it is necessary to test or walk through the survey before releasing it. User surveys and questionnaires can be also used for feedback after releasing the system. Surveys can be used for example to measure attitudes towards an issue. Likert-scale is one commonly used type of attitudinal scales. It is also called the summated rating scale and it can be considered as the easiest of the attitudinal scales to construct [Kumar 2005]. [UsabilityNet 2008]

> Attitudinal question can be for example:
>
> "I find the system pleasant to use"
>
> The answering options on a likert scale could be: 1. strongly disagree, 2. disagree, 3. uncertain, 4. agree, and 5. strongly agree.

Context of Use

In the context of use process the users, their tasks, and their operating environment are analyzed. The results of the analysis contain information of the users and their goals, the characteristics of the users' tasks and descriptions of the users' environment of operating. The goal is something the user wants to achieve, the tasks are a way to get to the goal and the environment is the context in which the user works for the goal. The purpose of the context of use analysis is to ensure that everything that relates to the use is identified before the design work starts. Context of use analysis also gives a starting point for designing the usability tests for the system. The requirements gathering bases on the context of use analysis. Also the information needed for context of use analysis can be gathered in a half day meeting with stakeholders who have knowledge about the users and usage. [UsabilityNet 2008; Jokela 2003]

Table 2-2 Context of use -factors [Maguire & Bevan 2002]

User group	Tasks	Technical environment
• System skills and experience • Task knowledge • Training • Qualifications • Language skills • Age & gender • Physical & cognitive capabilities • Attitudes and motivations	• Task list • Goal • Output • Steps • Frequency • Importance • Duration • Dependencies	• Hardware • Software • Network • Reference material • Other equipment
Physical environment	**Organizational environment**	
• Auditory environment • Thermal environment • Visual environment • Vibration • Space and furniture • User posture • Health hazards • Protective clothing & equipment	• Work practices • Assistance • Interruptions • Management & communications structure • Computer use policy • Organizational aims • Industrial relations • Job characteristics	

In the Table 2-2 there are represented different areas of user context and their central factors. User environment divides into physical, technical, and organizational environment which all can constrain or affect the operating of a system to be designed. Users can form different groups according to their experience and knowledge and other factors. Users can have different kinds of tasks. They can use the same system to get to different goals, and their using frequency may vary. All these elements have an

influence on the design of the system and they have to be considered when designing a usable system.

2.2.3.2. Data Analyzing Methods

Data analyzing methods are applied to gain an understanding of the gathered data. The data should be processed and documented in a way that it can be utilized in product developing. The user requirements can be written based on the gathered and analyzed data.

Task Scenarios

When the context of use is known, the tasks of users can be examined. A task is always performed in a context and the context has an influence on the task. Scenarios detail how the tasks are carried out in a specific context. The scenarios do not define or include the features of the products used. They just tell the steps the users have to make to accomplish their goal. A scenario can consist of several real tasks and not match exactly to an observed task. [usabilityNet 2008; Usabilityframework 2008]

Task scenarios can be used as a part of wider analysis. For example in the collaboration usability analysis, the task scenarios method forms one component of the task model. The other components are tasks, individual and collaborative task instantiations, and actions.

Evaluating an Existing System

If there is a previous or a competitor version of the product being developed, it is worthwhile to be evaluated. Evaluating an existing system can identify problems that should be avoided in the design of the new system. It also gives a good starting point for the usability measures and metrics the new system needs to fulfill. [UsabilityNet 2008]

The evaluation can be performed by applying the usability testing method or the method used to evaluate a prototype, both techniques are described below. Also task analysis can be used. The test is run by using the most important tasks and user groups. The goal is to find out usability problems that should be avoided in the new system. [UsabilityNet 2008]

Usability Requirements

Usability requirements are gathered based on the user, context and task analysis. The requirements are specific and consider things such as user task performance, user satisfaction, learnability and memorability. The requirements should be clear and measurable so that they can be verified for example in tests or questionnaires. For example when measuring effectiveness, task completion rate can be used as a metric; the percentage of test users who completely and correctly achieve each goal. The following are examples of decent usability requirements with a separate definition of target level: “95 % of the primary users can perform the task in three minutes after ten minutes training” and with the minimum acceptance level: “90 % of the users give at least 6 on a scale of 1 to 7 when asking how satisfied they are with the system”. They are examples of good, measurable usability requirements. [TRUMP 2008, NIST 2007]

2.2.3.3. Product Design Methods

The following methods are utilized during the product design phase after the requirements are specified.

Parallel Design

In parallel design two to four independent design groups create alternative designs at the same time. The aim is to generate as much diversity as possible, to create different ideas before settling to a single concept. When the designers work as one group, the ideas lose their diversity. [Nielsen 1993; Maguire 2001; UsabilityNet 2008]

Paper Prototyping

Paper prototyping is a form of rapid prototyping where quick low-fidelity prototypes are generated. The idea is to produce drafts of screens and interaction very rapidly. The equipment includes paper, sticky notes and pencils. The method includes brainstorming and the group rapidly reworks the new ideas to the draft. The participants are designers, developers and users. One person should record the ideas and issues that rise during the meeting. Paper prototyping is a method that does not require very deep understanding in

the usability area, whereupon it is a suitable method in many product development organizations. [TRUMP 2008]

Paper prototyping takes several sessions in many cases. A typical set is to do four stages of paper prototyping. The stages are concept design, interaction design, screen design and screen testing. Paper prototyping is an inexpensive and fast technique that motivates the participants to brainstorm and generate new ideas and ways to do things differently. Parallel design can be combined with prototyping. Alternative design ideas are a very good way to deviate from the traditional way of doing development work. [TRUMP 2008]

Paper prototypes can be used in early stage usability tests when the user interaction methods and the interface can still be easily and cost-effectively modified. Time and resources are saved when the changes are done in the early phase.

Style Guide

A style guide is a collection of well-known good practices and organizational practices in interface design [TRUMP 2008]. A style guide identifies, documents, and helps the product development to commit to the industry, corporate or project conventions for screen and page design. [Bevan & Bogomolni 2000] The factors that have to be catered in the product or service design are listed and explained in a style guide. Style guides help especially with the conformity and consistence of product families because the style of the user interfaces is in line.

A style guide may be general or focused on something, for example on web design. It can define principles of general user interface design or for category-specific interfaces such as principles for designing a certain system consisting of different parts. A style guide can also cater only the design of one product and its versions. A style guide can cover different forms of user interaction design. It can define the style of graphics, sounds, language, and phrases the design uses. [TRUMP 2008]

2.2.3.4. Evaluation Methods

These methods are applied to evaluate a concept, prototype, design or an actual system. They can be utilized in the design phase for example to iterate prototypes.

Thinking Aloud

In thinking aloud the users are asked to verbalize their thoughts, ideas, beliefs, expectations etc. when using the system. The method reveals user's mental processes, thoughts about the system and reasons for the user's actions. An experimenter documents the user's comments or the session can be videoed. Thinking aloud is usually performed with an evaluation method such as usability testing. [ISO/TR 16982:2002]

Evaluation of Prototypes

Prototypes are evaluated to get rapid feedback on the usability of the system being designed. Prototype evaluation is a simplified version of usability testing. Real users of the system are needed for the evaluation. It is recommended that from three to five users evaluate the prototype. Evaluation of prototypes ensures that the potential usability problems can be detected at an early stage before the design work is completed. The user should explain their impression of the content of each screen and the reasons for their choices. The think aloud method can be used when evaluating. [TRUMP 2008]

Also expert or heuristic evaluation can be used to evaluate prototypes. Both of these evaluation methods are performed by usability experts. In expert evaluation a usability expert inspects the system or its prototype and identifies usability problems. A usability expert can use heuristic lists to help in the inspection.

Usability Testing

Usability testing is a method in which a system or prototype is tested for usability problems. Actual, representative users are selected to conduct the tests. The test includes real or real-based tasks that the users carry out. The users should be encouraged to think aloud and tell what they are trying to do when using the system. It is beneficial if the developers can attend the test session as observers. The result of the

method is a list of usability faults, problems and deficiencies discovered during the testing, categorized by importance and type of the problem. [TRUMP 2008]

Collecting Feedback

Collecting feedback is essential for measuring the quality and learning from the past. Feedback should be collected in a planned and systematic manner to be extensive and reliable. Feedback can be gathered for example with questionnaires, surveys, interviews, or by observing users [TRUMP 2008]. A good way to gather feedback is to ask the users' opinion six to twelve months after launch. Then the users have already learned to use the system and they do not just compare the system to the previous one. Collecting feedback and utilizing it in the prospective product development is often failing in the companies [Palviainen 2008].

2.3. Chapter Summary

This chapter collected up the basic theory of HCD and usability. Usability can be seen as a factor of usage together with functionality and user experience. HCD is a systematized means to constantly develop usable products. HCD is a process which emphasizes the user participation in the development. Different methods can be used to ensure the product quality of use.

3. Product Development and Innovations

This chapter represents industrial product development and innovating involved with it. It also represents an innovation process model.

To grow into an innovation, an idea needs support both from people and processes of an organization. When the basic processes are functional, the people are able to use their resources freely for the innovating work. Nowadays innovativeness is an essential factor in competing in almost any business area. Business model innovations are one group of innovations that may lead to huge competitive advantage when the business environment is remade to be more cost-effective in a totally new way. By questioning the old way, a new and simpler way can be found. And when a company does business differently than the others, the rivals usually cannot achieve as low costs just by making their current operation more efficient. [Apilo et al. 2007]

An innovative company is more interesting to employees, to investors and to other companies as an ally. Thus by being innovative a company gets many kinds of advantage and the innovativeness feeds itself when the professionals are interested to work for and with it.

An innovation process is a wider concept than the traditional product development process. It covers the actions between the times of looking for innovations to the moment an innovation is born. An innovation process includes the new product development process but also a separate forepart and a research part. [Apilo et al. 2007]

3.1. Adopting New Ideas

People can be divided into different groups based on how easily they adopt new ideas. This information can be used when categorizing the users or customers but it is also good to understand within any development organization. Any organization consists of different kinds of people and when innovations are desired, people give their best when they can work in a way that is natural to them. It is also easier to make a change when the right people are running it. New ideas are adopted in a process in which they are

communicated through certain channels over time among the members of a social system [Rogers 2003].

Greenhalgh et al. [2004] make a difference in their service innovation research between diffusion and dissemination. Diffusion can be seen as passive spread of innovation whereas dissemination of innovation takes place through active and planned efforts.

About 2.5 percent of people can be considered as innovators who are fascinated with new things just because of their novelty. These people accept new ideas quickly but as easily they can get bored and change their object of interest. Because of their enthusiastic character they are good at testing and developing new ideas. [Rogers, 2003; Manns & Rising 2005]

The early adopters make up a bit larger part of people, about 13.5 percent of normal population. They are also open to new ideas but they are more deliberate than the innovators. They are looking for strategic opportunities from innovations. The early adopters are often respected by their peers and therefore they can act as opinion leaders. [Rogers 2003; Manns & Rising 2005]

The first larger group is the early majority. About a third of people belong to this group. They are more of followers and they need to know that other people have adopted and liked the new idea before seizing to it; they need proof. The attitude of the early majority correlates highly with the likelihood of an idea to succeed. [Rogers 2003; Manns & Rising 2005]

The late majority is another significant group with the size of a third of the population also. These people are conservative and they approach new ideas with skepticism and caution. They do not want to follow unless they feel it is risk-free and they get pressured towards the new idea. The pressure can for example be social – everybody else seems to favor the new idea or a superior tells to do so. [Rogers 2003; Manns & Rising 2005]

3.2. Innovating

Innovating can be understood as realizing an idea in such a way that it can be commercially utilized [Schumpeter]. In many cases learned from industry there is no shortage of ideas but the problem is how to make profit out of the ideas; how to select the best ideas and render them into successful products or services.

Industrial innovating is at its best done in groups where the organization has true excellence in certain areas and strength in many others in which it is not afraid to ask help from the others. When the organization centers on their core competences by themselves and utilizes its partners', customers' and users' knowledge on the other areas, the organization has more extensive understanding of the field it is operating in. [Kelley & Littman 2001]

Kelley and Littman [2001] present a five-step methodology for innovating or product creation. The core functions are the following:

- Understand the business area widely,
- Observe potential users and customers,
- Visualize new concepts,
- Iterate prototypes, and
- Implement the new concept.

The HCD process emphasizes largely the same functions as described in the chapter 2 of this thesis. It is important to know the field in which the organization is operating, the market, the users and the other stakeholders as well as the technology and the constraints the area has. [Kelley & Littman 2001; ISO 13407; TRUMP 2008]

3.3. Product Development

Product development is an industrial process in which products are created [Ulrich & Eppinger 2003]. Before starting a product development project the idea is examined in the product planning process to fit the company strategy. In a product planning process the portfolio of different products that will be developed and the timing of product

introduction to market are identified. The planning process seeks out product development opportunities that would form a project portfolio, which supports the business strategy of the company. The opportunities are sought after using many sources like research, marketing, customers, users and other stakeholders, current and ended development projects and benchmarking of competitors. The identification of the product development opportunities is closely related to identifying customer and user needs. Both can be done by using partially same tools and methods like interviewing users, going through user and customer feedback and studying competing products. [Ulrich & Eppinger 2003] The author of this thesis suggests that the planning process is the right time to start with HCD in the product lifecycle.

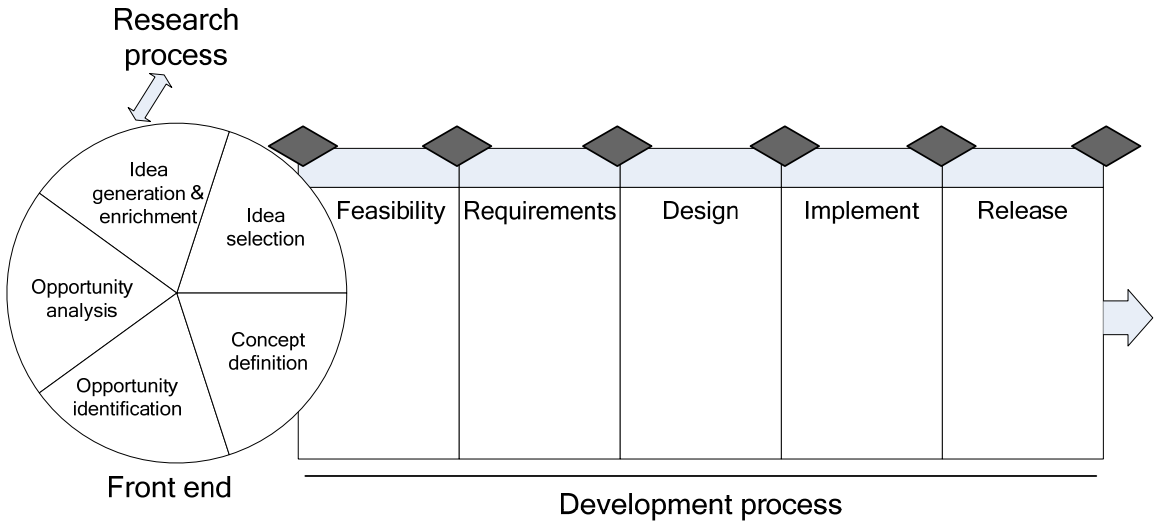

Figure 3-1 A generalized innovation process. Based on Apilo et al. [2007], Belliveau et al. [2002] and Bevan and Bogomolni [2000].

The front end of innovation process is pictured inside the circle in the figure 3-1. The front end is not as tight of a process as the development part which is normally performed in strictly defined projects and because of its indefiniteness it is often called the fuzzy front-end. The front end of innovation tasks include recognizing opportunities, ideating, and developing and evaluating ideas. Opportunities may arise for example from customer and user feedback or technological innovations. Ideas can be gathered in idea lists or banks and utilized in an adequate moment. [Apilo et al. 2007] It is worthwhile to actively seek feedback from users and conduct user studies since it may give very profitable ideas that can lead to product development later.

When an idea is selected to be further examined, a concept is created. This happens in the front end. It is sustainable to do conceptual design in multidisciplinary groups. There should be experts from different areas to give their viewpoints into the design. [Wiklund 1994; Apilo et al. 2007]

When the strategic planning in the fuzzy front-end is executed and the decision of producing a product or service is made, the actual product development process takes place. [Cagan & Vogel 2002; Apilo et al. 2007] Some companies do a part of concept design in the actual product development process. They start product development as soon as they see the potential of the prospective product and they do the more specific concept design after the product development decision.

The product development process part illustrated in the figure 3-1 is a stage-gate process originally created by Dr. Robert G. Cooper in the mid 1980's. It is a very widely used product development process. The diamond-shapes in the upper part of the process figure represent the gates of the process and the areas between the diamonds are the stages (or also called phases) of the process. At each gate a go/kill decision is made – it is decided whether the project will continue or if it is closed down. In each stage the developers do the tasks that are given in a process description or otherwise agreed. At each gate a meeting is arranged where the steering group reviews the project and checks whether the demands are met and if it is profitable to continue the project to the next stage. [Unger & Eppinger 2002]

Stage-gate model expects detailed specifications in the early phase and thus it gives clear goals to designers [Unger & Eppinger 2002]. This can be seen as an advantage for HCD since the model allows time for requirements gathering and data collecting in the low-cost early phase. Unger and Eppinger [2002] also state that waterfall process performs well when quality and error-avoidance are high priorities because of the stable product definition and the clarity of the process.

3.3.1. Product Development Process

The stages in the figure 3-1, feasibility, requirements, design, implement and release, are an example of possible stage labels and they are based on ISO 13407 [Bevan &

Bogomolni 2000]. The names and even the number of the stages may vary from company to company but usually the principles remain the same. [Karlström & Runeson 2005] Originally the stage-gate model is a waterfall model and thus proceeds sequentially from start to end. But it can be utilized with intra-stage iteration or even iteration between stages. [Unger & Eppinger 2002]

There are also inherently iterative product development models available. They are utilized especially in software development where different teams can build different parts of the system at the same time. With agile methods system can be built incrementally and thus the actual system can be demonstrated generally whenever. In many cases agile methods are used together with a stage-gate product development model for example in sub-project creating software for the hardware that is designed in a stage-gate process. [Cusumano 2007; Karlström & Runeson 2006]

3.4. Chapter Summary

This chapter briefly introduced some processes of industrial product development. It opened the concepts of innovating and adapting new ideas. The ideas can be disseminated purposefully or diffused over time. A classical product development process runs straightforwardly phase to phase. Newer processes are more evolutive and include more iteration. Both process types have their application areas and they can be combined.

4. Organizational Change and Change Management

This chapter discusses change processes such as integrating HCD into product development is also. The purpose of the chapter is to find methods that make the change process more likely to succeed.

Integrating HCD into a product development process is a big change. It means change in the daily routines and working methods. It means a new distribution of power and a new way to value different matters. Many people tend to do their work as they have done it before. They might have personally invested a lot to the way things have been done in the past or until now. They feel they have power in the way things are done and when the methods are being changed, they feel threatened. They might feel that their work is no longer valued and that the change in the process is an assault on them and their contribution to the work. [Schaffer 2004]

Table 4-1 Spread of innovation and change [Greenhalgh et al. 2004].

"Let it happen"		"Help it happen"		"Make it happen"
Unpredictable, unprogrammed, uncertain, emergent, adaptive, self-organizing		Negotiated, influenced, enabled		Scientific, orderly, planned, regulated, programmed, managed
Emergence, adaptation	Diffusion	Negotiation	Dissemination, cascading	Re-engineering

In the table 4-1 there is illustrated the different spreading mechanisms of an innovation or change. When the change is managed, it is made happen. The methods to manage change are discussed in the following chapters.

4.1. Change and Change Management

The current state represents the functioning of the organization before a change. The current state of HCD work can be analyzed for example by going through a usability maturity assessment, which is discussed in the chapter 5. A change in an organization

contains movement toward a desired future state which describes how the organization should function after the change. Transition state is the period between the current state and the desired future state and change management helps the organization to get through it. Change management includes creating an understanding of the current state, developing a picture of the wanted future state and carrying the organization through the unstable transition state. It aims to making the transition easy and effective. [Tushman & Anderson 2004; Russell-Jones 1995; Schaffer 2004]

Nowadays companies and work organizations are often in a continuous change which can be considered also as growing [Erämetsä 2003]. The actions of a competitor, alteration in prices, change in technology, legislation and the requirements of consumers are examples of economical and technical reasons for organizational change [Russell-Jones 1995]. Generally the stimuli to change are driven from technology, economic conditions, world politics, social and demographic change and internal challenges. [Cook & Hunsaker 2001]

Implementing or rejecting change has always consequences. When a new idea ignites, it should be examined and then based on the gathered knowledge implemented or rejected. In many cases learned from the industry the decision of implementing or rejecting is not based solely on rational issues. Rogers classifies the consequences of adopting or rejecting a new idea as follows [Rogers 2003]:

1. Desirable and undesirable consequences measure how well the idea works in the social system

2. Direct consequences give an immediate response while indirect come as a result to another effect

3. Anticipated consequences are recognized and intended and unanticipated are unknown and accidental.

Direct and anticipated consequences are usually desirable and easy to predict. Unanticipated and indirect consequences add uncertainty and fear that may lead to resistance. In the case of an organization, different individuals may desire different consequences that can lead to value conflicts and power struggles.

4.1.1. Common Issues during the Transition Process

A transition process aims to changing towards some new wanted state; the new state is the result of the process. The people, the organization and its culture need to forget the current and learn to follow, even internalize the new way. The people have to adapt as individuals but they also have to learn new as an organization. According to Cameron [2004] outcomes, interests, and emotions are the three dimensions of an organizational change. Interests include influence, authority and power, outcomes are the results and emotions are the feelings people go through when adapting the new way [Cameron 2004]. Tushman and Anderson [2004] claim that whenever a significant organizational change is attempted, three types of problems are encountered:

1. The problem of power
2. The problem of anxiety, and
3. The problem of organizational control.

Every organization is a political system that builds upon individuals, groups, and coalitions competing for power. The power has distributed in a quite stabile way both in the current state and the future state, but in the transition state there will be a redistribution of power. The balance of power can be modified in a change. [Tushman & Anderson 2004] Some might have to give up power and usually that is not easy. Also new things such as usability or HCD might get more weight and that leads to new kind of power distribution, the HCI experts get more power for example when planning new projects. Ideological things might change in the transition state [Tushman & Anderson 2004]. The new approach may be inconsistent with the old values or the old image of the organization. If the organization has been seen as an engineer-driven technology company, it might be against one's image of organization when HCI gets more value in the new product development process.

The Cameron's dimensions as well as Tushman's and Andersons's problem types are issues of which organizational leaders have to be aware of and handle in their work under the transition phase. People have difficulties in processing many things at the same time because of the limitedness of our consciousness. The leaders have to solve

how to concentrate on the central issues and maintain an understanding of the other dimensions [Cameron 2004].

Organizational change means changing or developing into something new and unknown [Russell-Jones 1995]. People tend to feel comfortable with familiar and steady things. During an organizational change people do not necessarily know what is really going to happen to them and their work in the future, or if they are even needed any more. Uncertainty and insecurity create stress and anxiety and can lead to behavior or performance problems. Stress can even make it harder to understand what is said. That can lead to going against things that would be supported otherwise. Resisting change is a common reaction. People may seem to agree but still resist passively or by being unconstructive. [Tushman & Anderson 2004]

A change tends to disrupt the normal course of events within the organization. That can lead to losing control when the control systems become irrelevant. Many times in an organizational change also goals, structures, and people change and that makes it more difficult to monitor and measure the performance and operations. Usually the formal organizational arrangements are designed to measure and manage operation in steady states such as the current state or the future state. In many cases the same arrangements will not work in the altering transition state. [Tushman & Anderson 2004]

Resistance towards change occurs typically if the change harms people's interests or the change is not being communicated honestly. Change can harm people's interest for example by reducing their power, or affecting their income or job security. [Kotter 1996] Cook and Hunsaker [2001] present that both individuals and organizations may resist change for the same reasons. In addition many organizational practices are built to minimize risk taking; if a process is working well enough on the moment, why to change it. The author of this thesis believes that these kinds of problems arouse mainly from lack of communication and information.

4.1.2. Levels of Change

Organizational change can be grouped in levels according to how wide its area of influence is. Erämetsä [2003] groups change in four levels: individual, tactical, strategic, and cultural. The individual level changes are e.g. learning a skill or changing a personal way of doing something. All organizational change bases on individual change; no change will happen without individual changing. The second level changes are tactical or work-related but they do not concern the whole organization. They are not strategic or tangled up in culture. For example an implementation of a new system can be a tactical level change. Strategic changes are on the third level. They can relate to one or more divisions or departments. Strategic change usually demands growth or actual change in corporate culture; in the way of action, the attitudes of people and collective thinking. Company acquisitions or new products, markets or partnerships and changing the brand are all strategic changes. The fourth level of change is cultural. Corporate culture includes the real values and beliefs that direct the corporate operations. Changing culture is difficult and slow; it rather should be developed continuously than try to change all at once. [Erämetsä 2003]

Individual change can be approached with different perspectives since change affects people in many levels. It arouses emotions in people and through emotions it has an effect on our behavior. Normally new situations make people anxious and more aware of themselves and the environment. We are not as confident and sure as usually, we need to attend and focus. The little everyday things we normally execute unconsciously suddenly need our consciousness. Our personality has an impact on the way we react to a change. Also our position in the work place and the situation in our personal life may affect how we react to the change. The change can be made easier for the people and the organization by understanding its affects on a personal level. The change can be turned more attractive and people's behavior can be affected. [Cameron 2004]

4.1.3. Getting Through the Transition State

Preparing for the change should be started before the actual implementation of the change. The political systems of an organization must shape the political dynamics

associated with the change. The employees should be motivated and informed about what is coming and why the change is needed. Also the reward systems need to be modified to support the change. In general, change management aims to lead the organization from the current state to the desired future state but also to manage the transition state as well as possible. When the transition state is managed well, there should not be any significant control problems because the possible problems are taken into account in advance. [Tushman & Anderson 2004]

As described in the chapter 3, innovations are adopted in a process in which they are communicated through certain channels over time among the members of a social system [Rogers 2003]. So to come true, a change requires communication, time and social acceptance. Due to personal differences, people tend to take change and new things differently. Others are more open to new and different, while some people have doubts or even are afraid in front of change. The well-known classification into innovators, early adopters, early majority, late majority, and laggards [Rogers 2003] presented in the previous chapter applies also when talking about adopting an organizational change.

Change is often about learning and people have different learning styles and abilities. People learn with all our senses, by seeing, hearing, and touching and trying. That makes it worthwhile to communicate the change by written notes and by speaking; through channels that reach different senses. Also many other problems arise from poor communication as described earlier in this chapter. Communication can be improved by putting effort to it. Making messages honest, complete and relevant, and congruent to the behavior of leaders and messengers makes the communication clearer. Using multiple channels helps to understand and remember the communication. Trust can be gained by sharing the motives and being consistent. It is beneficial if the messengers have good personal reputation inside the organization. [Cook & Hunsaker 2001]

A typical way of handling change is to divide it into different stages or steps (table 4-2). For example Kotter [1996] divides creating change into eight stages while Mayhew [1999] has three phases. Different phases can naturally contain many steps or methods. However it can be seen that change and change management are composed of stages

and there are phases that have to be gone through practically in any organizational change.

In all change, the individuals are in the center. They are the ones who start the transition and take the organization through it. If there are not enough motivated people to fulfill the change, it will not happen on the organizational level. Groups of people are also in an important role. Very rarely individuals manage to create an organizational change by themselves but if they can gather a highly motivated group of people around them, then they are likely to succeed. When groups of people are favoring the change and follow the new way, it becomes harder for the individuals to resist. [Erämetsä 2003; Rogers 2003; Schaffer 2004]

Table 4-2 Comparison of the change processes according to Kotter [1996], Rogers [2003], Schaffer [2004] and Mayhew [1999].

Author / Phase	Kotter	Rogers	Schaffer	Mayhew
A		Knowledge	Startup	
B	Establish a sense of urgency	Persuasion		Promotion
C	Create the guiding coalition			
D	Develop a vision and strategy	Decision	Setup	
E	Communicate the change vision			
F	Empowering broad-based action	Implementation	Organization	Implementation
G	Generate short-term wins			
H	Broaden the transformation			
I	Anchor new approach in the culture	Confirmation	Long-term operations	Institutionalization

In the table 4-2 there are represented the different phases of a change process according to some authors in proportion to each other. Kotter is a known authority on leadership and change and Rogers was known as a pioneer in the field of innovation dissemination. Schaffer and Mayhew are known on HCI. Schaffer's and Mayhew's approaches to change concern the area of institutionalization of HCD. The table is created comparing the actions the authors present for each phase. It seems that the authors understand quite similarly the change process.

This chapter describes the actions performed in each phase illustrated in the table 4-2 and here a capital letter in the braces indicates the according phase in the table. (A) First the organization's or some individuals' attention has to be brought to the problematic issue. This can be based on conscious seeking or on a "disaster" that forces towards the change. The organization or a member of it becomes aware of the possibility of changing. (B) If the organization or its representative becomes interested, they will gather more information about it and create a sense of urgency. What will happen if we do not react? A favorable or unfavorable attitude is created. The process of changing is started if the attitude is favorable. The interested persons start to act and communicate the change. (C) A "change group" will be gathered. The change gets a leader and spokespersons. (D) The group creates a plan to implement the change. (E) The key persons are educated or trained. The change is communicated to the organization. The lower-level tools and methods are selected and utilized. The first results of the possible affects of changing are gained. (F) The obstacles are broken down, for example the old reward system is abandoned if it is not beneficial for the change. The implementation phase changes the focus from individuals to the organization. The change is disseminated over the organization. (G) The leading coalition hungers for unarguable wins. The change process has taken about 6 to 18 months and some proof is needed. In the models of Mayhew and Schaffer, these wins are expected in the phase (E) when the methods are tried out in a pilot project. (H) The changing work is continued with new projects and people. The systems are reformed based on the earlier experiences. (I) The implementation has happened and the actual results of the change can be seen. The new conditions will be anchored as a fixed, permanent state. The work is continued for years, until the new way to operate will be a norm. [Kotter 1996; Mayhew 1999; Rogers 2003, Schaffer 2004]

4.2. The Patterns of Effectively Managed Change

Any organizational change should be managed. People tend to resist or move on doing as they have done before if they are not encouraged to switching to the new way. Any change takes a long time to be institutionalized so that the new way of operating will be the normal way.

In an effectively managed change everybody participates and people are kept informed about what is going on. Participation and informing are good ways to minimize uncertainty and resistance towards the change. [Tushman & Anderson 2004] People do not resist change as much as they resist being changed [Manns & Rising 2005]. If they know why the change should happen and they can be part of it, they are more likely to cooperate. If the organization is compelled to change, the people will probably resist. No change in processes takes place without people and their actions even if the corporate culture were supporting it.

The organizational culture has a significant impact on how easily new innovations are spread. In a supportive organization, the change will be easier and faster. A supportive culture has flexibility enough to allow change; it supports and nurtures new ideas. It allows people to use time for learning and doing new things and accepts also longer learning curves. It is patient enough to support innovations that have benefits in the long term, and does not impose a penalty or embarrass on failure. [Manns & Rising 2005; Tushman & Anderson 2004]

The change needs to be defined as somebody's responsibility. Although the change may necessitate that almost everyone participates the change, somebody has to be liable for it. The responsible person can be called an evangelist or a dedicated champion [Manns & Rising 2005; Schaffer 2004]. Manns & Rising [2005] advise the dedicated champion to start with finding some people who do not need much convincing, who are most receptive to new ideas and get excited of new things. These innovators act as a support group for the champion and they help spreading the new idea across the organization.

4.3. Change in Product Development Organization

The employees in product development can be considered as a user group of the product development process. They should be involved mainly for two reasons. The HCD process expects that the users are involved when designing for them and the literature suggest that participation is a success factor in change management. Participation increases the acceptance of the changed process because the development organization has been designing and realizing the change; the new state can be considered as its own accomplishment.

In a product development organization there are usually many changes ongoing. Many issues that different stakeholders consider important influence the employees. They have to constantly learn new. They may be stressed and therefore not so willing to support the change. If an employee feels there is already too much work, they do not want to be encumbered by any new responsibilities.

4.4. Chapter Summary

This chapter discussed the issues that are confronted in an organizational change process. It clarified the methods that can be used to manage change and to make it more comfortable for the people the change is affecting. It introduced different theories of the change processes and divisions of change to different levels.

5. Integrating HCD with Product Development

This chapter introduces the current research in the area of HCD integration. It also describes some integration methods and a generalized process improvement model. Also the situation of HCD in the industry is discussed in this chapter.

Usability integration means integrating usability and HCD into an existing product, service or software development process or life cycle so that the process is followed in the development. That means many different area activities have to work together. It is challenging because the processes, activities and conditions differ from each other in every case and in every organization. The integration requires knowledge of the current development process of the organization, knowledge of many different usability methods, flexibility in using the methods, strong leadership, and will for the change. The general HCD process model needs to be adapted into the product development process and into the other conditions the organization has. The product development process has probably different phases than the HCD process and the actions of the new process may be unfamiliar to the product developers. [Rosenbaum et al. 2002; Woletz & Zimmermann 2005]

HCD methods have been developed outside the software engineering community that has its own software development life cycle and tools [Seffah & Metzker 2004]. Because of the differences in the conditions, processes and methods, it is not obvious how the processes should be integrated to maximize the benefits in the product development in its entirety. Usability is an important factor in the product development process, but usually it should be integrated into a process in a way that the whole operation benefits from it. So in a real product development environment, it is not expedient to execute the usability techniques at the best but to understand what the organization wants from usability and realize the HCD process in a way that it fulfils the unique organizational needs.

In many cases the product developers are not familiar with HCD and its methods and it complicates the usage of the methods [Seffah & Metzker 2004]. If the methods cannot be fully used, following the HCD process is difficult. The product developers have to be trained to use the methods and it requires resources. In many organizations, the product

developers have traditionally been engineers. There is an ongoing change in the industry where a greater number of companies improve their product development and hire usability experts and industrial designers to their product development teams. In many cases the conventional engineer-driven product development is not adequate any more, also industrial design and HCD are needed. In the 1980's it was typical that engineers designed professional tools for other engineers and the technique was a value in itself. A product or a system was appreciated for the technology it kept inside and not so much for its quality of use.

The actual product development in an organization consists of the official product development process but also of the habits and unofficial processes that has developed with time. Every developer has their own way of working that differs more or less from the ways of the others. Official product development process should be monitored and measured so that the real product development work would be accordant with the official processes. The working methods change over time and the official processes should be updated to congruent with the actual working methods.

It is clear that an organization benefits most when it invests in the HCD in the early phases of product development process. Then there is the greatest possibility to have an influence in the usability of the system being developed. The sooner the usability work is started the greater the impact of the work can be. According to research, the organizations are increasingly emphasizing usability work in the early phases of product development [Venturi et al. 2006]. The usability of a system is generally the sum of the input of the realized work for the usability in a product development process. Therefore it is important to start in an early phase and continue the work through the whole process.

5.1. HCD in the Industry

The degree to which HCD is integrated in the new product development and the level of usability maturity varies much from company to company. Venturi and Troost [2004] executed a rather wide web-survey about UCD integration in the industry about five years ago. They found out that UCD is integrated deeper in big companies but they typically have only few usability practitioners representing less than one percent of the

total amount of employees. They also mapped the most used methods and the factors that affect the success of integration.

According to Venturi [2004] the most used usability methods in the industry include prototyping, qualitative usability test, user interviews, style guides, observation of real usage, and expert or heuristic evaluation. In their survey Vredenburg et al. [2002] found out that the most commonly used UCD methods are iterative design, usability evaluation, task analysis, informal expert review, and field studies. They also found out that although the respondents used these methods the most, the respondents did not think they had the strongest impact on the design. The most important methods were participatory design, card sorting, informal expert review, surveys, prototypes, and user interviews. On the contrary Gulliksen et al. [2004] claim that the most liked methods include think aloud, prototyping (particularly lo-fidelity), evaluations, scenarios, interviews and field studies. The research results concerning usability methods set against each other are hereby rather diverse and there is no universal order of superiority for the methods. The purpose of use, the knowledge of the method, and the budget and schedule need to be considered when selecting the most suitable methods.

Based on our research group's perception it seems that automation industry in Finland is rather immature in the area of usability. Typically there is interest towards usability and HCD but quite little has been done to ensure the usability of the products being created. The companies have relatively short experience in human-centered technology and therefore also the HCD skills need improvement. [Palviainen 2008]

5.2. Defining the Integration

Integration requires change in human behavior and it does not happen overnight. A cultural change in a company may take from three to ten years. The change has to be anchored in the corporate culture and it requires years of work. [Erämetsä 2003]

Schaffer [2004] states that the integration has very likely succeeded when it is a routine in the organization to seek a HCD process for the projects and when there are usability practitioners doing the work routinely. Bloomer et al. [1997] represent that “usability is successfully integrated into an organization when a strategy is developed which leads to

key usability benefits and supports overall business objectives". Venturi and Troost [2004] have an itemized definition; HCD has been fully integrated into the organization's operation when the following is true:

- The product lifecycle follows the principles of HCD at its every phase
- The HCD team members have the skills and experience to follow the HCD process
- Management supports it
- The organization has proper HCD infrastructure
- Awareness and culture are properly spread both in the organization and outside of it.

This definition demands quite a lot of the organization. The change has happened when the new ways to operate become the norm. It will not be considered as a change any more but a normal way to operate. People have adapted the new methods and they do not want to go back to the old habits.

Integration and institutionalization can be seen as different concepts. Integrating may refer to implementation and institutionalization to anchoring the change. Mayhew [1999] sees institutionalization as influencing the process and implementing as influencing individual projects and products.

5.3. Why to Integrate HCD into Product Development

The users are increasingly demanding products that are pleasant to use. This development is slower with the products that are used in working context than with the consumer products that are mainly used in the leisure time. The competition is in many cases vigorous and the competitors may already invest into making usable products. Usability and user experience are getting additionally important elements in the markets. The customers want to get products that are ready to use without preparation and learning. The product should not be the goal in itself but it should rather be seen as a means to provide a good experience to the user. The users want to experience

something with the product and not just to have it without a purpose; without a goal of having or using it. [Tullis & Albert 2008]

Improving the usability of the products enhances a company's sales, productivity, competitiveness, profitability, and user and customer satisfaction. At the same time it reduces support costs and remaking the design work. [Bias & Mayhew 2005] When changes are made earlier in the life cycle, money and time are saved. In the ideal case better design solutions are made from the beginning. The costly changes in the design are not necessarily needed if the developers understand the basics of HCD and the fundamental design mistakes are not made at all. Prototyping is about making iterations and some changes constantly but when the design is already decent after the first iterations, prototyping can be done on a higher level. [Radle & Young 2001, Bias & Mayhew 2005; Schaffer 2004]

When utilizing the best practices in the field of HCD, the probability for having to rework decreases highly. The product can be made usable and of adequate quality at once. Also using reusable templates lessens rework significantly. Implementing unnecessary functions takes time and money. When the users' actual needs are understood, the unnecessary functions will not be designed and built at all. The absence of the useless functions makes the user interfaces clearer and thus the product easier to use. Also manuals may be shorter and the whole system will be simpler. A usable product benefits its users quickly; the user and the customer gain from usable products in many ways. User productivity increases whereas user errors and training costs decrease. Usable products lead to increased sales and the stakeholders perceive the value of the company increased. A usable product sells more and needs less maintenance. [Radle & Young 2001; Bias & Mayhew 2005; Schaffer 2004]

Market uncertainty can be noticeably reduced when the user and customer needs, wants and specifications are well understood for the product prior to development. Also knowing the competitor products and the "appeal" characteristics to sell the product, as well as integrating the user and customer requirements into the new product concept substantially reduce the market uncertainty. [Verworn, Herstatt & Nagahira 2006]

Generally the goal of integrating HCD into the product development process of an organization is to ensure that HCD work will be performed. Without an official role the HCD actions may be easily bypassed in a hurry. Integrating makes HCD a solid part of the product creation process and the HCD methods will be executed as a normal part of the operation.

5.4. How to Integrate HCD into Product Development

Integrating HCD into product development is a change process that concerns the majority of the people in the changing organization. It requires change in working habits and in power distribution. The goal is to execute a sustaining change where the wanted future state is rather permanent and different from the initial state. It requires applying organizational management and change management and understanding of HCD.

Generally process improvement aims to doing things better than before [Mutafelija & Stromberg 2003]. The integration might be for example improve efficiency, be faster than before, or cover the user's point of view. Process improvement is about increasing the process quality. Niazi, Wilson and Zowghi [2003] state that the problem is to find an effective strategy to successfully implement the selected standard or models with the current operation. Selecting the suitable standards or models is a rather trivial problem compared to how to integrate them with the current process.

The main points of many different process improvement approaches seem to be the following: The starting point is to understand the initial state of the changing organization, find out the strengths and weaknesses of the organization, declare what the desired state is and make a plan or strategy how to make the transition towards the desired state. It is also good to be aware of the possible threats and problems that may be encountered during the transition and make a plan how to prevent these threats from happening. The improvements are implemented and the results are monitored and sustained so that the change will be permanent. Two example approaches are introduced below.

ISO TR 15504, part 7 is a process improvement approach that was known as SPICE (Software Process Improvement Capability Determination) during its development. It is a general model and besides software processes it is suitable also for other process improvement. ISO TR 15504, part 7 process improvement approach has eight steps:

1. examine the organization's needs and business goals
2. initiate process improvement
3. prepare for and conduct a process assessment
4. analyze assessment output and derive an action plan
5. implement improvements
6. confirm improvements
7. sustain improvement gains
8. monitor performance

PDCA (Plan, Do, Check, Act) model is another common approach to process improvement. PDCA is part of the overall total quality management (TQM) process and many process improvement approaches base on it. [Mutafelija & Stromberg 2003]

1. plan: identify the problem, analyze the problem
2. do: develop solutions, implement solution
3. check: evaluate the results
4. act: standardize the solutions

Both of these models follow in practice the same structure. First the initial state is mapped. Then a plan to resolve the problems is made and implemented. After the improvements have been carried out, the results are confirmed. In the end the final modifications are made and the improvements are institutionalized. Also the action research method that is used in this master’s thesis follows the same frame.

5.5. Maturity Assessment

Organizational change process can be started with a maturity assessment (MA) to find out the initial state. It can also be used as a meter that reveals the change when MA is reapplied later. The capability of an organization is measured in a maturity assessment. Usability capability models are used for assessing the ability of the development organizations to develop usable products. The main aim of usability maturity assessment (UMA) is certainly to improve the usability of the end product. High level of usability capability means that HCD is effective and efficient and it leads to usable products [Jokela 2000].

5.5.1. Usability Maturity Models

There are at least over ten different known usability maturity models. One of the well-known maturity models in the software business is CMM, capability maturity model that is widely used in evaluating the maturity of software development but it does not discuss usability. Many of the maturity models in usability area are based on usability standards and they help to follow the standards. In general all the usability maturity models date back to quality management and Crosby's quality management maturity grid, QMMG. Usability maturity models measure the quality of development processes. [Kuutti et al. 1998; Jokela et al. 2006]

The practices in the usability maturity model, UMM-P that is used in this thesis, are based on the standard ISO 13407 and conform to the standard ISO 15504, the international standard for software process assessment. The Usability Maturity Model: Processes, UMM-P, has been developed in the EU research project called INUSE and utilized and further refined in the EU-TRUMP project. Also the commonly known maturity model CMM can be mapped with UMM. Earthy [1999] has a mapping between CMM processes and UMM practices. Jokela [2000] has listed different usability maturity models and Jokela et al. [2006] compares the different maturity models. [Earthy 1998; Earthy 1999; Jokela 2000; Jokela et al. 2006]

Table 5-1 QMMG and ISO 15504 stages [Jokela et al. 2006]

Stage in QMMG	QMMG Description	Level in ISO 15504	ISO 15504 description
V: Certainty	We know why we do not have problems with quality	V: Optimizing	The organization can reliably tailor the process to particular requirements
IV: Wisdom	Defect prevention is a routine part of our operation	IV: Predictable	The performance of the process is within predicted resource and quality limits
III: Enlightenment	Through management commitment and quality improvement we are identifying and resolving our problems	III: Established	The process is carried out in a manner specified by the organization and the resources are defined
II: Awakening	Is it absolutely necessary to always have problems with quality?	II: Managed	The quality, time, and resource requirements for the process are known and controlled
I: Uncertainty	We do not know why we have problems with quality	I: Performed	The process achieves its purpose. Individuals carry out processes
-	-	0: Incomplete	The organization is not able to carry out the process

A maturity model consists of several categories of human-centered processes that are measured of how well they are performed and managed in an organization. In the UMM-P maturity model there are seven categories that all are evaluated individually. All of the categories include several processes that all are gone through in the assessment to reveal the maturity level in certain category. The categories are listed below. In the brackets there is communicated the amount of different processes in the category in question. [Earthy 1999] The human-centered development processes of UMM-P are as follows:

HCD.1. Ensure HCD content in systems strategy (includes 5 processes)

HCD.2. Plan and manage the HCD process (8 processes)

HCD.3. Specify the user and organizational requirements (6 processes)

HCD.4. Understand and specify the context of use (5 processes)

HCD.5. Produce design solutions (8 processes)

HCD.6. Evaluate designs against requirements (6 processes)

HCD.7. Introduce and operate the system (6 processes)

The UMM-P maturity model measures performance and capability in the areas listed above. The processes in each category are questioned for measuring the maturity in the category. The processes in the first category are listed below. A table containing all the categories and processes can be found in the Appendix A.

HCD.1.1 Represent stakeholders

HCD.1.2 Collect market intelligence

HCD.1.3 Define and plan system strategy

HCD.1.4 Collect market feedback

HCD.1.5 Analyze user trends

The questions can be for example “How the users were represented in the last product development project you attended?” or “How the user feedback is gathered?”

The performance is measured by interviewing people attending the development work in different roles in different phases of the development process and also by examining any process descriptions and documentation available. Both the workers’ and managers’ point of view is important. It is good to have some knowledge of the sector the interviewee works in and also of the projects they work with. The interview should concentrate on the particular process and it should be based on discussion rather than exact questions. [Earthy 1999] We have also noticed that it is worthwhile to have two interviewers in every session. It liberates one of the interviewers to ask more freely while the other makes notes. Having two interviewers also protects from

misunderstandings, extends memory and gives a possibility to discuss and interpret the findings.

After the interviews the maturity assessors analyze the gathered data. The assessors evaluate the performance on the six level scale of ISO 15504 described in the Table 5-1. The performance is evaluated for every process category individually and it reveals the problematic areas and also the areas where the organization performs well already.

5.6. Chapter Summary

This chapter collected the theory discussed in the previous chapters to understand the context of integration. This chapter defined the integration and introduced the research in the field of study. It discussed also the state of HCD in the industry and introduced common process improvement approaches.

6. The Operational Environment of Metso Automation

This chapter discusses the subscriber of this thesis, its line of business and customers and user groups. This information is gathered mainly from the interviews made in the product development organization of Metso Automation, and some internal documentation and industrial references.

6.1. Market Position

Metso is a global engineering and technology corporation mainly concentrating on customers in the industries of pulp and paper, energy, and rock and minerals processing. The net sales of Metso were approximately EUR 6.4 billion in year 2008. Metso has over 29,000 employees in more than 50 countries. Metso Corporation consists of three business areas: Metso Paper, Metso Minerals, and Metso Automation that is discussed in this master's thesis. [metsoautomation.com 2008; metso.com 2009]

Metso Automation is a global process automation supplier for the pulp and paper industry. It also has customers operation in energy, power and process industries worldwide. It has sales and customer support units in 34 countries in Europe, North and South America, Asia and Australia, and Africa. In 2007, Metso Automation's net sales were EUR 698 million, which was 11 percent of the Metso Corporation's net sales. The number of employees of Metso Automation totals over 3,500. Metso Automation specializes in automation and information management application networks and systems, field control technology and life cycle performance services. It is organized into two business lines that are Process Automation Systems and Flow Control. Metso Automation Tampere is a part of Process Automation Systems line that develops analyzers and sensors and extensive automation and information management systems for process industry. Metso Automation Tampere develops, produces and supplies automation and information platform, DNA (Dynamic Network of Applications) product family. [metso.com 2008; metsoautomation.com 2008]

The vision of Metso Corporation is to become the industry benchmark. The strategy towards the vision includes customer satisfaction as well as making operation more

effective. Metso wants its solutions to best meet the customer needs. Customer satisfaction includes customer-oriented mode of operation and solutions that meet customer needs. Effective operation means improvement in quality and productivity and also processes of a high level. [metso.com 2008] HCD and usability helps with both customer satisfaction and effective operation. HCD process leads to more usable products and customer satisfaction. It also makes the operations more effective when the right actions are embedded in the product development process and the developers can concentrate on designing usable products by using the best practices. [metso.com 2008; metsoautomation.com 2008]

6.2. The Context of Use and the User Groups

Metso Automation in Tampere supplies automation and information management systems mainly for power plants and paper mills. The purpose of process automation is to improve the efficiency and quality of production and processes and thus to improve the productivity and competitiveness of the company. Other reasons are to allocate the monotonous, unsafe and laborious work to the machines leaving the control and operating to human workers. A control room supervisor or operator in a power plant or a paper mill monitors typically multiple ongoing processes at the same time. A control room is typically centralized and an operator works in a group of operators with many computer monitors. An operator monitors real-time processes trying to maintain them stable. The operators communicate e.g. with each other, with maintenance and with their foreman. [Interviews 2008]

The processes in paper mill or power plant are typically highly automated and the operator does not see the actual process but different metrics, values and states of the processes through an automation system. An automation system is a piece of software or an embedded system that collects measurement data of the processes and it is used to automate the production processes or parts of them. In many cases an automation system is also used for reporting and collecting historical data from the processes. Automatization makes production more efficient and improves its quality and thus increases the competitive strength. At the minimum it usually handles the monotonous and dangerous tasks in the industry. [Interviews 2008; ABB 2000]

A control room is a centralized area where the operators control and operate the processes. The physical process is complicated and remote. The distances in a mill can be kilometers long. An automation system creates an abstract description of the state of the process. The operator cannot observe the processes without an automation system because of their complexity and unattainability. For example in power plants the processes are closed and one cannot go and have look at them. Several processes can be operated from one control room and that requires the operators to cooperate. [Paunonen 1997; Interviews 2008]

The process operators working in a control room take care of the current production. They watch the control room monitors to stay aware of the situation by following the measurement data that the automation system gathers from the actual ongoing processes. The data can be processed and shown in a form that helps the user to understand the process conditions. The automation system makes decisions independently depending on the measurement data and controls and adjusts different actuators. The process operator takes control when needed and adjusts the automation system values so that the process is running optimally in the control of the automation system. [ABB 2000]

The work in a control room is very critical. A fault may cause great danger to the personnel working in the plant but also to the people and environment outside the factory. The automation industry started to think more about usability after the accidents in nuclear power plants and chemical industry in 1980's. Many accidents arose from a human error and it means that the system is not supporting the user and their actions well enough. When a disturbance in a process occurs, the operator has to react rapidly and effectively. The processes have many variables and it might make the changes hard to notice. That makes the exception to spread widely. [Interviews 2008]

Good usability of the products and services of Metso Automation is important to prevent accidents but also for competitiveness, safety, costs, the efficiency of the process and work, and the meaningfulness of the work. Good usability decreases the probability of an accident because it supports the natural actions and intuition of a human; it makes the user interface consequent and clear. It also increases the efficiency of the work when the tools the users really need are available and easy to use. Also if

the start up of a mill is so difficult that just a professional can do it, the costs will be too high nowadays. This was the case before; starting up and even using the system was meant to be done only by highly trained and experienced people. Nowadays more and more of work is moved to new markets like East Asia or Southern America where the general education level is not as high as it is in Europe and the work culture is also different. The wastage rate of employees change more rapidly and they might not get years of education to perform their job. Those people have to be able to use the systems by themselves. It is very expensive to send an expert from Europe to help them for example in starting the mill. [Interviews 2008]

6.2.1. Usability in the Control Room

Usability in automated systems means for the control room operators that they are able to do their work efficiently and pleasantly without errors. Preventing errors is very important mainly for safety reasons. Errors can be decreased if the user is able to monitor and understand the complex processes and systems also under pressure and in critical situations. In a disturbance situation a user should be able to quickly determine what is going wrong. In many cases a fault in a process may create numerous new alarms in the automation system and the original fault may be hidden. [Sheridan 2002] Efficiency is a key to make profit. Learnability and easiness of remembering have not been considered very important before because only experienced professionals have used the automation systems. Systems that are used in a work context have not valued to be especially pleasant either – the workers do not have to enjoy working with the system. Nowadays also the importance of pleasantness and learnability are realized.

To ensure good usability, the whole product development has to support it. The HCD work has to be started in the front end of innovation process, before a product development project is started. Good usability demands knowing the users and their work and catering the users in many ways. In most of the cases, the work of the user is very different from the work of the persons who design or create the tools and products for the user. Without any help from users, it is hard to design products suitable for the users and their purpose of use. A product can be made usable only by change if the designers do not understand how the product will be used. In many cases the tools or

products are novel and they will change the current ways of operation. The designer can imagine the product to be used in very different way than the users will use it eventually. Therefore the users and their tasks should be examined carefully before starting to design the product.

When the user work is being automated, knowing the tasks is essential. Function allocation between the user and the system should be based on knowledge of the work and context. Many tasks need to be operated by human users because they cannot be automated. Other tasks are left for users because they like doing them and they keep the user attentive and aware of the situation. On the other hand it is worth of automating the boring, fatiguing, or hazardous tasks. Both too much and too little workload declines the operator's monitoring performance. User studies and task analysis help to find the appropriate level of automation. [Sheridan 2002]

6.2.2. Metso Automation Products

Metso Automation in Tampere develops the metsoDNA automation platform. In metsoDNA the information and automation systems are combined to a shared application network. Above the field level there are a great number of software applications. The system consists of many logical layers that transmit information to each other. The platform is very complicated unity. The automation platform is used for engineering and maintenance activity that can be divided into information management, operations, controls, connectivity and field activities. The activities represent the operation on the different layers of the process. The user interface for the operators is on the highest layer. The user interfaces can be personalized for each user; every operator is able to build up a user interface that best serves the work and personal preferences. The platform has also the corresponding activity layers for the design and maintenance activities. It is also used as the application development platform for the development engineer users. The complicatedness of the system and the meta-usability layers for the developers make the usability work challenging.

DNAdiary is one of the applications visible in the user layer in metsoDNA. Its purpose is to enable making notes of the system during the usage. The operators use it as a diary where they can entry any noticeable event that may be essential for e.g. the operators in

the following shift. The operators need to keep books of the daily happenings and troubles in the process in order to manage their work. DNAdiary was created to replace the notebooks the operators had earlier. With the notebooks it was harder to browse the history or e.g. to find similar situations to learn from them. Also the lower level activities of metsoDNA apply DNAdiary; they can make automatic entries into it for example if there is some disturbance in the process. Thus all the entries concerning the system can be found in the same place.

The functions of the automation platform are to automatize and control the process, to inform the user about the process and organization, to network the processes and users, and to save the information. Automating increases the abstraction level and thus it lets the users to concentrate on the bigger context in the processes and in the work.

6.2.3. The User Groups of metsoDNA

The products of Metso Automation have various kinds of users. The most typical user roles of the metsoDNA platform in a paper mill or a power plant are the following:

- Process operator
- Shift supervisor
- Production manager
- Production development / trouble shooting
- Remote service
- Production planner
- Maintenance person
- Maintenance manager
- Mechanical maintenance manager
- Laboratory worker
- Laboratory manager
- Environmental manager
- Automation manager
- Project manager
- Product development / research
- Mill director
- Corporate level

The main user groups of a control system in a paper mill or a power plant and their frequency of use are listed below in the Table 6-1.

Table 6-1 the main user groups of a control system and their frequency of use

User group	**Frequency of Use**
Process operators	Continuous
Shift supervisors Production manager	Rather occasional Occasional
Process / automation maintenance	Occasional

Because there are also occasional users, it increases the demands for learnability and memorability.

Process Operators

As a user of the products of Metso Automation, an operator works in process industry, typically in a paper mill or in a power plant but also in e.g. a dairy or a refinery. The operators answer for the current operation of the organization. They monitor the operation of the process or multiple processes and aim to keep the process running undisturbed. They keep the process as optimal as possible. A process operator may have responsibility for the whole production and therefore their work is very critical. A process operator working in a control room of a paper mill or power plant has typically a vocational education background. At some factories there are also engineers as operators especially if the operator's job description includes also maintenance tasks. The tasks in the production plants are not so narrowly specified any more as they used to be; the same persons can perform both maintenance and monitoring tasks. The educational level of the personnel is rising because e.g. for maintenance workers the factories may demand vocational qualification in automation.

Shift Supervisor

Shift supervisors are in charge of their working shift. The shift supervisor is responsible for ordering raw material, conversing with the maintenance, and organizing different kinds of operational activities. In the last years the role of a shift supervisor has been changing and in some organizations the title has become obsolete.

Production Manager

A production manager or an operating engineer is responsible for the operation of a production line and makes decisions in a wider context. The production managers are responsible of improving the production. The production managers follow the functioning of the organization for example by viewing long-term reports. An operator is responsible for the current status of the processes whereas a production manager is responsible for a longer-term operations and developing them. They observe problems that have occurred in the production in longer period and finds solutions for them.

6.3. Product Development in Metso Automation

Metso Automation uses Metso Automation Innovation Process, MAIP in their innovation process management. The innovation process is designated to be used in producing new innovations and it includes a product development process. MAIP was brought in use about five years ago in Metso Automation in Tampere. It is originated from Metso Innovation Process, MIP that is used across the whole Metso Corporation (fig 6-1). The purpose of the innovation process is to serve as a framework for putting the strategy of Metso in practice. Metso Automation has product development activities in six sites in Finland and in several places in North America. MAIP is used everywhere in Metso Automation. It is a non-specific process definition because it has to work with developing software and electronics as well as mechanics; all of them are developed in Metso Automation. Mainly software is developed in Tampere and therefore the process has undergone some changes. The meaning of MIP and MAIP is that the basis of the process is the same everywhere in Metso Corporation but it can be refined to be better suited for the particular usage. [Interviews 2008]

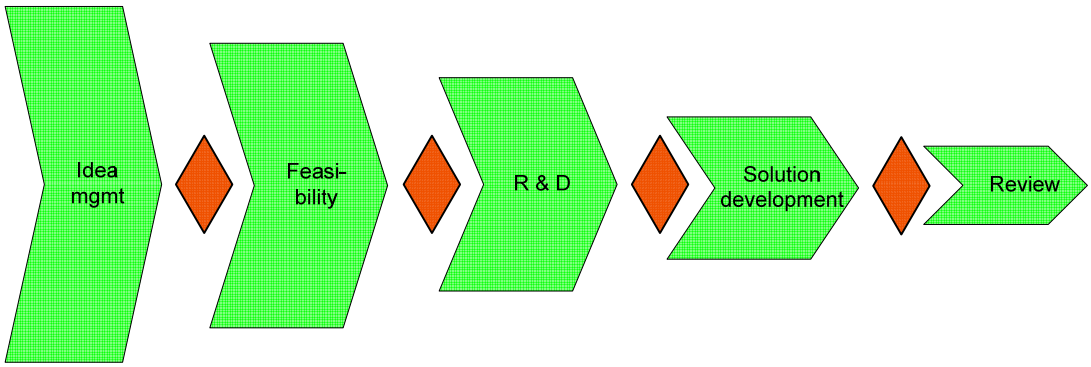

Figure 6-1 Metso Innovation Process (MIP) Overview

MAIP consists of three different processes: Roadmapping, Research Process, and Product and Service Creation Process. This thesis concentrates on the last-mentioned Product and Service Creation Process and developing it so that the product and service development would better support HCD. The Roadmapping process embodies strategic planning of future product and service offering. Research process is in connection with technology and concept development. In one sense it is groundwork for future products and product development projects. The Product and Service Creation Process is a strict gateway model with flexibility and it is focused on development based on business plans. [Interviews 2008; Metso Automation intranet 2008]

The Product and Service Creation Process is compounded of several phases and gateways. At every gateway certain points are checked and the gateway meeting decides whether the project is continued or given up. In every phase certain tasks have to be fulfilled for the project to pass the next gateway. The process is measured in different kinds of meters. According to several interviews made when doing the research for this thesis, the process seems to be followed very strictly in Metso Automation, so it is reasoned to make changes to the official product and service creation process. Based on the current behavior, it can be assumed that the changes made into the process would reflect on the daily routines of the product developers.

7. Developing the Usability Work in Metso Automation

This chapter discusses the product development organization's work and the studies made in this thesis.

The purpose of this thesis is to improve the Metso Automation product development process so that it would support the HCD work. The intention is to find the problems in the product development process and suggest ways to improve the process quality. The aim is to develop usable products and be able to answer to the user needs.

This thesis originated from the need of Metso Automation to produce more usable products and services. Metso Automation's stategy calls for customer satisfaction and efficient working. People in Metso Automation had noticed the need for products that are easier to start-up and use. This thesis was initiated to answer to the need of improving the product development process.

A meeting where the topic and the expectations were discussed started the thesis work. We decided that the author of this thesis should start the work by studying the organization and product development documents as well as the literature resources. The author of this thesis selected action research as the research method. It is suitable for improving organizational processes and it seeks involvement of the organization members. It has three phases in minimum: analyze, suggest, and take action. It can be executed iteratively. [Kumar 2005; Järvinen & Järvinen 2004]

After initiation a current state analysis (UMA) were to take place (fig. 7-1). It was executed based on a usability maturity assessment model that had been used also in the previous studies of the research group where the author of this thesis works in. It was evaluated and selected earlier and we decided to use it also in this thesis work to get results that are comparable with the other work. The assessment is discussed more widely later in this thesis.

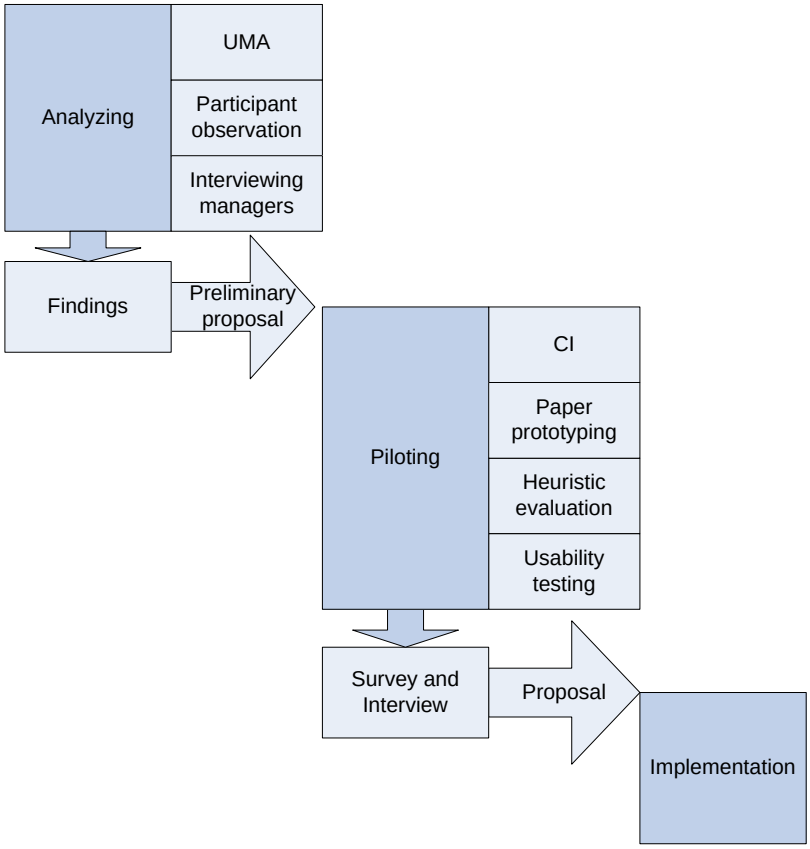

Figure 7-1 The research process conducted in this thesis

The current state analysis was followed by participant observation where the author of this thesis was working inside the organization and could make observations of the developers' daily work. The developers were also able to ask questions from the author and introduce their work to her. It also helped to make quick interviews and participate the developers' meetings. One goal was also to make the process improvement work more visible for the organization as a part of the communicating work. The last analyzing method was interviewing the managers where the author of this thesis interviewed the automation manager, quality manager, and the research manager.

After analyzing the organization and gathering the findings, the author of this thesis made a proposal of the alterations to be made in the official product development process and the working methods. Then we conducted a pilot project where some selected HCD methods were experimented and trained. The pilot project attendees were questioned and interviewed after the project.

Based on these studies, the author made an improved proposal how the product development process should be changed and how the change could be implemented. The proposal was discussed with the product developers. The product development organization introduced the proposal to the management who implemented it later.

The study is represented in details in the following chapters.

7.1. Usability Maturity Assessment

To start this thesis work we did a usability maturity assessment in Metso Automation product development organization in Tampere. The aim of the assessment was to clarify the current state of the usability work in Metso Automation. We interviewed people in different roles of product development. The interviewees' job titles were product manager, project manager, requirements engineer, software developer and tester. The interviews were carried out during two days and each of the respondents was interviewed individually. An interview took approximately an hour and a half. Researcher Palviainen from the KASTE-project acted as the main interviewer and the author of this thesis acted as the second interviewer and also as the bookkeeper. Since researcher Palviainen had conducted the earlier assessments and there was no documented question frame available, it was reasoned that he would lead the interviews because of the comparability of the results. Besides the interviewers one representative of Metso Automation who worked as a requirements engineer in the product development organization attended each of the interviews. The requirements engineer had an understanding of each interviewee's work and he presented some additional questions and supplemented few answers. He also arranged the meetings and interviews and helped to select the interviewees. He was not interviewed as such.

The interviews based on the usability maturity assessment of the TRUMP project [TRUMP 2008; Kuutti et al. 1998]. The interviews were done semi-structured; they were not gone through in a strict question order but rather discussion like. The maturity assessment document and instructions that we used are based on the usability maturity model accordant to the standard ISO TR 18529. The assessment is advised in ISO 15504-2 and the used process categories are based on ISO 13407. [Palviainen 2008]

The usability maturity assessment realized in Metso Automation in this thesis was unofficial and it did not aim to a strict definition of the usability maturity level. It intended to map the current state of the usability maturity in order to get to know the starting point for improving the usability work in Metso Automation. Knowing the present state helps to find the black spots and to select the most important targets for development and ways to realize the improvement. The theory of usability maturity assessments is discussed in the chapter 5 of this thesis.

7.2. Participant Observation

After executing the usability maturity assessment, the author of this thesis conducted participant observation to acquire an understanding of the sociocultural practices of the product development organization. The author of this thesis had a labeled place of work inside the organization. The personnel were informed about the reason and the purpose of her presence and they were told that they are free to ask any questions. The author of this thesis tried to disseminate the idea of HCD and that the working methods were going to change. She also familiarized herself with the current working methods and their black spots. She tried to socialize with the developers as much as possible. The two major goals were to understand the context and find the challenging objects, and to communicate and disseminate the change as widely as possible.

The author of this thesis was present in the organization on one to two days per week for five weeks. She attended some of the design meetings and discussed with several people. She tried to attend the coffee breaks regularly and attempted to be approachable. She sought to clarify the common attitude towards usability and changing. Her purpose was to become neutral to the members of the organization so that she would not influence the daily work too much.

7.3. Interviewing the Managers

The author of this thesis interviewed several managers and discussed the change with them. She interviewed the quality manager, the automation manager, and the research manager. The purpose was to find out the problematic areas in the innovation process that HCD could answer for. Another object was to introduce the change to the managers

and confirm the management support. The interviews concentrated on the product development process and its strengths and challenges, and collecting and utilizing customer feedback.

The interviews were conducted semi-structured. The author of this thesis planned the interviews, executed and analyzed them. The sessions were individual interviews but in the interview of the quality manager also the arranging requirements engineer was present. The sessions took place in a meeting room in Metso Automation premises. The first instructor of this thesis helped to arrange the interviewing sessions since he worked inside the organization.

7.4. Piloting the Preliminary Proposal

Based on the interviews and observations conducted in the development organization and the gathered theoretical knowledge, the author of this thesis made a preliminary proposal for the new practicalities in product development.

The proposed HCD methods were experimented in practice in a product development project. There were no applicable projects ongoing in a suitable phase, so we started a new one which was planned to be projected later. A suitable phase for a project would have been in this case a project that has just started. The project would have had a schedule and appointed workers but ideally no design or requirements gathering work would have been done already. Also it would be desirable that the project could be carried out in a time frame of a master's thesis. The most important criterion was that the project concerned a human-computer interface.

The purpose of the pilot project was to instruct and train the product development personnel to use the new design methods and find the most suitable methods for the use of Metso Automation product development organization. The results of the pilot project would be utilized after piloting when a HCD process was going to be integrated in MAIP. The results were going to be used to improve the preliminary proposal. The participants of the pilot project would be able to exploit the methods in their future work and also to teach other product developers to use them. The experiences of the pilot

project could also be used as a proof when HCD was going to be disseminated wider in the organization.

The participants of the pilot project were two requirements engineers, and an industrial designer. Later an expert in human factors joined the project too. All of the participants had a good attitude towards HCD and usability and they wanted to work for the process integration. Also a user attended in every phase of the pilot project. The requirements engineers selected the pilot project because they had the best knowledge to make the selection. They also recruited the users.

The selected project was about improving the user interface of an internal tool that would later be delivered also for the customer with metsoDNA. Now the tool was used by the projecting organization of Metso Automation. They used the tool to configure the DNAdiary so that it would be suitable for an individual customer. The Diary application is an accessory tool for the metsoDna automation platform. The process operators use it to write down notes of the processes, for example any abnormalities or disturbance. The Diary tool is mainly used in the control rooms as part of the control system.

The piloting process is described in the chapter 8.

7.5. The Survey and Interviews about Piloting

The pilot project participants were surveyed and interviewed after the project. All of them filled in the questionnaire and were interviewed individually afterwards. The survey mapped the participants' subjective opinions of the piloting generally and of the HCD methods experimented during the pilot project. The personal survey answers were analyzed with each participant individually in an interview. The survey and the participant's own answers were discussed in the interview and the author of this thesis asked also defining questions. The survey can be found in the appendices of this thesis.

After the individual interviews the author of this thesis analyzed the answers and formed an overview of the material. Based on the experiences of the pilot project, she improved the preliminary proposal. She presented the results of the pilot project and the reworked proposal to the product development organization in a meeting. The proposal and the follow-ups were discussed in the meeting.

8. The Results and Conclusions

This chapter collects the findings and results of this master's thesis.

8.1. Data Gathering

8.1.1. The Usability Maturity Assessment

The usability maturity assessment seemed to be successful. We felt that we got a clear picture of the current state of the usability maturity in product development unit based on the interviews. The person that handles most the usability related work in Metso Automation was on job alternation leave during the maturity interviews so we did not get his point of view in the assessment. Later we were criticized that we did not see the whole field of usability related work they do in the organization. That was a justifiable comment. However the interviewees told us about those many things the usability person handles. To the author's observation the noteworthy finding was that the interviewees knew that somebody handles the usability issues but they were not fully aware of the work content and they felt that they did not participate in the work very much.

To the author of this thesis it seemed that the will to invest energy to the usability work is strong in the development organization. But because there is no official process or guide for the usability work in the product development, it is very challenging. There are no official directions of designing usable systems and the concept seemed to be based on the views of the individuals working in the product development. There is a common thought of usability being a matter of opinion and therefore the usability work is experienced to be difficult. There is also some deprivation in the expertise and knowledge of HCD.

Metso Automation has its own style guide for user interface design and we found out that its usage is on a good level in the product development. The style guide Metso Automation has created is thorough and it is followed very strictly in the product development. Its existence is well known in the product development organization and the developers use it widely. The importance of following a definite style in different

products and their different versions is internalized in the product development unit. The compliance with the style guide is not truly supervised but a tester revises that the user interface is accordant with the style guide. Nevertheless the usability faults are considered in many cases as minor faults that are corrected if there is enough time for it. Usually these faults are not corrected until after launch if the users complain about them enough. In every larger project, the product is piloted before launch. In piloting the product or its prototype is tested by the real end users. The product is delivered to a customer and they test it in their own premises. Normally the users of the customer use the product being piloted alongside with the previous system. Usually they do their normal work with the previous system and test or familiarize themselves with the system being piloted. Because the system being piloted is not used for the actual work, many of the defects may not be found. It would be helpful if the users had some tasks they have to do with the system like in a usability test. That may help to reveal more imperfections in the design.

During the usability maturity assessment following a style guide was in practice the only usability method used more widely in Metso Automation's product development. The intention is to increase the selection of methods. The aim is to have methods that everybody is able to use and also methods that are used by experts. At the time of the usability maturity assessment, the HCD work was very focused on one person who carried out some user research and other HCD. Others participated occasionally but too little in their own opinion. Others knew about the work of this usability person but they were not broadly aware of the content of his work. They knew the reports he had made were available somewhere but they had not utilized them in their own work. People were mostly interested in HCD but they did not have the means or knowledge to realize it. They need some support and training.

8.1.2. Participant Observation

During the participant observation period the author of this thesis had a keycard, nametag, and a place of work inside the organization. Those aided her to appear more like a member of the organization. She had visited the organization earlier during the maturity assessment and she had worked many years in Metso Automation in Helsinki.

For her the context was quite familiar from the beginning. She felt that the attitude towards her was neutral enough for the method to succeed.

The observation did not reveal any major negative attitudes towards usability. The opinions were at the most concerned of the additional workload or how to associate the other important matters with usability work. One significant impact from the participant observation was to learn about the organizational practicalities and the working habits the developers had.

8.1.3. Interviewing the Managers

The management supports strongly integrating the HCD into MAIP and into the product development practicalities. They told that the process is strictly followed and the changes should be directed into it. Major changes however demand the approval of the consolidated company.

The managers that were interviewed have recognized the need for HCD and making usable products. They felt that the usability work has to be integrated into the official product development process, because that would make the product developers authorized to employ time to it. It would also make the project managers to direct the needed resources for the usability work. The activities that are not included in the process easily fail from executing and it would get costly in the case of usability. Also the quality system presumes that the activities are described; there should be a process description of the usability work. The managers believed also that HCD would increase the work performance and make the work more effective. One disclosed concern about the integration through the MAIP was that some people have a habit to reuse the old project card template from their computers and not reload it when planning new project. Naturally the changes do not come over if the current templates are not used. The fault will however be corrected in the project's first gateway review. A project card is a document that includes the basic information of the concerned project and its goals, phases and procedures, and results.

The business in the new market areas demands usability in a totally different way than the traditional markets as discussed in the chapter 6. Traditionally the users of

automation systems have been highly educated professionals but now Metso Automation is confronting new challenges with users that are not familiar with the traditional complicated systems. The new mills do not necessarily have the more experienced users from whom the novice users could ask for help. Usability is important also for competitive reasons.

Collecting and using feedback is rather undeveloped. There is an annual inquiry for the salespersons where the customers are heard through the salespersons. Trainings are also held annually and there the project engineers and salespersons present the results of the customer satisfaction surveys from the paper and energy platforms who sell the automation products. The development organization arranges user studies where the production users from production plants are interviewed. Feedback concerns in practice always the current development projects. The product managers get many development ideas but their utilization is challenging because of the long development cycles. The development is always fixed for the forthcoming year. Feedback may be missed out because it cannot be reacted immediately.

8.2. Proposed Actions

The product development process should support HCD work. If the processes do not support some function, it will be dependent on individuals' interests and time. It is important to record the intended actions on a project plan so that they will get resources such as time, money and the people needed to put the methods into practice. If some activities are not documented and required in the project plan, they probably will not be executed at all. Timing and timetables tend to be critical in most projects and in most projects there is no time to waste on anything that is not in the project plan. The tasks that are planned and booked in the project plan have to be done for the project to pass the next gate in the product development process.

8.2.1. Categorizing the Projects

Schaffer [2004] recommends dividing the development projects into four categories (gold, silver, bronze, and tin) according to their importance. The author of this thesis

thought that in this case it would be more straightforward to divide the product development projects into three categories. The categories are the following:

1. Usability critical projects
2. Usability attentive projects
3. Usability excluding projects

Two categories do not suffice the purpose since it oversimplifies the division and makes it coarse. In practice it would mean that either nothing will be done or something will be done. On the other hand four categories could make the selection of the category unnecessarily complicated.

The projects will be divided into these categories in an early phase of product development process, when making the business plan. The intention is that a product manager could be able to make the decision independently or with help of usability professional when needed. When selecting the category, the following will be considered:

- how user interface centered the project is
- does the product have different user roles
- how often the product is used
- how great the customer values are financially
- may a mistake in using the product put people or environment in danger

Many different user roles means there are different user needs that should be taken into account when developing the product. If the usage is continuous, the design should concentrate on efficiency and satisfaction issues whereas in an occasional use the easiness to recall is a key issue.

Usability Excluding Projects

The usability excluding projects typically deal with products that do not have any kind of human interface. People do not use the product that is created or modified in the project. The project outcome may for example be linked to automated controls that

humans do not have to be aware of. If the product has a human interface, it will fall at least to the category of usability attentive products.

In the usability excluding projects the best design practices are enough. No HCD is necessary. But the decisions in projects that do not deal with user interfaces may have an effect to usability in common for example through software architecture or application interface. That makes it important to be aware of the human-centered perspective also when implementing these kinds of projects. If the design follows the best practices, it will not prevent the human-centricity in other designs.

Usability Attentive Projects

Usability attentive projects deal with products that have user interfaces. These include projects that greatly base on an existing product and thus modifications have to be moderate or conservative. Also projects that produce minor new features fall into this category.

This will be the default category for product development projects in Metso Automation. If there is no justified reason to go to another category, the project will be usability attentive.

The category of usability attentive projects emphasizes the early phases of the design process. The project workers will do rapid prototyping and evaluating and reviewing of the prototypes. They will use e.g. personas and keep them on view during the development. The project workers can also analyze the existing system and consider the needs and potentiality to changes. They will also utilize the knowledge and feedback got from previous projects and piloting.

Usability Critical Projects

The Usability critical projects are typically large-scale projects that create or modify products that have many users or that are in continuous use. They may also be products that have occasional users and therefore their memorability and learnability are important. For example new product or extensive new features development projects

belong to this category. Also larger-scale product modifying projects typically are usability critical.

In the category of usability critical projects also a user study is done in addition to the procedures that are done in the two other categories mentioned before. The users are visited in their work context and they are studied with a user study method, for example contextual inquiry or task analysis. User study is not necessary if there already are reliable, well-documented and applicable previous user studies available. In that case the previous studies and their findings are utilized in the project after validating the data with a walkthrough method. Actual users are participated into early product development. The users will participate in the rapid prototyping sessions. Also usability testing is executed with the real users. In usability critical projects also user feedback is collected in a planned and organized way. The feedback is analyzed and documented for future use.

8.2.2. General Actions

The common knowledge of human-centered issues will be improved. In the usability maturity assessment we found that people do not know about the HCD work that is done in Metso Automation product development. The employees cannot use the results of HCD in their own work because they do not know about it or where to find it or how to utilize it. The product developers need both training and information about HCD. The concerned people should also be able to attend the usability work more freely.

Education and Training

First all the employees that need to use HCD methods will be trained to use them. Later all the product development personnel will be trained as well as every new person that will be working in the product development division. The central usability group will be educated to be experts in HCD. The group has to be able to comment and advice when the product development employees have problems with human-centered issues in a design.

Improving the Reporting System

The author of this thesis noticed there were problems in many different contexts with documents or reports. People could not find the documents they needed although they knew they existed. Also they could have benefitted from using some documents or instructions they were not aware of. Documenting and reporting need to be developed and the availability of the documents should be improved.

The Central Usability Group

A central usability group has already been working for years in Metso Automation. Its role and scope has been varying over the years. Now its position and role was rethought. The group was compacted so that there will only be individuals who are truly interested in HCD and usability. The group should be open for new and interested members. The group will meet once in a month. The author of this thesis suggested more frequent meetings but the members felt they do not have time for that. This could be discussed with the management. The group should have resources to do their job.

In the beginning the group will carry out the integration of HCD into the product development process. They will take care that the integration plan described later in this master's thesis (fig. 8-2, table 8-3) will be adopted in the product development. They already introduced the plan to the management and it was implemented. The central usability group has the final responsibility of that the integrated process will be followed and that the project categories are being applied as planned. A project's steering group is responsible for the separate projects and their HCD actions but the central usability group will have the highest responsibility to monitor the overall usability work and intervene when necessary; they lead the usability work. In the end, the central usability group is answerable for the usability of the products. The group needs to have some authority and power to be able to be responsible for the usability. They need to be able to lead people in the usability issues. The KASTE project will be helping the group with the integration and measuring its success. The monitoring and the follow-up will be discussed in the chapters 8.6 "Measuring Performance" and 8.8 "Conclusions" of this thesis. The position of the central usability team will be discussed more accurately later, after the time frame of this master's thesis. The suggestion is that

the group will have the responsibility of the usability of the products and they will be leading the usability work in Metso Automation.

Earlier the group has gathered mainly to evaluate the designs made in the product development. The operation should be directed more into the preventive work. Schaffer [2004] recommends having a central usability group who will answer for developing the usability work of the organization. Error correcting work is not as efficient as preventing the errors systematically from happening.

The tasks of the central usability group will include developing the HCD operation in Metso Automation. The group members will generate usability metrics for measuring usability work and templates that the designers can use in their work. Usability metrics were discussed in the chapter 2 of this thesis. They are used for measuring the usability of a system or a process. Creating suitable metrics demands both understanding of the usability issues and knowing the system. One metric could be e.g. the error rate when doing a particular task. Templates can be for example modeled user interface layouts; how to design e.g. functions such as save or help. The group will gather the standards needed, for example user interface standards and spread them out for the use of the designers. The group will make sure that the level of HCD competence is high enough. They will measure the competence level and arrange training for the designers when needed in addition to the trainings discussed earlier in this chapter. They will also take care that their own expertise in the area of HCD will grow with time and be constantly up to date.

The central usability group will be the usability leader in Metso Automation. They will be responsible for any usability work that does not belong to a product development project. In other words they will be responsible for common issues related to HCD and usability and matters that enable and support usability work in the product development projects.

Informing the Personnel

The change was discussed and designed with the product development workers. The other personnel were informed in an internal magazine of the company when the

integration work was started. The intention is to keep the personnel up to date in usability integration process. Open communication helps in change process as discussed in the chapter four, ”Organizational Change and Change Management” of this thesis. Also customers and other stakeholders will be informed when the first results of the new process are achieved.

8.3. Piloting

The proposed actions were tested in a pilot project as described in the chapter 7.4 of this thesis. The author of this thesis started to make requests for the project about six weeks prior to starting the piloting. There were no suitable projects ongoing or starting soon. Typically the projects’ duration is from several months to couple of years and therefore they are not suitable to utilize in piloting methods for a master’s thesis. The usability methods are used in several phases of a project and if one phase takes months, the next method can be tried in months. We started a pending project that concerned a design tool that the projecting used for configurations, and that could be utilized in piloting.

8.3.1. The Human-Centered Methods Utilized in the Pilot Project

Officially the pilot project would have fallen into the second project category, the usability attentive projects. For learning purposes we decided also to execute some methods of the first category, the usability critical projects. We extended the methods to give the product development personnel a better insight into HCD methods. The pilot project was such that it was easy to carry out for example a user study because the application has internal users. The user study was nice to practice with an internal user because he was easily available and it is more comfortable with a user that does not mind if something goes wrong. The user was present in almost every session where we practiced the HCD methods.

The methods selected for the pilot project were contextual inquiry, paper prototyping, heuristic evaluation and usability testing. The methods were selected to cover the early phases of product development because then there is the best opportunity to influence the system and its usability. The first-mentioned method is applied to get information about the users and the purpose of the second method is to rapidly go through different

design ideas and by iterating the ideas to get closer to the final design. The last two methods are used to evaluate the design. The selection included both lighter and more laborious methods. All of these methods were used in the design phase of product development, so nothing was implemented before all these phases were gone through. More of the methods can be found in the chapter two “Human-centered Design” of this thesis.

Before using any of these methods the group familiarized with the configuration tool and its user interface that was going to be redesigned in the project as discussed in the chapter 7.4 of this thesis. The configuration tool is a web-based application that is used to tailor the DNAdiary application for an individual customer. Its user interface was disorganized and it was considered hard to use. We had two meetings with the requirements engineers in which we went through the current user interface, the user’s tasks and the task sequence. We found out that we do not know if the user has any sequence in which he has to perform the tasks. Also we did not know how the user normally does the work.

The author of this thesis tried to clarify every method to the partakers before it was utilized.

User Study

The first actual method used was a user study method, contextual inquiry, CI. The participants were the two requirements engineers and the author of this thesis. We interviewed the user at his working place

We used the master-apprentice –approach in the interviewing session; we asked the user to do his job normally and interrupted him by asking what he is doing and why. The user seemed relaxed and eager to introduce his work to us. We thought the session was successful; we learned about the user’s task and the requirements engineers felt that the CI session helped them to understand the user better.

We found out among other things that there might be problem in the availability of the internal documents. Last week the user had found a document that helps a lot in his work. The document had existed for years. The same problem had been noticed in the

participant observation with some other internal documents. The user has to work with many different applications and the compatibility is a problem sometimes. A nice detail is that the DNAdiary is configured to use the customer's terminology and conditions with the customer's help. The user utilizes the DNAdiary configuration tool about five times in every project. The idea is that the customers could themselves maintain the classification. Now this is often found difficult because the tool is not easy to use.

The user does his task in an order based on his feeling and needs. In principle the whole form can be configured in one go if all the information needed is available. If the user does not know some value that is needed in the configuration, he uses his expertise and puts something suitable. He offers default values because he thinks simpler is better. He does not mind how the configuration tool user interface is arranged because he thinks that it does not mind in which order the task is done.

When doing the configuration the user used computer, printed documents and phone. With the computer he used the DNAdiary configuration tool, MS Excel, Notepad, MS Word to read the requirements instruction document, and Reportdesigner to create the layout of the report form. In addition he has to deal with C# code file and SQL file sometimes. Reportdesigner is a tool for creating layouts for user interfaces.

Analyzing the CI session

After the CI interviewing session we had a meeting in which we tried to analyze the data we got from the contextual inquiry. The meeting was arranged about a week after the CI session. That was too late. The recommendation is that the walkthrough session or meeting should be held preferably within 48 hours after the CI session. We did not manage to arrange time for the meeting any sooner. That was a pity because we had then forgot some things and the memorizing and analyzing was harder because of that.

Another drawback was that we did not have a user with us in the CI analyzing meeting. The participants did not consider the analyzing purposeful because they felt that the things were already cleared in the contextual inquiry session. The presence of a user might have motivated the participants to analyze the interview. The analyzing process would have been finding the work practices and to create a work model to understand

the workflow. The author of this thesis tried to keep the conversation to the findings made in the CI session in a way that Holtzblatt et al. [2005] describe but in her own opinion she did not manage to do it as planned, probably because of her inexperience. Holtzblatt et al. suggest that one of the interviewers should describe the study session and the listeners capture the key issues. The participants seemed to be convinced that everything could be understood from the CI session records. The author documented the analyzing session, both the results and the intercommunication.

The results of the analysis remained quite shallow and we were not able to properly bring the CI results into the next phase, prototyping. The participants seemed eager to hurry into the next phase and method and they seemed to be convinced that the information we got in the interview was understood right and documented well. They could not concentrate on the analyzing and they might have thought it was not necessary to analyze the results. The author of this thesis thinks that she could have explained the method more properly beforehand to make the participants better understand the meaning of the method and its phases.

We learned that we should have the CI analyzing session planned and scheduled in the same time we plan and schedule the CI interviewing session. We also should invite in time a couple of users to come to the analyzing session so that we can be sure there will be at least one user with us in the session. Maybe it would not be bad to plan also a back-up meeting if the participants are unexpectedly prevented to attend the first meeting. The analyzing session is very important because it validates the correctness of the interpretation of the interviewing and communicates and documents the results.

People have made user studies in Metso Automation before. The person who has been responsible for the previous user studies did not partake the user study in the pilot project. In the future he will be participating actively the usability work in Metso Automation. However it is recommended that some other persons are also able to run user studies independently.

Paper Prototyping

Paper prototyping is an iterative rapid prototyping method. We had several prototyping sessions with the requirements engineers and the user. The expert in human factors was also present in the latter sessions and an industrial designer partook some sessions. The participants appeared to wait for this method but they also made jokes about it being playing with papers.

The idea was to start with two teams that would independently design their own rapid prototypes and after that they would discuss it with the other team. That would have prevented from sticking into one model too soon. We did not have enough partakers in the first session so we could not follow through that plan. Instead we started with studying the old user interface and understanding the users' work through the data gathered in the CI. To the author's observation, we made good use of paper prototyping mostly just in the first session (fig 8-1). In the second session we used the paper prototype to help in iteration but we did not do the iteration on paper. Later we ended up looking user interface pictures made with MS Visio from projector. One of the partakers operated the MS Visio from his computer and the others made comments and the pictures were modified based on the comments.

Figure 8-1 Paper Prototyping

The idea of paper prototyping is that everybody can easily participate in the modification of the prototype. When sticky notes are used, everybody can do modifications at the same time. When using computer, in practice one person operates it and the other ones make comments. Prototyping is quick and easy with flip-chart paper and sticky notes. The prototyping should be kept in a rough level and the details should be discussed later. It was challenging to get the people work in a new way. They had been doing the design work with MS Visio so that one person operates it and the others make comments. Now the way of working easily slid towards the traditional habit. The danger in this kind of working is that there might not be room for very divergent ideas. It is difficult to create fresh ideas that differ from the existing model when the model is already created and refined further.

Some of the participants criticized the paper prototyping. They felt that the traditional way of doing with the MS Visio is better. They felt that the general view was easier to piece together and it is easy to move components with copy and paste in the MS Visio. They told also that they do not normally start with MS Visio but first they sketch on paper. They liked that in paper prototyping it is easy to think up several different early

phase sketches. Thus far they usually have not thought about different potential solutions at all. They have more held to the first reasonable solution and made changes to it when needed.

The participants had certain prejudice towards the paper prototyping method. Some of the participants did not talk about paper prototyping but “playing paper games”. We wanted to test the method after all because in paper the sketches are visible all the time and everybody can edit them. The participants told they also have a habit to sketch on paper before starting to use MS Visio. Some of the participants felt that they cannot draw or that it is slow to draw by hand. The meaning was to sketch quickly and roughly, but apparently it was hard to do something imperfect even in front of others. The participants seemed to concentrate quite much on insubstantial and detailed issues such as how the buttons should be aligned or how the text should be formulated. The author of this thesis had guided them to utilize the method but it is not easy to learn a new way to work. They were aware of this tendency they had but they were not able to give it up. They also made suggestions verbally and asked the others to sketch them because they said that the others are better in drawing. Maybe the author of this thesis did not clarify the purpose and techniques of the paper prototyping well enough before the sessions. And it might have been worthwhile to practice the paper prototyping technique with a simple exemplar user interface before the actual use.

The paper prototyping was started somewhat precipitated. The results of the user study should have been analyzed and processed more before starting to prototype. The user’s task should be understood better. On the other hand we did deal with these issues but the troubles with the user study affected the paper prototyping.

We had several sessions of paper prototyping. The idea got refined and it resulted into a user interface prototype. Some of the participants felt that paper prototyping is a convenient means to reveal the structure. Some others thought it is a bit clumsy to use. To the author’s observation the method helped to outline the prototype but the method should be practiced several times and the group should not contain people who feel strongly against the method.

Heuristic Evaluation

After several iterations of the prototype, one of the pilot project participants made the user interface pictures for heuristic evaluation with MS Visio. Metso Automation has its own document of instructions for heuristic evaluation. At least some of the participants had familiarized themselves with it before. However they told that it is obscure and they do not understand it in full. We used the heuristic evaluation instructions of the UsabilityMate web site. The instructions are directed to machinery automation so there were items that were not applicable in the process automation context we were dealing with. The author of this thesis instructed the participants to make a heuristic evaluation and we walked through the UsabilityMate site shortly before the participants made their own evaluations. The evaluations were made alone and unattended. Two out of four participants and the author of this thesis made an evaluation. The participants who made an evaluation liked the method and the relatively detailed instructions in the UsabilityMate. They found different faults and proposals for improvement. They felt that the method was also suitable for revealing issues that have been slipped from the prototype or other unmade issues. The instructions for heuristic evaluation in UsabilityMate are based on Jakob Nielsen's ten usability heuristics. The heuristics are explained in a way that should make it possible for also other people than the usability experts to make an evaluation easily but also comprehensively.

It took approximately two hours per person to make the heuristic evaluation. The findings were analyzed with the five person pilot project group and some decisions were proposed in the meeting. Some of the findings were corrected immediately to the prototype and some were registered to be decided later. We documented the heuristic evaluation walkthrough session and all the findings. We did not record the severity of the findings because the evaluation was made to a prototype and correcting all the findings was possible. The heuristic evaluation walkthrough session took approximately two hours.

The experiences of the heuristic evaluation were mostly positive. One of the participants who did not make an evaluation told that it seemed too difficult. The other ones said they were too busy to do the evaluation. The method was considered to be quick to perform and still it can reveal lacks or faults in a user interface. Depending on the

amount of persons making an evaluation and the scope of the user interface, it takes about one to three working days per person. Utilizing the method does not require any specific preparations and a person doing the evaluation for the first time can make findings by following a heuristic list.

The heuristic evaluation will be adopted as a usability method in Metso Automation product development. It is an affordable, rapid and effortless method for finding faults in a user interface or its prototype. It can also be used as a quick check before usability testing. The method can be performed by the project members and no other stakeholders are needed. In Metso Automation product development the heuristic evaluation will be done with a prototype prior to possible usability testing. The instructions for heuristic evaluation in Metso Automation will be produced outside the thesis work but within the KASTE project. The intention is that Metso Automation will use the tailored instructions of the heuristic evaluation that will be made later. The instructions will emphasize the special qualities of process automation user interfaces. Heuristic evaluation will be a basic method that will be used in every project concerning a user interface.

Usability Testing

Usability testing was the most well-known method in piloting. Many participants had familiarized themselves with the method earlier. However the author of this thesis advised the group for the method and making the test cases. A requirements engineer was responsible of making the test cases with the assistance of the user who participated the project. The user helped to make the test cases as realistic as possible. The author of this thesis advised them to make test cases relating both to creating new diary and to configuring an existing diary. The test tasks should be realistic and base on actual work tasks, and use the real names and other variables. An internal user who had some experience in configuring the diaries was selected as the testee. In a normal case there should be at least two testees. The literature recommends using at least three to five testees who should be actual users.

The usability testing revealed many faults in the prototype. One of the findings can be considered a major fault. It can be considered as a sign of successful usability testing

but the author of this thesis believes that it tells about weaknesses in the earlier phases. The user task was not understood properly and it affected the later work. The author of this thesis suggests adding some interpretative analyzing method between user study and prototyping.

8.3.2. Conclusions of the Pilot Project

Different usability methods were experienced in the pilot project. The methods were contextual inquiry, paper prototyping, heuristic evaluation and usability testing. We also familiarized with the user's current work but it could be productive to experience a method such as task analysis or task flow modeling. It seemed that we started the prototyping too soon without a proper understanding of the user's task. The participants were eager to create something concrete and the author of this thesis did not have the needed experience to slow down. More time and effort should have spent in analyzing the users and the tasks and collecting the requirements. It is a common mistake not to use enough resources in the early phase. It was known before starting the pilot project and still it happened. Paper prototyping could have been more successful if the user and context would have been understood properly.

We had problems with paper prototyping. It was difficult to get some of the participants to use the sticky notes and ideating a new user interface. There was quite much resistance towards the method. However the participants seemed to understand the meaning of working for usability in the early phase when they found defects in the usability testing. Maybe the attitude would be different in a following project.

The pilot project was started purposely to experience the usability methods because there was no suitable project ongoing. Therefore we did not find out e.g. how utilizing usability methods would affect the schedule and resources. Again if we would have piloted the methods in a scheduled project, we probably would not have valid results of the affects usability work has on schedule and resources because we were experiencing and learning the methods. However we might have got a clearer idea of the impact using the methods have. It could have been easier to measure the effect the methods have on the experienced usability of the product. Anyway, the results would have been demarcated outside the scope and schedule of this thesis.

8.4. The Results of the Survey and Interviews after Piloting

The participants were questioned about the piloted methods and the piloting in general. The survey and the interviews were conducted with five respondents who attended the pilot project. Based on the survey and the interviews, the participants felt that it was necessary to have the user participating in the pilot project. It helped in going at "the real and essential problems". The results can be utilized directly in the development work and the usability of the system was clearly improved.

Table 8-1 The results of the survey of piloting and usability methods, scale 1-5

Question / Method	Contextual Inquiry	Paper Prototyping	Heuristic Evaluation	Usability Testing	Question average
The method is easy to apply	3,80	4,50	4,50	3,40	**4,05**
I would be able to apply the method in the future	4,00	4,00	4,33	4,10	**4,11**
The method is useful in the product development	4,60	3,50	4,00	4,80	**4,23**
The method fits in the organization's practicalities	4,00	3,00	4,25	4,00	**3,81**
I will use the method in my work	4,00	3,50	4,00	4,20	**3,93**
Method average	**4,08**	**3,70**	**4,22**	**4,10**	

The table 8-1 presents the results of the questionnaire about the experimented usability methods. The methods were surveyed on a likert-scale from 1, "totally disagree" to 5, "totally agree". Three was a neutral option, not agreeing or disagreeing. The numbers in the grid are averages of all the respondents, all of them are at least three. The bolded numbers are the row or column averages, presenting either the average of a method or a question. There were only individual disagreeing responses. For example the difference between paper prototyping and the other methods is explained by one respondent disliking the method. Due to the small amount of respondents, the results are mainly suggestive. However the survey and the interviews gave further information about the attitudes of the participants. Based on the impression the author of this thesis got from

observing the participants during the piloting sessions, she expected the participants to dislike the paper prototyping method. The majority of the participants told that they supported the method and that they would like to try it again. It was the most unknown method for the participants and it went deep to the daily designing work.

Usability testing was considered to be the most laborious method. Making the test scenarios was experienced to take a long time and lots of effort. The participants believed that the organization will utilize the lighter methods like heuristic evaluation but the heavier methods may be forgotten in the hurry. The methods will not become popular if the developers think that they are difficult to use or take too much time.

The author of this thesis concludes that it is easier to adopt methods that can be added to the daily work as separate sessions. It is clearly harder to change the daily working habits than to apply a method once. Thus it is more effortless to perform a user study than to make parallel designs or rapid prototypes. A user study can be conducted in one day whilst parallel designs or rapid prototyping requires changing the everyday working. Even if the attitude is positive, it can be hard to change one's ways to work.

The participants were asked what would support the utilization of usability methods in the product development and what prevents it. The issues they brought up are listed in the table 8-2.

Table 8-2 Issues that support or prevent HCD in product development

Supporting issues	Preventing issues
Good experiences with usability	Usability is not seen as a "high-priority" issue
Management support	Sticking to the old habits
An official status in the product development process	HCD is not seen as "real work"
Usability training	Applying HCD with agile methods is challenging
Controlling that the usability work will be done	Problems with resources
The role of the central usability group as a HCD leader	Recruiting actual and representative users

Management support was ensured in the manager interviews. Integrating HCD into the product development process will give the HCD work an official status and it will be required and controlled. Changing the role of the central usability group will depend on the group's own activity. Communicating and training should have an influence on the general attitude. Resources will be allocated when the work is required in the project plan. The most considerable challenges will be with the human attitudes and how the individuals motivate themselves to change their working methods.

8.5. The Proposal after the Adjustments

The proposed actions were refined after the pilot project and the related studies. The final process model is illustrated in the figure 8-2. In the figure the product development project is generalized. The early stages are emphasized in the model.

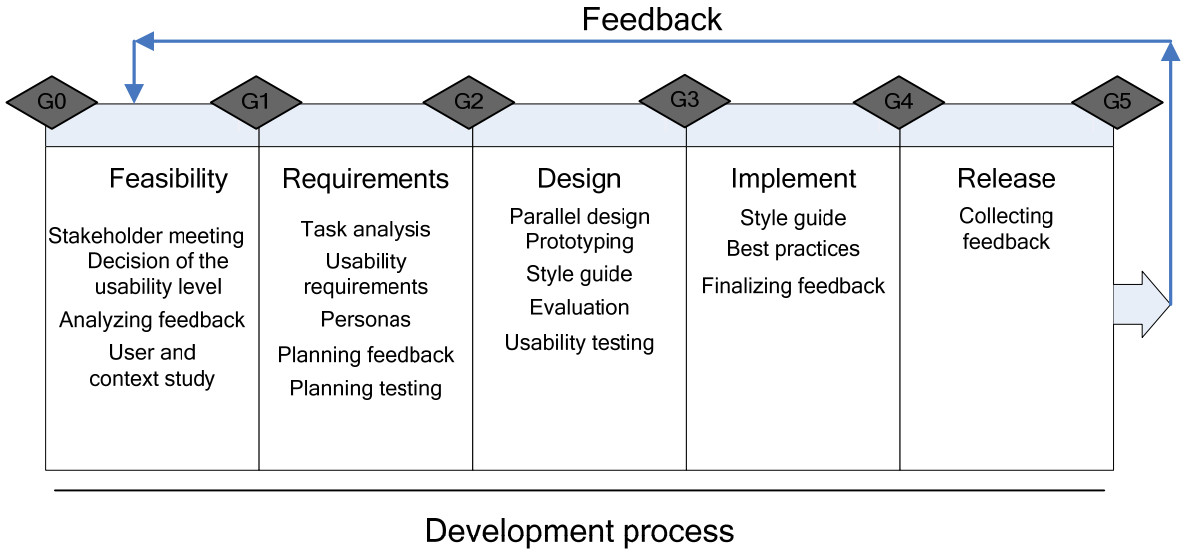

Figure 8-2 The proposed process model

The product development project is started with a stakeholder meeting where the level of usability importance is decided. The existing feedback from the old projects or from the front-end of innovation is analyzed and utilized in the feasibility study. The user and the context can be studied in this phase too. Definition of the usability level, understanding of the main user groups, and the rough usability metrics are needed to pass the first gate review.

In the requirements phase the users' tasks are analyzed and redesigned if needed. The usability requirements are written based on the user and context studies and the task analysis. Personas may be used to help in the requirements gathering. The detailed usability metrics are created to measure the system's quality of use. The feedback gathering and usability testing are planned based on the usability requirements. To be approved in the G2 meeting, the usability requirements with traceable documenting and a plan of feedback gathering are needed.

The system design is done following the style guide. Parallel design and iterative prototyping should be used. The designs are evaluated e.g. with heuristic evaluation and usability testing. Rapid evaluations can be executed between the iterations. In the G3 meeting the design is approved to be implemented if the design is tested to realize the user requirements.

When starting to implement the system, most of the usability work will be already done. The implementation should follow the style guides and the best practices. If the product is piloted, usability testing takes place. In the G4 meeting the usability testing report and the finalized and detailed feedback gathering program are needed.

When the product is released, the project ends. However the feedback should be gathered six to twelve months after the release. The project workers organize the feedback gathering according to the plans made in the requirements and implementation phases. They analyze and document the collected feedback and discuss it for learning. The feedback should be analyzed and documented in such a way that makes it effortless to utilize in the future projects.

Table 8-3 The usability actions in different categories

	Usability critical	Usability attentive
G0	Preliminary decision of the usability level	Preliminary decision of the usability level
G1	Rough metrics, rough user groups, feedback analysis, user and context study, competitive products evaluation	Feedback analysis, final usability level
G2	Task analysis, feedback gathering and usability testing plans	The user, tasks and context are defined, usability requirements
G3	Parallel designs, iterative rapid prototyping, evaluations, usability testing	Style guide, prototyping, heuristic evaluation
G4	Confirm that the requirements are met, finalize the feedback gathering	Confirm that the requirements are met
G5	Feedback collection and analyzing	

The table 8-3 describes the differences in the method usage between usability critical and usability attentive projects. The usability excluding projects are designed and implemented following the best practices. The table 8-3 presents the methods that are needed in the numbered gates, the actual method usage happens in the preceding stage. In the G0 meeting where the development project is launched, the preliminary usability level is decided; the project will be categorized to be either usability critical, usability attentive or usability excluding. In the G0 meeting the required usability work for the project is decided. The G1 meeting confirms the methods that will be used during the project lifecycle.

To be approved in the G1 meeting the usability level needs to be confirmed. Existing feedback should be examined. In usability critical projects also user and context needs to be studied and documented. The user study results are needed in the G1 meeting. When the project is reviewed in the G2 meeting, the documented and traceable user requirements are required. In the category of the usability critical projects also a usability testing plan and a feedback gathering plan are needed.

Usability test report is required for the usability critical projects in the G3 meeting. Also parallel design has to be done in the preceding stage. In the usability attentive category a heuristic evaluation performed by at least four people are needed. The findings have to

be corrected in the design. In the G4 meeting after implementation, verification is required that the system is tested to be accordant to the requirements and designs. For the usability critical projects the feedback gathering needs to be finalized, scheduled and detailed. The persons responsible for implementing the feedback gathering and analyzing have to be designated before the G4 meeting or in the meeting.

The feedback will be collected and analyzed six to eighteen months after releasing the project. The feedback gathering methods and questions are planned before the G2 meeting. The plan is finalized in the G4 meeting. Then the target organizations, the point of time, the analyzing methods and the responsible persons are designated. The plan is documented carefully and the needed resources are fixed before the G4 meeting.

8.6. Measuring Performance

The operation should be measured to make sure it is beneficial and to develop it. In this case the target level of usability maturity does not necessitate measuring and developing the process. However the author of this thesis recommends using some meters to reveal how intensively the usability work is done and what kind of affect it has on performance and customer satisfaction.

One metric that would measure the usability work on a process level could be the project distribution on the three project categories. The project distribution should be estimated before implementing the proposal described in this master's thesis. The estimation can be done by examining the ended and ongoing processes on an annual level and consider how many of them would fall into the usability critical, usability attentive or the usability excluding category. After utilizing the HCD process for six to twelve months the estimated and the realized number should be compared. If the numbers show that there are fewer usability critical and usability attentive projects than estimated, the project-specific reasons should be analyzed.

Another metric could record the utilized methods to reveal the focus of the work. If the focus is not on the early phase, the methods selection should be corrected.

One descriptive metric is customer and user satisfaction. It should be measured before changing the ways of working and six to twelve months after launching a product that has been developed with the new methods. Also support call rate can be used as a metric that measures the customer satisfaction and the ability to work without major problems.

8.7. Research Questions Revisited

The research questions for this thesis have been answered throughout the thesis. This chapter shortly summarizes the answers for the questions.

1. Why should a product development process support human-centered design?

   HCD is a mean to ensure usability and the desired user experience. The market need for usability and UX is constantly growing. HCD can also make the product development more efficient because its focus is on the early phases. Usability is one aspect of quality. It supports human performance and thus reduces hazards and accidents. It also increases efficiency and decreases support and redesigning costs.

2. What does human-centered design mean in product development process?

   HCD is also a process and it should be performed throughout the product development. Usability is a quality attribute and it is an outcome of processes. Integrating HCD into product development process means that HCD will be utilized like any other design method. When HCD is integrated into the product development, the development process but also the development practicalities support making usable products. Process support means that the developers are able to concentrate on designing usable products because the operation is properly managed.

3. What is the present state of the application of human-centered design approach in the product development process and practicalities in Metso Automation?

   Metso Automation utilized some HCD work in their product development. The work was rather unofficial and not supported by the product development process.

HCD actions were depending on the individual's interest and possibility to arrange time for it. The work was greatly depending on one individual. The interest towards HCD was broad and its importance was understood widely. Consistence was seen as the most important usability factor and there was a style guide in use mainly for ensuring the consistence between the products.

4. How should the present product development process be changed in order to support HCD?

The process should ensure that the needed quality of use is achieved constantly. The changes include dividing the projects into three categories according to the importance of the usability of the outcome. The HCD methods should be utilized during every phase of the product development process. The early phases should be emphasized since the earlier the work is started the greater the impact can be.

5. How the change can be realized?

Change is a time-consuming process. According to the literature the best indicators for successful change are management support, establishing a team that is responsible for usability issues, close collaboration between product managers and HCD people, re-definition of responsibilities, and adjustment of operations. Also training and communication are key issues. Everybody should be participated.

8.8. Conclusions

In this master's thesis a method to integrate human-centered design process into product development of an organization was created. It was evaluated in a pilot project. The future phases of the integration process include systematic usage of the integrated methods and changing the product development instructions. The employees will be trained to follow the new process and the new process will be put in use organization-wide.

Both the developers and the managers are positive towards the change and HCD. They seem to understand widely the meaning and the possibilities of HCD and making usable products. The current innovation process is followed strictly and there is no reason to

believe that integrating HCD into the process would change it. The developers told that there have been some changes in the process before and there was no problems implementing them. Following the process is extensively controlled and the author of this thesis believes that if the changes have positive effects, they will be kept in the process.

The product development organization of Metso Automation had utilized some HCD methods already prior to this thesis and the changes made mainly supported the previous work. One aim for this master's thesis was to obtain an official status for the HCD work in Metso Automation. That seems to be taking place. HCD has been added into the Metso Automation Innovation Process description and instructions.

There is still much work to be done. As stated earlier, a change does not happen without long-time human effort. Future will show whether the proposal will work and if the project categorization will be followed. Some training should be arranged, new methods should be learned, and new professionals have to be acquired either by training or recruiting. The responsibilities should be changed; the central usability group should gain a position of a usability leader and more of the developers outside the central usability group should take responsibility of the daily usability work. Also the status of the central usability group should be established.

The changes focus on the working habits and integrating the new methods into the existing practicalities. The most significant change is that the usability work will gain the needed valuation and status as an integral part of the Metso Automation Innovation Process. It will get the needed resources in every project plan and it is controlled and measured. To the author's understanding, the greatest risk is that the product developers do not change their working methods or go back to the earlier. Some resistance towards the change was seen already during the pilot project, though all the participants had a positive attitude towards HCD. If these central people do not fully commit to work for the new process, the change hardly comes true. However the general positive attitude, the will to make usable products and the trainings are supporting the commitment. In addition the KASTE project will continue the institutionalizing work with Metso Automation. The project will monitor the success of the integration with different metrics and actions will be taken if the metered requirements are not filled.

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APPENDIX A - Survey for The Participants of the Pilot Project [Earthy 1999]

Human-Centered System Development

HCD 1	HCD 2	HCD 3	HCD 4	HCD 5	HCD 6	HCD 7
Ensure HCD content in systems strategy	**Plan and manage the HCD process**	**Specify stakeholder and organizational requirements**	**Understand and specify the context of use**	**Produce design solutions**	**Evaluate designs against requirements**	**Introduce and operate the system**
— represent stakeholders — collect market intelligence — define and plan system strategy — collect market feedback — analyze user trends	— consult stakeholders — plan user involvement — select human-centered methods — ensure a human-centered approach — plan HCD activities manage HC activities — champion HC approach — support HCD	— clarify system goals — analyze stakeholders — assess H&S risk — define system — generate requirements — set quality in use objectives	— identify user's tasks — identify user attributes — identify organizational environment — identify technical environment — identify physical environment	— allocate functions — produce task model — explore system design — develop design solutions — specify system and use — develop prototypes — develop user training — develop user support	— specify context of evaluation — evaluate for requirements — evaluate to improve design — evaluate against system requirements — evaluate against required practice — evaluate in use	— manage change — determine impact — customization and local design — deliver user training — support users — conformance to ergonomic legislation

APPENDIX B – Survey for The Participants of the Pilot Project

In the KASTE project we experienced some usability methods in the redesign project of the DNAdiary configuration tool user interface. The purpose is to survey the expediency of the pilot project. The survey grounds the subsequent interviews. In the open questions it is good to think up some key words to support the discussion. The results of the survey and interviews are utilized in developing MAIP. Please answer the questions concerning the methods you partook.

1. Your Opinion of the Experienced Usability Methods

The experimented methods were

- CI, contextual inquiry, in which we interviewed the user in his work context and summarized the results in a group
- Paper prototyping where we iterated the user interface prototype on paper
- Heuristic evaluation, in which each of us walked through the user interface prototype with a heuristic list and searched any defects. At the end we discussed the findings with each other
- Usability testing where a user executed the given tasks with the user interface prototype.

Contextual Inquiry, CI, interviewing user in his work context, interpreting the interview in a group, and documenting the results

I attended the interviewing session Yes No
I attended the interpreting session Yes No

Answer the following statements by circling the most suitable alternative.
1. totally disagree, 2. somewhat disagree 3. neither disagree nor agree 4. somewhat agree 5. totally agree

• It was easy to apply the method:	1	2	3	4	5
• I would be able to apply the method in the future:	1	2	3	4	5
• The method is useful in the product development:	1	2	3	4	5
• The method fits in the organization's practicalities:	1	2	3	4	5
• I will use the method in my work:	1	2	3	4	5

My opinion and experiences of the method:

_____
_____
_____
_____

Paper prototyping

I attended about ____ prototyping sessions.

Answer the following statements by circling the most suitable alternative.
1. totally disagree, 2. somewhat disagree 3. neither disagree nor agree 4. somewhat agree 5. totally agree

• It was easy to apply the method:	1	2	3	4	5
• I would be able to apply the method in the future:	1	2	3	4	5
• The method is useful in the product development:	1	2	3	4	5
• The method fits in the organization's practicalities:	1	2	3	4	5
• I will use the method in my work:	1	2	3	4	5

My opinion and experiences of the method:

_____
_____
_____
_____

Heuristic evaluation:

I made a heuristic evaluation to the prototype Yes No
I participated the shared evaluation session Yes No

Answer the following statements by circling the most suitable alternative.
1. totally disagree, 2. somewhat disagree 3. neither disagree nor agree 4. somewhat agree 5. totally agree

• It was easy to apply the method:	1	2	3	4	5
• I would be able to apply the method in the future:	1	2	3	4	5
• The method is useful in the product development:	1	2	3	4	5
• The method fits in the organization's practicalities:	1	2	3	4	5
• I will use the method in my work:	1	2	3	4	5

My opinion and experiences of the method:

_____
_____
_____
_____

Usability testing:

I participated designing the test cases Yes No
I participated the testing session Yes No

Answer the following statements by circling the most suitable alternative.
1. totally disagree 2. somewhat disagree 3. neither disagree nor agree 4. somewhat agree 5. totally agree

- It was easy to apply the method: 1 2 3 4 5
- I would be able to apply the method in the future: 1 2 3 4 5
- The method is useful in the product development: 1 2 3 4 5
- The method fits in the organization's practicalities: 1 2 3 4 5
- I will use the method in my work: 1 2 3 4 5

My opinion and experiences of the method:

_____
_____
_____
_____

2. Your Opinion of the Piloting in General

Evaluate the success of the project in general

_____
_____
_____
_____

In your opinion, what kind of meaning the user participation had in the project?

_____
_____
_____
_____

What kind of problems or challenges do you see in the utilization of usability methods in the future in the product development in your organization?

_____
_____
_____
_____

What would increase the future utilization of the usability methods in the product development in your organization?

How have you utilized the experienced methods in your work after the pilot project?

How the piloting of the usability work came up to your expectations?

What kind of affect the usability methods experimenting has had on your opinions or conceptions of
-the nature of the usability work?

-the possibilities of the usability work?

-the meaning of the user participation?

Thank you for your answers!