

User involvement in the innovation process

In a mobile service and application development perspective

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USER INVOLVEMENT IN THE INNOVATION PROCESS

In a mobile service and application development perspective

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Summary

User involvement in the innovation process is not a new phenomenon. However, combined with the growing individualisation of demand and with highly competitive and dynamic environments, user involvement in the innovation process and thereby in the design, development, and manufacturing process, can nevertheless provide a competitive advantage. This is the case as an intensified user involvement in the innovation process potentially results in a more comprehensive understanding of the user needs and requirements and the context within which these are required, and thereby provides the possibility of developing better and more suitable products.

The theoretical framework of this thesis is based on user involvement in the innovation process and how user involvement in the innovation process can be deployed in relation to deriving and collecting user needs and requirements, and thereby serves as a foundation for developing better and more supportive service and application concepts within the information and communication technology domain. Three interrelated research areas are deployed within the theoretical framework, which combined constitute and highlight the intertwined and complex interaction of people and their use of information and communication technologies: mobile system requirements, mobility, and the concept of Personal Networks. The mobile system requirement perspective is related to providing a more user oriented research approach, which historically has not been the case. The mobility perspective is related to categorising and conceptualising the term mobility in a combined user need and requirement perspective and service and application development perspective. The Personal Network concept perspective is seen in relation to the introduction of new information and communication technologies, and in particular in relation to derive and collect user needs and requirements.

Within the theoretical framework of user involvement in the innovation process the concepts of lead users, sticky information, and toolkits, and the usages and perspectives of these rooted in a method development and testing perspective, have been deployed to derive user needs and requirements within two case studies: a diabetes case and a journalist case. The diabetes case has been conducted in collaboration with a diabetes treatment centre and diabetics and the journalist case in

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collaboration with the sports department at a large Danish broadcasting company, both with the main objective of deriving and collecting real user needs and requirements and based on these to develop service and application concepts which support diabetics and journalists in their activities and tasks. The lead user theory has been deployed as it indicates that users residing on the leading edge of any given market, technology, etc. are more likely to develop innovations compared to more ordinary users as the lead users will be experiencing needs and requirements presently, which the ordinary users will not experience until later. Sticky information denotes the transferability of a given unit of information, which in this context is related to the transferability of user needs and requirements. The deployment of different toolkits has been related to transferring sticky information (user needs and requirements) into less sticky information and thereby shifting the deriving and collecting of user needs and requirements into the user domain.

This thesis shows how the deployment of the lead user, sticky information, and toolkit methods combined with some more traditional approaches and in relation to the two case studies have proven to provide a more detailed and context related understanding of the user needs and requirements within the two case segments. Furthermore the mobility and context related aspects of user needs and requirements have been deployed and incorporated into the gathering and collecting process, and have provided valuable insights in relation to the developed future service and application concepts, which are based on real user needs, requirements, mobility, and contexts. All with the purpose of deriving user needs and requirements and thereby develop and describe the concepts for future services and applications, which support these users in their everyday life, tasks, and contexts – value innovation.

Resumé

Brugerinvolvering i innovationsprocessen er ikke et nyt fænomen. Kombineret med den stigende individualisering i efterspørgslen og den forholdsvis dynamiske og konkurrenceprægede verden, som virksomheder generelt opererer i, kan brugerinvolvering i innovationsprocessen og dermed også i design-, udviklings- og produktionsprocessen give en klar konkurrencefordel. En øget brugerinvolvering i innovationsprocessen kan potentielt resultere i en større forståelse af brugernes behov og krav og i hvilken sammenhæng disse opstår.

Den teoretiske ramme i denne afhandling er baseret på brugerinvolvering i innovationsprocessen og hvordan brugerinvolveringen i innovationsprocessen kan anvendes i forbindelse med indsamling af brugernes behov og krav, og derved fungere som fundamentet for at udvikle bedre og mere brugerorienterede service- og applikationskoncepter inden for informations- og kommunikationsteknologi. Tre indbyrdes sammenhængende og overlappende forskningsområder er anvendt inden for teorirammen af dette projekt, som kombineret udgør og understøtter den sammenhængende og komplekse interaktion mellem mennesker og deres brug af informations- og kommunikationsteknologier: krav til udviklingen af mobilsystemer, mobilitet og Personal Network-konceptet. Kravene til udvikling af mobilsystemer, skal ses i forhold til det at understøtte en mere brugerorienteret udviklingsproces, hvilket historisk set ikke har været tilfældet. Mobilitetsperspektivet er anvendt i forhold til kategorisering og konceptualisering af begrebet mobilitet i et kombineret brugerbehovs- og udviklingsperspektiv. Personal Network-perspektivet skal ses i forbindelse med introduktionen af nye informations- og kommunikationsteknologier og specielt i forhold til at indsamle brugerbehov og brugerkrav.

Inden for den teoretiske ramme vedrørende brugerinvolvering i innovationsprocessen er koncepterne lead users, sticky information og toolkits blevet anvendt til at udlede brugerbehov og brugerkrav inden for to case studier: en diabetes case og en journalist case, baseret på et metodeudviklingsperspektiv. Diabetes casen er udført i samarbejde med et diabetesbehandlingscenter og diabetikere og journalist casen er udført i samarbejde med sportsafdelingen hos en dansk radio/tv-station, begge med det

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hovedformål at indsamle brugerbehov og brugerkrav, samt baseret på disse at udvikle service- og applikationskoncepter, som understøtter diabetikere og journalister i deres aktiviteter og opgaver. Lead user teorien er anvendt, fordi den indikerer at det er mere sandsynligt at brugere, som er på forkant med udviklingen fx på et givet marked eller indenfor en given teknologi, er mere tilbøjelige til at udvikle eller efterspørge produkter, som endnu ikke findes på markedet, eftersom disse brugere vil have behov og krav i dag, som almindelige brugere først vil efterspørge på et senere tidspunkt. Sticky information betegner hvor forankret en given informationsenhed er hos brugeren, samt hvor kompliceret det er at overføre denne informationsenhed. Anvendelsen af forskellige toolkits er relateret til konverteringen af sticky information (brugerbehov og brugerkrav) til information, som er mere forståelig og lettere at anvende, og samtidig er brugen af toolkits med til at flytte indsamlingen af brugerbehov og brugerkrav over til brugerne.

Denne afhandling viser hvordan lead user, sticky information og toolkits metoderne, i forbindelse med de to case studier, er anvendt til at udarbejde en mere detaljeret, brugerorienteret og kontekstrelateret forståelse af brugernes behov og krav. Derudover er de mobilitets- og kontekstrelaterede aspekter vedrørende brugerbehov og brugerkrav blevet anvendt og indarbejdet i indsamlingsprocessen og har bidraget til en bedre forståelse i relation til udviklingen af fremtidige service- og applikationskoncepter, som bygger på brugernes reelle behov, krav, mobilitet og kontekst. Alt sammen med det formål at udlede brugerbehov og derved udvikle og beskrive koncepterne for fremtidige service og applikationer, som støtter brugerne i deres dagligdag, i deres opgaver og i de kontekster, som de befinder sig i.

Preface

This thesis is a result of a three year project period and the final step in obtaining a PhD degree at the Center for Information and Communication Technologies, Department of Informatics and Mathematical Modelling, Technical University of Denmark.¹ The dissertation describes the core aspects of my work during this period. However it only partially represents what I have been doing throughout this period and more or less neglects the personal development that was a substantial part of the whole project and one of the main reasons for embarking on this challenging and edifying journey in the first place.

The work has mainly been carried out in Denmark at the Center for Information and Communication Technologies, but I have been fortunate enough to work together with Professor Johannes M. Bauer when I was a guest researcher at the Quello Center, Michigan State University, USA, for six months. In addition to adding substance to the thesis, this period also broadened my personal horizon and strengthened the dimensions of my work. The six month stay at Michigan State University would not have been possible without financial support, and I would especially like to thank Kaj og Hermilla Ostenfeld's Fond and Otto Mønsted Fond for their generous contributions, which made this possible.

During my work many highly competent and qualified people have assisted me and thereby indirectly contributed to the final result. I would especially like to thank Lene Sørensen, Morten Falch and Anders Henten for collaboration and guidance throughout my work at the Center for Information and Communication Technologies together with the rest of the faculty and staff at the Center for Information and Communication Technologies. Furthermore I would like to extend my thanks to the faculty and staff at the Quello Center, Michigan State University for opening their doors and minds to me during my stay.

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In addition, I would like to thank all the involved persons from DiasNet and from the sports department at the broadcasting company for getting involved in the project and thereby their direct and indirect contributions. Especially, I would like to thank the sports department and the journalists and reporters for allowing me the opportunity to observe how they worked during the 2006 FIFA World Cup in Germany.

Last but not least I would like to extend my sincere gratitude to Signe Knutzen for her encouragement and moral support throughout the project and furthermore for always being there for me.

Lyngby, November 2007

Dan Saugstrup

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1. Introduction

1.1. Motivation

User involvement in the innovation process has gained increasing attention during the last decade and is today considered and accepted as a valid research area within the innovation theory framework – the user centred innovation process. One of the main reasons for this is believed to be the fact that companies are forced to react to the growing individualisation of demand as most of them operate in highly competitive and dynamic environments, where the possibility of user involvement in the design, development, and production process might provide a competitive advantage.

In general, the user centred innovation processes offer a more specific and detailed knowledge and furthermore a better understanding about explicit user requirements compared to the traditional manufacturer centred innovation process, which has been the main focus of innovation for decades or even centuries. User involvement in the innovation process has the potential to derive and develop more exact products and services closer to what the users want instead of relying on manufacturers to derive and develop less than perfect products based on a least denominator perspective (Hippel 1988b; Baldwin, Hienerth et al. 2006; Fagerberg 2006; Franke, Hippel et al. 2006; Hippel 2006). The least denominator perspective implies developing products or services that are less than perfect regarding a specific purpose, but on the other hand can be used by as many users as possible. From a traditional company perspective, the users' only role is to have needs, which the companies try to fulfil by providing products, which more or less suit the users' needs. Potentially, user involvement in the innovation process results in a more detailed understanding of the user demands and thereby a better and more comprehensive perspective of the complexity of user needs and requirements within a specific area. This should result in improved products, i.e. products that fit the users' needs and requirements better and support the users in whatever task the product was developed to perform in an easy to use and an easy to learn kind of way.

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In general terms the development and evolution within the information and communication technology sphere is basically driven and motivated by: the general developments within the society; the growth and competitive environment in which different entities operate; international and national policy and regulatory regimes; and in particular the technological development, where the technological development is mainly related to fast moving technology developments and technology trajectories, i.e. how will new industries develop and form, who are the customers, and how will the competition evolve (Funk 2003). These trends contribute to the fact that information and communication technologies are becoming a more and more integrated part of our lives and society and thereby intertwined in a wide range of usage situations and activities in relation to both our leisure and professional activities. The research within mobile informatics and information systems reflects this development: studies of mobile phone usages (Palen, Salzman et al. 2000; Laurier 2001; Taylor and Harper 2001; Weilenmann 2003); social shaping of technology and technological innovations supporting social settings (Williams and Edge 1996; Boudourides and Harper 2002); social aspects of mobile work (Dryer, Eisbach et al. 1999; Wiberg and Grönlund 1999; Wiberg and Grönlund 2000; Hardless, Lundin et al. 2001); and mobile work and the concept of mobility (Bellotti and Bly 1996; Kristoffersen and Ljungberg 1998; Luff and Heath 1998; Kristoffersen and Ljungberg 1999b; Kristoffersen and Ljungberg 1999a; Wiberg 1999; Wiberg and Ljungberg 2000; Kakihara and Sørensen 2002; Sørensen, Mathiassen et al. 2002; Barnes 2003; Kakihara and Sørensen 2004; Bardram and Bossen 2005; Wiberg 2005). However, most of these research contributions are related to what role technologies undertake in the specific settings studied, especially in work related situations and less to actually designing and developing new products, services, applications, and solutions that support the users in their everyday activities.

This thesis is motivated by a desire to further investigate the concept of user involvement in the innovation process in relation to the gathering and collecting of user needs and requirements. Furthermore, the thesis is motivated by a desire to develop and test new methods and tools in relation to the gathering and collecting of user needs and requirements and to combine these with more traditional approaches of deriving user needs and requirements. This will be the foundation for designing and conceptually developing potentially better and more supportive service and application concepts within the information and communication technology domain, all based on real user needs and requirements and thereby customised to specific user segments by actually involving the users in the innovation process, hence potentially reducing the uncertainty of predicting future needs and requirements as the actual future users are involved in the development process.

1.2. Problem definition

The main focus of this PhD thesis is related to how users can be involved in and contribute to the gathering of user needs and requirements and what kind of methods that support or can be developed to support a more comprehensive gathering and deriving of user needs and requirements. All with the objective of developing improved services and applications within the information and communication technology domain. Most important, these new services and applications should support the users in their private and professional activities and contexts. Based on this background the following research question will be elaborated:

How can the user involvement in the innovation process enhance the outcome of the mobile service and application development process and what methods can be used or developed for this in order to design and develop service and application concepts that better support user needs, requirements, mobility, and contexts?

The problem definition is overall related to innovation theory and more specifically to user involvement in the innovation process, the concept of lead users, sticky information, and toolkits and the usages and perspectives of these rooted in a method development and testing perspective. All with the purpose of deriving user needs and requirements and thereby develop and describe the concepts for future services and applications, which support the users in their everyday life, tasks, and contexts. The concept based services and applications are in relation to the PhD thesis defined as abstract and elaborated ideas in relation to potential future services and applications. User involvement in the innovation process is a broad and wide ranging concept, ranging from next to no user involvement to a very high level of user involvement in the innovation process. In this thesis the term user involvement is defined as and referred to as indicating a high level of user involvement, i.e. actively involving the users in the innovation process. This implies that the more the users are actively involved in the innovation process and thereby contributing extensively to the innovation process, the more detailed and context related an understanding is expected to be derived in relation to user needs, requirements, mobility, and context.

The high level of active user involvement in the innovation process is closely related to the lead user concept, which in this context is defined as users who are among the frontrunners within their domain and therefore face needs and requirements some time before the general marketplace and furthermore stand to benefit by obtaining a solution to those needs. This definition is related to (Hippel 1986) original definition of lead

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users, which is explained later in detail. However, in this thesis the lead user concept is defined in a more broad sense, meaning that the term lead users is covering a broader range of frontrunners within a specific domain, compared to Hippel's original and fairly narrow definition. This somewhat broader definition of the lead user concept is mainly chosen in order to make it possible to find and involve lead users in relation to the thesis.

In relation to user needs and requirements, which serve as input to developing concepts for future services and applications, the user needs and requirements are defined as something the user find desirable, useful, essential, or vital in relation to future services and applications. A service is defined as a software system that supports interoperable interaction over a network and an application is defined as a service enabler, i.e. application software (program) that is implemented on a device, e.g. word processors, spreadsheets, or browsers. The mobility and context perspectives are included to enhance the understanding of the context and environment in which the users are present, which is vital in order to design and develop future services and applications that support the users in their everyday lives and routines both in their professional and private environments. Mobility is therefore defined as the mobility of the user, i.e. how mobile are the users. Context is defined in relation to the different contexts in which the users are present. Based on the user involvement in the innovation process approach the purpose of the PhD project has been to derive and gather user needs and requirements and convert these into concept based services and applications, which support the users in their activities.

1.3. Theoretical framework

The overall theoretical approach for this thesis is based on innovation theory, where the more specific and narrow defined user involvement in the innovation process is applied as the theoretical framework. The theoretical framework is used to analyse the user centred innovation process including the concept of lead users, sticky information, and the deployment of innovation toolkits. The research in this thesis demonstrate how the users can be drawn into the process of developing better services and applications within the information and communication technology sphere that support the users in their everyday activities and furthermore what methods can be developed and deployed for this process. In particular the focus is related to the gathering and collecting of user needs and requirements from the end users in order to get a better and more elaborated understanding of the user contexts (Nulden 2005; Taylor and Swan 2005). This approach is chosen in order to understand the context better within which the

users are present and thereby based on the user needs and requirements designing and developing better products that actually fit within these contexts.

The user involvement in the innovation process framework

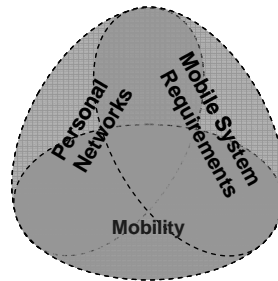


Figure 1-1 **Research areas**

Three interrelated research areas are drawn into the theoretical framework for user involvement in the innovation process applied in this thesis; 1) mobile system requirements, 2) mobility, and 3) the concept of Personal Networks. Figure 1-1 illustrates the three main research areas within the framework of user involvement in the innovation process, which constitute the boundaries of this thesis. The framework and the three interrelated areas will be elaborated on in the sections below and analysed in detail in relation to the user involvement in the innovation process framework throughout the thesis.

The three connected and overlapping research areas within the framework constitute an important combination for a development approach, highlighting the intertwined and complex interaction of people and their use of information and communication technologies. The main research approach of this thesis is a theory, design, and method development approach, in relation to the usages of information and communication technologies, with the intention of designing and developing better and more supportive services and applications on a concept level based on real user needs and requirements. This means describing and defining both the usages of information and communication technologies and the implications for development of future services and applications.

1.3.1. User involvement in the innovation process

User involvement in the innovation process or the user centred innovation process is based on the principle that users (firms and individuals) are more and more able to innovate for themselves. This line of research within the innovation theory has been

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promoted and studied foremost by Erik von Hippel and colleagues (Hippel 1986; Hippel 1988b; Hippel 1994; Hippel 1998; Hippel, Thomke et al. 1999; Hippel 2001; Hippel and Katz 2002; Hippel 2005b; Hippel 2005a; Hippel 2006; Hippel 2007) who believe that the user centred innovation processes offer great advantages compared to the traditional manufacturer centred innovation approach.

The core research object and theory applied within this thesis is the user involvement in the innovation process compared to the more traditional manufacturer and mass market based approach. The research conducted is based on a cross disciplinary approach (information and communication technology development, mobile system requirements, and mobility within the theoretical framework of the user involvement in the innovation process), in order to get a better understanding of the different aspects of how users can be involved in and contribute to the gathering of user needs and requirements and furthermore in the design and development of new or improved services and applications within the information and communication technology domain.

In general, it is believed that most of today's products, services, or solutions are developed and manufactured to meet the widest possible needs, i.e. mass market products, which often are based on technological possibilities and less on actual user needs and requirements. In contrast, (Hippel 1986; Hippel 1988b; Hippel 1994; Hippel 1998; Hippel 2005a; Hippel 2006) actually found that most products and services are developed with modifications suggested by users, who pass on their ideas to companies, hoping that they will initiate a manufacturing process of the given product. Hippel argues that the reason for this, is related to the fact that most products originally are developed to meet mass market needs, and when users or individuals with special needs or requirements face problems with current or available products, i.e. that these products do not fully suit their needs or the tasks at hand, they are left with very few options. They either have to modify existing products or develop entirely new products, which fit their needs better and thereby solve their problems at hand.

This trend can mainly be attributed to the general development within information technology, which makes it possible for more and more users and customers with fairly special demands to design and develop exactly the products, services, or solutions that fit their needs (Hippel 1986). Furthermore (Hippel 1986) argues that the increased user involvement in the innovation process is based on unsatisfied user needs and requirements and on new opportunities. The current shift, in which product development in general is moving from the manufacturing company domain into the end user domain, could based on the higher degree of user involvement in the innovation process lead to better and more successful products.

According to (Hippel 1986; Hippel 1988b) lead users can be defined as: A) users that face needs and requirements that will be general in the marketplace, but the lead users face these needs months or years before others and B) users that are positioned to benefit significantly by obtaining a solution to those needs. Basically, lead users are users or customers that are on the forefront on specific markets, having leading edge needs and requirements, which the traditional or average user or customer will not need or require until later. The lead user theory is based on the notion that users residing on the leading edge of any given market, technology, etc. are more likely to develop commercial attractive innovations compared to 'ordinary' users as the lead users will be experiencing needs today, this week, or this year, which the majority of the market will experience tomorrow, next week, or next year. This suggest that lead users provide valuable insights to potential mass market needs and requirements sometime in the future and that innovations developed by lead users today, should later be attractive to the majority of people or markets as they most likely also will encounter these specific needs some time in the future. The concept of lead users has largely been researched and promoted by Hippel and colleagues (Hippel 1986; Hippel 1988b; Urban and Hippel 1988; Hippel, Thomke et al. 1999; Hippel and Katz 2002; Lilien, Morrison et al. 2002; Hippel 2006). According to Hippel, democratising of innovation means that users of products and services are increasingly able to innovate themselves and thereby develop exactly what they want, compared to relying on companies to act as their agents and thereby most likely end up with a less than perfect product or service. In relation to this, it is important to mention that the users in this connection can be both manufacturers and single users, i.e. both companies and individuals.

Another term for lead users is alpha geeks, which can be found in the following quote by Tim O'Reilly: 'we follow the enthusiastic amateurs, these are the people who can show in which direction technology is moving. I use to say, that we follow the alpha geeks. This is a term used for people who are at the leading edge. They do strange things, they play with the technology and they are the first to discover or reveal new opportunities' (Tim O'Reilly, CEO O'Reilly Media Inc.). In relation to the lead user approach, the term sticky information is used to describe the stickiness of information and how difficult it is to transfer. This means that when information is expensive and difficult to acquire, transfer, and use it will be labelled sticky, whereas when information is inexpensive to acquire, transfer, and use the stickiness is low. The level of stickiness is very important in relation to deriving and collecting user needs and requirements from the users, i.e. how sticky is the knowledge contained by the users and how is it transformed into information and thereby made transferable. The main purpose and function of toolkits is to transfer sticky information (user needs and requirements) into

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less sticky information and furthermore to shift the deriving and collecting of user needs and requirements into the user domain.

User driven innovation is all about what the users are doing, when and how. From a research and methodological perspective, the user driven innovation process is very much related to ethnographic and anthropology based research methods, i.e. to observe what the users are doing, when they are doing it and in what context they are doing it. This way one gets a much more elaborated understanding of the context in which the users are present and therefore also a richer understanding of what elements a possible solution should/could contain, in order to fully support the users needs and requirements. The strength of these methods is that, it is not only about what the users think, but more about what they are actually doing and within which context. Overall the concept of user involvement in the innovation process is based on a microeconomic perspective, being very demand and supply oriented. However, the approach to obtaining user needs and user requirements is very different from traditional market analysis methods where users or customers are asked what they want or think about certain products, services, or solutions and where the companies are 'listening' to what the users or customers want. The approach within user involvement in the innovation process is different. In this case it is important to understand that a few users or customers already have gone beyond expressing their needs and requirements, they have already invented and developed the product, service, or solution they needed, they are lead users.

1.3.2. Mobile system requirements

In general, the number of wireless communication technologies and communication devices, services, and applications has increased dramatically over the last decade, albeit most of these were developed and designed based on what was technologically possible without much attention being paid to specific user needs. From a historic perspective the mobile system requirements research approach has focused on designing and developing new products based on what was technologically feasible and less on actual user needs and requirements, i.e. a technology driven approach (Hosbond and Nielsen 2005). However, this has changed during the last decade or so, now the users and thereby the user needs and requirements seem to be getting more attention, even though the main focus is still related to; engineering, re-engineering, testing, and evaluation of systems (Kjeldskov and Graham 2003). Furthermore a trial and error approach appears to be the way forward, as real life situations and context awareness is not considered as important (Kjeldskov and Graham 2003). This implies

that the 'developing entities' already know what to build or develop and that user perspectives, user needs, and requirements are rarely taken into consideration.

Early research concerning the concepts and ideas of nomadicity was presented and discussed foremost by computer scientist Kleinrock (Kleinrock 1996a; Kleinrock 1996b; Kleinrock 1997; Kleinrock 2000), who described and outlined the essence of nomadicity (nomadic computing and communications). This he defines as the system support needed to provide a rich set of computing and communication capabilities and services to nomads in a transparent, integrated and convenient form as they move from place to place. According to Kleinrock, nomadic computing and communication described from a system perspective should support capabilities that enable independence of: location, motion, computing platform, communication devices, and communication bandwidth, which means that specific mobile computing environments should automatically adjust to the processing power, communication context and bandwidth available at any given time.

From a second but related perspective, design studies of mobile systems were introduced in the late nineties – mobile informatics - with a focus on the exploration on how mobile work and mobile workers could be supported by wireless technologies, services and applications and furthermore on how the users actually used and applied these new possibilities (Dahlbom 1996; Dahlbom and Ljungberg 1998; Kristoffersen and Ljungberg 1998; Kristoffersen and Ljungberg 1999a; Ljungberg 1999; Dahlbom 2000; Dahlberg, Ljungberg et al. 2002). Today the overall viewpoint on mobile system requirements is mainly related to user needs and requirements and more specifically to design studies and human computer interaction perspectives. However, during the last couple of years, increasing attention has been allocated to actually defining real user needs and to designing and developing services and applications based on these. The challenge today is therefore to develop services and applications that actually support users in their everyday lives and professional working environments.

From the user centred innovation framework perspective, the focus is therefore mainly related to the traditional research approach and methodology deployed within the mobile system requirement field, compared to the user involvement in the innovation process approach and methodology. Furthermore the focus is on how an extended degree of user involvement provides a more elaborated understanding of user needs and requirements and how to translate these into services and applications which support the user needs, requirements, and the context within which the users are present (Orlikowski 2000).

1.3.3. Mobility

In relation to the theoretical framework applied and from a mobility perspective both, organisations and people in general are continually becoming more mobile, both in relation to their physical movement and in relation to their communication needs and requirements. The combination of mobile computing and mobile communication is rapidly changing the way we think about information processing and communication and ubiquitous access and connectivity is almost taken for granted. The mobility concept has gained increased attention during the last decade, as both organisations and people in general are continuously becoming more mobile, resulting in an increased demand for nomadic and mobile communication and interaction possibilities (Dahlbom and Ljungberg 1998; Kristoffersen and Ljungberg 1999a; Dahlbom 2000; Barnes 2003; Saugstrup and Henten 2003a; Bardram and Bossen 2005; Wiberg 2005). The increased mobility calls for additional demands and requirements on mobile services and applications in order to provide ubiquitous connectivity and interaction.

Mobility is most often conceptualized as geographic mobility, i.e. the spatial movement of persons or things. However, this very simple definition of mobility is believed to be too narrow, the definition should also concern temporal, context, and organisational based aspects (Bellotti and Bly 1996; Luff and Heath 1998; Kakihara and Sørensen 2002; Sherry and Salvador 2002; Sørensen, Mathiassen et al. 2002; Barnes 2003; Saugstrup and Henten 2003b; Kakihara and Sørensen 2004; Krogstie, Lyytinen et al. 2004). The concept of mobilisation, namely to activate something, has been dealt with by (Andersen, Fogelgren-Pedersen et al. 2003) with regards to the potentials of information technologies for mobilising mobile and virtual organisations, i.e. the implications of information and communication technologies on work organisations.

The increase in the level of mobility results in an increased demand for nomadic computing, where information can be accessed and received on any terminal at all time. Furthermore this increases calls for additional user needs and requirements in relation to future services and applications, and in particular in relation to organisations and their ability to provide services and applications that actually support their users in their work processes and tasks, i.e. mobile productivity related services and applications. In order to fulfil these expectations it is important to incorporate the mobility and context related aspects into the design and developing process in relation to future services and applications in order to provide the users with better and more supportive services and applications.

1.3.4. Personal Networks

The concept of Personal Networks is an integrated and given part of the PhD project, and relates to and is being developed and researched within the MAGNET² project (My personal Adaptive Global NET). This means that some of the research carried out within the PhD project is partly based on and related to the research done within the MAGNET project.

The main objective of the MAGNET project is to determine, clarify and further develop the concept of Personal Networks in a user oriented perspective, i.e. that future services and applications need to be developed based on real user needs and requirements and furthermore support the users in both their professional and private activities. The goal of the MAGNET project is therefore to develop and enable commercially viable Personal Networks, i.e. they should be affordable, user-friendly and beneficial to different kinds of users in all aspects of their everyday life. The MAGNET project is based on the hypothesis that successful and emerging technologies have to focus on user demands enabled by technology and that the technology enriches the user's quality of life. Furthermore, future services and applications should be adapted to the needs and requirements of individuals, i.e. having a high level of personalization and context awareness. The research within the MAGNET project addresses in particular issues within personal distributed environments, where users interact with a multitude of entities in their close vicinity, but potentially anywhere. These systems are defined as Personal Networks and constitute a category of distributed systems with very specific characteristics (Niemegeers and Heemstra de Groot 2002b; Niemegeers and Heemstra de Groot 2002a; Niemegeers and Heemstra de Groot 2003).

The concept of Personal Networks is related to pervasive computing and personal communication environments, consisting of a multitude of devices, e.g. laptops, PDAs, mobile phones, headsets, cameras, etc., basically all kinds of IP-based and thereby Internet enabled devices with communication and processing capabilities which all can interconnect via different networks, i.e. service or ad-hoc based. This means that Personal Networks should facilitate a collaborative communication environment within a distributed network, which supports the users in both their professional and private activities, without being obtrusive and at the same time safeguarding privacy and security. A Personal Area Network constitutes the main components of a Personal Network. The Personal Area Network concerns very local (10-20 meters) communication among an ad hoc cluster of devices while a Personal Network provides the user with access to all of a person's devices and services regardless of location. In

² <http://www.ist-magnet.org>

other words, the Personal Network concept builds on a significant amount of peer-to-peer and ad hoc connections and internetworking between different wired and wireless technologies.

In relation to the theoretical framework of the thesis the Personal Network concept is seen as the introduction of new technologies, i.e. the technological perspective in relation to the introducing of new services and applications within the information and communication technology domain. The main focus of the PhD project in relation to the Personal Network concept has been to derive and collect user needs and requirements based on a very user centric and active user involvement approach. In relation to deriving user needs and requirements this has been done in collaboration with the sports department at a large Danish broadcasting company and with a diabetes treatment centre, which has resulted in two case studies; a journalist and a diabetes case study. Within the two case studies, both well known and self developed methods and approaches to deriving and collecting user needs and requirements have been deployed and tested. Even though the two cases were given as an integrated part of the PhD project and furthermore related to the MAGNET project, they have provided valuable input into the user needs and requirements within the two segments. In relation to the overall user centred framework and the mobile system requirement and mobility perspective, the two cases have provided significant input as both segments were very mobile in their activities and at the same time demanded more mobile services and applications, which supported them in their everyday activities.

1.4. Methodology

The methodology is based on a case study research strategy which contains both qualitative and quantitative data collection combined with a literature review of articles, books, and other materials in relation to the user centred innovation framework. The case study approach is chosen as the main methodology for this thesis, as it was clearly seen as the best approach to analyse the complex environment of user involvement in the innovation process, i.e. the most appropriate method of research concerning a fairly bounded system but at the same time emphasising the unity and wholeness of that system. Furthermore the case study approach is generally preferred when the researcher has little control of the events studied and when the research is related to contemporary settings within a real-life context, which is clearly the situation for user involvement in the innovation process. In addition, one of the main advantages of a case study strategy is the possibility of utilising and involving several sources and approaches to the information collecting process together with the triangulation of collected data and methods used. By combining multiple empirical data, theories, and

methods it is more likely to overcome the weakness or intrinsic biases and other problems that come from relying on single data, theories, and methods. They all potentially provide a more elaborated understanding of the context and process of involving the users in the innovation process and how the different elements within this context influence each other, together with the in-depth richness in exploration, description, and understanding, which a case study provides.

Case study research is seen as a method of learning about a fairly complex 'environment' through extensive description and contextual analysis. The case study research strategy or method involves in-depth, longitudinal examination of a small number of entities or events and provides a systematic way of describing an instance or event, collecting data, analysing information and reporting results (Yin 1994; Stake 1995; Yin 2002; Stake 2005; Flyvbjerg 2006). Case studies typically utilise questionnaires, interviews, or observation techniques as the preferred methods of collecting information (Boudreau, Gefen et al. 2001). The basic idea or concept of a case study is that one or more cases is studied in detail, using whatever methods that seem most appropriate for the given situation, with the general objective to develop as full an understanding of the case as possible (Punch 2005). Recognising the complexity, context, wholeness, and unity of the case, case studies are not a specific technique applied but rather a research strategy (Yin 2002; Punch 2005). In that line (Stake 2005) states that 'A case study is not a methodological choice but a choice of what is to be studied... by whatever methods, we choose to study a case. We could study it analytically or holistically, entirely by repeated measures or hermeneutically, organically or culturally, and by mixed models – but we concentrate, at least for the time being, on the case' (p 443)(Stake 2005).

So what constitutes a case? Unfortunately, there is no clear cut definition of a case within case studies. However different scholars have tried to define the boundaries of a case. Miles and Huberman have defined a case as a phenomenon of some sort occurring in a bounded context where the case may be an individual, a role, a small group, an organisation, community, or a nation. Furthermore it could be related to a decision, policy, process, incident, or event of some kind (Miles and Huberman 1994). In addition, (Brewer and Hunter 1989) define six types of unites which can be studied within social science: individuals; attributes of individuals; actions and interactions; residues and artefacts of behaviour; settings; incidents and events; and collectivities – which all, or a combination of them, may be the focus of a case study (Brewer and Hunter 1989). Furthermore, Stake distinguishes between three different types of case studies, arguing, that if there are different types of case studies, there are also different types of cases. Where the first two are single case studies, with some what different

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perspectives, the last one involves multiple cases, i.e. a multiple or comparative case study (Punch 2005; Stake 2005). See Table 1-1.

The intrinsic case study, where the study is undertaken because the researcher wants a better understanding of this particular case.
The instrumental case study, where a particular case is examined to give insight into an issue, or refine a theory.
The comparative case study, where the instrumental case is extended to cover several cases, to learn more about the phenomenon, population or general condition.

Table 1-1 **Types of case studies**

According to Yin the technical definition of a case study begins with defining the scope of a case study. Therefore, a case study is first and foremost an empirical inquiry that: 1) investigates a contemporary phenomenon within its real-life context, especially when, 2) the boundaries between phenomenon and context are not clearly evident (Yin 1994). Therefore, the case study method is appropriate and well founded when contextual conditions are important. Second, as phenomenon and context are not always distinguishable in real-life circumstances, a set of other technical characteristics now become part of the definition. The case study inquiry therefore: a) copes with the technically distinctive situations in which there will be many more variables of interest than data points, and as one result; b) relies on multiple sources of evidence, with data needing to converge in a triangulation fashion, and as another result; c) benefits from the prior development of theoretical propositions to guide data collection and analysis (Yin 1994). Implying that a case study research strategy comprises an all encompassing method, i.e. that a case study is neither a data collection tactic nor merely a design feature alone but a comprehensive research strategy. Based on the above definitions and furthermore on Punch's reasoning described earlier, three main characteristics of case studies can be highlighted (Yin 1994; Yin 2002; Punch 2005). See Table 1-2.

Generally, case studies are preferred when 'how' and 'why' questions are used as research questions and when the researcher has little control over the events, and furthermore when the focus is based on a contemporary setting within real-life context. Case studies can be explanatory, exploratory, or descriptive with a certain amount of overlap between them. Overall the major advantage of a case study approach is that it involves multiple sources and techniques in the data gathering process (Yin 1994; Dube

and Pare 2003). However, this is also considered one of the major critics of the case study approach. Studying one or a small number of cases can offer no grounds for establishing reliability or generality of the findings (depends on context and purposes) combined with a lack of rigor of the case study research are among the main critic points (Yin 1994; Stake 1995; Tellis 1997; Punch 2005).

A case is a bounded system, where the boundaries between the case and context might not be clear cut. Furthermore, it is important to clearly describe and define the boundaries in relation to the case.

As not everything can be studied (even about one case) even though case studies often are referred to as being holistic and unity, covering every aspect of a case – a specific focus is required.

Multiple sources of data and multiple data collection methods are likely to be used: observation, interviews, questionnaires etc., both qualitative and quantitative methods can be applied.

Table 1-2 *Characteristics of a case studies*

However, Flyvbjerg in his paper 'Five misunderstandings about case-study research' argues and corrects these so-called misunderstandings: 1) theoretical knowledge is more valuable than practical knowledge; 2) one cannot generalise from a single case, therefore, the single case study cannot contribute to scientific development; 3) the case study is most useful for generating hypotheses, whereas other methods are more suitable for hypotheses testing and theory building; 4) the case study contains a bias toward verification; and 5) it is often difficult to summarise specific case studies (Flyvbjerg 2006). Furthermore, Flyvbjerg concludes with a citation from Thomas Kuhn, which state that '...a scientific discipline without a large number of thoroughly executed case studies is a discipline without systematic production of exemplars, and a discipline without exemplars is an ineffective one' (Kuhn 1987; Flyvbjerg 2006).

The case study method will in the current context be used to provide a more elaborated understanding regarding user needs and requirements of users in two cases: the journalist and diabetes cases, where the definition of a case study is based on the three characteristics summarised in Table 1-2. The case study approach is viewed as the most appropriate method of research regarding the two fairly bounded systems (journalist and diabetes environments), in order to analyse the contemporary, real-life, and complex environments in relation to deriving user needs and requirements. To

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support the case studies, both qualitative and quantitative data collection will be used. The qualitative research methodology is mainly related to the understanding of human behaviour and the reasons behind various aspects of human behaviour, i.e. investigation of the why and how of certain events, situations, decision making processes, etc. (Fontana and Frey 2005; Stake 2005; Tedlock 2005). The quantitative research method is a much more systematic investigation of quantitative properties and their relationship, providing a connection between the empirical data and mathematical expressions of quantitative relationships (Creswell 2003; Gunter 2004).

1.4.1. Qualitative method

The qualitative research methods were developed in the social sciences domain to enable researchers to explain and understand a social and cultural phenomenon. The main data collecting methods within qualitative research are: interviews; documents and text; participant observation (field work); questionnaires; and the researcher's impression and reactions. The main reason for doing qualitative research springs from the distinguished difference between humans and the natural world – humans can talk – allowing the researcher to better understand people and the cultural context, which they live in (Kaplan and Maxwell 1994; Myers 1997).

From a philosophical perspective, it is important to know what constitutes 'valid' research and what research methods are most appropriate for a given field or area of research, i.e. what are the (sometimes hidden) assumptions, which are used to conduct or evaluate any given research. In qualitative research, three underlying paradigms in relation to research epistemology are mainly used, where epistemology refers to the assumptions about knowledge, and how this knowledge is obtained (Orlikowski and Robey 1991; Myers 1997). The three philosophical assumptions are illustrated in Figure 1-2.



Figure 1-2 Philosophical assumption

The positivist paradigms assume that reality is objectively given, and that it can be described by measurable properties, which are sovereign of the single researcher. In

general, the positivist approach is mainly used to test or support a theory, in order to increase the understanding of a specific phenomenon. The interpretative paradigm is mainly related to understanding a phenomenon (the richness, depth and complexity of a phenomenon), based on the meaning and significance that people give to the object in question, i.e. an understanding of context and process and how these influence each other. From an information system perspective Walsham defines the interpretive approach as '...aimed at producing an understanding of the context of the information system, and the process whereby the information system influences and is influenced by the context.' (p. 4-5)(Walsham 1993). The critical approach to qualitative research is based on the assumption that social reality is historically constituted and furthermore that it is produced and reproduced by people, however people can take action (intentionally) to change their social and economic status. In other words, the critical approach explores the social world, critiques it, and looks for ways to give power to individuals to prevail over problems in the social world, by providing a better understanding of social functions (Myers 1997).

Depending on the research methods chosen for a given research object or project, one or more techniques for collecting empirical material can be used. These techniques vary from different kinds of interviews over participant observation and fieldwork to archival research and use of other sorts of written material. In addition, some researchers work with two kinds of data sources, primary and secondary. The primary source refers to material or data collected by the researcher and which are unpublished, whereas the secondary sources refers to already published material (Myers 1997). Overall, the main strength of the qualitative research approach is the in-depth and richness in exploration and description, which usually results in very detailed accounts, offering a thorough understanding of the research in question. On the down side, one of the main criticisms of qualitative research is mainly related to its lack of generalisability and its dependence of small samples (Creswell 2003; Punch 2005).

1.4.2. Quantitative method

The quantitative research method, compared to qualitative, is a much more systematic investigation of quantitative properties and their relationship. Based on mathematical models, the quantitative method provides a connection between the empirical observations and the mathematical expression of quantitative relationships, i.e. investigation of the what, where and when of events, situations or phenomena (Creswell 2003; Gunter 2004). In quantitative studies theories are generally used deductively, with the object of testing or verifying a theory, rather than developing it. In other words quantitative research can be described as '...a formal, objective,

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systematic process in which numerical data are utilized to obtain information about the world.' (p. 140)(Cormack 1991). Basically there are three major types of quantitative research: descriptive, quasi-experimental, and experimental. The descriptive approach is designed to obtain additional information concerning specific characteristics within a particular field or sample and is mainly used to identify problems, develop theory, validate current practise, etc., i.e. examine specific characteristics or variables in their natural or original environment. The quasi-experimental and experimental approaches are related to examine cause and affect.

Quantitative	Qualitative
Both are systematic in their approach	
Objective	Subjective
Deductive	Inductive
Generalisable	Not generalisable
Numbers	Words

Table 1-3 *Quantitative vs. qualitative method*

The main difference between quantitative and qualitative research methods are summarised in Table 1-3. Generally speaking, both approaches are somewhat systematic in their approach, depending on the approach and research in question. The quantitative method is mainly considered to be objective, i.e. the researcher is likely to remain objective and somewhat detached from the sample in relation to gaining, analysing and interpreting empirical material. The qualitative researcher is more subjective, i.e. the researcher is more likely to be somehow involved in the research conducted and thereby biased in some degree.

Quantitative research tends to be deductive in its approach, i.e. testing theory, whereas qualitative research tends to be more inductive, i.e. generate theory or theories. Furthermore, the outcome of quantitative research tends to be more generalisable, i.e. be compared with similar samples, whereas the qualitative approach is not that generalisable, as the approach is more subjective oriented. Last, and most obviously, quantitative research uses data in form of numbers or data that can be converted into numbers easily, whereas qualitative research mainly is based on words (Creswell 2003; Punch 2005).

1.5. Cases

Two cases are used in relation to deriving and collecting user needs and requirements: a diabetes case and a journalist case. The diabetes case is part of the MAGNET project and is related to developing services and applications for persons with diabetes in general and particular in relation to Personal Networks. The journalist case is only partly related to the MAGNET project as some of the work was carried out in relation to the MAGNET project and some was carried out only in relation to this PhD project. For both cases the main focus has been to collect and derive user needs and requirements, in order to give input to the development of future service and application concepts. Both cases were an integrated part of the PhD project from the beginning, and the selection process has therefore not been part of the PhD project.

1.5.1. Diabetes case

The main objective of the diabetes case study is to develop information and communication based service and application concepts, which should support insulin dependent diabetics in disease self-management and provide a more effective control and treatment of the disease and its complications. This should provide the users with a higher quality of life and enable a more preventive approach rather than treatment care, and a more effective treatment of the disease and its complications, which possibly could lower the disease related costs for both individuals and the public healthcare system (Pedersen, Jensen et al. 2004b; Jiang, Schultz et al. 2005). The diabetes case is based on ongoing research within the field of diabetes and in particular on an existing diabetes service called DiasNet (Diabetes Advisory System), which currently is a pilot project running at Frederikshavn Hospital (DK) and Bournemouth Hospital (UK). DiasNet is an active research project - and has been for the last 15 years - at the Institute of Health Science and Technology, Aalborg University. For additional information on the DiasNet research group and activities see (Hejlesen, Andreassen et al. 1997; Hejlesen, Plougmann et al. 2000; Pedersen, Dahlsgaard et al. 2004).

From a PhD perspective, the main objective is to draw together and extract real user needs and requirements regarding disease management and future service and application concepts that would support the single users in their everyday lives thereby enhancing the quality of life for people with diabetes. This is done within the overall theoretical framework, by actively involving the users in the innovation process by applying the lead user concept together with the sticky information and toolkit approach to deriving user needs and requirements. Furthermore the mobility and context related aspects of user needs and requirements are drawn into the gathering and collecting process, thereby developing future service and application concepts that are based on

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user needs, requirements, mobility, and contexts. In relation to the case study methodology, a qualitative method is used in relation to conducting workshops within the diabetes case, i.e. a workshop approach where the participants are involved in different kinds of problem solving and hands-on tasks in order to gather empirical material regarding the participants' given situation and context, which can be used in relation to developing future service and application concepts.

1.5.2. Journalist case

The journalist case study is an aggregated case study, which contains part of a MAGNET related case study and a sports journalist case study. The MAGNET case study covered what was labelled 'nomadic professionals' which is related to supporting distributed work in a professional setting, where the main focus was to analyse how extended mobility among organisations and people in general can be supported by future service and application concepts. The sports journalist case is related to supporting sports journalists, i.e. journalists and reporters from a broadcasting company developing service and application concepts that can support these people in their everyday work. As there is a significant overlap between the two environments (very mobile and distributed) and a number of the 'nomadic professional' case participants were from the media and journalistic segment the two cases have within this context been aggregated into one case: the journalist case. The overall purpose of the journalist is to derive and collect user needs and requirements, which serve as input for future service and application concepts.

The journalist case has been conducted in collaboration with the sports department at a large Danish broadcasting company. The overall focus of the journalist case has been to gain an insight into the demands of professionals working in a highly mobile environment, with very demanding system requirements. The highly mobile and communication intensive environment implies that the design of efficient and supportive service and application concepts in this context is rather complex.

Based on the overall theoretical framework for user involvement in the innovation process, the lead user, sticky information, and toolkit method have been deployed in order to derive user needs and requirements. These methods have been deployed through: participatory observation of the lead user journalists; a survey among the sports journalists to obtain a more detailed and quantitative understanding of their current use of information and communication technologies and their level of mobility; and a mobile toolkit, which has been developed and deployed in relation to obtaining user needs and requirements in a very mobile environment. In relation to the case

study methodology, a qualitative data approach has been deployed in relation to participatory observation, open ended interviews, workshops, etc. The participatory observation is related to observing how the journalists work in the field, thereby observing problems, processes, the use of tools/equipment, communication patterns, etc., i.e. descriptive observation of verbal or non-verbal behaviour within a given context. In relation to the participatory observation, also interviews have been used to further elaborate on the registered observations and to support and elaborate on these observations, i.e. the participants have been asked to verbally describe their experiences or understanding of a given situation or object. The workshop approach was used in relation to the development and deployment of a mobile toolkit. The quantitative methodology approach has been deployed in relation to conducting a survey using a questionnaire among the sports department employees regarding their current use of communication technologies and the different levels of mobility, in particular in relation to the journalists and reporters, which are the most mobile.

1.6. Structure of the thesis

Chapter 1: The introduction presents the problem definition, the overall theoretical framework, and the methodology applied within the thesis.

Chapter 2: Provides an introduction to Personal Networks and the basic concepts and potentials of the Personal Network and Personal Area Network, which is the main component of the Personal Network.

Chapter 3: Presents the theoretical framework of the user involvement in the innovation process. Including a historic perspective on the innovation model proliferation over the last fifty years and a thorough analysis and description of the user involvement in the innovation process theory, including the concepts of lead users, sticky information, and toolkits in relation to deriving user needs and requirements.

Chapter 4: Presents the mobile system requirements and mobility perspectives, in relation to the user involvement in the innovation process. Describing and analysing the mobile system requirements in relation to deriving and developing new services and applications based on real user needs and requirements. Furthermore the mobility concept is described and analysed, in relation to different conceptualisations of the mobility concept, all leading to a mobility framework.

Chapter 5 and 6: Presents respectively a diabetes and a journalist case study, where the theoretical framework has been applied to derive user needs and requirements

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within both cases. This is done by applying and testing different methods and tools from within the theoretical framework combined with more traditional methods of deriving user needs and requirements. Furthermore the derived user needs and requirements are translated into potentially future service and application concepts.

Chapter 7: Presents the conclusion, which contains a discussion and sums up the research and results reached through the research carried out within this thesis.

2. Personal Networks

Today the fixed and wireless worlds are merging into a multi access world where the end-users will be able to roam transparently between an array of different access networks and thereby reach the services the users want or have subscribed to independently of access network, leading to a Personal Network service architecture. The overall concept of Personal Networks is related to personal communication environments, consisting of a multitude of entities, which can all interconnect via different networks, i.e. service or ad-hoc based. This means that Personal Networks should facilitate a collaborative communication environment within a distributed network, which supports the users in both their professional and private activities, without being obtrusive and at the same time safeguarding privacy and security.

This section describes the concept and architecture of Personal Networks, a concept related to the field of pervasive computing and Personal Area Networks, which basically constitute the main components of a Personal Network. A Personal Area Network concerns very local (10-20 meters) communication among an ad hoc cluster of devices, while a Personal Network provides the user with access to all of a person's devices and services regardless of location. The descriptions, definitions, and concepts described are based on ongoing work in the MAGNET project and other contributions in order to determine, clarify, and understand the concept of Personal Networks and the future demands for services in a Personal Network setting. Furthermore it includes a discussion of the main characteristics of such a Personal Network especially regarding heterogeneity, personalisation, autonomy, security, privacy, and human-computer interaction aspects as well as some Personal Network service perspectives.

The user centric approach is based on the widely accepted notion (or belief in the idea) that future applications and services need to be developed with the users in the 'driver's seat'. Furthermore the vision is that Personal Networks will support the users' professional and private activities, without being obtrusive and while safeguarding their privacy and security. The Personal Network approach to user requirements is based on considering several aspects, where user-needs, technology, and economics are the three most important. Therefore the approach to user requirements is that services and

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applications first of all should be based on ‘real’ user needs and requirements and second on terminal and network possibilities in combination with general technological possibilities. Third the services and applications should be based on economic parameters concerning both the demand and supply side, i.e. what are the possible business models from a service provider perspective and how much are the users willing to pay for certain services etc.

2.1. The Personal Network concept

The Personal Area Network functions as the core part of a Personal Network, where the Personal Area Network constitutes all the devices within close vicinity of the user and the Personal Network constitutes the Personal Area Network as well as the devices “outside” the close vicinity of the end user. Basically, a Personal Area Network is related to a communication cluster of different devices within a range of approximately 10-20 meters, i.e. interconnecting all kinds of different devices (laptops, PDAs, cell phones etc.) using short range wireless technologies like Bluetooth (<http://www.bluetooth.com>; Haartsen 2000), IrDA (<http://www.irda.org>; Williams 2000), or IEEE 802.15 (Siep, Gifford et al. 2000).

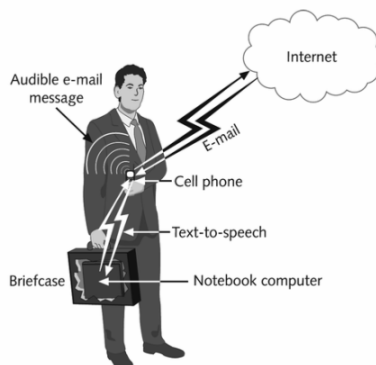


Figure 2-1 Personal Area Network

Personal Area Networks provide and allow a seamless connection between wireless devices in different situations based on low-cost, low-power, and short-range wireless technologies (Zimmerman 1996). Besides the interpersonal communication between the different devices within the Personal Area Network, some of the devices also provide connections to the Internet or other IP-based networks.

The overall concept of Personal Networks is related to personal communication environments, consisting of a multitude of entities, which all can interconnect via different networks supporting the users in both their professional and private activities without being obtrusive and at the same time safeguarding privacy and security. The research especially addresses issues within personal distributed environments, where users interact with a number of entities in their close vicinity but potentially anywhere. These systems are defined as Personal Networks and constitute a category of distributed systems with specific characteristics (Niemegeers and Heemstra de Groot 2002a; Niemegeers and Heemstra de Groot 2002b; Niemegeers and Heemstra de Groot 2003; Groot, Niemegeers et al. 2006; Niemegeers and Wu 2006).

The Personal Network concept is closely related to e.g. the Virtual Home Environment (VHE) concept promoted in 3GPP and other similar concepts related to the use of heterogeneous networks for delivering personalized services to end-users (3GPP 2002; Suomalainen 2002). The main difference is that the VHE concept is largely based on a service delivery architecture, whereas the Personal Network concept is based on both a service delivery architecture and an ad hoc based architecture allowing peer-to-peer communication to be an integrated part of the Personal Network concept. Furthermore the idea of Personal Networks is also related to the concept of Personal Distributed Environments, mainly promoted by the Virtual Center of Excellence on Mobile and Personal Communication in the UK (Dunlop, Atkinson et al. 2003) and other related concepts regarding communication clusters of personal devices (Kravets, Carter et al. 2001). However, the main characteristic of the Personal Network concept, as described in this paper, is the incorporation of the Personal Area Network as the central element and furthermore the extended amount of peer-to-peer or ad hoc organized networks, communications, and interconnections, organised and set up by the users themselves, and thereby implicating a self-organising perspective on networks and services.

An important strength of the Personal Network concept is that it puts to the fore the use of different network and information resources aiming at creating a personal service environment no matter where the user is located. Allowing the Personal Area Network (the core Personal Network) to be configured in an ad hoc way as the demand arises or as opportunities become available regarding services and other devices within the close vicinity of the user, creates a local communication cluster of devices and services connected through various interconnections. Simultaneously, allowing the Personal Network to encompass potentially all of a person's devices capable of network connecting, whether in the near vicinity or remote, e.g. at home, at the office or somewhere else, constructs a communication sphere around the user (Personal Area Network) and a communication environment which is independent of the physical

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locations of devices (Personal Network) (Niemegeers and Heemstra de Groot 2002a; Saugstrup, Sørensen et al. 2005).

A Personal Area Network consisting of personal devices in the close physical vicinity of the user, including devices moving with the end-user. A personal device is a device related to a given user within a pre-established trust relationship
Remote personal devices or clusters thereof, connected to a Personal Area Network or Personal Network via infrastructure or ad hoc based networks.
Local foreign devices or clusters thereof, which are owned by other parties and could either be reserved or shared devices. The foreign device is a non personal device that can be either trusted or not trusted.
Remote foreign devices or clusters thereof, which are connected to a Personal Area Network or Personal Network, which can be shared or reserved for specific users or usages.
Communication infrastructures, which can be public (e.g. cellular or Internet) or private (licensed or unlicensed) e.g. WLAN.

Table 2-1 The main components of a Personal Network

A Personal Network can therefore be characterised as a communicating cluster of local and remote devices, possibly shared with others, and connected through various communication means, interconnecting all kinds of devices into one communication cluster with theoretically unlimited geographical coverage. Figure 2-2 illustrates a generic setup of a Personal Network and some communication environments, which can be interconnected through networks.

The Personal Network concept is built and developed around the concept of interconnecting Personal Area Networks and other communication environments or networks. A Personal Network consists of a Personal Area Network and other communication environments and networks, which physically can be located anywhere. The Personal Area Network will be related to the end-user of a specific Personal Network, meaning that every user will have their own Personal Network, which consists of a core Personal Area Network and other communication environments or networks, which again consist of a number of devices. Interconnecting and integrating Personal Area Network devices with devices in other communication environments and networks via wired or wireless networks will allow the end-user to reach a multitude of services

and applications, including services and applications offered by other Personal Networks or Personal Area Networks.

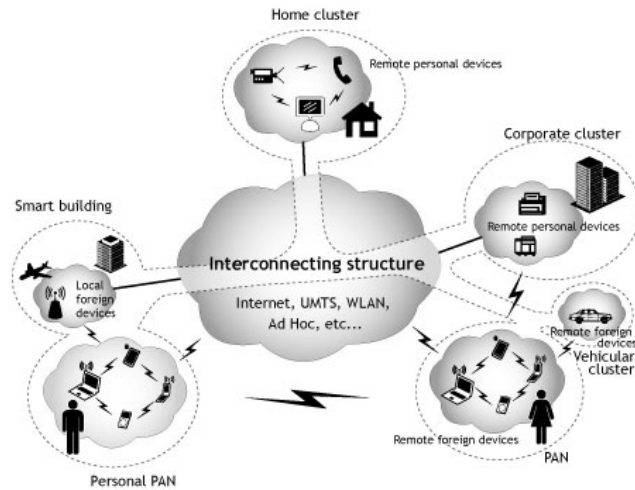


Figure 2-2 *Personal Network illustration*³

A Personal Network can operate on top of a number of networks, which exist for subscriber services or are composed in an ad hoc manner for this particular purpose. These networks are dynamic and diverse in composition, configuration and connectivity depending on time, place, preference, and context, as well as resources available and required.

2.2. Characteristics of Personal Networks

The main characteristics of Personal Networks are; heterogeneity, personalisation, autonomy, and security, which are all important characteristics and have great influence on the concept of Personal Networks (Niemegeers and Wu 2006).

Within the concept of a Personal Network, heterogeneity (consisting of dissimilar or diverse elements/entities) exists in many ways; the variety of devices that can be connected, the multiple geographical locations of these devices (local, regional and global locations), the different wired and wireless interfaces these devices use, and the different resource constraints both by devices (energy supply, memory, and processing capabilities) and by interfaces. These are some of the most important considerations

³ <http://www.ist-magnet.org/technicalapproach>

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and characteristics and this implies that a Personal Network can or will consist of a wide range of devices; computers, PDAs, sensors, cell phones, home appliances, office equipment, etc. which can be distributed at local, regional or global locations. These devices can have one or more wired or wireless interfaces, which may change due to availability of access networks, and thereby continuously change the access resources to these devices. The Personal Network should therefore support seamless connectivity and end-user mobility and at the same time integrate these heterogeneous devices in a simple and easy to use manner, which means it should be “plug and play” from the end-user perspective.

Also personalisation (to make personal or individual) and customisation (to build, fit or alter according to individual specifications) are important features in relation to Personal Networks, as the goal is to make Personal Networks very user centric, i.e. emphasising end-user requirements. Today most devices can be customized or programmed to some degree to suit different personal preferences. However, in the future all kinds of devices are expected to be able to understand a person’s needs and to some degree be context aware and thereby able to accommodate the user’s likes, habits and situations based on all kinds of inputs. It is therefore very important that a Personal Network supports personalisation and customisation based on an understanding of a person’s needs and habits.

From a Personal Network perspective, autonomy (the quality or state of being self-governing) can be related to two aspects. First of all the devices within a Personal Network should be able to organise and interconnect themselves with a minimum of human interaction (plug and play, like described earlier). The different clusters of devices within a Personal Network are or can be highly distributed, and are part of a very dynamic topology as the single devices can join or leave a specific cluster at any time. Also, clusters can merge or split up as the need arises or disappears. Second, a Personal Network should be able to make its own decisions, based on the awareness of the devices and furthermore based on personalised and customised profiles and related input all with minimal intervention or input from the user.

One of the big challenges regarding Personal Networks is security, as a Personal Network consists of a multitude of devices using a variety of different interfaces and as access technologies make Personal Networks vulnerable from a security perspective. Also trust and trusted relationships are a big challenge, as the concept of Personal Networks are very much built on the needs and requirements of the individual users and the interconnection of devices, e.g. between known and unknown devices.

The above characteristics all suggest or imply some kind of intelligent behaviour for the Personal Network, Personal Area Network and all the different devices that constitute the concept. In this context intelligence should be related to the capability of gathering information concerning the user’s personal environment and to learn from the current and continuously gathered information. This data should then be related to prior collected information and data and combined with the user’s personal preferences in order for the Personal Network devices to automatically adapt to the current situation and known user preferences (Niemegeers and Wu 2006).

To reduce the inherent complexity of the network architecture of Personal Networks and Personal Area Networks, the MAGNET project is working with three abstraction levels: connectivity, network, and services abstraction levels. The connectivity level is related to the physical layer and data link layer of the OSI model. The network layer is related to the transport and network layer. Finally the service level is related to the application layer in the OSI model (Frattasi, Sanctis et al. 2005; Petrova, Wellens et al. 2005).

ISO layers	Personal Network abstraction levels
Application	Service
Presentation	
Session	
Transport	Network
Network	
Data link	Connectivity
Physical	

Table 2-2 Network architecture

The connectivity abstraction level is basically composed of different radio domains, i.e. a collection of devices with a common radio interface, which describes an area within which devices can communicate with each other. The overall objective within each radio domain is to minimize interference and to optimize the radio link quality regarding both current and future air interfaces (Petrova, Wellens et al. 2005).

The network abstraction level is where the Personal Area Network and the Personal Network are defined. Furthermore, the remote devices can be grouped together in different clusters, e.g. home cluster, office cluster, etc. At the network level, two types of devices are defined; the personal devices and the foreign devices. A personal device is a device related to a given user within a pre-established trust relationship and a

foreign device is a non personal device that can be either trusted or not trusted. A trusted relationship is established when two or more entities want to set up a secure communication channel, by whatever means possible (Petrova, Wellens et al. 2005). At the service abstraction level, the provision and usages of services is defined, filling out the remaining OSI layers (5, 6 and 7) and contains all the services offered on the devices.

2.3. Market perspectives

From a mass-market perspective the Personal Network concept could potentially open up for a variety of new services and applications, especially regarding the combination of Personal Network and Personal Area Network services and applications. Furthermore the current trends in personal and professional mobility and nomadic patterns (mobility of the end-user) could potentially be a driver in developing new services and applications supporting the users in their everyday activities, both professionally and personally.

This has important consequences from a business modelling perspective. Generally, business modelling is a supply side exercise. User needs, targeted market segments, and value propositions must be part of the modelling exercise as business modelling basically deals with the relationships between the players on the supply side in order to determine how they can service the needs on the demand side.

In the case of Personal Networks, the demand side has to be more directly involved in the creation of business models. The reason is that user groups (individuals, companies, organisations, etc.) to a large extent can set up parts of the network infrastructure and deliver specific services themselves. Therefore, Personal Networks will often consist of a combination of service delivery relations (i.e. from a business enterprise/operator to an end-user) and self-organised services and applications. However, the possibility of user groups organising parts of the communication processes and applications by themselves makes the involvement of the demand side necessary in the development of business models (Henten and Saugstrup 2004a; Henten and Saugstrup 2005a; Henten and Saugstrup 2005b; Saugstrup and Henten 2006b).

The business model concept has increasingly gained prominence in business research during the past 10 years. Though business models have existed as long as businesses themselves, the business model concept was developed in relation to the implementation of Internet-based e-commerce. At first, focus was primarily on taxonomies of different kinds of e-commerce operations (Timmers 1999; Rappa 2001)

but emphasis shifted towards a description and an analysis of the different aspects of business models, for instance the value propositions and value networks (Chesbrough and Rosenbloom 2000; Afuah and Tucci 2001). Business strategy, on the other hand, has been a topic in business research for a much longer time (Chandler 1962; Porter 1980) and the relationship between the concepts of business models and strategy is a continuous discussion. In 2003 (Seddon and Lewis 2003) published a paper distinguishing between strategy, as 'grounded firmly in the real world', and business models, as 'abstractions of firms "real-world" strategies' (p. 236)(Seddon and Lewis 2003). This means that a business model can be applied by a number of different companies in the same business area, for instance mobile network operators, while their more specific strategies will differ.

Regarding mobile and other wireless business operations, research has mainly concentrated on the services offered to different market segments and the accompanying value propositions and, furthermore, the interplay between different kinds of market players to be involved in the value network delivering the services, i.e. network and service providers, content providers and aggregators, etc. (Camponovo 2002; Bohlin, Björkdahl et al. 2003). Lately, this type of approach has been summarized in an understanding of business models as encompassing a service design, a technology design, an organisation design, and a financial design (Faber, Ballon et al. 2003). A similar approach with slightly differing wording has been proposed in a publication by IPTS on 'The Future of Mobile Communications in the EU: Assessing the Potentials of 4G' (Casal, Lindmark et al. 2004). Basically, the implication of this approach is that when designing a business model, one should include the services offered, the technologies used, the organisation of the actors in the value network, and the financial aspects, including charging models and revenue distribution. This is the model adopted by the MAGNET project in combination with the view that business models are abstractions of more specific business strategies.

A number of research and development projects are found in fields close to the MAGNET concept of Personal Networks. Some of the work in these projects is summarized in (Casal, Lindmark et al. 2004). Of special relevance in a European context is the work performed in Eurescom, an organisation whose members are European network operators, and the Virtual Home Environment (VHE) project of 3GPP. Eurescom has been using the term Beyond 3G (B3G), focusing on the interoperability of heterogeneous networks, identifying four main drivers in the development of B3G: Personalisation, seamless access, QoS, and intelligent billing (Casal, Lindmark et al. 2004). The VHE project has been dealing with the issue of building a platform for 'a system concept for personal service environment portability across boundaries and

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between terminals' (3GPP 2002). The specificity of the Personal Network concept as developed by the MAGNET project is related to its focus on ad-hoc networking and peer-to-peer communications. Furthermore, the Personal Network concept widely emphasises the many different kinds of Personal Networks, which will be developed in the coming years. Services for the general public will be part of many Personal Network services, and Personal Networks will include many group specific features and applications. This means that many different contributing entities will participate, including traditional commercial communication operators, and many non-commercial organisations.

3. User involvement in the innovation process

3.1. Innovation

The concept of innovation is not new at all; one could argue that it is as old as mankind or even older being an important part of the evolution theory – the idea or concept of trying to do things in new, better and somehow more efficient ways. In a long term perspective, one could speculate how the world as we know it today would look like without innovation taking place, where would the world and mankind be if it wasn't for such important innovations as: agriculture, the wheel, the alphabet, or printing. Looking at a somewhat shorter time horizon perspective, some very distinct and important innovations could be the steam engine, automobiles, airplanes, jet-engines, and telecommunications to mention a few (Fagerberg 2006).

From a historic perspective, the phenomenon of innovation and innovation theory has not always received the scholarly attention it deserves - in spite of its apparent importance within many fields and areas of research. However this has changed over the last couple of decades, as the role and importance of innovation theory in economic, social science, technology, and cross disciplinary research has increased noticeably, all resulting in an improved understanding of and knowledge about the innovation process, the determinants, social, and economic impacts (Sundbo 1998; Fagerberg 2006). In general, most of the research within innovation theory is based on a cross-disciplinary research perspective underlining the need of studying innovation from different schools of thought in order to reach a comprehensive picture.

Joseph A. Schumpeter is viewed as one of the great pioneers within innovation theory, especially regarding technological innovation and entrepreneurship – where one of his main arguments was that: entrepreneurs will seek to use technological innovation to obtain a strategic advantage, i.e. providing a new product or service or improve the production/manufacturing process of an already known product (Tidd, Bessant et al. 2005). The centre of attention in Schumpeter's research is focused on the role of

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innovation in an economic and social change perspective. According to Schumpeter, economic development should be seen as a process of qualitative change with innovation as the main driver, where innovation is related to new; products, methods of production, sources of supply, markets (exploration of), and ways to organise businesses (Schumpeter 1934; Andersen 1991; Fagerberg 2006). In the Schumpeterian view innovation is therefore strongly related to new combinations of existing resources, and the entrepreneurial action is related to the combination activity. Schumpeter's notion on economic development (evolutionary analysis) is based on an initial equilibrium (a non innovative state), which is disrupted by an irreversible disturbance, an innovation, and after this disturbance a new and different equilibrium is reached. The disturbance can be based on one or more of the five types of innovations mentioned earlier. This cyclical process will go on continuously, starting with an equilibrium phase, then the disruption phase, and further on to a new equilibrium etc.

Innovation can be approached and analysed from different perspectives and levels. Schumpeter's early work (also referred to as Schumpeter Mark I) was very much focused on the individual entrepreneurs, whereas his later work (also referred to as Schumpeter Mark II) also recognised the importance of innovation in large firms (Andersen 1991; Fagerberg 2006). While Schumpeter's theories of innovation and entrepreneurship are mainly based on a microeconomic level and perspective, i.e. analysing market mechanisms e.g. how individuals, households and firms make decisions in relation to allocating limited resources and how these decisions and behaviours affect the supply and demand for goods and services. The overall implications of innovation and entrepreneurship activities can also be related to macroeconomic perspectives, i.e. the performance, structure and behaviour of the economy on regional, national, or international levels in order to understand the determinants of aggregated economic trends e.g. national income, unemployment, inflation, investment, national trade, etc. - the total sum of economic activity. The implications of innovation and entrepreneurship influence the total sum of economic activities within a given area, branch, or market.

One of the main drivers for innovation is competition. Overall three different areas or sources of innovation can be identified in relation to competition: price competition; new research and technology; and unknown user requirements (Rosted 2005). However, this of course vary from company to company and from market to market but in general these are believed to be the main sources of competition and thereby also innovation related. The price competition approach is related to providing what users believe to be cheaper products. Price competition is as old as the market economy itself and the results are often less than perfect products (but cheap), which from a

manufacturing perspective mainly result in purchasing, manufacturing, and distribution cost optimisation. The research and technology innovation approach is related to getting ahead of competitors, e.g. by developing and manufacturing newer and more advanced products based on a technology lead, which thereby open up for new business opportunities. The unknown user requirements approach to innovation is related to actually designing, developing, and manufacturing products that add more value to the users. This is done by acquiring a better understanding of the actual user needs and requirements and transferring these into new products and thereby creating more value adding products, i.e. the user involvement in the innovation process, which is the main emphasis of this chapter. Focusing on the user involvement in the innovation process obviously leave out other and equally important perspectives, theories, and concepts of the innovation theory field of research: diffusion studies cf. (Silverberg, Dosi et al. 1988; Rogers 1995; Rogers 2003); innovation research in relation to economic studies and technological change and society perspectives cf. (Dosi 1982; Dosi 1988; Dosi, Freeman et al. 1994; Dosi and Nelson 1994; Dosi 1997; Dosi, Marengo et al. 2006); and innovation policy aspects cf. (Edquist 1999; Edquist, Hommen et al. 2001).

This chapter starts by presenting a short description and analysis of some different innovation perspectives, mainly in relation to economic, technological, organisational, and creativity perspectives as these are the most important in relation to the theoretical framework applied within the thesis. Furthermore the imperative distinction between invention and innovation are briefly described and analysed together with the distinction between product and process innovation. This is followed by a historical review which describes and discusses the evolution within the innovation field of research during the post world war II period and furthermore highlights what have been the dominant models of best practice within the innovation process, with an emphasis on user involvement in the innovation process perspective. Section four in this chapter deals with the user involvement in the innovation process, with a particular focus on the concepts of lead users, sticky information, and toolkits, which all are described and analysed in detail. Finally, the chapter is summarised, highlighting the key findings within this chapter.

3.2. Innovation perspectives

The term innovation is widely used and generally referred to as consisting of both radical and incremental changes to products, processes, and services and in many situations the unspoken goal of innovation is to solve some kind of problem. Innovation theory and innovation mechanisms are studied within many areas of research and in

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different contexts providing the literature with numerous approaches to innovation, e.g. policy, economy, technology, engineering and organisational (Fagerberg 2006), thereby making the conceptualizing of the term innovation a challenging and by no means an easy task.

Some general dictionary definitions of innovation:

- Introducing something new / something newly introduced⁴
- The introduction of something new / a new idea, method or device⁵
- The action or process of innovating / a new method, idea, product, etc.⁶

Based on the above definitions innovation could in general be defined as the introduction of something new and useful, i.e. new methods, new techniques, new practices, and new or somewhat changed products or services. However, it is also imperative to distinguish between invention and innovation; invention being the first occurrence of an idea for a new product or process, while innovation is the first attempt to carry it out into practice (Edquist 1999; Edquist, Hommen et al. 2001; Fagerberg 2006). In practice these terms are however closely linked and hard to distinguish, as the concepts of enhancement, development, progress, and similar expressions are often used in connection with/to innovation or as a substitute for innovation. However, these concepts might not always be the same as innovation, i.e. incremental innovation, and are therefore more related to improvements than innovations. Incremental innovation can be defined as and related to improving something that already exists or to the reconfiguring of existing forms to serve other purposes (Luecke and Katz 2003). It is difficult, if possible at all, to distinguish between incremental innovations and general enhancements, improvements, etc. as these concepts overlap in relation to their definitions.

From an economic perspective and departing from Schumpeter's theory of economic growth to the work after the innovation, but before the wider diffusion, i.e. innovation is the developing of a 'product' for practical and economic use, but does not involve the actual invention. Below, innovation is defined in Schumpeter's terms, involving one or more of the mentioned events (p. 66)(Schumpeter 1934).

- The introduction of a new product or a new quality of a product
- The introduction of a new production method
- The opening of a new market

⁴ <http://www.bartleby.com/61/>

⁵ www.m-w.com

⁶ <http://www.oed.com/>

- The conquest or opening up of a new source of supply or half-manufactured goods
- The creation of a new organisation structure in industry

Even though this definition is very broad, which also is a criticism of Schumpeter's definition of innovation, the core aspects of Schumpeter's definition is that innovation is an effort made by one or more persons, which in turn generates an economic gain (Sundbo 1998). Schumpeter defines innovation as the introduction of a new product or a new quality of a product, which is defined as product innovation and in general related to manufacturing/producing new or better products. Furthermore, he defines goods or qualities of goods, which the consumers are not familiar with, as new or better products (Schumpeter 1934). However it might not be as simple as that, as the category of product innovation can include both new goods (material production) and new services (intangible products). In addition, and to make the distinction of a new product even more difficult, one has to consider the distinction between minor (trivial) and major (non-trivial) product changes and reserve the term product innovation to the latter (Edquist, Hommen et al. 2001).

Process innovation is related to new ways of producing goods and services, which can be divided into technological process innovation (products that have been changed/improved through technical change) and organisational process innovation (new ways to organise work). Edquist et al. suggest an analytical distinction of innovation, where the primary distinction is between product and process innovation. Second, product innovation is divided into product innovation regarding material goods and intangible services. Process innovation is further distinguished into two sub categories; technological process innovation and organisational process innovation (Edquist, Hommen et al. 2001). See Figure 3-1.

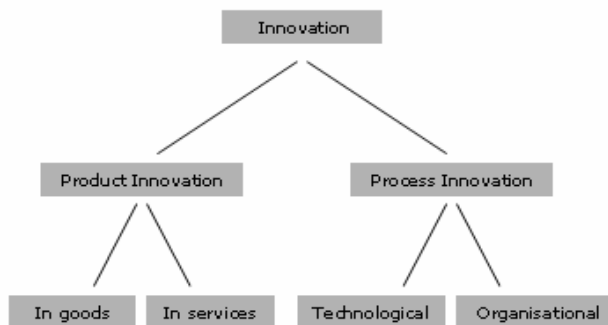


Figure 3-1 *Different kinds of innovation*⁷

⁷ (Edquist, Hommen et al. 2001)

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From a technological perspective, the Oslo manual is one of the key documents in relation to collection, measurement, and interpretation of data relating especially to innovation but also science and technology in general, evaluating the various theoretical approaches to innovation and assessing the implications for policy and data collection (OECD 2005). The Oslo manual defines innovation broadly as ‘...the implementation of a new or significantly improved product (goods or services), process, a new marketing method, or a new organisational method in business practices, workplace organisation, or external relations.’ (p. 46)(OECD 2005). This very broad definition obviously covers a wide range of innovations. However, more narrow and specific sub definitions are also defined and included in the Oslo manual. The Oslo manual identifies four types of innovations: 1) a product innovation is the introduction of goods or services that are new or significantly improved with respect to its characteristics or intended uses. This includes significant improvements in technical specifications, components and materials, incorporated software, user friendliness or other functional characteristics; 2) a process innovation is the implementation of a new or significantly improved production or delivery method. This includes significant changes in techniques, equipment and/or software; 3) an organisational innovation is the implementation of a new organisational method in the firm’s business practices, workplace organisation or external relations; and 4) a marketing innovation is the implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion, or pricing (p. 46-51)(OECD 2005).

From an organisation perspective innovation has been defined as ‘Innovation is a management process that requires specific tools, rules, and disciplines [...] and for any organisation, innovation represents not only the opportunity to grow and survive but also the opportunity to significantly influence the direction of the industry.’ (p. xviii and 1)(Davila, Epstein et al. 2006). From a creativity perspective (Amabile, Conti et al. 1996) states that ‘All innovation begins with creative ideas. Successful implementation of new programs, new product introductions, or new services depend on a person or a team having a good idea – and developing that idea beyond its initial state [...] we define innovation as the successful implementation of creative ideas within an organisation. In this view, creativity by individuals and teams is a starting point for innovation; the first is a necessary but not sufficient condition for the second. Successful innovation depends on other factors as well, and it can stem not only from creative ideas that originate within an organisation but also from ideas that originate elsewhere (as in technology transfer).’ (p. 1154 - 1155)(Amabile, Conti et al. 1996). Generally speaking, creativity is a broad concept, not easily defined, and often based on combinations between theoretical foundations and the beliefs of the user of the concept (Pope 2005). Within the creativity domain, Torrance (Millar 1995) stands out with his

research on creativity as a process, and his view, that each individual is creative. According to Torrance, all persons are born creative, and it is possible to maintain or even increase a person's creativity level by applying creative enhancing activities, methods, and motivation. Within the creativity domain, there is a large amount of different methods and techniques to increase and support creativity in different situations cf. (Higgins 2005). However there are also some pitfalls cf. (Amabile, Hadley et al. 2002). Within creativity, the brainstorming technique is perhaps one of the most successful and well-known tools, introduced by (Osborn 1957) as an element of creative problem solving in order to stimulate and support the idea generation. Also the concept of divergent and convergent thinking is one of the main principles within creativity. The divergent phase is characterised by generating as many ideas as possible concerning the question or problem at hand, whereas the convergent phase, is based on a more systematic thinking and structured process as well as prioritisation of the generated ideas (Goff 1998; Vidal 2004; Vidal 2006).

As described and illustrated, the definition of innovation is highly complex as it builds on many different contributions and conceptualisations of the concept of innovation, together with related and overlapping definitions, e.g. innovation vs. invention, incremental innovation vs. improvements, enhancements, etc. Furthermore these concepts are used independently and interchangeably of each other in practise, which makes the concept of innovation even more vague or unclear. However, in relation to this thesis the definitions within the Oslo manual will be deployed in relation to the definitions of product and process innovation. These definitions are also closely related to (Edquist, Hommen et al. 2001) distinctions between process and product innovation and the sub-categories they present. In relation to the user involvement in the innovation process, and the process and methods deployed to actually involve the users in the innovation process and thereby allow them to come up with innovative ideas, new user needs, and requirements, inspiration has been found in the definition of innovation from a creativity perspective presented by (Amabile, Conti et al. 1996).

3.3. Historic perspectives on innovation models

Generally speaking, there is a large and increasing body of literature dealing with the topic of innovation models and processes, and in retrospect the last fifty years of research within this area has seen some noticeably changes in relation to prevailing innovation models. Overall the main approach has been driven by external factors like economic development and competition and little attention has been allocated to the users or customers as being part of the innovation models and process. Even though a generalised model of innovation would be very difficult to identify and extremely

multifaceted there have been several attempts to develop a generalised model or a number of sub models. The complexity of the innovation process itself and the difficulties in explaining and studying all aspects of the process seem to be the major barriers of developing a generalised model (Saren 1984). However, based on the assumption that most innovation models are not developed as a generalised representation of the innovation process itself, but as a basis for examining the innovation process in different settings, (Saren 1984) classified the innovation process according to a taxonomy of five different types of innovation based on a literature review: 1) Departmental-stage models, 2) Activity-stage models, 3) Decision-stage models, 4) Conversion process models, and 5) Response models (Saren 1984). In contrast, (Cooper 1983) suggests, that because of the diversity of different types of innovation processes, the construction of a generalised model is inappropriate. The appropriateness of a generalised model or not, the following section will provide a brief overview of the last fifty years of research concerning innovation process models, highlighting the proliferation of new approaches to the innovation models and in particular in relation to user involvement in the innovation process and how the extent of incorporating the users or customers into the innovation process has changed over the last fifty years.

3.3.1. The technology push innovation model

The first industrial revolution was driven by the development of the steam engine starting in the 1760ies and ending in the 1850ies. The second industrial revolution, which started during the late nineteenth century and ended in the early twentieth century, was based on the development of electricity. This led to what has been called the third industrial revolution, starting after World War II, which is based on electronics and information and communication technologies (Bruland and Mowery 2006).

The overall economic environment in the decades following World War II could be characterised as a fast moving industrial expansion period both in relation to traditional industries but also in relation to new and emerging technologies and industries, i.e. semiconductors, pharmaceuticals, electronic computing, synthetic and composite materials, and in relation to technology led regeneration of existing industries, i.e. textiles, steel and agriculture (Rothwell 1994). The fast moving industrial expansion and the thereby driven proliferation of new technologies and regeneration of exciting technologies and industries all contributed to a decrease in unemployment and an increase in consumer white goods and automobile industries, which often exceeded the production capacity in the earlier years (Freeman, Clark et al. 1992; Rothwell 1992a; Rogers 1995; Karnowski, Pape et al. 2004).

This led companies to focus almost solely on technology and science in relation to design and management of the innovation process, thereby supporting the 'technology push' innovation model. Furthermore, the technology push or supply side based innovation model was supported by the successful formula of R&D departments and correlated positively with market success (Rogers 1995; Karnowski, Pape et al. 2004). Basically this led to a number of different innovation models, which all, more or less, were based on intra-firm innovation processes, thereby leaving no or little room for end user or customer input in relation to the innovation process: the department stage models (Robertson 1974; Saren 1984) where an innovation moves from its conception as an idea through different departments until it emerges as a new product and is introduced to the market. This model also assumes that there are clear broken stages between the different departments (Saren 1984); the activity models of the innovation process (Booz, Allen et al. 1960; Rothwell and Robertson 1973; Baker and McTavish 1976; Kotler 1980), which are related to the different activities that are performed during an innovation. According to (Utterback 1974) three clear stages of activities can be identified in the activity stage models of innovation: 1) idea generation, 2) problem solving, and 3) implementation (Utterback 1974); and finally the decision stage model, which is based on decision points (go / no go) throughout the innovation process (Cooper and More 1979; Saren 1984).

'...During a four-year period before Henry Ford produced the renowned Model T, his company developed, produced, and sold five different engines, ranging from two to six cylinders. These were made in a factory that was flexibly organised much as a job shop, relying on trade craftsmen working with general-purpose machine tools not nearly so advanced as the best then available. Each engine tested a new concept. Out of this experience came the dominant design – the Model T; and within 15 years 2 million engines of this single basic design were being produced each year in a facility then recognised as the most efficient and highly integrated in the world. During the 15-year period there were incremental – but no fundamental – innovations in the Ford product.'

(p. 44) (Abernathy and Utterback 1978)

This 'first generation' of the technology push models of innovation, was viewed as a linear progression of the industrial innovation process, i.e. starting with scientific discovery, over technological development to the marketplace believing that more R&D would result in more new and successful products. Generally speaking, technology was

viewed as the 'drug' that potentially could cure society's greatest problems (Rothwell 1994)

3.3.2. The market pull innovation model

During the 60ies the general market conditions changed, while the industrial expansion continued mainly due to increased manufacturing productivity. From a market perspective, companies relied more on product and market diversification and for these to become independent of increasingly saturated core markets, thereby putting more emphasis on marketing activities. At the same time, there was an increased focus on economics of scale in relation to manufacturing and R&D departments came under rationalisation pressure (Clark 1980; Karnowski, Pape et al. 2004). In relation to user involvement in the innovation process (Knight 1963) showed in a study of computer models that emerged between 1944 and 1950 that three-quarters of these models were actually developed by users (Knight 1963; Abernathy and Utterback 1978).

In order to succeed under these new circumstances, the factors that emerged as being most important were related to need satisfaction, i.e. user needs, which had to be determined and met, and as user needs are not static it was vital to monitor these throughout the course on the innovation process. Furthermore, companies, in order to be successful had to school the users in the right usages and advantages of a given product. Also the integration between marketing and R&D functions and departments were emphasised as important, i.e. good and valid communication was highly important factors in relation to successful technological innovation (Rothwell and Robertson 1973; Rothwell, Freeman et al. 1974; Clark 1980). In relation to communication (Allen 1966) coined the term 'technological gatekeepers', which were related to people with a very high information potential (internal consultants) and viewed as important agents in relation to technology transfer between entities (Rothwell and Robertson 1973).

In general this can be viewed as a period where the technology push paradigm gave way to a more market pull oriented innovation model; thereby emphasising market demands to some extent, i.e. the introduction of the second generation innovation model (Knight 1963). However, one should keep in mind that the pure technology push and pure market pull are two extreme conditions and that there are a multitude of variations in between, which all are more pragmatic, compared to the pure technology push or market pull situations (Rothwell and Zegveld 1985). In relation to the innovation process models reflecting these changes, the marketing orientation model by (Twiss 1980) is a valid example. This model views innovation as a conversion model, converging inputs (raw materials, scientific knowledge and manpower) into output, i.e.

new products. In addition Twiss distinguish between two types of firms: the product oriented and market oriented firm. The product oriented firm views innovation as an internal process, opposite the market oriented model, which viewed customer needs as input (Twiss 1980; Saren 1984).

3.3.3. The combination model of innovation

From the early 1970ies to the mid 1980ies the general market conditions were affected by two oil crises, high inflation rates, demand saturation, oversupply, and a growing unemployment rate, which from an organisational perspective resulted in emphasis on cost reduction, economics of scale, rationalisation, and consolidation as important parameters (Rothwell 1994; Rogers 1995; Karnowski, Pape et al. 2004). These unfavourable conditions put further pressure on understanding the basis of successful innovation, in order to reduce wasteful failures (Rothwell 1994). At the same time a number of detailed empirical studies were published, suggesting that the very linear push and pull models of innovation were increasingly being regarded as an oversimplified model of innovation (Rothwell, Freeman et al. 1974; Utterback 1974; Utterback and Abernathy 1975; Rothwell 1976; Rubenstein, Chakrabarti et al. 1976; Cooper 1980; Mowery and Rosenberg 1997).

Based on empirical tests of the relationship between the characteristics of the innovation process, production processes, and market dynamics (Utterback and Abernathy 1975) developed what they called 'A dynamic model of the process and product innovation'. See Figure 3-2. The model shows the relationship between the rate of innovation (vertical axis) and the stage of process and product development (horizontal axis). 'The model suggests a consistent pattern of variables which will change systematically with the changes in firm's product and process development. Further, it suggests ways to integrate concepts of the innovation process from different disciplines and perspectives: economics (firm size and market structure, product cost and price elasticity, trade flows) management and engineering (type of innovation, cost impact on production process, degree of technical change required) and organisation theory and behaviour (organisation structure, formality, planning process, communication).' (p. 654)(Utterback and Abernathy 1975). This implies that major innovations in general are followed by numerous minor product and process improvements, i.e. product innovation will be the driving force in the beginning of the process, whereas process innovations and minor product innovation will be the later focus based on a cost reduction approach.

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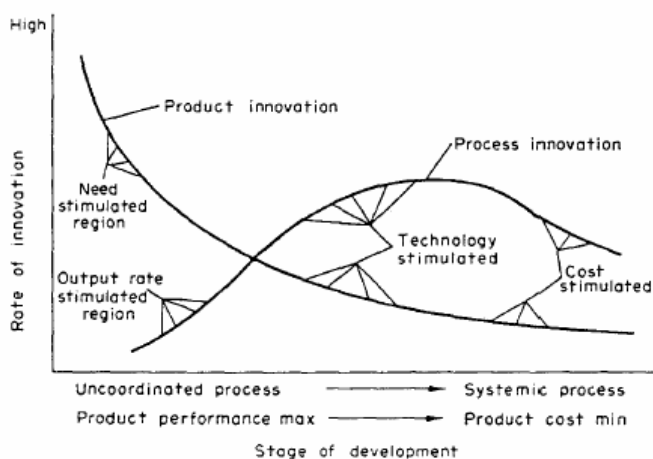


Figure 3-2 *Dynamic model of process and product innovation⁸*

As the linear technology push and market pull models of innovation increasingly began to be considered as oversimplified and uncharacteristic examples, a more general model based on the coupling between science, technology and markets emerged: the so-called coupling model (Rothwell and Zegveld 1985; Rothwell 1992b). The coupling model could be regarded as ‘...a logical sequential, though not necessarily continuous process, that can be divided into a series of functionally distinct but interacting and interdependent stages. The overall pattern of the innovation process can be thought of as a complex net of communication paths, both intra-organisational and extra-organisational, linking together the various in-house functions and linking the firm to the broader scientific and technological community and to the marketplace.’ (p. 50) (Rothwell and Zegveld 1985). See Figure 3-3. This so-called third generation innovation model, viewed the innovation process based on the confluence of market needs/demand and technological capabilities all shaped and moulded within the innovation framework of the firm (Rothwell 1994). Even though the coupling model of the innovation process still to some degree could be viewed as a sequential process, feedback loops were included in the process, allowing for iterations within the process (Rothwell 1992a). Also the so-called concomitance model of innovation, which is based on a description of the entire industrial activity in terms of three functions (research, technical, and commercial) can be attributed to this kind of models (Schmidt-Tiedemann 1982).

⁸ (p. 645) (Utterback and Abernathy 1975)

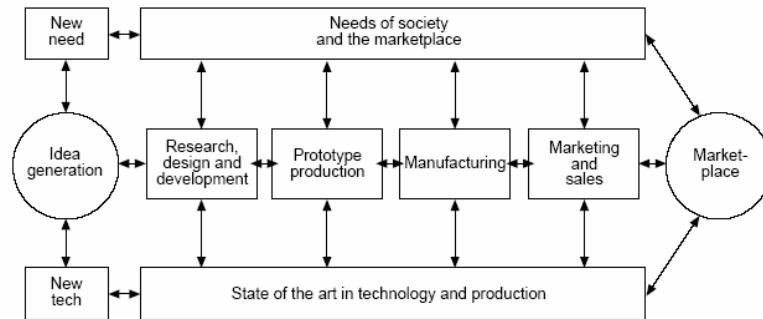


Figure 3-3 *The coupling model of innovation⁹*

In general, this period showed that one or two single factors or tasks could seldom explain the success or failure of the innovation process. Rather, it was a combination of factors or tasks that had to be carried out in a balanced and well coordinated way in order to have the largest chance of succeeding, which is very well represented in the coupling model.

From a user involvement perspective, (Rubenstein, Chakrabarti et al. 1976) conclude that success is people centred. Basically, their research results show that people make innovation successful not organisational structure, control mechanisms, formal decision making processes, delegation of authority, etc. Innovation is essentially a people's process. In relation to a more active customer or user involvement in the innovation process (Parkinson 1981; Parkinson 1982) showed (in a comparative study between the British and West German machine tool industry in relation to new product development) that one of the main reasons for the West German success within this field could be attributed to the fact that the West German machine tool suppliers actively involved the users as an integral part of the design and development process. This was not the case in the British machine tool industry. In West Germany customer involvement in the product design and development process was seen as axiomatic to be successful, opposite the British companies, which relied on not involving the customers before the product was on the market (Parkinson 1981; Parkinson 1982). A similar result could be observed in the UK textile machinery industry, where the more successful companies in most cases actively involved the customers in the development process (Rothwell 1976). The active involvement of the users in the innovation process was at that time somewhat in contrast to the more general marketing approach of scanning the marketplace to foresee or identify new or evolving user needs, which then served as

⁹ (p. 50) (Rothwell and Zegveld 1985)

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input in relation to new product developments or modifications of existing products, where general marketing approach implies a passive or at best a reactive role answering some questions.

Based on a study of over 160 major and minor innovations within instrumentation, process equipment, polymers, and additives (Hippel 1976; Hippel 1977; Hippel 1978; Hippel and Finkelstein 1978) concluded that users of products, rather than the manufacturers within the instrument and process equipment industries, are the real entities behind the design and development of commercially viable products. Within the polymer and additive industries, it was the manufacturers that designed and developed new products.

3.3.4. The fourth generation innovation process

The time period from the early 1980ies to the early 1990ies constitutes the fourth generation innovation process, in which companies in general focused on core competences, i.e. core technologies and core businesses areas (Rothwell 1994). In addition, it was also in this time frame that strategic alliances, external networking activities, and global strategies were being emphasised and seen as the way forward (Nelson 1982; Cooper and Kleinschmidt 1986; Cohen and Levinthal 1990; Stalk and Hout 1990; Rothwell 1991). Therefore different kinds of suppliers were being vertically integrated into the manufacturing and innovation process, as the ability to integrate and take advantage of external knowledge were viewed as a critical factor in relation to successful manufacturing and the innovation processes. In relation to the manufacturing processes, new generations of IT-based manufacturing tools and equipment, resulted in an increased focus on manufacturing strategies (Rothwell 1994).

From a competition perspective speed of development and fast introductions of new products were viewed as key elements, leading manufacturers to adopt so-called time based strategies. In this process, Japanese companies were leading the way forward on the basis of technological imitation, parallel development, just-in-time relationships with suppliers, and efficient quality oriented manufacturing procedures (Rothwell 1994). Integration and parallel development were the two key features of innovation within the Japanese companies and also the key ingredients of the fourth generation innovation process, where the integration were related to integrating all relevant internal departments and external suppliers into the product development process and manufacturing process as early as possible in order to design for manufacturability from day one. The parallel development part is related to working simultaneously on new product development projects, rather than working sequentially (Rothwell 1994). This is

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also known as the 'rugby' approach to new product development (Imai, Nonaka et al. 1985). Figure 3-4 shows the fourth generation, or integrated innovation process (Graves 1987; Rothwell 1994).

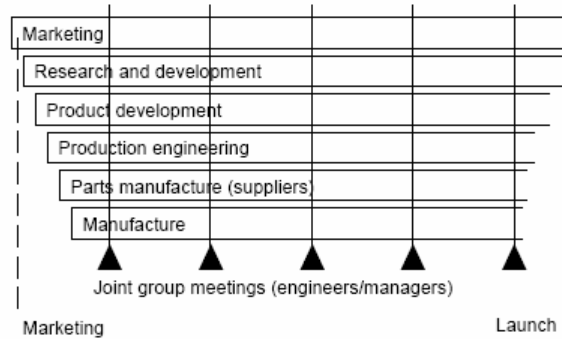


Figure 3-4 *The fourth generation innovation process*¹⁰

The rugby approach can be described as a holistic approach to new product development, compared to the more traditional and sequential approach. The traditional approach could be compared to a relay race, where different groups of specialist pass the baton onto the next group. The rugby approach can be compared to a rugby game (thereof the name), where a team tries to go the distance as a unit by passing the ball back and forward between the players (Imai, Nonaka et al. 1985; Takeuchi and Nonaka 1986). 'This holistic approach has six characteristics namely built-in instability, self-organising project teams, overlapping development phases, multi learning, subtle control and organizational transfer of learning. The six pieces fit together like a jigsaw puzzle, forming a fast and flexible process for new product development. Just as important, the new approach can act as a change agent. It is a vehicle for introducing creative, market-driven ideas and processes into an old, rigid organisation.' (p. 1)(Takeuchi and Nonaka 1986).

From a user involvement perspective, this period saw an increasing amount of research where the users or customers were seen as important entities in the innovation process (Cooper 1980; Hippel 1982; Nelson 1982; Parkinson 1982; Schmidt-Tiedemann 1982; Cooper 1983; Saren 1984; Abernathy and Clark 1985; Gardiner and Rothwell 1985; Imai, Nonaka et al. 1985; Maidique and Zirger 1985; Shaw 1985; Cooper and Kleinschmidt 1986; Hippel 1986; Takeuchi and Nonaka 1986; Hippel 1988b; Hippel 1988a; Urban and Hippel 1988; Hippel 1989; Hippel 1990b; Rothwell 1992a; Rothwell

¹⁰ Adopted from (Rothwell 1994), which is based on (Gaaves 1987)

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1994; Bjercknes and Bratteteig 1995; Hippel 1998; Troy, Szymanski et al. 2001; Drucker 2002). Understanding the market and user needs were believed to result in products of 'high value' and to be very important factors within the innovation process; however these factors might also be the least specific (Maidique and Zirger 1985). In relation to this (Mowery and Rosenberg 1979) emphasised that the term 'user needs' is very vague and lacks definition precision.

Based on substantial research and empirical evidence (Hippel 1982; Hippel 1986; Hippel 1988b; Hippel 1988a; Urban and Hippel 1988; Hippel 1989; Hippel 1990b; Hippel 1998) introduced the novel concept of lead users in this period, where the end users or customers were seen as the primary source of innovation. Even though, earlier models of innovation have included and integrated the customers demand and preferences into the innovation process, mainly based on a fairly passive role or late in the innovation process, Hippel's approach were seen as a radically new approach. 'Lead users are users whose present strong needs will become general in a marketplace months or years in the future. Since lead users are familiar with conditions, which lie in the future for most others, they can serve as a need-forecasting laboratory for marketing research. Moreover, since lead users often attempt to fill the need they experience, they can provide new product concepts and design data as well.' (p. 791)(Hippel 1986). More specifically lead users are defined as: 'lead users of a novel or enhanced product, process, or service are those displaying two characteristics with respect to it: lead users face needs that will be general in the marketplace – but face them months or years before the bulk of that marketplace encounters them, and lead users are positioned to benefit significantly by obtaining a solution to those needs.' (p. 796)(Hippel 1986), i.e. users should possess the ability to innovate and the motivation to innovate.

The above mentioned literature and research on the innovation process and product innovation, is very much related to the sources of ideas and techniques for gathering ideas, however an important part on the innovation process is the idea generation and idea evaluation process, among the other parts of the innovation process, e.g. product development, testing, etc. (Booz, Allen et al. 1982; Conway and Norman 1986; Cooper and Kleinschmidt 1986; Crawford 1997; Troy, Szymanski et al. 2001). According to (Troy, Szymanski et al. 2001) the best starting point for studying product innovation performance is therefore in the idea generation stage of the whole innovation process. From a creativity perspective, (Gagliano 1985) emphasises the importance of never looking for the best way to solve a problem, look instead for the 100 best ways, based on the rationale that the more ideas or solutions, the bigger the likelihood of actually finding the best idea or solution through screening and evaluation (Troy, Szymanski et

al. 2001). In other words, creativity emphasises the quantity of ideas over the quality of the ideas in the initial phase of the innovation process.

Furthermore there seemed to be a positive relation between market orientation/market information and the success of new products, which indicated that more information equals successful product developments at least for market oriented firms. The information is regarded as very valuable for identifying new market opportunities and customer needs (Cooper and Kleinschmidt 1993; Ottum and Moore 1997; Troy, Szymanski et al. 2001). However, some researchers suggest that too much information can have a dysfunctional effect: information overload (Fiol and Lyles 1985; Kimble, Grimshaw et al. 1998).

3.3.5. Towards the fifth generation innovation model

The fifth generation innovation model builds very much on the fourth generation innovation model(s), as many of the trends established in the 1980ies continued into the following decade, however with some of these intensifying in importance e.g. design for manufacturability, flexibility, adaptability, and time based strategies (speed of development) in relation to production, products, and organisations (Rothwell 1994). In particular, the speed of development is viewed as very important within markets and industries where the rates of technological change are high and furthermore where product life cycles are relatively short. Under these circumstances, being first to market bring certain benefits such as larger market share, experience curve benefits, and monopoly profits to mention a few. Opposite, being late to market could result in reduced market share and thereby reduced profitability (Reiner 1989). In general, and in markets or segments where being first is not vital, being fast and timely can be very advantageous (Rothwell 1994). However, the time and speed issue cannot be viewed in isolation, as these are closely related to the costs of development, i.e. the cost of speed. The point is that there will be a trade off between cost and time, and this trade off is a significant factor, in relation to the possible speed of development and speed of innovation when introducing new products or services into the market (Gupta and Wilemon 1990b). The time/cost relationship is shown in Figure 3-5 (Gupta and Wilemon 1990b; Rothwell 1994).

According to the U-shaped curve presented by (Rothwell 1994) there seems to be an optimal range of development time, in relation to cost of development. However, this is not a static model and it will therefore vary from industry to industry and from technology to technology and different companies within the same industry might operate along different curves. Paying the cost of acceleration may be worth it, if the

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project delivers value to the customers (Gupta and Wilemon 1990b). The more integrated the development and innovation process is, i.e. internal and external integration as described earlier, the closer to origin (in a Cartesian coordinate system) the U-curve will be situated reducing the development time and the development cost. 'There exists evidence to suggest that a number of leading innovators are adopting a variety of practices that are now shifting them towards a more favourable cost/time curve, i.e. towards even faster development speed and greater efficiency. These practices include internal organisational features, strong inter-firm vertical linkages, external horizontal linkages and, more radically, the use of a sophisticated electronic toolkit. The organisation, practice, technology and institutional scope of product development in leading innovators, taken together, represent a shift towards the fifth generation innovation process, a process of systems integration and networking (SIN).' (p. 15)(Rothwell 1994). Furthermore (Rothwell 1994) has identified twenty-four factors, which can be attributed to increasing development speed, efficiency, and flexibility, i.e. involved in or contributing to minimising the development time or bringing more efficiency and flexibility into the development process. See (Rothwell 1994) for a full detail on the twenty-four factors.

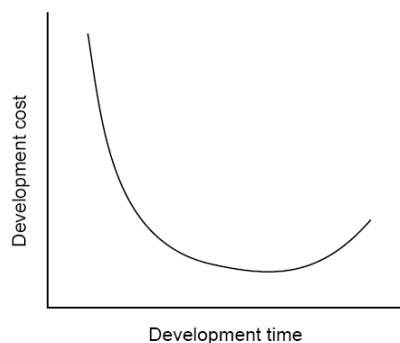


Figure 3-5 *Time/cost development relationship*¹¹

One of the twenty-four factors, i.e. #17 (Rothwell 1994) is related to involving leading edge users in the design and development process and the usages of toolkits. Most manufacturers agree, that it is important to 'listen' to what the customers want and then transform these inputs into new products that meet or even exceed the customers' needs. However, one thing is to try and understand customer needs, another is to transfer these into new products, therefore some companies have abandoned the traditional approach to collecting user needs. Instead they have developed toolkits, i.e.

¹¹ Adopted from (Rothwell 1994), which is based on (Gupta and Wilemon 1990b)

tools so the customers themselves can design and develop their own products, from small incremental modifications to radical or major new innovations (Shaw 1985; Hippel 2001; Thomke and Hippel 2002). Based on research within the medical equipment sector (Shaw 1985) found that there were multiple and continuous interaction between the end users and manufacturers, almost seventy-six per cent of the innovations within a thirty-four sample were designed and developed based on interaction between the end user and the manufacturing company. Furthermore (Shaw 1985) found that the degree of interaction between the end user and the manufacturing company were very high when developing basic or major improvements or innovations, whereas the continuous and minor improvements were mainly developed by the manufacturing company. These findings are supported by the research done by (Gardiner and Rothwell 1985) who reached the same conclusions. Finally (Shaw 1985) also found that most successful innovations were based on a demand pull model, within a sample of thirty-four medical equipment innovations, whereas the only technology push innovation within this sample failed. According to (Hippel 1988b; Hippel 2001; Hippel and Katz 2002; Thomke and Hippel 2002) user toolkits should contain the following five important objectives and characteristics: 1) the toolkit should allow the end users to do repeated trial and error experiments; 2) provide the end users with a solution space; 3) be user friendly, in the sense that the end users do not have to acquire additional skills; 4) be based on or contain libraries of commonly used modules or items; and 5) ensure that the solutions are producible.

This section has described and discussed the evolution within the innovation field of research during the post WW-II period and furthermore highlighted what have been the dominant models of best practice within the innovation process, all with a specific perspective on user involvement in the innovation process. During this time period researchers have tried to build general models of the innovation process in a diagrammatic form, in order to condense and simplify the understanding of innovation, i.e. to build simplified representations of a very complex reality (Howells 2005). In a review paper of the process of technological innovation (Forrest 1991) argues that no universal model is applicable to all processes of technological innovation, even though a variety of more and less complex models have been put forward by a number of distinctive researchers. This supports the conclusion, that a generalised model of innovation is inappropriate (Cooper 1983).

The great variety of innovation models is rooted in researchers adding more elements to the diagrammatic representations of the innovation process to improve the representational coverage of the models, i.e. to include all possible elements, which are carried out at the expense of simplicity. Basically there seems to be a trade off between

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complexity and all included models and simplicity. In her review (Forrest 1991) observed that not even the most complex models of innovation were all inclusive, even though they were very complex representations. Also (Saren 1984) and (Cooper 1983) found that a generalised model of innovation would be difficult to realise, due to the complexity of the innovation process. See Twiss's activity stage model in Figure 3-6 (p. 25)(Twiss 1992) and Schmidt-Tiedemann's concomitance model of innovation in Figure 3-7 (p. 20)(Schmidt-Tiedemann 1982) as examples of fairly complex models of innovation.

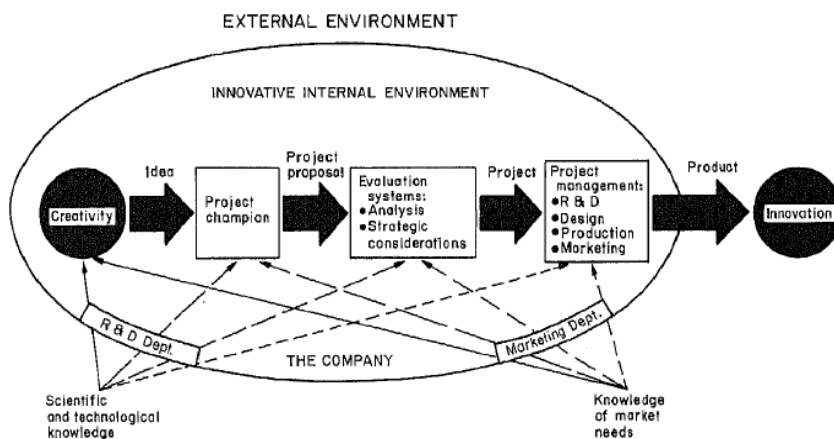


Figure 3-6 Twiss's Activity stage model¹²

Even within these complex models (Forrest 1991) argues that it is possible to think of further elements which should or could be included in a model. According to (Forrest 1991) Twiss's model of innovation, which draws on several studies of successful/unsuccessful innovations, fails to recognise the different pathways an innovation can take at various stages of the process. Also the Schmidt-Tiedemann's model of innovation is not complete. This model draws together three functional areas of the innovation process: the research, technical, and commercial function and the three phases: exploration, innovation, and diffusion. Thereof the name concomitance model, i.e. different functions go together throughout the innovation process (Forrest 1991).

In her concluding remarks (Forrest 1991) argues that innovation is an extremely complex process, which cannot be described and represented adequately in models, as

¹² (p. 25)(Twiss 1992)

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such models would have to include myriads of factors and elements. Instead she lists a minimum of elements which have to be included in a 'complete' innovation process model: 'A comprehensive, generalized model of innovation should include factors, among other, as a definite pre-analysis and pre-evaluation stage, definitive feedback loops, both internally within the firm and externally with the environment; an identification of decision points throughout the process; the life stage/maturity of the industry and life stage of the organisation within industry; a recognition of the environmental variables – not only the marketing and technological, but socio-cultural and political environment variables and the internal environment (culture) of the firm; and the important dimensions of time and cost/resource commitment. At the same time the model must not be industry-specific, should be of use with both product and process innovations, and must take into account the effects of both market pull and technological push on the process of innovation. In addition, if appropriate, it should incorporate strategic alliances into the process.' (p. 450)(Forrest 1991). In a similar perspective (Martin 1994) described the innovation process as an continuous evaluation process of the innovation and he argues that technological innovation should be seen in respect to the system, which the innovation is part of, therefore innovation could be seen as technological mutation, with products and processes evolving as new knowledge is obtained from either the market or technological environments.

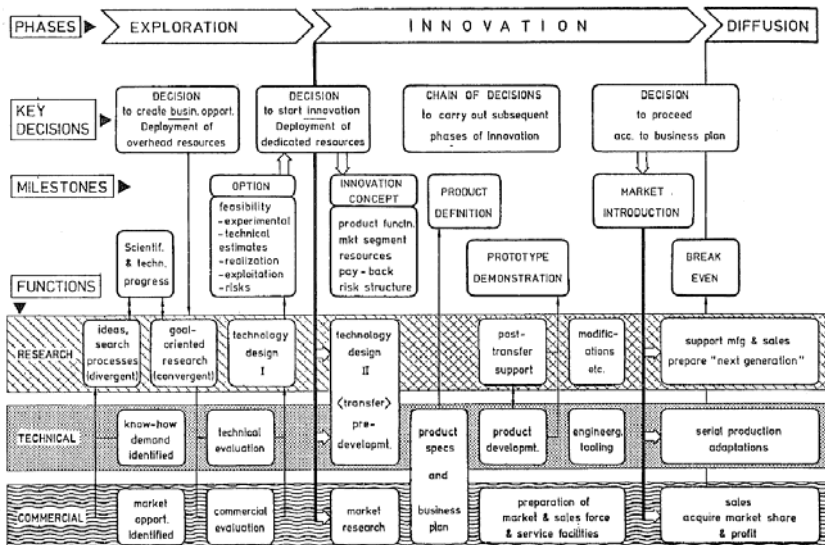


Figure 3-7 Concomitance model of innovation¹³

¹³ (p. 20)(Schmidt-Tidemann 1982)

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Appropriateness of innovation models or not, the reality is often much more complex than any model can represent and it is therefore very difficult to talk about technology push, market pull, or parallel and integrated models of innovation. It seems that all models of innovation exist in a wide range of forms and contexts. In general the pharmaceutical industries seem to lean towards technology push and science based models of innovation, whereas consumer products seem to be more demand oriented, while the innovation models in the assemble industries and sectors are more based on integrated and parallel oriented innovation models (Rothwell 1994). It appears to be impossible to talk about dominant models of innovation, however for certain industries or products, there might be some general trends within different industries or sectors. Overall the innovation process in most cases is a combination of models reflecting the diversity and complexity of the: innovation process; the industry or sector in question; the products produced or services offered; and the people and organisations involved in the innovation process.

3.4. User involvement in the innovation process

User involvement in the innovation process refers to innovations developed by users or actively contributed to by users rather than innovations developed by manufacturers. Most products and services are actually developed by users (individuals and firms) as users that innovate can develop exactly what they want, rather than relying on different manufacturers to develop and manufacture the wanted product. The user involvement in the innovation process offers great advantages over the traditional (manufacture centric) innovation development system (Hippel 1988b; Hippel 2006). To some extent the user involvement in the innovation process is related to the concept of open innovation. The key term in open innovation is 'open', meaning that ideas or innovations can come from both inside and outside a specific company, e.g. customers, trade partners, suppliers, etc. The central idea within the concept of open innovation is related to the fact that most entities cannot rely entirely on their own research (innovation) therefore and in order to succeed, most entities will have to collaborate with other entities or purchase innovations outside the company (Chesbrough 2005).

Furthermore the user involvement in the innovation process concept is closely related to the New Product Development (NPD) theory, which has been researched extensively during the last decade's cf. (Cooper and Kleinschmidt 1986; Johne and Snelson 1989; Cooper 1996; Poolton and Barclay 1998; Kok, Hillebrand et al. 2003; Trott 2005). In general, new product development in rapidly changing markets is one of the main challenges for companies, and adding technological innovation and fast moving technology developments to the equation equals even greater uncertainty when

developing new products and services. Uncertainty is related to an information defect, i.e. the difference between the amount of required information to perform a particular task and the amount of information already acquired (Spender 1993; Mullins and Sutherland 1998). According to (Mullins and Sutherland 1998) and based on their research within a large telecommunication company and rapidly changing markets as those faced by the telecommunication industry, there are three levels of uncertainty: 1) the uncertainty associated with the inability of customers to articulate their needs; 2) the uncertainty of the possibilities of new technology; and 3) the uncertainty of top managers making resource commitments. In general (Mullins and Sutherland 1998) found that the case company, in order to minimise the uncertainty, relied on prototyping much earlier in the process, compared to the traditional market research approach and furthermore relied on qualitative research methods to identify new product ideas and to refine prototypes to real life products.

Integrating customer needs and requirements into new product design and development is in general viewed as a very important and a fairly large challenge by most market oriented firms. According to (Bailetti and Litva 1995) the literature on product development has mainly focused on three perspectives: 1) the different ways to provide operational definitions of customer requirements and needs, including the lead user method and other related methods for deriving and operationalising user requirements, especially when operating when both the product and context are fairly complex cf. (Crawford 1984; Wilson and Ghingold 1987; Hippel 1988b; Urban and Hippel 1988; Griffin and Hauser 1993; Bailetti and Litva 1995; Crawford 1997; Kok, Hillebrand et al. 2003; Schröder and Jetter 2003; Hippel 2006); 2) the problems of integrating marketing and R&D groups, which is very much related to the perceived quality of received information and the perceived functions of the other group cf. (Nelson 1982; Gupta, Raj et al. 1985; Souder 1988; John and Snelson 1989; Gupta and Wilemon 1990a; Cooper 1996; Trott 2005); and 3) the interaction of design and customer concepts, i.e. the interaction between designers and customers transferring ideas and concepts into manufacturable products cf. (Clark 1985; Hise, O'Neal et al. 1989; Dwyer and Mellor 1991; Meyers and Athaide 1991; Cooper 1996; Salomo, Steinhoff et al. 2003). The following sections will focus on the lead user method, sticky information, and the usages of toolkits, which all can be related to the lead user concept and the user involvement in the innovation process and which constitute the overall theoretical framework of this thesis.

3.5. Lead users

Within the user involvement in the innovation process area, the concept of lead users was presented by (Hippel 1986) in a paper, where he argues that the traditional market research analysis is not reliable, when talking about very novel products or in product areas considered as rapidly changing as for instance high-tech technology. The concept of lead users was therefore put forward as a possible solution to this problem and as it turned out, lead users were and have in numerous cases been able to provide valuable insights for novel products, processes, and services (Urban and Hippel 1988; Herstatt and Hippel 1992; Baldwin, Gellatly et al. 1999; Shah 2000; Lilien, Morrison et al. 2002; Lüthje 2003a; Lüthje 2003b; Baldwin, Hienerth et al. 2006; Franke, Hippel et al. 2006; Hienerth 2006; Schreier and Prügl 2006; Schreier, Oberhauser et al. 2007). Hippel uses the term 'Democratising innovation' to describe this trend and in his recently published book of the same name he provides insights to how users increasingly are able to innovate themselves and thereby develop exactly what they want, compared to relying on manufacturers to act as their agents (Hippel 2006). In relation to this, it is important to mention that the users in this connection can be both manufacturers and single users, e.g. both firms and individuals. Basically, this means that the lead user method or construct was developed as a way to identify new and innovative products, processes or services developed only or partly by users, and which furthermore seemed commercially attractive. Compared to a more traditional approach, the lead user approach provides solutions based on users from the leading edge of a given market, whereas the traditional approach seeks needs from the center of a given market target, which is then converted into new products, services, or processes in-house (Franke and Shah 2003; Alam 2005; Robert 2005).

Since first introduced, the concept of lead users has been studied, further developed, and empirically tested in numerous contributions (Hippel 1986; Hippel 1988b; Hippel 1988a; Urban and Hippel 1988; Hippel 1989; Hippel 1990b; Herstatt and Hippel 1992; Baldwin, Gellatly et al. 1999; Morrison, Roberts et al. 2000; Shah 2000; Goldenberg, Lehmann et al. 2001; Thomke 2001; Lilien, Morrison et al. 2002; Lüthje, Herstatt et al. 2002; Thomke and Hippel 2002; Franke and Hippel 2003; Franke and Shah 2003; Lüthje 2003a; Lüthje 2003b; Thomke 2003; Hippel 2005b; Lüthje, Herstatt et al. 2005; Baldwin, Hienerth et al. 2006; Franke, Hippel et al. 2006; Hienerth 2006; Schreier and Prügl 2006; Schreier, Oberhauser et al. 2007) to mention a few. In his 1986 paper (Hippel 1986) defined lead users as: '...lead users of a novel or enhanced product, process or service are those displaying two characteristics with respect to it: lead users face needs that will be general in the marketplace – but face them months or years before the bulk of that marketplace encounters them, and lead users are positioned to benefit significantly by obtaining a solution to those needs.' (p. 796)(Hippel 1986), i.e.

users should possess the ability to innovate and the motivation to innovate. This first characteristic of the lead user method (lead users face needs that will be general in the marketplace – but face them months or years before the bulk of that marketplace encounters them) is derived from problem solving research (Hippel 1986; Franke, Hippel et al. 2006). In general, subjects can be considered to be strongly constrained by their real-world experience (functional fixedness), i.e. people, who have used or seen an object used in a recognizable situation, were found blocked from using that object in a novel way and the more recently this occurred, the bigger the blocking (Adamson 1952; Baldwin, Gellatly et al. 1999; German and Barrett 2005; Franke, Hippel et al. 2006). This clearly indicates that lead users residing on the leading edge of a given market in general would be better or more precise in their future need expectations, compared to average users, residing at the center of a given market, predicting leading edge user needs. The second characteristic (lead users are positioned to benefit significantly by obtaining a solution to those needs) is very much related to economic parameters of the innovation process. In general, product and process innovation have shown that the greater the benefit of a given innovation, the more resources this entity is willing to invest in a given innovation. However, it is important to note that not all innovations will provide benefits or be attractive to all users even though the originator will benefit significantly (Schmookler 1966; Mansfield 1968; Hippel 1986; Franke, Hippel et al. 2006). For instance, highly specialised manufacturing equipment might only be valuable to a given manufacturing company and the same is valid for highly customised products and build-to-order products.

According to Hippel, lead users are believed to contribute with valuable insights in relation to the innovation process, based on their needs and self developed prototypes, in relation to new products, processes, or services. Thus (Hippel 1986) suggests a four step process in order to integrate the lead users into the innovation process: 1) identify an important market or technical trend, i.e. before identifying the lead users it is important to identify the underlying trend, (which is changing over time) within a given market, technology, or product segment on which the lead users have a leading position; 2) identify lead users who lead that trend in terms of (a) experience and (b) intensity of need, i.e. lead users who are pioneers at a given trend in relation to new products and process needs and who expects a high benefit from a solution to those needs. Furthermore, it might be beneficiary to look outside the normal scope or industry for these lead users and in addition it is important to not only be looking for lead users who only solve the whole problem, but also for lead users who have solved a few attributes or a single attribute of a given problem; 3) analyse lead user need data, i.e. analysing lead user data from real life experience, implicit or explicit need statements, new product concepts, or not before seen combinations of existing

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products; and 4) project lead user data onto the general market of interest. However, not all lead user needs might be straightforward transferable into general market solutions or products, it is therefore important to assess the lead user data collected in relation to more typical users. Testing lead user prototypes on more typical users would resolve in more accurate product evaluations and might reveal some improvement or alteration points.

In general, lead users can be characterised as users or customers with needs, which not yet can be fulfilled by any available products, processes or services and furthermore it is most likely that these needs will become universal needs for the average user or customer sometime in the future. Residing on the edge of a given development (and thereby future need requirements) and the familiarity these lead users have in relation to their needs and the forefront of a given development, lead users are predicted to be very well suited as a forecasting laboratory function. In addition and based on the assumption that many of these lead users often invent and develop own solutions to their unsatisfied requirements, further support the assumption, that they will be able to provide valuable product, process, and service concepts together with general information and design data regarding future user requirements (Urban and Hippel 1988). It is important to underline that the lead user concept was mainly developed to be deployed in fast (or fairly fast) moving industries, where the industry moves so fast that the average users and their experience, ideas, and concepts for new products are obsolete by the time the product is developed as the life time of many products in fast moving industries is very short. Based on empirical evidence this does not seem to be the final truth, as there during the last decade have been published a number of studies that show that the lead user concept can also be deployed successfully within less fast moving industries, i.e. more traditional and consumer oriented industries. (see Table 3-1) These studies have tested and proven the concept of lead users through empirical research and successful experiments, where the lead user approach is proving to reduce the information asymmetries between users/customers and manufacturing entities, thereby providing benefits for both parties, i.e. decreasing the probability for inaccurate customer understandings from a manufacturing perspective and providing the requested or needed products from a user/customer perspective. This is further supported by studies reporting that a great number of products are terminated due to insufficient market prospects, which mainly can be related to information asymmetries (Achilladelis, Jervis et al. 1971; Rothwell, Freeman et al. 1974; Mansfield and Wagner 1975)

After (Hippel 1986) proposed the lead user concept, (Urban and Hippel 1988) were the first to empirically test the concept. In their research, they tested the lead user concept

and methodology in the fast moving fields of computer aided systems for design of printed circuit boards (PC-CAD). Overall they found that lead users could be identified and furthermore that these identified lead users had unique and useful data regarding new product needs and solutions to these needs. In addition, and maybe most important, they found that within their sample the lead user concept was superior, compared to alternative methods. At the same time they also underline that there are some problematic issues that need to be further researched within the lead user concept, i.e. accurate trend identification, how is it done and how is it judged; the fact that product perceptions and preferences of lead users might not be directly transferable to non lead users as the market develops. The requirements or predictions of lead users are to novel for non lead users (Urban and Hippel 1988).

Study	Industry	Sample	User developed innovations
Franke and Shah 2003	Extreme sporting equipment	197	32%
Franke, Hippel et al. 2006	Apache web servers	132	23%
Herstatt and Hippel 1992	Pipe hangers	74	36%
Lüthje 2003a	Outdoor consumer products	153	37%
Lüthje 2003b	Medical equipment	261	22%
Lüthje, Herstatt et al. 2002	Mountain biking	287	38%
Morrison, Roberts et al. 2000	Library information search systems	102	26%
Shah 2000	Sporting equipment	57	58%
Urban and Hippel 1988	Computer aided design within printed circuits	136	23%

Table 3-1 User innovation studies

In their study of security related modifications to Apache open source web server software (Franke, Hippel et al. 2006) found that 23 per cent of the sample users (Apache webmasters or webmasters subscribing to a online Apache newsgroup) had developed and incorporated their own code into the software. In addition, approximately 30 per cent had made minor customisations to the standard software, whereas the rest were using standard versions of the software. One can argue, that these lead users most likely are highly skilled, and in a position where self development of code is not that surprising. On the other side, and in line with Hippel's original reasoning, they also stand to gain substantially by developing their own code, as they are on the leading edge and therefore not able to obtain standard products that fit their needs or requirements. However, one has to keep in mind that one of the main

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attributes behind the open software idea, is that users are encouraged to modify and add to already existing software products, i.e. the basic idea behind open source software builds on the concept of everybody contributing and freely sharing their developments with each other.

The study by (Morrison, Roberts et al. 2000) is also within the software area, as they studied the OPAC information search system (Online Public ACcess systems) used by libraries in Australia in relation to innovation, innovators, and sharing of innovations. Overall (Morrison, Roberts et al. 2000) found that 26 per cent of the users within this area innovated and modified the standard system in major and minor ways. As in previously mentioned studies, also in this case the users freely share their innovations and modification with other users of the systems. In addition, they found that when the OPAC manufacturing company actually evaluated many of these innovations and modifications, they found a substantial number of these to be commercially attractive.

Also in the 'low-tech' area the lead user method has been tested and proven its worth. In a study by (Herstatt and Hippel 1992) they focused on joint user-manufacturer development of new products. Together with a leading manufacturer of components, equipment, and materials used in construction, (Herstatt and Hippel 1992) selected a case study concerning pipe hangers, i.e. a fastening system used in commercial and industrial buildings, where the manufacturing company was a major player. The sample was based on firms that install these pipe hangers, and more specific on the most expert person on pipe hangers within each firm. Based on the selected sample of lead users, some product concept generation workshops involving both lead users and individuals from the manufacturing company were set up. At the end of the workshops the participants, as one group, recommended a single pipe hanger system which incorporated the best of all the elements discussed and developed throughout the workshops. After an internal evaluation process at the manufacturing company, the company concluded that the workshops had resulted in a very valuable new pipe hanger product, which was well in advance of market competitors (Herstatt and Hippel 1992).

Studying the performance assessment of the lead user idea generation process at 3M (Lilien, Morrison et al. 2002) found that breakthrough or major innovations will often be found outside a given market segment, i.e. by lead users facing a larger need earlier in another market or industry, than the foreseen target market population - emphasising the importance of exploring the possibilities within other industries or markets. In addition the (Lilien, Morrison et al. 2002) study showed a much higher commercial attractiveness of lead user generated ideas, compared to traditionally developed ideas, which also is the case with the study by (Urban and Hippel 1988). In relation to this, a

study by (Hadjimanolis 2000) showed that available resources and general support from the entire organisation should have a positive effect on the performance of the innovative outcome.

Shifting perspectives from commercial products to more consumer oriented products and product development, the studies by (Shah 2000; Lüthje, Herstatt et al. 2002; Franke and Shah 2003; Lüthje 2003a; Hienerth 2006; Schreier, Oberhauser et al. 2007) all showed that major innovations within the area of sporting goods were made by users rather than manufacturing companies and furthermore that a fairly large portion of these users do innovate and furthermore share their innovations among each other and within their respective sports communities, thereby benefiting the community as a whole and encouraging others to further build on these. Also research by (Harhoff, Henkel et al. 2000) describe how users benefit from freely revealing their innovations. Generally speaking, only a small proportion of the users in these studies interacted with manufacturing companies regarding a commercialisation of their innovation (Gans and Stern 1998). According to (Lüthje 2003a) this is mainly due to disappointing prior experiences with manufacturers. In the study by (Shah 2000) she reported that many innovations within skateboarding, snowboarding, and windsurfing were made by a few early and expert practitioners of the particular sport. Mainly it was a learning by using process, if it did not work the first time they simply kept on going until they got it right, sometimes making several alterations every day. '...existing sports equipment firms – even those producing products closely related to snowboarding, skateboarding and windsurfing were not present as innovators in these new fields. This finding is certainly contrary to conventional wisdom. There is a vast marketing and product development literature devoted to helping manufacturers to better understand consumer needs. This literature generally assumes that it is the manufacturer's role to understand and identify market needs, engage in research and development as well as prototyping activities, and then commercialize and diffuse the resultant innovation.' (p. 17-18)(Shah 2000). Overall there seems to be two explanations for this, the relative expectations of the innovation benefit both from a user and manufacturer perspective and second the allocation of sticky information between the two entities (Shah 2000). In addition (Lüthje, Herstatt et al. 2002) in their study of innovation in the mountain biking field found that a user's 'local' stock of technical knowledge and skills, will determine the outcome of the innovation process, together with the need and requirement for a given solution in combination with the user's general experience.

In relation to end user innovations (Franke and Shah 2003) in their research on innovative communities within extreme sports found that individuals within these communities both developed novel prototypes and that they received assistance from

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other individuals within the same community. In addition, they found that the developed prototypes, assistance, and information were generally freely distributed within the community, i.e. user innovations can generally be described as a joint effort within these communities.

'... it [innovation] was happening daily and we were all helping each other and giving each other ideas, and we'd brainstorm and go out and do this and the next day the guy would do it a little better, you know, that's how all these things came about. I would say a lot of it stemmed from Mike Hogan because, if something didn't work, he would just rush home and changed it or he'd whip out the saw and cut it right there at the beach. [...] there was a new enthusiasm for jumping and they were all trying to outdo each other by jumping higher and higher. The problem was that, like in the past, the riders flew off in mid-air because there was no way to keep the board with you – and as a result you hurt your feet, your legs, and the board. Then I remembered the Chip [a small experimental board built by "the Hawaiians"] with its foot straps and thought "it's dumb not to use this for jumping." The whole sport of high performance windsurfing really started from that. As soon as I did it, there were about 10 of us who sailed all the time together and within one or two days there were various boards out there that had foot straps of various kinds on them and we were all going fast and jumping waves and stuff. It just kind of snowballed from there.'

(p. 14)(Shah 2000)(Interview with windsurfing innovator Larry Stanley)

Another example of the lead user method deployed in real life is the successful story of 'Creating breakthroughs at 3M' by (Hippel, Thomke et al. 1999), which might also be one of the most cited lead user studies. Basically, 3M was one of the first companies to adopt and deploy the lead user method and it all started in 1996 when the Surgical Markets Division at 3M was charged with the task of creating a breakthrough idea or innovation in the area of surgical drapes, i.e. find a better type of disposable surgical draping. Surgical draping is the material that prevents infections from spreading during surgery. After thoroughly researching the area, talking to experts, and travelling around the world in order to understand the needs of medical professionals in developing countries, the team redefined their goal to finding a much cheaper and more effective way of preventing infection from spreading. Following the new goal, the team talked to e.g. specialists in leading veterinarian hospitals and Hollywood make-up artists who apply different kinds of non-irritating and easy removable materials to the skin. The input from these second round expert and lead user interviews with people in very

diverse fields of competences, together with the initial knowledge gained during research and the first round of expert and lead user interviews all served as input to combined workshops. The workshops consisted of lead users, different experts, and the 3M lead user team. The outcome was six new product lines and a radical new approach to infection control. Out of the six ideas, three was chosen as most valuable: 1) an economy line of surgical drapes; 2) an 'skin doctor' line of handheld devices (laying out an antimicrobial substance during operation and vacuuming up blood); and 3) an 'armor' line that could be used to coat catheters and tubes with antimicrobial protection. All three innovations could be developed and manufactured with existing 3M technology and knowledge, but opened up completely new business areas for 3M (Hippel, Thomke et al. 1999; Olson and Bakke 2004).

Within the Telecom area Nortel Networks was among the first to deploy the lead user method when they in year 2000 were looking for new voice, data, and location based services for the wireless internet, as it was labelled at that time, to help them identify future trends and technologies, all in relation to mobility, technology, devices, and services (NortelNetworks 2000; Olson and Bakke 2004). When defining the needs of the lead users, these were defined as having one or more extreme communication or data requirements: critical issues with profound implications for life; wireless Internet user; need to establish outbound voice channels; need to receive inbound voice channels; use of data that is context sensitive; need for real time data transfer; need for voice and data integration; need for location-based information; and no commercial solutions available to satisfy critical needs. Besides the above listed requirements, it was also important that the identified lead users had developed, or partly developed, solutions that actually supported their requirements. In search for the potential lead users the Nortel Networks team looked for and interviewed people in so diverse fields of expertise as: military battle management, remote diagnostic field technicians, mobile telemedicine, law enforcement, aviation specialists, oil field operations, remote news broadcast operations, animal trackers, and storm chasers. More than twenty lead users were identified within the above areas of expertise, all with critical requirements for mobile solutions to transmit data collected in the field. Based on inputs from the lead user team regarding three predefined concepts: a dynamic tether, insuring always on connections to a centralised support system; a dynamic information transfer concept, facilitating information access and intelligent processing while on the move; and a store-and-forward caching concept, which maintain a person's data local to the person and through different workshops the lead users were able to identify several opportunities within mobile services, devices, and technologies, i.e. emergency medicine, avionics, fleet management, and severe weather tracking solutions (NortelNetworks 2000; Olson and Bakke 2004). In relation to the law enforcement

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research, also (Nulden 2002; Nulden 2005) has made some very interesting studies and contributions.

Besides the Nortel Networks case study regarding the deployment of lead users within the telecom sector, also Telenor and Cinet have used the lead user method, however with different results (Olson and Bakke 2001; Olson and Bakke 2004). Cinet's experience of using lead user methods in relation to new product development was positive and resulted in numerous ideas and solutions, however Cinet did not continue with the lead user method for several reasons: after a few months, most of the key persons involved in the lead user method were no longer at Cinet and thereby a large amount of the knowledge was lost as it was not passed on; second a very strong engineering culture and lack of management support eventually made the usage of the lead user method come to a stop; and third; even though a number of ideas were generated and implemented, no measurement of the success and its economic results was ever initiated and therefore Cinet never knew the results of their lead user method (Olson and Bakke 2004).

In the Telenor case, the lead user process was largely driven by external consultants, however Telenor managers selected the areas to focus on. The consultants interviewed and conducted workshops with Telenor experts on technologies and markets, and the ideas and trends that emerged throughout this process was thought of as enough, therefore no external experts (lead users) were ever involved in the process. Throughout the process a great number of ideas and concepts were developed and discussed, however, at the end of the whole process the generated ideas and concepts were mainly seen as confirmations of already and previously discussed ideas by Telenor researchers and engineers. One of the major reasons to the lack of success could be related to the lack of internal resources and backing (Olson and Bakke 2001; Olson and Bakke 2004).

In relation to the telecom industry, (Barczak 1995) has studied the new product development strategy, structure and process within the telecommunication industry and the interconnection between these in relation to effect and performance of new products. Overall she concludes that firms within the same industry use different strategies and furthermore she found no evidence that one strategy should be more successful than another within a given industry. However, at the same time she found that R&D teams and project teams within the telecommunication industry are more effective organising mechanisms than other structures. Finally, she also concluded that idea generation and idea screening are critical activities in the 'fuzzy front end' of the new product development process in fast moving industries (Barczak 1995).

Summarising the above literature review, empirical examples, and discussions in relation to the lead user concept, there seems to be a general support for the concept both in fast and less fast moving industries, however, there are also some challenges that need to be resolved or further tested. In their empirical test of the lead user theory (Franke, Hippel et al. 2006) found clear support for the lead user theory and furthermore found that the two key components of the lead user concept was confirmed, i.e. being ahead of time and obtaining significant benefits from a potential solution. In relation to the lead user concept (Karnowski, Pape et al. 2004) argue that the predictability of innovation success can suffer significantly in very dynamic and fast moving industries, especially where network effects are present. Altogether this can potentially alter the lead user trajectories and thereby deviate the lead user path put forward, before reaching the average user. However, one could argue that this will always be the case in highly dynamic industries, no matter if new products are based on the lead user method or not. In essence, it is presumably more difficult to predict future successes in a fast moving industry, compared to a slow moving industry.

In their critique of the lead user method (Karnowski, Pape et al. 2004) also mentioned a case from Philips, where lead users were less helpful as their recommendations for more sophisticated software and video technology regarding the Philips CDI entertainment system failed on the market. When introduced to the market, the updated system failed and in retrospect it turned out that the average user would have preferred easy to programme and easy to use software and interfaces over complex high-end software and interfaces. This highlights the problem of differences between very technology savvy lead users and early adopters compared to the less technology aware average user. In relation to this, one can also draw into the equation the 'innovators dilemma' put forward by (Christensen 1997) which can be summarised as: if you only do exactly what your customers want, you never go beyond this. Therefore, it is very important, that the deployment of the lead user concept is combined with general market knowledge and other approaches to innovation and new product development (Christensen and Raynor 2003). In relation to network effects, lead users cannot predict these in the course of diffusion, they can only inform about their current needs and requirements, which most likely will be common needs and requirements in the future. In retrospect, and in relation to the above, it is also difficult to see that the lead users of mobile phones, i.e. business people in the early nineties, could have predicted the success of the short messages service (SMS) and ring tones, based on their needs and requirements. Therefore one could argue that the user's contextual situation, social situation, and personal experience are very important parameters, and that these can be very different within the lead user environment compared to the

average user environment, potentially resulting in the failure of lead user suggested products.

3.6. Sticky information

In relation to the lead user approach the term 'sticky information' has been used in an innovation perspective, describing the stickiness of information in relation to problem solving, i.e. to solve a problem, information and problem solving capabilities must be brought together physically or virtually. The stickiness of a given unit of information in a given instance can be defined as the incremental expenditure required to transferring that particular unit of information to a specified locus in a form that is usable by another entity, i.e. a low level of information stickiness results in low transferring costs and a high level of information stickiness results in high transferring costs (Hippel 1990a; Hippel 1994; Hippel 1995a; Hippel 1995b). This means that when information is expensive to acquire, transfer, and use, it will be labelled sticky, whereas when information is inexpensive to acquire, transfer, and use the stickiness is low or almost nonexistent.

From an economic perspective the term sticky information is a well known aspect within economic theories, explaining the slowness of market mechanisms, i.e. prices do not change easily or quickly even though there are changes in supply and demand as firms in general do not instantaneously adjust charged prices in response to a change in demand or supply mainly due to long term contracts, inventory, and price catalogues: the sticky price model. However, there are also markets where prices are changed continuously, e.g. monetary markets and crude oil. Within economics, the term sticky is also referred to as a variable that is resistant to change (Szulanski 1996; Mankiw and Reis 2002; Bils and Klenow 2004). In other words a high level of stickiness is related to some kind of asymmetrical distributed information among entities, i.e. not all entities have the same information at a given time. Opposite perfect or symmetrical information, i.e. all information is known to all entities; therefore the level of stickiness will be zero or close to zero.

Generally speaking, it has not always been evident that technical information used by innovators might be rather costly to transfer. Indeed, information in general has in many situations been viewed as costless to transfer (Hippel 1994). The level of stickiness in relation to information can vary (as will be described below), which can be attributed to a number of factors and influence on the transfer costs. First of all, these variations can be related to the information itself, i.e. the way it is coded (Pavitt 1987; Nelson 1989). Besides the distinction between tacit knowledge and explicit information,

it can also be related to a variety of attributes of the knowledge and information holders and seekers and their capabilities of acquiring, absorbing, and distributing knowledge and information (Lüthje, Herstatt et al. 2002). Also known as the 'absorptive capacity' (Cohen and Levinthal 1990) and related to the term 'technological gatekeepers' (Allen 1966).

Sticky information can also be related to knowledge management, especially regarding tacit and explicit knowledge, which will be explained below. Generally speaking, the main idea behind knowledge management is to store and transfer knowledge, i.e. to identify, create, maintain, represent, and dispense knowledge for reuse, awareness, and learning, focusing on knowledge assets and how these are developed, maintained, and distributed (Su, Chen et al. 2007). Within the information and communication technology domain, knowledge management aspects are most often techno centric, i.e. focusing on technology and how technology can enhance and support the knowledge sharing process or they are organisational centric, i.e. focusing on the design of the organisation in order to facilitate the best possible knowledge sharing process throughout the organisation (Grant 1996; Svanaes 1997; Lee and Yang 2000).

In general explicit knowledge can be described and defined as knowledge that can be articulated, codified, and stored in different media, making it reusable and transmittable. Most explicit knowledge is based on data or information that can be described in a formal language like manuals, documents, mathematical expressions, etc. (Dienes and Perner 1999; Smith 2001). Tacit knowledge can be described and defined as knowledge for which there are no words or described and defined as knowledge that people have in their minds, unaware of it and the value of it, and therefore difficult to transfer (Svanaes 1997). According to (Smith 2001) tacit knowledge can be defined as 'technical or cognitive and is made up of mental models, values, beliefs, perceptions, insights, and assumptions'. The technical tacit knowledge is related to mastering specific bodies of knowledge and skills, and the cognitive tacit knowledge is related to information and knowledge that is taken for granted and can be related to mental models and perceptions (Smith 2001). According to (Polanyi 1998) tacit knowledge can be described as knowing more than we can tell or knowing something without thinking about it, like riding a bike, i.e. a very personal and subjective form of knowledge. However, one should keep in mind that the distinction between tacit and explicit knowledge could be described as being each an end point within a given continuum, implying that in reality the distinction might not be that simple. According to (Wilson 2003) and somewhat in line with Polanyi's definition of tacit knowledge (Polanyi 1998) it is very important to distinguish between knowledge and information. Knowledge is defined as what we know, i.e. the mental process of

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comprehension, understanding, and learning what goes on in the mind, and only in the mind. Information is what is transferred or communicated when we wish to express our knowledge by uttering a message, which can be oral, written, graphic, or gestural in nature. This means that a given message does not contain knowledge; it constitutes information, which the receiver then may assimilate, understand, comprehend, and add to his or her knowledge base. However, as the knowledge structure of the uttering and receiving person are not identical, the knowledge structure built from the information received, will never be the same as the knowledge structure from which the information was uttered (Wilson 2003) as the knowledge structure of a person is biographically determined (Schutz 1967).

In relation to sticky information and the general transferability of information it is very important to be aware of these different aspects and variations of stickiness of any given information as some information is encoded in explicit terms, while other are tacit by nature. In the context of innovation and lead user it might furthermore also be important to distinguish between the creation of new knowledge versus the transferability of already known knowledge. According to (Smith 2001) '...The value of tacit knowledge, like customer good will, is often underrated and underutilised in the workplace. Nearly two-thirds of work related information that is gradually transformed into tacit knowledge comes from face-to-face contacts, like casual conversations, stories, mentionings, internships, and apprenticeships. One-of-a-kind, spontaneous, creative conversations often occur when people exchange ideas and practicalities in a free and open environment.' (p. 314-315)(Smith 2001).

According to (Nonaka and Takeushi 1995; Nonaka 2007) the transferability of tacit knowledge and furthermore the distinction between tacit and explicit knowledge suggests four basic patterns for creating and transferring knowledge within a given organisation: 1) from tacit to tacit, i.e. learning by observing, imitating, practicing, and socialising into the area of expertise; 2) from explicit to explicit, i.e. combining discrete pieces of knowledge into a new whole; 3) from tacit to explicit, i.e. 'finding a way to express the inexpressible.' (p. 136)(Smith 2001); and 4) from explicit to tacit, i.e. transferring information into knowledge cf. (Wilson 2003). In a study of twenty-four equipment innovations (Ogawa 1998) showed that, when information is sticky, there seems to be a bias towards using local information compared to non local information. Similar, (Franke 2002) found in a study of open software innovations that information, which is local to the innovator, seems to be a stronger trigger for innovation. In line with the above, (Winter and Szulanski 2001) in a study concerning replication of well known organisational routines at new locations found, that the transferring process was both difficult and costly. In a study regarding internal stickiness of knowledge transfer,

based on 271 observations of 122 best practise transfers in eight companies (Szulanski 1996) showed that the major barriers to internal knowledge transfer was related to: lack of absorptive and retentive capacity by the recipients; casual ambiguity (imperfectly understood idiosyncratic features); and an arduous relationship between the source and the recipient.

'...that allocation of the application-specific portion of the problem-solving work of custom product and service design to users will be economically attractive for a supplier when: (1) the supplier faces heterogeneous demand for a given type of product or service (this is, many of the users served place a high value on custom solutions); (2) agency costs experienced by users who outsource design activities are high; (3) the stickiness of application-specific user information is high; and (4) the stickiness of information held by the suppliers that is relevant to application specific problem solving is low.'

(p. 631)(Hippel 1998)

This bias towards using or relying more on local information by innovators, as the lack of transferability of information increases with the distance, tends to suggest that lead users or users in general would emphasise their local need information in a product development context. At the same time, this also suggests that manufacturers would tend to focus on product development tasks, based on their local solution information (Lüthje, Herstatt et al. 2005). The level of stickiness regarding information can, as described earlier, be attributed to several reasons; the nature of the information itself, the amount of information, and different aspects of the information seeker and provider. However, the stickiness of a unit of information is not immutable. Therefore the level of stickiness can be reduced by investing in converting expertise/information from tacit knowledge to explicit and more easily transferable information cf. (Davis 1986; Davis 1989; Nonaka and Takeushi 1995; King 1999; Nonaka 2007) or by encoding the information differently, so it can be understood better by the target recipients. Investing in unsticking a unit of information is a one time investment, therefore, the incentive to do so is very much related to the expected number of transfer times, i.e. the more times a unit of information is expected to be transferred, the greater the incentive to invest in unsticking it (Hippel 1998).

In general and from an innovation and product development perspective, sticky information and the transferability of this information is often a neglected parameter. Overall, manufacturers and other development firms tend to focus on specialising in a particular solution type, which they are very familiar with, and apply this to a broad

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range of applications and solutions. Thereby, they overlook or in a worst case neglect to realise the real user needs and requirements, i.e. overlooking lead user or user information, which could lead to novel products and solutions. More awareness and a greater focus on sticky information transfer costs and general transferability opportunities, should underpin a shift towards a greater focus, usage, and involvement of the users and their needs and requirements in the innovation process, i.e. shifting the locus of innovation towards user information. Empowering the users by providing these with toolkits that reduce the cost of problem solving and innovation, i.e. lowering the level of sticky information between the users/lead users and manufacturing/producing entities, should provide better and more nuanced information regarding real user needs and requirements (Hippel 1998).

This section has described and analysed the concept of sticky information in relation to deriving and collecting user needs and requirement, within the user involvement in the innovation process framework. The above literature review has described some different approaches to sticky information, where the overall perspective in relation to sticky information is related to the transferability of a given unit of information, i.e. the easier to transfer a given unit of information the lower the stickiness and the higher the cost of transferring the higher the stickiness. Furthermore the stickiness of information can also be related to tacit and explicit knowledge and information and a variety of attributes of the knowledge and information holders and seekers and their capabilities of acquiring, absorbing, and distributing knowledge and information. All in all these different attributes of the term sticky information is very important to take into consideration when involving the user in the innovation process and trying to decode their needs and requirements in relation to future products, services, applications, and solutions.

3.7. Toolkits

This section will analyse and describe some different kinds of toolkits and their appropriateness in relation to developing new products and services and in relation to actively involving the users in the innovation process (Hippel 2001). The deployment of toolkits potentially minimises the sometimes very difficult and time consuming task of gathering often fairly complex user needs and requirements and transferring these into actual products. The use of toolkits can be explained as an innovation process in which the users themselves do part of the innovation, within a given solution space. Generally speaking and from an innovation perspective, user needs and requirements are continuously changing, thereby pressuring companies to develop successful products faster and faster and at the same time companies are increasingly trying to serve

'markets as one', i.e. creating customer unique value through mass customisation, where mass customisation is related to computerised process equipment and production systems that can deliver down to one of a kind products close to mass production costs (Gilmore and Pine-II 1997).

In this ever changing world, the use of different kinds of toolkits has the potential to allow companies to focus less on completely understanding user needs and requirements in order to develop successful products. By deploying appropriate toolkits, companies can instead focus on transferring user knowledge and information (sticky information) in relation to product and service development, thereby letting the actual users inform the company about specific user needs and requirements, i.e. shifting the task of collecting user needs and requirements from the company to the users themselves and thereby empowering the users to: come up with preliminary input for design and functionality specifications, provide more specific design suggestions, construct simple prototypes, and furthermore to test and re-evaluate until satisfied with the suggestion/solution, all within a given solution space, provided by the toolkit (Hippel 2001).

User toolkits are not an entirely new phenomenon; during the early 1980s LSI Logic introduced a design toolkit for its customers in the high-tech field of integrated circuit design and manufacturing. The reason for introducing the toolkit was that the costs of not understanding the customers needs exactly and entirely at the beginning of the process was very high, and at the same time, the design and manufacturing process was continuously becoming ever more complex and growing in size. Basically, LSI Logic developed a proprietary software application tool, which their customers could use to design and develop their own integrated circuits within. By transferring the design, development, and specification task to the customer, based on a predefined solution space, LSI Logic was able to manufacture the developed integrated circuits. All in all this dramatically cut the development time and costs (Walker and Tersini 1992).

Overall, the main benefits of deploying toolkits can be related to a faster and more exact transfer of user needs and requirements, which is obtained by shifting the design and development stage, or parts of it, from the manufacturers to the users themselves. The main advantages of transferring the need related work to the users are: 1) easier access to sticky information, i.e. allowing the users to design and develop novel products based on trial and error experimentation; and 2) potentially a faster, better, and cheaper learning by doing process, i.e. providing instant or simulated feedback on the suggested design and development concepts (Hippel 2001). In general, users have a great deal of sticky information in relation to their needs and requirements, and the

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context within which they have these needs and requirements can be difficult and fairly costly to transfer. In addition, the users might not know exactly what they want, and some iterations of trial and error are therefore necessary, before the final solution is reached – a learning by doing process (Rosenberg 1983; Hippel 1994; Hippel and Tyre 1995; Thomke, Hippel et al. 1998). Opposite the traditional approach to obtaining customer input, where data meticulously is collected from representative customers and then used internally to create new ideas for new products or solutions. In addition, there seems to also be a general trend within the traditional approach to integrate need related information into more entities, within the product development process (Lonsdale, Noel et al. 1997).

The use of toolkits in relation to the development and innovation of new products enables the transferability of need and requirement information to be shifted to the user domain, which potentially makes the process of developing new products both faster and better. This is mainly obtained for two reasons: 1) the sticky information regarding user needs and requirements and the context within which these needs or requirements are present is already 'located' at the user site and does not need to be transferred to a manufacturer/production site and to manufacturing/production personnel, thereby avoiding the costly transfer of this information; and 2) keeping/locating the innovation and development tasks at the user site also eliminates the back and forward process of problem solving and trial and error process between the idea and production entities, potentially reducing the development time considerably (Hippel 2001; Thomke and Hippel 2002).

This allows the users, based on an innovation toolkit with a well defined solution space; to identify, develop, and correct the self developed solutions based on a learning by doing and trial and error basis, all contributing to a faster and low cost development process (Thomke, Hippel et al. 1998). It is however, important to note that shifting the innovation and development process to the users, does not eliminate the company specific learning by doing process, it simply makes it faster and more accurate mainly based on the two reasons mentioned above. In relation to the user involvement in the innovation process, it is also important to be aware of who the real users are, as there might be several user groups with different user attributes, i.e. in relation to an everyday thing like electrical installations and components. One user group is the electricians who install the light switches etc., another is the users who use the lights switches etc. These two user groups have very different user experiences, needs, and requirements regarding a specific installation and the components used.

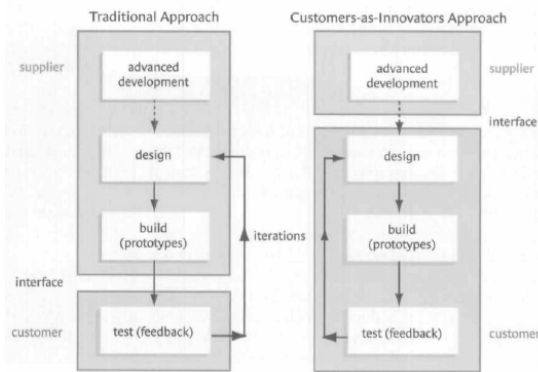


Figure 3-8 *User involvement in the innovation approach*¹⁴

When deploying different kinds of toolkits, it is of course very important that the users are well informed about the possibilities and limits of a given toolkit, but also, that the users are well instructed in using the toolkit in order to carry out the tasks at hand effectively and in a satisfying manner for everyone. Second, it is equally important, that the toolkit itself is designed and built to support the user in the innovation and development process and that the toolkit reflects a given manufacturer's/producer's solution space, i.e. the manufacturer's/producer's production and process capabilities and constraints. According to (Hippel 2001; Hippel and Katz 2002; Thomke and Hippel 2002) an effective toolkit for user innovation should contain and enable five important objectives: 1) learning by doing via trial and error. This is a crucial element of a toolkit, as it allows the user to go through several trial and error cycles and correct mistakes, i.e. the users can test their design or solution by conducting different kinds of simulations of a given solution, thereby testing it for errors, which then can be corrected; 2) appropriate solution spaces. The design or solution freedom within a given toolkit should be related to the limits of a given manufacturer's production system, processes, and general capabilities, i.e. designs and solutions that can be implemented based on minor or low cost adjustments to the production process. Solutions outside the given solution space, will require major or high cost adjustments and thereby most likely additional investments. However, this might sometimes be advantageous, if the solution or innovation has substantial potential; 3) user friendly and easy to use. The toolkits should be user friendly, which means enabling the users to deploy the skills they already have and work in their own 'language', thereby enabling the users to innovate, design, develop, and test in a well-known and familiar environment; 4) modularity. The modularity of a toolkit is related to providing the user with a list or

¹⁴ (p. 76)(Thomeke and Hippel 2002)

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library of well-known solutions, i.e. useful and standard components, which can be used as some of the building blocks as new innovations, designs, and solutions seldom are novel in all their parts; and 5) provide producible outputs. Finally the language of the toolkit should be directly and error-free transferable into the manufacturing/production system.

A very good example of a well designed toolkit is the Nestlé food service toolkit for developing new recipes. Before the toolkit was introduced, new recipes were developed based on traditional tools taught at culinary schools, but by executive chefs, and based on ingredients available to individuals and restaurants. Especially the ingredients and the equipment used to develop these new recipes are very different compared to large scale food process and manufacturing equipment and industrial ingredients. This resulted in a number of iterations between the chef and the manufacturing company before the industrial product was the same or almost the same as the original developed dish with regard to texture and taste. After introducing the Nestlé food service toolkit, which was based on industrial ingredients, which differ slightly from the normal used ingredients, the development time was reduced from 26 to 3 weeks mainly by eliminating the refinement interactions. The two most obvious advantages of using the Nestlé toolkit, were the direct transferability to industrial production and the possibility of making test batches of a recipe on industrial equipment (Hippel and Katz 2002).

Other examples of empirical research regarding the usages of toolkits have been conducted by for instance (Franke and Piller 2004), who in their study analysed the value created by using toolkits for user innovation within the watch market. Based on a relatively simple design focused toolkit, they conducted experiments with a total of 717 participants out of which 267 actually designed their own watches, based on a modular library containing 80 strap alternatives, 60 case alternatives, 150 face alternatives, 30 hour/minute hand alternatives and finally 30 second hand alternatives, all adding up to 648 million possible different watch designs. On average, they found that the willingness to pay was almost twice the amount for a self designed watch, compared to buying a standard watch. However, it is important to note that the deployed toolkit only allowed the users to 'assemble' their new watch based on a modular library, no true innovation was possible. Also Mattel has tried to offer customised products to the end users, i.e. My Design Barbie, but due to a larger than expected demand for this premium priced product and inadequate production flexibility and logistic capabilities the possibility of designing and ordering your own designed Barbie was terminated (Franke and Piller 2004). In addition Nike (NIKEiD) has and still is offering customers

the possibility to design mainly different kinds of sports shoes, but also some other related products can be designed based on a modular library.¹⁵

What mass customization is-and isn't

'Imagine a mass manufacturer that could customize products for each of its customers. Economically, that would require two things: first, learning how to design specialized products efficiently (the R&D problem), and, second, learning how to manufacture those goods cheaply and quickly (the production problem). The second problem has been addressed by the popular concept of mass customized production. In that approach, computerized process equipment or flexible assembly procedures can be adjusted quickly and inexpensively so companies can make single-unit quantities of one-of-a-kind products at a cost that is reasonably competitive with the manufacture of similar, mass-produced items. The classic example is Dell Computer: Consumers can buy a Dell computer by picking the major components they want (the size of the hard drive, the kind of monitor, the number and types of memory modules, and so on) from a menu on a Dell Web site. The company assembles and delivers the custom products in days. But Dell's mass-customization approach does not address the first problem: learning how to design novel custom goods efficiently. The company's customers have only a limited number of standard components and combinations to choose from, leaving them little room for creativity or real innovation. What if someone wants a computer that cannot be assembled from those standard components or what if that person is uncertain that a particular product will actually fulfil her needs? For instance, will the computer she's assembled be able to run the latest game software without crashing? Unless customers can test a computer design that they've assembled before placing the order, they can't perform the trial-and-error experiments needed to develop the product best suited to their needs. In other words, with mass customization, the cost of manufacturing unique products has dropped, but the cost of designing such items has not. The approach presented in this article - using toolkits that enable customers to become innovators - targets the first problem; its goal is to provide customers with enough creative freedom to design innovative custom products that will truly satisfy their needs.'

(p.18)(Thomke and Hippel 2002)

In an empirical study of customer involvement in the computer game development process, (Jeppesen 2003) found that some of the costs saved on information gathering

¹⁵ <http://nikeid.nike.com> (Retrieved June 2007)

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by using toolkits should be expected to re-emerge as additional consumer support costs and as a potential solution to the increased support costs (Jeppesen 2003) suggests the establishment of a consumer to consumer interaction forum. On the positive side (Franke and Hippel 2003) in their study on Apache security software and (Kamali and Loker 2002) in their study on user involvement in T-shirt design using a toolkit, both found that the users are significantly more satisfied and have a higher willingness to pay for these customised products. From a somewhat different but related perspective (Park, Jun et al. 2000) have examined the effect of deploying a subtractive versus additive option framing method on the user perception of a customisable product and found that subtractive option framing increases the willingness to pay, i.e. subtractive option framing presents the users with a fully loaded product and asks them to delete the options they do not need or want and the additive option framing methods present the user with a base model and ask them to add the options they want or need.

Some researchers have argued that the broad solution space offered by some toolkits, is of limited value for most users, based on the assumption that the cost of actively designing and developing new products and solutions via toolkits might exceed the benefit of getting a user specific solution or product for the single user (Agrawal, Kumaresh et al. 2001; Zipkin 2001). However it is important to note that this critique is more related to the fact that mass customisation might not always be the best solution or way to deliver individual products and variety for all goods. In addition, the critique is also more related to only a part of the toolkit deployment solution, i.e. the production problem and not the R&D problem cf. above textbox with a quotation from (Thomke and Hippel 2002). In other words, the main critique is related to the production and mass customisation problem, i.e. what are the costs of manufacturing flexibility, and are the customers always willing to pay this additional cost for an individualized product. Most likely not. Also it is important to make a clear distinction between mass customisation and mass production, as these are two very different approaches to production methods. Mass production facilities are fairly inflexible, but with low variable production costs, i.e. economy of scale production and thereby satisfying the general needs and preferences of a given market segment with standard products. Mass customisation facilities are highly flexible, mainly built on the concept of solutions spaces and furthermore there is no finished goods inventory, as everything is customised to the single user according to the user's requirements and specifications and shipped when finished (Wind and Rangaswamy 2001; Zipkin 2001). In addition, some researchers argue that the share number of possible solutions offered by modular library based toolkits simply overwhelms the users and confuse them in their design and development process (Zipkin 2001; Kamali and Loker 2002). In other words, the complexity of a wide assortment of options potentially confuses the users in their

selection process (Huffman and Kahn 1998; Stump, Athaide et al. 2002) or what (Kimble, Grimshaw et al. 1998) describe as information overload.

In their review paper on toolkits (Franke and Piller 2003) identified four key issues in relation to the usages of toolkits and user interaction with these toolkits, where toolkits are defined as systems that are responsible for guiding the user through a configuration process aka configurators, choice boards, design systems, or co-design platforms. Based on interviews and a literature review (Franke and Piller 2003) have identified four key issues in relation to mass customisation, which all together are fairly closely linked to the usages of toolkits and user involvement in the innovation process: 1) process pattern of user interaction, i.e. the user interaction with these toolkits; 2) reception of complexity, i.e. does mass confusion exist due to a overwhelming number of choices; 3) user, satisfaction, i.e. what satisfies the users with these toolkits and what drives this satisfaction (creativity, innovativeness, individuality etc.); and 4) the value of individualisation, i.e. from a user perspective the expected return should exceed the expected costs. Overall, toolkits do not have to be based on software, however most known systems are to some extent based on information technologies. Even though there is a great variation among toolkits, i.e. how they function, from very simple toolkits where the user only can chose from a limited number of options to the very sophisticated toolkits allowing the users to actually create something new, i.e. for example within open source software, there seems to be three main components within most toolkits: 1) the core configuration tool, which presents the possible variations and guides the user through the process; 2) a feedback tool, which presents the selected configuration, tests the configuration etc. and serves as the trial and error process tool; and 3) the analysing tool, which translates the chosen configuration into manufacturable parts (Bourke 2000; Franke and Piller 2003; Tseng and Piller 2003).

This section has described and analysed the concept and deployment of toolkits in relation deriving and collecting user needs and requirements regarding the user involvement in the innovation process. The above literature review has shown a general support for the toolkit approach, and several of the described contributions have through empirical material proven the validity and usefulness of the toolkit approach. In general terms the deployment of toolkits has the potential to allow companies to focus less on completely understanding user needs and requirements in order to develop successful products, by deploying appropriate toolkits. Deployment of appropriate toolkits will allow companies to easier transform user knowledge and information (sticky information) into product and service development, by actually letting the user inform the company about specific user needs and requirements.

3.8. Other perspectives on user involvement

This section will very briefly mention some related perspectives and aspects in relation to the user involvement in the innovation process, as the mentioned perspectives are referred to within the thesis. From related but different perspectives participatory design and human-computer interaction are also linked to the concept of user involvement in the innovation process, however, mainly in relation to the communication and interaction between the users and designers, i.e. different kinds of tools have been deployed in order to retrieve and gather user needs and requirements. Especially in Scandinavia, the user involvement in system development has a long tradition, where participatory methods have been centred on democracy issues, and developed in collaboration with trade unions (Ehn 1988; Ehn and Kyng 1991; Bodker, Ehn et al. 2000).

In general, participatory design can be described as a move of end users into the environment of research and development and in relation to the users the participatory design concept emphasises the involvement of a broad user population, compared to a limited sample number. This is a somewhat different approach compared to the lead user approach, which focuses on the very front runners within a specific segment or market. The concept of participatory design is linked to user participation, however, mainly in relation to the design and development of different information and communication technology systems. Aiming at establishing a meaningful and fruitful cooperation between designers and users, by deploying a range of techniques for developing a better understanding of the user's current task at hand and the context in which they are situated, resulting in preliminary design inputs (Kyng 1995; Kensing, Boedker et al. 1998; Kensing 2003). In addition, (Kensing and Munk-Madsen 1993) in their review paper suggest a conceptual framework for the understanding and creation of successful communication between users and designers, as well as tools and techniques for facilitating this communication in relation to six predefined areas of knowledge (Kensing 2003). In relation to participatory design, and in general, it is most likely not possible to have all affected users participating in a given project, nor is it necessary. Consequently, it is very important to allocate full attention to the selection process, i.e. who selects the participants and who participates to obtain a valid sample. However, (Kyng 1994) repudiates the difficulty of finding appropriate users, instead he argues that the problems are related to: 1) the willingness and competence in the development organisation to actually cooperate with end users; and 2) resources to finance the cooperation' (p. 7)(Kyng 1994) which is in line with arguments and experience from (Kensing 2003).

In relation to the human-computer interaction research approach, and the general difficulties of accessing, making available and collecting data about mobile technology use, a number of approaches have been deployed over time. One of the well known and widely applied approaches is the use of cultural probes introduced by (Gaver, Dunne et al. 1999; Gaver and Dunne 1999), which has been extended and modified in many ways ranging from a very creative driven approach to a more technological driven approach (Gaver, Boucher et al. 2004; Boehner, Vertesi et al. 2007). Initially, the concept of probes was developed by (Gaver, Dunne et al. 1999; Gaver and Dunne 1999) as a tool which explored new or better ways of integrating older participants into the everyday life of their communities. In this setting they developed what they called 'cultural probes', mainly because they were unable to immerse themselves in these communities for longer periods of time, i.e. they developed a design oriented toolbox, which provided an additional form of engagement with the participants. Basically, the cultural probes as designed by (Gaver, Dunne et al. 1999; Gaver and Dunne 1999) can be described as designed objects, i.e. physical packets containing open-ended, provocative and oblique tasks to support early participant engagement with the design process, especially in relation to information about the users' lives and thoughts which could lead to inspiring ideas for design solutions that would enrich people's lives. Or as the designers described it '...these packages of maps, postcards, and other materials were designed to provoke inspirational responses from elderly people in diverse communities. Like astronomic or surgical probes, we left them behind where we had gone and waited for them to return fragmentary data over time.' (p. 22)(Gaver, Dunne et al. 1999). Even though, the probe approach has proven adaptable and deployed in other research settings in support of design related agendas cf. (Iacucci, Kuutti et al. 2000; Iversen and Nielsen 2003; Hulkko, Mattelmäki et al. 2004; Kjeldskov, Gibbs et al. 2004; Taylor and Swan 2005; Sellen, Harper et al. 2006) the nature of the probes approach remain strangely elusive (Boehner, Vertesi et al. 2007). Also (Gaver, Boucher et al. 2004) have expressed concern about the ways the concept or method of probes have been adopted. Others have criticised it for being a poor substitute for ethnographic or other methods for obtaining qualitative data (Dourish 2006).

3.9. Summary

Initially this chapter presented a short description of different innovation perspectives, mainly in relation to economic, technological, organisational, and creativity perspectives. In relation to the overall theoretical user involvement in the innovation process framework applied, an historic account on the changing innovation models during the post world war II period has been described and analysed. Highlighting the proliferation of new approaches to the innovation models and in particular in relation to

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user involvement in the innovation process and how incorporating the users or customers into the innovation process has changed over the last fifty years. Within this context different innovation models have been described and analysed, however the reality is often more complex than any model can represent and it is therefore very difficult to talk about technology push, market pull, or parallel, and integrated models of innovation. It seems that all models of innovation exist in a wide range of forms and contexts. As a consequence, the innovation process in most cases can be viewed as a combination of models reflecting the diversity and complexity of the: innovation process; the industry or sector in question, the products produced, or services offered; and the people and organisations involved in the innovation process.

Based on a substantial literature review containing empirical examples, analyses, and discussions in relation to the lead user concept there seems to be a general support for the concept both in fast and less fast moving industries, however, there are also some challenges that need to be resolved. In general the material analyses found a fairly clear support for the lead user theory, and the two main assumptions behind it, i.e. being ahead of time and obtaining significant benefits from a potential solution. However, the predictability of the innovation success can be questioned in very dynamic and fast moving industries, especially where network effects are present. This could potentially alter the lead user trajectories and thereby deviate the lead user path put forward, before reaching the average user. This highlights the problem of differences between very technology savvy lead users and early adopters compared to the less technology aware average user. Therefore, it is very important, that the deployment of the lead user concept is combined with general market knowledge and other approaches to innovation and new product development.

In connection with the lead user approach, the concept of sticky information has been analysed and described in relation to deriving and collecting user needs and requirement within the user involvement in the innovation process framework. Some different approaches to sticky information have been described and analysed, where the overall perspective is related to the transferability of a given unit of information, i.e. the easier to transfer the lower the stickiness and the higher the cost of transferring a given unit of information the higher the stickiness. Furthermore the stickiness of information can also be related to tacit and explicit knowledge and information combined with a variety of attributes of the knowledge and information holders and seekers and their capabilities of acquiring, absorbing, and distributing knowledge and information, which all are important considerations when involving the users in the innovation process and trying to decode their needs and requirements in relation to future products, services, applications, and solutions.

Finally the concept of toolkits was described and analysed in relation to deriving and collecting user needs and requirements based on the overall user involvement in the innovation process framework. Based on a literature review a general support for the toolkit approach was found, and several of the analysed contributions have through empirical material proven the validity and usefulness of the toolkit approach. In general terms the deployment of toolkits has the potential to allow companies to focus less on completely understanding user needs and requirements in order to develop successful products, by deploying appropriate toolkit, as the deployment of appropriate toolkits will allow companies to transform user knowledge and information (sticky information) into product and service development, by actually letting the user inform the company about specific user needs and requirements based on predefined solutions spaces.

4. Mobile system requirements and mobility

In the past decade mobile system requirements have been researched extensively from an engineering system development and organisational point of view. Within the information and communication technology domain the number of wireless devices, services, and applications has increased dramatically over the last decade, albeit most of these were developed and designed based on what was technologically possible without much attention being paid to specific user needs. However, during the last couple of years the user perspective has emerged, which as the name implies focuses on the user perspective and user involvement. This means actively involving users, drawing social aspects into the development process and creating a high level of user acceptance and usefulness in practice. Based on research concerning nomadicity, mobile system requirements, and mobility during the last decade, the present section contains a description of the important developments in this area and provides an overview of important research carried out within the field.

The overall viewpoint on mobile system requirements within this thesis is mainly related to user needs, requirements, and more specifically to design studies and human-computer interaction perspectives. In relation to the user involvement in the innovation process theoretical framework applied within this thesis, the focus of the mobile system requirement perspective is mainly related to the historic and current development of this field of research and thereby how mobile systems, services, and applications have been developed in the past combined with the research approach and methodology used. This means that the traditional research approach and methodology deployed within the mobile system requirement can be compared to the user involvement in the innovation process approach and methodology, where the latter is expected to provide a more elaborated understanding of user needs and requirements and translate these into service and application concepts, which support the user needs, requirements, and the context within which the users are present (Orlikowski 2000).

Also the mobility concept has gained increased attention during the last decade, as both organisations and people in general are continuously becoming more mobile, resulting in an increased demand for nomadic and mobile communication and interaction

possibilities (Dahlbom and Ljungberg 1998; Kristoffersen and Ljungberg 1999a; Dahlbom 2000; Barnes 2003; Saugstrup and Henten 2003a; Bardram and Bossen 2005; Wiberg 2005). The increased mobility calls for additional demands and requirements on mobile services and applications in order to provide ubiquitous connectivity and interaction, and in particular in relation to organisations and their ability to provide services and applications that actually support their users in their work processes and tasks, i.e. mobile productivity related services and applications.

Mobility is often conceptualized as geographic mobility, i.e. the spatial movement of persons or things. However, this very simple definition of mobility is believed to be too narrow, the definition should also concern temporal, context, and social based aspects (Bellotti and Bly 1996; Luff and Heath 1998; Kakiyara and Sørensen 2002; Sherry and Salvador 2002; Sørensen, Mathiassen et al. 2002; Barnes 2003; Saugstrup and Henten 2003b; Kakiyara and Sørensen 2004; Krogstie, Lyytinen et al. 2004). Based on a thorough literature review on mobility and mobile informatics a conceptual mobility framework is presented, containing spatial, temporal, contextual and social mobility perspectives, which are important aspects to take into consideration when developing new service and application concepts, especially the context and social related aspects as these can vary significantly. In relation to the theoretical framework applied within this thesis and from a mobility perspective both organisations and people in general are continuously becoming more mobile, in relation to both their physical movement and in relation to their information and communication needs, requirements, and contexts. This trend calls for additional user needs and requirements in relation to future services and applications and in order to fulfil these expectations it is important to incorporate the mobility and context related aspects into the design and developing process in relation to future services and applications in order to provide the users with better and more supportive services and applications.

4.1. User needs, requirements, and design studies

Today the combination of mobile computing and communication is rapidly changing the way we think about information processing and communication in general, and it is taken for granted that access to computing and communication is necessary from all locations, e.g. office, home, but also while in transit and when arriving at unfamiliar destinations. The basis for some of these ideas and concepts has been discussed in (Kleinrock 1996a; Kleinrock 1996b; Kleinrock 1997; Kleinrock 2000; Pierre 2001) and describes and outlines the essence of nomadicity (nomadic computing and communications). Generally speaking, nomadicity is defined as the system support needed to provide a rich set of computing and communication capabilities and services

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to nomads in a transparent, integrated, and convenient form as they move from place to place. From an engineering perspective, this approach and concept is more or less based on making computers and computer communication systems mobile. According to (Kleinrock 1996a; Kleinrock 1996b; Kleinrock 1997; Kleinrock 2000) nomadic computing and communication described from a system perspective should support capabilities that enable independence of: location, motion, computing platform, communication device, and communication bandwidth, which means that specific mobile computing environments should automatically adjust to the processing power, communication, and bandwidth available at any given time.

In a 2005 article (Hosbond and Nielsen 2005) reviewed 105 articles concerning mobile system development published or indexed by well known and large publishing houses (ACM, IEEE, Emerald, Kluwer, Elsevier, etc.) together with selected conference proceedings all from year 2000 to 2005, with a special focus on system development regarding mobile applications based on the concepts outlined by (Webster and Watson 2002). The article reviewed a broad spectrum of literature on mobile system development, and was addressing mobile system development and mobile applications, for both the consumer market and organisational purposes, in order to sort out what characterises the field and to draw out (categorise) the different perspectives on mobile systems developments. Based on their review, Hosbond and Nielsen found four primary research perspectives, which together covered eight secondary research perspectives or areas of research, focusing on the specific contribution of each paper (Hosbond and Nielsen 2005). See Table 4-1. The numbers in square brackets indicate the number of papers reviewed in each area.

<i>Primary perspectives</i>	<i>Areas of research</i>
Requirements	Modelling techniques [4] Design studies [26]
Technology	Wireless communication [18] Architecture [17] Security [18]
Application	Application [6]
Business	Adoption and diffusion [7] Business models [9]

Table 4-1 *Research perspectives on mobile system development*¹⁶

¹⁶ Adopted from (Hosbond and Nielsen 2005)

Hosbond and Nielsen argue that all the areas of research categorised, both the primary and secondary perspectives, have important roles to play and in some way influence the field of mobile systems development (Hosbond and Nielsen 2005). However, in relation to the context of this thesis, it is evident that the primary perspective on requirements is the most interesting and especially the secondary perspective concerning design studies, not to suggest that the other areas are not equally important. Also, according to Hosbond and Nielsen's review it is the secondary perspective, design studies, which during the five year period in question has obtained the most attention and is the area within which the most contributions have been made.

However, looking at the overall picture (Hosbond and Nielsen 2005) show that the technology perspective represents roughly 50 per cent of the reviewed papers, which indicates that the mobility debate so far has been very technology driven. Furthermore, they suggest that the reason for this uneven distribution could be related to continuous development and innovation within mobile technologies, which furthermore reflects somewhat immature technologies and a derived demand for more robust and flexible mobile technologies, services, and applications. Furthermore, (Hosbond and Nielsen 2005) argue that the technology perspective has immediate or correlated implications for the requirements perspective and 'it is striking that very little research has been directed at establishing requirements that do not merely reflect the mobile technologies, but also the organisational and social context of mobility.' (p. 13)(Hosbond and Nielsen 2005). The increased dynamics of user needs are also providing new challenges for the design of mobile technologies, services, and applications, i.e. addressing the coordination of multiple devices and services situated in different social contexts (Messeter, Brandt et al. 2004).

In a review of mobile human-computer interaction methods (Kjeldskov and Graham 2003) found a bias towards using applied approaches and evaluating them, if at all, only in laboratory settings. The overall goal of their work was to review the methods applied within the mobile human-computer interaction field of research, thereby providing an overview of the practice for studying this area, to point out shortcomings and propose future directions and approaches, in order to overcome the shortcomings. All together they reviewed 102 publications, published in top level journals and conference proceedings within the field of mobile HCI from 2000 to 2003. Based on (Benbasat 1985; Wynekoop and Conger 1990), (Kjeldskov and Graham 2003) developed a two dimensional matrix framework relating research methods and research purposes together and thereby providing a picture of the current research practice and a tool for comparing the research methods applied within mobile human-computer

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interaction research area. See Table 4-2. The figures indicate the number of papers in each category. However, as some of the papers employed more than one research method and had multiple purposes, these will be represented more than once in the table, giving 132 contributions overall.

		<i>Research purpose</i>				
		Understand	Engineer	Re-engineer	Evaluate	Describe
<i>Research methods</i>	Case studies	3	2	1	-	-
	Field studies	4	5	-	8	3
	Action research	-	-	-	-	-
	Lab experiment	1	-	-	30	1
	Survey research	4	-	-	4	-
	Applied research	1	45	9	-	1
	Basic research	3	-	-	-	-
	Normative writings	2	-	-	-	5

Table 4-2 *Research methods and purpose*¹⁷

From the research method perspective the bulk of the papers reviewed fall within the category of applied research (56 contributions), lab experiments account for 32 contributions, and field studies account for 20 contributions whereas the remaining categories: case studies, action research, survey research, basic research, and normative writings account for only 24 contributions altogether. Looking at the lab experiment method, 30 out of 32 contributions within this field are related to evaluation. According to (Kjeldskov and Graham 2003) the distribution of papers shows an apparent bias towards environment independent and artificial settings, e.g. lab experiments and applied research methods, at the expense of case studies, action research, surveys, basic research, and normative writings, which mainly focus on real use and theory generation. In addition, one could argue that the gap between the most used and less used research methods are fairly large, as four out of the eight research methods categorised have eight or less contributions out of the 132 overall. This implies

¹⁷ Based on (Kjeldskov and Graham 2003)

a need for a more diversified employment of methods, if possible, to incorporate more focus on real use context and to broaden the scope of methods and thereby the understanding of this particular field of research. One reason, that lab experiments and applied methods of research are overrepresented, could be related to the easiness of conducting these compared to the other research methods, which are more time consuming.

Turning to the research purpose, the picture is somewhat similar, however the distinction between the five areas is not as clear as with the research methods. Here 62 contributions are engineering related (52 engineering and 10 re-engineering), meaning that 62 contributions can be related to building or rebuilding of systems. 42 contributions are related to evaluation, of which the majority is done in lab settings. 18 contributions are related to understanding, i.e. focusing on finding the meaning or expanding the knowledge of a given phenomena. Finally, 10 contributions are related to describing different aspects of human-computer interaction, e.g. defining properties of products. Overall, this portray a focus on building systems (engineering and re-engineering) and evaluating these, mainly within lab settings, whereas the learning from real use is limited. Furthermore this indicates a trial and error approach, which limits the generation of knowledge and the development of a knowledge body within this area compared to actual user studies. One of the reasons for this, could according to (Kjeldskov and Graham 2003) be related to the fact that mobile HCI is a relatively young research field, which often is recognised as being highly opportunity and technology driven and very solution oriented while less attention is devoted to methodology and reflection.

Based on their findings, both regarding method and purpose, (Kjeldskov and Graham 2003) suggest to change or at least to broaden the research focus within this area in order to achieve a better understanding of the pros and cons of the different research methods in relation to their purpose. They suggest focusing more on some of the less used methods to get a broader perspective and thereby a better understanding of the methods' usefulness. Reflecting on the results (Kjeldskov and Graham 2003) provide some general characteristics of the field of research. First of all, it seems that most 'people' already know what to build or develop and the constrains of these 'projects', as the end-user perspective (requirements) are rarely taken into consideration. Furthermore the evaluation process is more function than context related, and the trial and error approach seems to be the way forward as the limited attention to real life situations and context awareness is not considered as important.

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One could argue that both the eight research methods and the five research purposes are too vague or overlapping or that the selected papers are not representative, which (Kjeldskov and Graham 2003) also mention themselves. That aside, the results also indicate future opportunities. The use of field studies presents the possibility of using this approach to further explore the context, user needs, and requirements, which could provide part of the missing link between context and user needs and requirements in relation to the design of new systems, services, and applications. Furthermore an extended use of case studies and field studies would provide real usage cases, and thereby a more elaborated understanding of the users and their needs and requirements. In addition, surveys, which are almost non existent, have the potential to provide a large knowledge base of user needs, requirements, and user preferences within specific areas and contexts.

From a somewhat different perspective (Krogstie, Lyytinen et al. 2004) explore the challenges of developing mobile information systems at the conceptual and logical levels, with a special focus on mobile knowledge workers and a user oriented perspective. The conceptual level is related to an abstract class of entities and interactions and the relationship between these and the logical level is related to the structuring of the entities, interactions, and relationships. According to (Krogstie, Lyytinen et al. 2004) one of the main challenges on the conceptual level is related to user orientation and personalisation. Therefore, mobile systems should be configured to support the users' work processes, which in many situations include interaction with other persons, i.e. that social mobility (teamwork, interaction, and the sharing of knowledge resources) should be taken into consideration when developing future services and applications both in relation to content and context. In addition, it is important to take the limitations of mobile devices regarding memory capacity, display size, and available power to mention a few into consideration especially regarding possible teamwork, interaction, collaboration, and knowledge sharing solutions (Papadopoulos 2006). At the logical level, especially the separation of content and medium is very important in relation to delivering a maximum level of user personalisation, as the systems should automatically adapt to the preferences of the user, i.e. it is important to take into account the characteristics and limitations of the different mobile devices in order to provide a high level of personalisation.

Based on a somewhat different perspective (Wiredu 2007) has studied the appropriation of mobile technologies as a function of motives, conditions of use, and technology design properties and argues that the flexibility of mobile computing is dependent on the appropriation in both organisational and personal domains of use. Others and more generic perspectives on technology use contain different aspects of perceived

usefulness, and ease of use cf. (Davis 1989; Adams, Nelson et al. 1992; Boudreau, Gefen et al. 2001; Boudreau and Robey 2005).

Based on the above reviewed research, there seems to be a need for more user oriented research approach in relation to mobile system requirements, as little research is actually done in order to establish real user needs and requirements that do not only reflect mobile technologies but also the social context of mobility (Hosbond 2005; Hosbond and Nielsen 2005). Furthermore there seems to be a clear bias towards environment independent and artificial settings within the mobile system requirement area. Lab experiments and applied research methods are by far the most used approaches, compared to for instance case studies, action research, and surveys (Kjeldskov and Graham 2003; Kjeldskov, Skov et al. 2004). This bias suggests more focus on case studies and alike, trying to get a better understanding of the field in question, and thereby also a more user oriented approach to future research. In addition, an extended use of field studies and case studies would arguably provide a better understanding of context issues and user needs and requirements, bridging the gap between context and user needs and requirements and the actual design process. It is important that both researchers and practitioners obtain a 'better understanding of how and why people are likely to use technologies and with what (intended and unintended) consequences in different conditions.' (p 423)(Orlikowski 2000). Overall, there seems to be a need to acquire a better understanding of user needs and requirements and afterwards translate these into future service and application concepts, which supports the context and social environment within which the users roam.

4.2. Mobility

This section presents an overview of recent Scandinavian research concerning mobility, and based on that, presents a mobility framework regarding implications of mobility in relation to deriving user needs and requirements in a context related perspective. The reason for focusing primarily on Scandinavian contributions within this area is based on the fact that for a long time there has been a Scandinavian tradition for user-centric studies concerning information technologies on the basis of which mobility research has been able to build cf. (Bansler 1987). However, not all Scandinavian contributions within this area can be covered. Therefore the focus will concentrate on the ones that most explicitly deal with mobility and its relations to the development and use of information and communication technologies. The computer supported cooperative work types of (almost) ethnographic studies of work processes and practices clearly fall under this heading, as do the so-called informatics, and more specific mobile

informatics studies. On the other hand, studies on the adoption of information and communication technologies taking into consideration all the circumstances determining the diffusion of technologies are not included, although this type of research has reached a high level of development cf. (Pedersen and Methlie 2002; Pedersen, Nysveen et al. 2002; Pedersen and Ling 2003). This is not to pretend that the mobility approach and research is specifically Scandinavian, as there have been contributions from other parts of the world cf. (Kleinrock 1996a; Kleinrock 1996b; Kleinrock 1997; Kleinrock 2000; Perry, O'hara et al. 2001; Pierre 2001; Boudourides and Harper 2002; Lyytinen and Yoo 2002; Krogstie, Lyytinen et al. 2004).

The concept and implications of mobility has gained much attention during the last decade, from a number of different perspectives and research areas all contributing to a better and more integrated understanding of the mobility concept. In some circumstances, the word mobility refers to mobile or wireless technologies, at least in communities interested in communication technologies. However, in this context and as in the research presented, mobility refers to the spatial, temporal, and context related mobility, in which people or things are situated, and not to the technologies used. The perspective is therefore related to mobility needs and requirements and how these should be reflected in future services and applications. It could, indeed, also be the other way round, as it is obvious that wireless technologies to a certain degree facilitate and shape the mobility of people and things. However, the perspective in this context emphasizes the user need and requirement perspective and not the push perspective of the relationships between technology and social contexts and behaviour.

4.2.1. The mobility concept

Mobile informatics was introduced and defined by foremost (Dahlbom 1996; Dahlbom and Ljungberg 1998; Kristoffersen and Ljungberg 1998; Kristoffersen and Ljungberg 1999b; Dahlbom 2000) describing and defining the usages of information technologies and the implications for technology design and development, describing a shift from early computer technology and informatics research mainly based on fixed technology and stationary work, to focusing on the use of mobile technology and design for mobile work, i.e. mobile informatics (at the time also referred to as 'mobile IT use' or 'mobile computing') (Dahlbom and Ljungberg 1998). The mobile part of mobile informatics is related to an increased mobility, which can mainly be attributed to the following topics: an increased amount of co-operative work and team-based organisations compared to earlier days' very functional and bureaucracy divided work environments, leading to a more communication intensive environment and at the same time increased mobility, as people travel to meet physically. Second, the emergence of service work in the

western society, compared to traditional manufacturing work, is also believed to have contributed to an increased level of mobility as service work takes place where the customer is located (which differ from customer to customer), whereas manufacturing work takes place where the factory/machinery is located. Third, the adoption of mobile devices has enabled people to be accessible and reachable independent of place, compared to traditional communication devices, e.g. fixed phones (Dahlbom and Ljungberg 1998).

Originally, mobility was most often conceptualized as geographic mobility, i.e. the spatial movement of persons or things. However, during the last decade the mobility concept has been broadening its scope to also include; temporal, context, and organizational elements (Luff and Heath 1998; Kristoffersen and Ljungberg 1999b; Kristoffersen and Ljungberg 1999a; Kakihara and Sørensen 2002; Saugstrup and Henten 2003a; Saugstrup and Henten 2003b; Bardram and Bossen 2005; Wiberg 2005) as many researchers found the original spatial definition of mobility to narrow. The Scandinavian research on spatial mobility was, primarily, centred in Sweden at the Victoria Institute in Gothenburg and Umeå University where some of the more outstanding contributions originated from. See for instance (Kristoffersen and Ljungberg 1999a; Kristoffersen and Ljungberg 1999b; Wiberg 1999; Wiberg and Grönlund 2000; Wiberg and Ljungberg 2000; Wiberg 2005). The headings of these contributions are very indicative, e.g. 'Exploring the vision of "anytime, anywhere" in the context of mobile work' (Wiberg and Ljungberg 2000) and 'Extending the modality of travelling – designing travelling support for mobile IT users' (Wiberg 1999). These studies are to a large extent empirical explorations of user behaviour in different circumstances, for instance employees at Telia (Wiberg and Grönlund 2000), but they are firmly based on a research tradition focusing on user needs and behaviour.

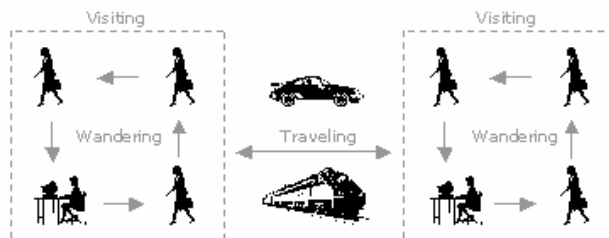


Figure 4-1 Spatially based mobility framework¹⁸

¹⁸ Based on (Kristoffersen and Ljungberg 1998, 1999a, 1999b)

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In the late nineties (Kristoffersen and Ljungberg 1998; Kristoffersen and Ljungberg 1999b; Kristoffersen and Ljungberg 1999a) presented a spatially based mobility framework, which has been referred to in a number of subsequent publications. In these papers, they focused on three different modalities of mobile work: travelling, visiting, and wandering. Travelling is the movement over a longer distance of a person, for instance when driving a car. Visiting is the situation in which a person is present for a while away from the home base, for instance when a consultant works for a period at the locality of a client. Wandering is the activity of a person moving around over shorter distances, for instance when working in different offices or departments in an office building. Figure 4-1 shows the spatially based mobility framework developed by (Kristoffersen and Ljungberg 1998; Kristoffersen and Ljungberg 1999b; Kristoffersen and Ljungberg 1999a).

In general, the early research on mobility was very much focused or grounded on work-based ideas and settings. Looking at Kristoffersen and Ljungbergs work this is clearly the case regarding the visiting and wandering modalities which are clearly related to office work – home office, client office, etc. - but offices, which people are moving around within. The same goes for the travelling modality, which is related to the transportation between offices. Recognising the importance of the modalities suggested by (Kristoffersen and Ljungberg 1998; Kristoffersen and Ljungberg 1999b; Kristoffersen and Ljungberg 1999a), however, this categorisation leaves out an entire category of situations, namely the situations where the physical movement is an integral part of the work itself, as the travelling modality is seen as the moving between places of work. Furthermore, one could argue that the suggested modalities are only related to work based situations and not leisure activities. From one perspective the work and leisure activities seem to be melting together, as more and more people are using the same devices for both leisure and work situations.

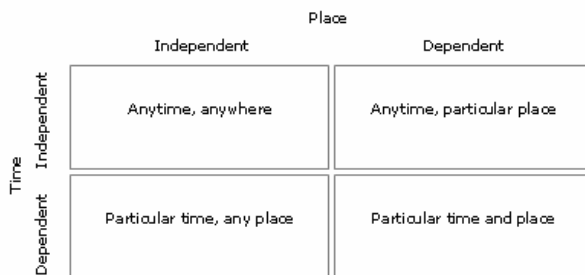


Figure 4-2 *Time and place dependency framework*¹⁹

¹⁹ Adopted from (Wiberg and Ljungberg 2000)

In order to explore the vision of “any time, any place” within the context of mobility (Wiberg 1999; Wiberg and Ljungberg 2000; Wiberg 2005) based on (Ellis, Gibbs et al. 1991) developed a conceptual framework that allowed them to analyse the relation between a particular task and the dimensions of time and space. The framework was developed in relation to a study of service engineers, travelling around maintaining and repairing equipment, and thereby placing the main focus on the work task at hand. The framework is shown in Figure 4-2 (Wiberg 1999; Wiberg and Ljungberg 2000; Wiberg 2005).

The anytime, anywhere quadrant represents the vision of the future, where it is possible to work anytime from anywhere. This means that work (tasks) can be independent of time and place, providing full flexibility. The anytime, particular place quadrant constrains the place dependency, meaning that the tasks can be executed at any particular time, but only at (or from) a specific location. The particular time, any place quadrant implies that tasks have to be done in a certain order or at specific times, but there are no limitations regarding the place of execution. In the particular time and place quadrant tasks need to be completed at certain places and at a particular time or time period.

Comparing or merging the three aspects of mobility described earlier, i.e. travelling, wandering and visiting, with the place and time dependent/independent framework described above, provides a combined perspective. The wandering and visiting profile applies to the place dependent quadrants, whereas the travelling profile applies to the place independent quadrants, since the travelling dimension is applied between two locations. Regarding the independence or dependence of time there is no clear distinction, due to the fact that all three types of mobility can be both time dependent and independent based on the actual case.

The early spatial conception of mobility, while recognised as useful, has been criticised for being too narrowly defined. In addition to the geographic aspects of mobility, some researchers believe that time and context should be added as important aspects of mobility, and suggest expanding the mobility concept by looking at three interrelated dimensions of human interaction; spatial, temporal, and contextual mobility. They propose a concept of ‘fluid interaction’ to encompass the different kinds of mobility (Kakihara and Sørensen 2002; Kakihara, Sørensen et al. 2002; Sørensen, Mathiassen et al. 2002). With respect to spatial mobility, the idea is that this cannot be confined to the movement of people; the mobility of objects and symbols should also be included. Regarding the temporal aspects of mobility, the point of view is that there is a complex social environment where monochronicity and polychronicity of interaction between

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humans are intertwined and renegotiated with each other. Concerning contextual mobility, the suggestion is that people are interacting in many different contexts, creating fluid kinds of situatedness in their relations (Kakihara and Sørensen 2002; Kakihara, Sørensen et al. 2002; Sørensen, Mathiassen et al. 2002).

These additions to the purely spatial aspects of mobility are indeed helpful for understanding the complex nature of human interactions and the user needs and requirements that may arise. Nevertheless, the concept of mobility itself still creates some confusion. It is difficult to understand how time and contexts can be mobile. They can be fluid or there can be a flexibility of time and contexts. But mobile? However, this is primarily a terminology issue, but may also be related to the definition of the term mobility. In the conceptual paper 'Mobility: An extended perspective', by (Kakihara and Sørensen 2002) it is stated that 'when considering the mobility, or more specifically societal mobilization, of human interaction, we need to deal with contextuality as well as spatiality and temporality, and, more specifically, mobilised situatedness of interaction in particular contexts and relations of social lives'. The term mobility is thus used more in the sense of mobilisation than being mobile. Technology allows for the mobilisation of human beings with respect to space, time and context. That's for certain! In that sense, the word mobility is quite understandable. Furthermore, it is obvious that not only spatial movements but also temporal and contextual aspects have an influence on the relevance of different kinds of user needs and requirements (Saugstrup and Henten 2003a; Saugstrup and Henten 2003b).

<i>Contextual dimensions</i>	
Spatiotemporal context	Time and space
Environment context	Surroundings, entities in the surroundings
Personal context	User state
Task context	What is the user doing
Social context	The social aspects of the user context
Information context	Information space

Table 4-3 *Contextual dimensions*²⁰

In a later paper and along the lines of the above (Kakihara and Sørensen 2004) proposed a three dimensional model of mobility where the essential aspects of mobility

²⁰ Based on (Krogstie, Lytinen et al. 2004)

in relation to a study of more than sixty professionals were analysed: locational, operational, and interactional mobility. The locational mobility is concerned with the workers' geographical movement, and the operational mobility is related to the flexibility of the work. This suggests, that these two dimensions are very much related to the time and place model described earlier. The interactional mobility is related to the interaction with other people. Also (Krogstie, Lyytinen et al. 2004) based on (Krogstie, Brandzæg et al. 2002) argue that besides spatial and temporal also contextual mobility is important, and have furthermore categorised/defined six different types of contextual mobility (Krogstie, Lyytinen et al. 2004). See Table 4-3.

From a somewhat different perspective (Luff and Heath 1998) have made another mobility distinction, where they based on a computer supported cooperative work (CSCW) perspective have made a distinction between three levels of mobility: micro mobility, local mobility, and remote mobility. Based on their CSCW and collaboration perspective, they define micro mobility as the way in which an artefact can be mobilised and manipulated for various purposes around a relatively circumscribed domain, i.e. mobility of specific objects and people within a small area like an office or alike. The local mobility concept is described as mobility within a certain space, such as a building, i.e. walking between offices or floors. The remote mobility concept is related to geographically separated people that interact through the use of technology, i.e. people who move around at a fairly large domain, and who need access to remote information and colleagues (Luff and Heath 1998). In relation to the above distinctions of mobility (Luff and Heath 1998) furthermore emphasise the importance of 'examining the activities in which people engage, with others, when they are 'mobile', and how various tools and artefacts, feature in those activities.' (p. 309)(Luff and Heath 1998).

Also (Bellotti and Bly 1996) have described the concept of local mobility, based on studies of product designers. They found that the people (and their work / routines) were very mobile as they continuously moved around the building to talk to other people and to use some shared resources. While the high level of local mobility enhanced the local collaboration, however, this also meant that they were seldom present at their desk, and thereby had less time for communicating with distance colleagues via phone and email. Based on their findings, they concluded that 'while local mobility enhances local collaboration, it penalise long distance collaboration severely.' (p. 209)(Bellotti and Bly 1996).

Another, but again somewhat related to earlier described work, way to analyse and conceptualise mobility is in relation to centrality and dependencies. Barnes developed a three dimensional framework in relation to enterprise mobility consisting of the

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following three dimensions: market, process, and mobility. The mobility dimension is divided into three sub-levels, describing the geographical independence of the enterprise workers in relation to wireless data solutions (Barnes 2003). According to (Barnes 2003) the three dimensions of mobility can be described as follows: 'The first level is 'transient', describing the basic support of employees as they move from one location to another. These employees are geographically tied to the locations between which they move. The second level is 'mobile'. Here employees have a much higher degree of geographic independence from the enterprise, and have geographic independence for prolonged periods of time, but they inevitably return to corporate locations to perform certain functions. Finally, the highest level of mobility is 'remote'. At this level, employees are almost completely removed from the corporate location, being empowered with a very high degree of geographic independence.' (p 344)(Barnes 2003). These three dimensions suggested by Barnes are very much focused on the geographical movement of the enterprise worker, with an emphasis on providing a better understanding of the development of enterprise mobility in organisations.

Based on ethnographic field work among mobile professionals, where their goal was to observe; 1) the interaction, 2) the types of activities people engaged in, and 3) objects and technologies they used (Sherry and Salvador 2002) identified two key elements of what typically is labelled as mobile work: '...remoteness, which means separation from a resource-rich home base, and truly mobile work, which involves both remoteness and motion, or at least more fleeting periods of stasis.' (p 110)(Sherry and Salvador 2002). The notion 'remoteness' that a person is interacting remotely using some kind of mobile technology, does not necessarily mean that the person is moving and interacting at the same time, it could very well be related to being stationary at a remote place and interacting. This is similar to the wandering and visiting modalities described earlier.

Churchill and Wakeford have in their research on workers' requirements for access to other persons and information in general made the distinction between tight and loose mobility and between close and distant information. Tight mobility relates to synchrony communication and collaboration based on already established relationships while on the move, whereas loose mobility is related to accessing different kinds of information also on the move, but asynchronously. The close and distant information, is not related to the physical distance, but to the degree of availability, i.e. how easy it is to get or access specific kinds of information from remote locations (Churchill and Wakeford 2002). Weilenmann has observed that the term mobility is used to describe very different things and poses the question; mobility of what? (p. 24)(Weilenmann 2003). In her work she distinguishes between; mobile individuals, mobile setting (bus, boat, car, train etc.), mobile technology and mobile information (accessing information

remotely). Furthermore she distinguishes between; present (co-located) and distant (remote) mobility and between synchronous and asynchronous communication (Weilenmann 2001; Weilenmann 2003).

Based on a study of mobile workers (Perry, O'hara et al. 2001) describe different factors of access to remote people and information, and different aspects of the anytime, anywhere concept. They identify four aspects of mobile work: the role of planning, working in 'dead time', accessing remote technological and informational resources, and monitoring the activities of remote colleagues. All related to explore important aspects of unpredictability and uncertainty in relation to resources and task flexibility. The term 'dead time' is related to time between tasks or meetings, when on the road, in which the participants have little or no control over the resources available to them. In their study of mobile workers (Perry, O'hara et al. 2001) found that '...much of what determines what they (read: mobile workers) do can be explained in terms of the limited resources available to do their work, as well as the ways in which these resources change depending on the context of the work. Taking this as a starting point, we can begin to see how activities are related to different settings (while travelling, in meetings, between offices, and so on) in which mobile work is done. We can also begin to see how uncertainty about available resources, and the contexts in which mobile workers find themselves, determines their activities.' (p. 342)(Perry, O'hara et al. 2001). According to the study by (Perry, O'hara et al. 2001) it can be inferred that 'information access' is not only about the possibility or capability of retrieving appropriate documents etc. across different networks. The access notion has to be extended to include 'how', i.e. can the service, application, or document be viewed or interacted with in an appropriate and workable form.

This section has based on the reviewed literature described and analysed a number of different conceptualisations in relation to the mobility concept. As can be seen in the different conceptualisations presented there are quite a number of different concepts of the term mobility, however, quite a few of them are also overlapping or identical. Most of the presented mobility concepts can in some way be related to: spatial, temporal, social, or context related concepts of mobility. The different mobility concepts are all integrated into the mobility framework presented in section 4.3.

4.2.2. Social aspects of mobile work

Based on the technological possibilities that are available today, and the general use of mobile communication, information and communication technologies, and devices it seems to a certain degree to be possible to work while on the move as mobile phones,

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laptops, and other devices and the increased capacity of computer networks and the integration between computer systems and wireless communication are factors, which in combination facilitate the development of mobile work. These technical developments have the potential of making all places central regarding communication possibilities. However, according to (Wiberg and Grönlund 1999; Wiberg and Grönlund 2000) this might not be the case, access to information may not be the only factor. They argue that interaction with people in general may be an equally important issue and have identified five areas where mobility changes fundamental aspects of the social interaction, which relates to or affects both the quality and the efficiency of work (Wiberg and Grönlund 1999; Wiberg and Grönlund 2000). The five areas include social aspects of work concerning the individual as a professional and social being. The professional aspects include sharing of knowledge both explicit and tacit and the forming of a professional identity. The social aspect includes becoming a member of a social group. The five areas and their implications on human behaviour are described below, based on the findings of (Wiberg and Grönlund 1999; Wiberg and Grönlund 2000).

The use of information technology and wireless communication is enabling a society that moves towards a higher degree of nomadicity, which is based on the possibilities of being independent of time and space regarding communication. However, not even nomads are completely alone, they live in groups and are social, both in community and work environments. How will the future mobile workers be introduced to groups of either social or professional character and how are these communities formed and maintained? These are some of the questions to consider, when applying and exploring the possibilities of mobile working environments. As a first generation of mobile workers, we have generally learned our skills in some kind of group setting and are now moving towards increased mobility and thereby separation. Perhaps, the next generation of mobile workers will be born into mobility and the question is then: how will they learn specific skills and socialising in general?

It is obvious that cooperation and knowledge sharing is difficult if there is no or little contact between entities in a wireless community. Furthermore learning to do the job and incorporating new knowledge, are to a large extent done by watching other peoples' work, discussing with others and listening to their discussions and opinions. This will likewise be more difficult in a wireless community (Wiberg and Grönlund 1999; Wiberg and Grönlund 2000; Hardless, Lundin et al. 2001). The research shows that there is a need for a new way of defining mobile cooperation since most mobile workers often work alone and two or more people working on the same task seldom characterise cooperation. In general it is believed that cooperation will gain ground in wireless

environments if the right circumstances and tools are available. These tools should support general coordination of work processes and procedures. Another important issue is how to maintain knowledge, both tacit and explicit and, furthermore, how to create forums for sharing knowledge in general.

Wiberg & Grönlund's research is very specific within the customer service area and therefore difficult to generalise from. However, the results show that a big challenge is the coordination of services as different people have different tasks and qualifications regarding a certain customer service task. Here also, the gathering of knowledge is an important task that needs to be coordinated. The optimisation of work processes through the use of mobile communication have led to an increased feeling of being alone and left out, since most people work individually, compared to working together with others and thereby getting a feeling of belonging to or being part of a team or a group. Another issue is the contact or competition from the head office. The research by Wiberg & Grönlund shows an increase in the competition between the mobile worker and the head office, their tasks are some times overlapping, which makes it difficult for both parties to do their jobs properly. This also relates to the problem of getting the feeling of working together with the rest of the group and representing one unit (Wiberg and Grönlund 1999; Wiberg and Grönlund 2000).

Being part of a professional community gives individuals some common values, which they can share and discuss with others. It is like a corporate image, which can build around certain values, which the company represents and wants its employees both to communicate and represent when at work, a 'we' feeling. These common standards are enforced and re-shaped by social interaction. How is this quality of interaction to be done in the future if everybody becomes more and more mobile and the people working in the field and thereby representing the company are the ones being most mobile? Wiberg & Grönlund's research shows that being together as a group is challenged and changed due to the possibilities of being able to and sometimes forced to work anytime and anywhere due to enhanced technology developments. Although some of the things found in the research are well known areas of concern today, the future will probably make these even more highlighted due to the increased mobility among people.

Based on a computer system perspective (Dryer, Eisbach et al. 1999) have studied the social impacts of mobility, based on four kinds of social relationships (system, system mediated collaborative, community, and interpersonal relationships), where they argue, based on their research, that the advent of pervasive systems may either promote or inhibit our social relations. Therefore they conclude that future pervasive systems, in order to be successful, have to support human social lives and general social settings.

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From a mobile phone usages perspective (Palen, Salzman et al. 2000) have in their research found that new users tend to modify their perception of social appropriateness around mobile phone use (Palen, Salzman et al. 2000). Also (Taylor and Harper 2001) have studied the use of mobile phones among young people and found that young people through owing and using mobile phones establish and maintain their participation in social networks.

From a different perspective, (Boudourides and Harper 2002) argue that technology actually is socially shaped, as new information and communication technologies are continuously becoming a larger part of our life, and thereby also an important part of our social life. From the theory of 'social shaping of technology' perspective, technology is better viewed as reflecting and embodying social environments and settings, rather than being viewed as an autonomous factor causing social change, i.e. that technological innovations are envisioned to represent or support social settings, thereby constituting multifaceted social processes (Williams and Edge 1996; Boudourides and Harper 2002). This means that the innovation process, from design, development, and until use is shaped by social factors. Socially shaped - yes, but only to a certain degree. One could argue that new information and communication technologies to a certain degree reflect social factors or patterns, but at the same time, it could also be seen as a very technology driven process, suggesting that the truth is somewhere in between. However, the user driven innovation process, might push to a more socially shaped perspective, as future services and applications within the mobile world are believed to be deeper rooted in actual user needs and requirements and thereby to a certain degree social settings.

4.2.3. Preliminary framework

Emphasising important aspects in relation to developing more user oriented services and applications the current author together with Anders Henten have presented a preliminary mobility framework focusing on the implications of mobility in relation to the use and development of future mobile services and applications. The framework is centred on four different aspects of mobility; geographical, time-related, contextual, and organizational aspects (Saugstrup and Henten 2003a; Saugstrup and Henten 2003b). In the following section the most important elements of the preliminary mobility framework is described in detail.

The geographic or spatial parameter was integrated into the framework in order to analyze and explore the vision of "anywhere" in the context of end user mobility. In addition, different work and leisure relations concerning location dependencies and how

this can be an integrated part of developing new mobile services and applications was considered. With a starting point in (Kristoffersen and Ljungberg 1998) who originally defined five modalities regarding mobility; stationary, walking, wandering, visiting and travelling. However, only the three latter modalities are used in this context due to the fact that the stationary and walking modality is related to stationary work and these two modalities can be described as being locally mobile. Furthermore, these two modalities are strongly related to the wandering modality. The three remaining modalities, wandering, visiting and travelling, were adopted into the framework as they have very different implications regarding choice of technology and thereby also in a mobile service and application developing perspective. However, in order to further categorise the travelling modality (and subsequently also the visiting modality) which we found more useful in a mobile service and application development perspective we defined three sub modalities/levels; local, regional, and world traveller. These sub-modalities were based on the variation of the end users' levels of spatial movement and thereby their different requirements and expectations regarding mobile communication, information, services, and applications. The world traveller sub-modality is related to persons who travel around the world and at the same time want to be able to use mobile communication devices no matter where she or he is located. The second defined level, the regional traveller, is related to persons who mainly move within a certain region, where the region could be defined as for instance the EU, a country, or a certain part of a larger country. The last level, the local traveller, is related to a specific local area, which could be a small country or a certain part of a region. These three levels of travelling are of course not static, but dynamic, allowing people to change level for a period of time and should, be seen as categories, which people can be related to most of the time. However, the distinctions between the three types should be done carefully, due to the problem of categorising.

In addition to this, roaming possibilities are believed to be of great importance in relation to future services and applications, as users to a greater extent will be roaming between multiple operators and different access technologies. This means that the services and applications, which the user has signed up for, should be provided at all locations. Therefore, some problems concerning home town/domestic and international roaming are inevitable regarding access and availability to subscribed services and applications when roaming internationally, unless these aspects are included and dealt with during the development and setup. In addition, there is the device capability issue to take into consideration, i.e. which devices can be used for which services and applications.

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The temporal parameters considered within the framework consist of four aspects: being dependent or independent of time regarding communication and interaction, and communicating and interacting synchronously or asynchronously. Starting with the time dependency, this can basically be either time dependent or time independent, where time dependent refers to a certain time frame or a certain order in which events are to take place. The time independent interaction can take place at any time. Looking at the synchronicity of the time dependent and time independent interaction, synchronous interaction is mainly used in voice communication and other real-time services and applications. However, time dependent communication can also be asynchronous, i.e. asynchronous but at the same time within a certain time frame. Asynchronous interaction is time independent interaction where there is no need for real-time interaction between two or more entities, being device to device, person to person, or person to device. When developing mobile services and applications, it is important to consider the interaction dependencies in order to make the services and applications as useful as possible.

Turning to the contextual aspects, the influence of contextual parameters is equally important when developing new mobile services and applications. More than ever the contextual parameters, i.e. the different contexts the user is within when using or having user needs and requirements in relation to mobile communication and interaction, are believed to be important in relation to developing services and applications that actually support the users within the different contexts they are present within. In general users are present in a variety of contexts, e.g. private vs. professional and within these the context constantly changing, e.g. being home vs. vacation or at the office vs. at a client and within these different contexts the users are having different needs and requirements in relation to mobile communication and interaction. Therefore, it is important to focus more on the needs and requirements of the users and how new services and applications can support them and their everyday work and life. This could be achieved by using a more user need and requirement oriented approach in relation to developing new services and applications, where the user need and requirement oriented development path should be seen as development of services and applications based on technological possibilities, but driven by actual user needs and requirements.

The organisational aspects could arguably be part of the contextual parameters, however as the organisational aspects in this constellation is related to professional organisations, i.e. companies and thereby work related organisations it is added as a fourth dimension. Many people today work in an environment where they are mobile, which could mean work in temporary constellations, at different locations, and at

varying times. These organisational changes and developments should be taken into consideration when trying to categorise the term mobility and developing services or applications for professionals in a mobility perspective. The main parameters within this setting are thought to be: cooperation, knowledge sharing, and the reliability of services and applications. It is obvious that cooperation and knowledge sharing becomes more difficult if there is no or very little physical contact between people in an organisation due to an increased level of mobility within the organisation. The more mobile an organisation becomes, the higher demands there will be on mobile services and applications, therefore it is important that mobile services and applications support cooperation and knowledge sharing and that this is considered when developing these services and applications.

4.3. Mobility framework

As can be seen in the described and analysed research concerning mobility, mobility is a term widely used in association with information and communication technologies (not surprisingly), but at the same time the term describes very different things. In some situations mobility is used in connection with technology, describing physical movement, remote access, or interaction of some kind. In other situations, mobility is used to describe people or artefacts and their movement in time and space or in different social and context related situations. Kristoffersen and Ljungberg early on described the contradictoriness of the understanding of the term mobility, which everybody seems to have some kind of understanding of and still it is fairly difficult to define. 'Mobility is one of those words that are virtually impossible to define in a meaningful way. You either come up with a definition that excludes obvious instances, or your definition is too vague; it fails to shed light on important aspects. At the same time we all have a feeling of what it means; the newsboy and the travelling salesman are mobile, the secretary and the cook are not. Thus, we can conceive typical situations in which people are mobile and when they are not.'(p 1)(Kristoffersen and Ljungberg 1999b).

Based on the literature review conducted and the preliminary framework presented previously, Table 4-4 summarize the different concepts of the term mobility, in which different types of users, based on their level of mobility and usage requirements have been categorized. Four different categorisations of mobility have been defined; spatial mobility, temporal mobility, context mobility, and social mobility. They are related to the different variations, definitions, and concepts of the term mobility researched and analysed in this chapter. However, the categorisation should be viewed carefully, due to the problem of categorising.

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	Mobility terms	Description
Spatial mobility	Wandering	Moving around at a "home" base
	Visiting	Present for a while, away from the home base
	Travelling	The movement between A and B (longer distance)
	Locational	Geographic movement of people
	Micro	Object/artefact mobility within a small and restricted area
	Local	Local (building, office, etc) mobility of people and objects
	Remote (I)	Interaction of spatially separated people or information
	Transient	Support of employees as they move from one place to another
	Mobile	Some geographical independence from the enterprise
	Remote (II)	Almost geographically removed from the enterprise location
	Remoteness	Separation from a resource rich home base
	Truly mobile work	Separation from a resource rich home base and motion
	Close	Easy access to information from remote locations
	Distant	Difficult to access information from remote locations
	Mobile individual	Individuals in motion
	Mobile setting	A moving setting (bus, train, etc) in which people are located
	Mobile technology	A technology that is designed to be used by people in motion
	Dead time	Time between tasks and meetings, when on the road
	Access	Accessing remote technological and information resources
	Monitoring	Monitoring the activities of remote colleagues
	Mobile information	Accessing information remotely
	Local traveller	Travelling/moving around within a locally defined area
	Regional traveller	Travelling/moving around within a regional area
World traveller	Travelling around the world	
Temporal mobility	Operational	Flexibility in relation to work operations
	Synchronous	Synchronous interaction
	Asynchronous	Asynchronous interaction
	Loose mobility	Accessing information on the move (asynchrony)
	Tight mobility	Synchrony communication and collaboration
	Time dependent	Time dependent communication or interaction
	Time independent	Time independent communication or interaction
Context mobility	The role of planning	Planning for the unpredictable
	Environment context	Surroundings, entities in the surroundings
	Personal context	User state
	Task context	What are the individual doing
	Information context	Information space, information situation
	Business context	Business/professional interaction and communication
	Leisure context	Private/leisure interaction and communication
	Interaction	One-to-one, one-to-many or many-to-many
Organisational context	Cooperation, knowledge sharing, work processes, reliability	

Social mobility	Social context	The social context of the user context
	Interactional mobility	Interaction with other people
	Knowledge sharing	Tacit and explicit knowledge sharing among distributed people
	Professional identity	Being part of a group / social environment
	Social relationships	Pervasive systems either promote or inhibit social relations
	Social shaped technology	Technology viewed as reflecting and embodying social settings

Table 4-4 **Categorisations of mobility**

The spatial mobility category can be related to different kinds of geographical movement of artefacts or persons and the challenges related to being away from the ‘home base’ and at the same time having the same opportunities or possibilities of interaction and access to information as when located at the home base. The temporal mobility category is related to synchronous or asynchronous interaction and communication possibilities and the flexibility in relation to operations and tasks. The context category is related to the specific contexts in which the users are situated and the context of the tasks at hand, i.e. reflecting the environment the users are situated within and how this might influence the usages, needs, and requirements. The social category is mainly related to the social interaction dimension, especially in relation to the social environment and social interaction with other people or groups of people.

Overall there seems to be some common factors regarding the understanding of the term mobility and the way in which it has been researched. Based on the research studied and analysed, one could clearly state that the most research is somehow work related to and treats the ‘office’ as a home base, i.e. very oriented towards mobile work and mobile workers. Furthermore there seems to be a common understanding of mobility as being related to transportation, i.e. being in transit between A and B (Bellotti and Bly 1996; Kristoffersen and Ljungberg 1998; Kristoffersen and Ljungberg 1999b; Kristoffersen and Ljungberg 1999a; Wiberg 1999; Wiberg and Ljungberg 2000; Weilenmann 2001; Weilenmann 2003; Wiberg 2005). However, the strong focus on work related aspects of mobility, does not take into consideration the interaction with other people in relation to private and everyday life activities, thereby leaving out a whole set of activities and concepts of mobility, i.e. the beyond work related mobility.

Also the travelling, transportation, or moving away from the office aspects seem to be very general, trying to figure out what kind of work can be done away from the home base or the office, i.e. providing access to information when on the move. The office seems to have some kind of extra important status, it is viewed as the base where all resources are available, and when people leave the base they generally detach themselves from the available resources. The mobility term is therefore often reflected

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in the challenge of providing access (as when working from the desktop) to the mobile workers (Luff and Heath 1998; Churchill and Wakeford 2002; Kakihara and Sørensen 2002; Kakihara, Sørensen et al. 2002; Sherry and Salvador 2002; Sørensen, Mathiassen et al. 2002; Barnes 2003; Weilenmann 2003; Kakihara and Sørensen 2004). However, this also leaves out some important aspects of mobility, namely the non office work and leisure activity aspects of mobility, i.e. where the movement is an important part of the work task at hand, or looking at non working segments (teenagers and elderly people).

The four categories are all believed to be important, each in their own setting, and very useful in relation to designing and developing new mobile services and applications that are more supportive of the users' activities. In order to design and develop better and more supportive mobile services and applications, one has to be aware of and include these four different categories of mobility into the design and development process, in order to fully understand the needs and requirements of the end user. This means that when designing and developing new services and applications, one should evaluate and take into consideration how each of the four categories of mobility are supported in the new products.

The four categories defined is believed to be very useful, when designing new mobile services or application, however it is also important to be aware to the pitfalls of such predefined categories. Categories can in general be described as abstract concepts, and sometimes they can be almost counterproductive and in some situations simplified models of fairly complex situations, i.e. what if a certain 'activity' does not fit in any category or is more complex than the category allows. It is therefore very important to view these predefined categories as recommended guidelines.

In relation to developing future mobile services and applications the key point is to base these on user involvement in the innovation process and to observe what people are really doing and what is relevant for them within their activities and interactions. Then use the four defined mobility categories to further support the design and development process to make sure that the services and applications are supporting the end users in their activities, i.e. what categories of mobility are relevant for the users, in relation to a given activity.

In addition, the big question is what determines the acceptance or rejection of a new service or application. According to (Davis 1989) there are especially two determinants that are particularly important; perceived usefulness and ease of use. 'First, people tend to use or not use an application to the extent they believe it will help them perform

their job better. We refer to this first variable as perceived usefulness. Second, even if potential users believe that a given application is useful, they may, at the same time, believe that the system is too hard to use and that the performance benefits of usages are outweighed by the effort of using the application.' (p 320)(Davis 1989). The perceived usefulness is related to the extent, to which a person believes that using a particular service or application enhance her or his activity performance and the perceived ease of use is related to the extent, to which a person believes that using a particular service or application would be free of effort or easy to use.

However, it should be underlined that perceived usefulness and ease of use obviously are subjective assessments of performance and effort, and do therefore do not necessarily reflect an objective reality. Several studies have observed inconsistencies between perceived and actual performance (Cats-Baril and Huber 1987; Sharda, Barr et al. 1988). If the users do not perceive it as useful they are unlikely to use it, even though the application would objectively improve the performance (Alavi and Henderson 1981). Basically this means that, in order for the users to accept and use specific services and applications, they have to provide the user with some level of usefulness (fulfilment of user needs and requirements). Furthermore the services and applications have to be easy and efficient to use and at the same time provide some kind of activity improvement or work enhancement (Löfgren 2007).

4.4. Summary

Based on a review and analysis of different contributions and perspectives in relation to mobile system requirements, there seems to be a need for a more user oriented research and development approach, as little research is actually done in relation to establishing real user needs and requirements that do not only reflect mobile technologies but also the social context of mobility. Furthermore there seems to be a clear bias towards environment independent and artificial settings within the mobile system requirement area, i.e. lab experiments and applied research methods are the most used approaches, compared to for instance case studies, action research, and surveys. This bias indicates that more focus on case studies and alike, thereby trying to get a better understanding of the field in question, and also a more user oriented approach to future research. In addition, an extended use of field studies and case studies would arguably provide a better understanding of context issues and user needs and requirements, bridging the gap between context and user needs and requirements and the actual design process.

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Furthermore different conceptualisations of the word and concept of mobility has been described and analysed, based on a literature review of mainly Scandinavian contributions, in order to get a broader and at the same time more nuanced understanding of the mobility concept and the use of the term mobility. This review and analysis revealed that there are numerous concepts, understandings, and deployment perspectives of the term mobility; however, quite a few of these are also overlapping or almost identical. In general, most of the reviewed and analysed mobility concepts, understandings, and deployment perspectives can in some way be related to: spatial, temporal, social, or context related concepts or perspectives of mobility. Based on the literature review conducted a mobility framework was presented to categorise and conceptualise the term mobility in a user need and requirement and service and application development perspective. The framework categorise the term mobility in relation to different types of users, their level of mobility, and user needs and requirements, where four different categorisations of mobility have been defined; spatial mobility, temporal mobility, context mobility, and social mobility. The four categories are important, each in their own setting, and very useful in relation to designing and developing new service and application concepts that are more supportive of the users' activities.

5. Diabetes case

5.1. Introduction

The main objective of the diabetes case study has been to derive and collect user needs and requirements from diabetic persons in relation to self-management and preventive treatment of their diabetes and diabetes related symptoms. This has been done by applying the lead user method and a workshop toolkit all within the user involvement in the innovation process framework and in relation to the mobility and Personal Network perspectives. In other words, the main goal has been to draw together and extract real user needs and requirements regarding disease self-management in relation to developing future service and application concepts that would support diabetic persons in their everyday lives based on an extended user involvement in the innovation process.

From an information and communication technology perspective, the main objective is to develop information and communication based service and application concepts, which help insulin dependent diabetics in disease self-management and provide a more effective control and treatment of the disease and its complications, potentially providing the users with a higher quality of life. Applying a preventive rather than treatment care perspective, and thereby a more effective treatment of the disease and its complications, could lower the disease related costs for both individuals and the public healthcare system (Pedersen, Jensen et al. 2004; Olesen, Jiang et al. 2005). From a mobility and context related perspective, the diabetes case is expected to provide significant input in relation to obtaining a better and more elaborated understanding of the user needs and requirements within this segment in particular in relation to mobile and context based future service and application concepts. From the lead user and toolkit perspective the diabetes case will be applied to deploy and analyse the lead user and toolkit concepts among a group of diabetic participants, with the overall purpose of developing future service and application concepts, based on the derived user needs and requirements.

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The diabetes case study is based on ongoing research within the field of diabetes and in particular on an existing diabetes services called DiasNet (Diabetes Advisory System), which currently is a pilot project running at Frederikshavn Hospital (DK) and Bournemouth Hospital (UK). DiasNet is an active research project at the Institute of Health Science and Technology, Aalborg University. For additional information on the DiasNet research group and activities see (Hejlesen, Andreassen et al. 1997; Hejlesen, Plougmann et al. 2000; Pedersen, Dahlsgaard et al. 2004; Hejlesen, Larsen et al. 2006). The results of the diabetes case study, i.e. future user needs and requirements, will serve as input to further development of the DiasNet service and community as well as input for the further work in MAGNET regarding developing new and highly user supportive applications and services in relation to the Personal Network concept.

There is no doubt that the best way to help and treat persons with diabetes would be to find a cure for diabetes. However, until that happens the second best way to help and support diabetics in their everyday lives is believed to provide these persons with tools that make the self-management, blood glucose measurements, and insulin intake as easy and convenient as possible. Focusing the attention on the diabetic persons, their surroundings, different contexts within which they are present, their contact with the public healthcare system, current diabetic self-management tools etc. is expected to reveal their current and future needs and requirements, and to provide important and valid input for future self-management tools, equipment, service, and application concepts.

This chapter is mainly based on the following publications and reports (Antonis, Dahlsgaard et al. 2004; Pedersen, Dahlsgaard et al. 2004; Pedersen, Jensen et al. 2004; Schultz, Saugstrup et al. 2004; Sørensen, Schultz et al. 2004; Olesen, Jiang et al. 2005; Saugstrup, Sørensen et al. 2005; Sørensen, Saugstrup et al. 2005; Schultz, Sørensen et al. 2007), where the current author has been a co-author and one of the driving forces behind the work and development of the method presented and deployed in relation to gathering user needs and requirements. I have been one of the main contributors in relation to developing the toolkit used at the workshop, planning the workshop and defining the different roles that the diabetes patients and involved academics would have during the workshop, guiding one of the two groups during the workshop in the role of facilitator, and finally in relation to analysing derived data and results.

5.2. Case background

This section provides an introduction to diabetes and diabetes related complications and conditions closely related to the diabetes illness. To fully understand the needs and requirements of persons with diabetes, basic knowledge about diabetes and related symptoms are important factors to take into consideration, hence this section on diabetes. Furthermore this chapter gives a brief overview of the DiasNet (Diabetes Advisory System), which currently is used as a pilot tool in Northern Jutland (Denmark) in relation to self management and treatment of persons with diabetes. The DiasNet service constitutes the foundation for further development and involvement of users in the innovation process in relation to the development of more elaborated and specific user needs and requirements, i.e. getting a more elaborated understanding of the needs and requirements of persons with diabetes.

5.2.1. Diabetes

Diabetes is a chronic condition where the body is unable to keep the blood glucose concentration within normal limits, approximately between 4.0-7.0 mmol/L. This is due to poor glucose metabolism, which mainly is due to the body's failure to produce insulin, being insulin resistant or a combination of the two. Insulin is a hormone and hormones are protein secreted by a gland. Insulin is secreted by the beta cells of the pancreas, and the hormone is necessary in order to transport blood glucose into the body's cells. In the cells, the absorbed glucose is either converted directly to energy or stored for future use in the form of glycogen in the muscle cells. If a person does not produce insulin, insulin dependent diabetes (type-1 diabetes) is developed and insulin needs to be injected daily. As insulin is a protein it would be broken down and digested if it was administered by pill. There are two main types of diabetes: type-1 and type-2 diabetes. Type-1 diabetes is also known as juvenile-onset diabetes or insulin dependent diabetes and is usually developed and diagnosed in children, teenagers and young adults. This type of diabetes is characterised by the pancreas producing no or hardly any insulin at all, and as a result the diabetic needs to inject insulin on a daily basis. Type-2 diabetes is also known as adult-onset diabetes or non-insulin dependent diabetes. Type-2 diabetes can be developed at any age, and is characterised by insufficient insulin secretion and/or insulin resistance, i.e. a state where the body's cells cannot utilise the insulin properly. Type-2 diabetes is mainly treated by diet and exercise, often combined with medicine, however, for some also with insulin (Pedersen, Jensen et al. 2004).

In general, persons with diabetes have to be constantly aware about their blood glucose level, as it needs to be regulated very carefully, in order to stay in the approximate

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range between 4.0 - 7.0 mmol/L. Without adequate regulation, the blood glucose concentration can either rise beyond the normal upper limit and cause hyperglycaemia or below the normal lower limit and cause hypoglycaemia. Therefore, it is imperative for persons with diabetes to manage their blood glucose concentration so it stays within the advised range, which requires a daily balancing of diet and for type-1 diabetics mainly insulin. Hyperglycaemia occurs when the blood glucose level is too high, i.e. above approximately 7.0 mmol/L. To bring down the concentration, insulin can be administered, which leads to glucose absorption in the cells. Hyperglycaemia can over the years lead to severe complications such as eye damages, infections, kidney failure and circulatory diseases. Hypoglycaemia occurs when the blood glucose level is too low, i.e. below approximately 3.5-4.0 mmol/L and is a recurring complication related to insulin treatment, as it can occur if too much insulin is injected in order to lower a too high blood glucose level. When hypoglycaemia occurs, it must be treated immediately by the intake of food with fast acting carbohydrates. If not treated timely, the blood glucose concentration keeps decreasing and insulin chock will occur, causing unconsciousness, possibly accompanied by seizures (Pedersen, Jensen et al. 2004).

From a general care perspective, the best solution for managing diabetes, is for the single person with diabetes to gain control or be able to control the blood glucose levels in order to prevent diabetic complications. This is mainly done by monitoring the blood glucose level continuously in combination with the awareness of which impact different kinds of food intake will have on the blood glucose level. As part of a day-to-day routine a person with diabetes checks their blood glucose levels between one and up to ten times a day, and accordingly injects multiple units of insulin every day. In general, diabetics will within five to twenty years after disease onset, start to develop a series of complications. However, many of the complications can be delayed or even avoided by proper disease management. Table 5-1 indicates the most common complications and consequences of diabetes.

Diabetic retinopathy is an important cause of blindness, and occurs as a result of long-term accumulated damage to the small blood vessels in the retina. After 15 years of diabetes, approximately 2% of people become blind, and about 10% develop severe visual impairment.

Diabetic neuropathy (inflammation of nerve endings) is damage to the nerves as a result of diabetes, and affects up to 50% of people with diabetes. Although many different problems can occur as a result of diabetic neuropathy, common symptoms are tingling, pain, numbness, or weakness in the feet and hands.

Combined with reduced blood flow, neuropathy in the feet increases the chance of foot ulcers and eventual limb amputation.

Diabetes is among the leading causes of kidney failure. 10-20% of people with diabetes die of kidney failure.

Diabetes increases the risk of heart disease and stroke. 50% of people with diabetes die of cardiovascular disease (primarily heart disease and stroke).

Circulatory system: Diabetics have an increased risk of developing atherosclerosis. Blood clots in the brain may occur 2-4 times more frequently in diabetics than in non-diabetics, and cardiac infarct 3-5 times as frequently (in Denmark).

Table 5-1 *Diabetes related complications*^{21, 22}

In general diabetics have three generic tools aiding them in their self-management of diabetes, i.e. a blood glucose meter, an insulin pen, and for most diabetics a diary. The blood glucose meter is a small device that can measure the blood glucose level. This is done by first pricking a small hole in either the finger or the ear, and then drip a drop of blood onto a strip of test paper. This is then inserted into the blood glucose meter, which upon analysis returns a value for the current level. The blood glucose meter is able to store the results (typically 200) and many of the devices are also able to calculate minimum, maximum and average levels of blood glucose over a period of time. These results are then used to plan the continued treatment of the disease.

The insulin pen is the tool used by the diabetic to supply the body with the insulin amount needed to regulate the blood glucose level. The diabetic injects insulin several times daily and the pen contains insulin that will last a longer period of time and it also has a simple mechanism for easy dosage. There are basically two types of insulin pens; one is refillable, while the other one is disposable. In the refillable pen the needle is changed every time and it comes with an ampoule of insulin that can be changed when empty. The disposable pen comes pre-filled with insulin, which means that only the needle needs to be replaced every time and once the pen is empty it is thrown out.

As diabetics inject insulin before eating, it is necessary to predict approximately how much she or he will eat, since the amount of insulin is based on that prediction. For most diabetics, this ability to predict the right amount of insulin is mainly based on experience from living with diabetes and having regulated diabetes for years. Keeping a diary with daily entries of blood glucose measurements, insulin injections, carbohydrate

²¹ <http://www.who.int/mediacentre/factsheets/fs312/en/index.html> (May 2007)

²² http://www.sst.dk/publ/tidsskrifter/nyetal/pdf/2006/24_06.pdf (May 2007)

intake, own notes etc. is therefore an important tool for keeping track of the disease and for a self-management purpose. The diary is also an important tool in relation to communication and consultation with the healthcare system.

Regarding diabetes statistics; in Denmark there were more than 220.000 persons diagnosed with type-2 diabetes at the end of 2005 and the number is increasing with approximately 20.000 persons a year (Sundhedsstyrelsen 2006). However, others have estimated that there are 400.000 persons with type-2 diabetes and in addition more than 500.000 persons are expected to have pre-diabetes symptoms by early 2007 as many are living with pre-diabetes and diabetes without being aware of it.²³ According to the same source there are currently 25.000 persons diagnosed with type-1 diabetes.²⁴ The cost of monitoring and treatment of diabetics is approximately 2.5 billion DKK equalling around 6% of the Danish health budget.²⁵ From an international perspective and according to the World Health Organisation statistics, more than 180 million people worldwide have diabetes and this number is likely to double by 2030. In addition, it is estimated that around 1.5 million people died from diabetes in 2005.²⁶

5.2.2. DiasNet

The setting-up of DiasNet (Diabetes Advisory System) took place in the beginning of January 2000 where the project was launched under the project 'The Digital Hospital' under the IT Project Activity 'The Digital North Denmark' that was under the auspices of the Danish Government. The main objectives of DiasNet are to provide an IT-based solution that helps type-1 diabetes patients in disease self-management, in order to promote a better understanding of the disease among the patients as well as a more effective control and treatment of the disease and its complications. DiasNet incorporates a Bayesian network model of the human carbohydrate metabolism, i.e. a statistical method that assigns probabilities to parameters based on experience before experimentation and data collection to revise the probabilities and distributions after obtaining experimental data. This modelling paradigm is able to cope with the inherent uncertainty which is present in, e.g. blood glucose measurements and physiological variations in glucose metabolism. DiasNet facilitates that patients enter retrospective data on carbohydrate intake, insulin injections and blood glucose readings. Based on this information and information about expected future carbohydrate intake the system provides a graphical overview of the data and estimates the future blood glucose profile and appropriate insulin dosages. Hereby, the patient has the possibility to experiment

²³ <http://www.diabetes.dk/wm5985> (June 2007)

²⁴ <http://www.diabetes.dk/wm5985> (June 2007)

²⁵ <http://www.netdokter.dk/sygdomme/fakta/diabetes.htm> (June 2007)

²⁶ <http://www.who.int/mediacentre/factsheets/fs312/en/index.html> (June 2007)

with data and learn how to optimise future insulin dosages according to carbohydrate intake. When a patient encounters a specific problem or has a question which cannot be handled directly by DiasNet the associated professional diabetes team at the healthcare clinic can be contacted and the patient's data can be reviewed. A diabetes team typically consists of a medical doctor, a nurse, a dietician and a secretary. DiasNet has two distinct user groups, i.e. a professional diabetes team and a patient group. Both groups interface the system via a web browser.

In Bournemouth in the UK an SMS interfacing facility for DiasNet has also been implemented. Up to now, patients have had to enter their data into DiasNet via a web browser after the specific values were known, but that would require access to a networked PC several times a day. Therefore, a common way of entering data is to collect the data during the day and then later, e.g. in the evening, enter the data into DiasNet. This way of entering data is a bit troublesome because paper notes tend to disappear and the patient have to write down the same information twice which increases the probability of errors and causes a waste of time. As a simple improvement to address these problems, a special SMS facility has been implemented so that patients can enter data immediately by using the SMS functionality on a standard mobile phone.

In connection with a meal, for example at 12:30, a patient may typically have to collect the following information: measured blood glucose, e.g. 7.2 mmol/L; insulin injection, e.g. 6 units; and carbohydrate intake in the meal, e.g. 60 grams. The patient then simply writes an SMS message and sends it to the DiasNet server. The server identifies the patient using a lookup table with information about the patients' phone numbers. In this example, the message would be 'b7.2 i6 m60', and unless the patient includes info on the time in the SMS message, e.g. 't1230', the server will automatically time stamp the data based on the time of the SMS. This way of entering data may solve the problem of the lost paper notes, but it does not completely solve the problem of erroneous data. Even though the server may do some consistency checking on the message, it can not remove the risk of errors in the data. However, the SMS functionality opens up for primitive, but truly mobile, interactions between the user and the system. Data can be entered and the user receives an SMS feedback from the server if the server, for example, cannot interpret the message, or as a confirmation of receipt. More sophisticated feedback is also, in principle, possible, but has so far not been implemented.

The usages of DiasNet cause some changes in the way diabetes is controlled and managed by both the clinical staff and patients. Basically, a patient enters via a web

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browser interface retrospective data on carbohydrate content in meals, insulin injections and blood glucose readings. In addition patients can enter information on expected future meals. Based on the entered data, DiasNet will provide the patient with advice on future insulin dosages. If a patient encounters a specific problem/question which cannot be handled automatically by DiasNet, the patient can contact the health care clinic and ask for personal assistance. The patient will periodically receive an email with feedback from the diabetes team when they have analysed the entered data for a given period of time. All diabetes patients are invited to attend an introductory course called 'diabetes school', in order to introduce the patients to DiasNet and its functionality before using it together with up to date information on diabetes and how to avoid or minimise the risk of diabetes related symptoms. The above mentioned approach reflects the practical use of the DiasNet application. Figure 5-1 shows the web browser interface of the DiasNet application.

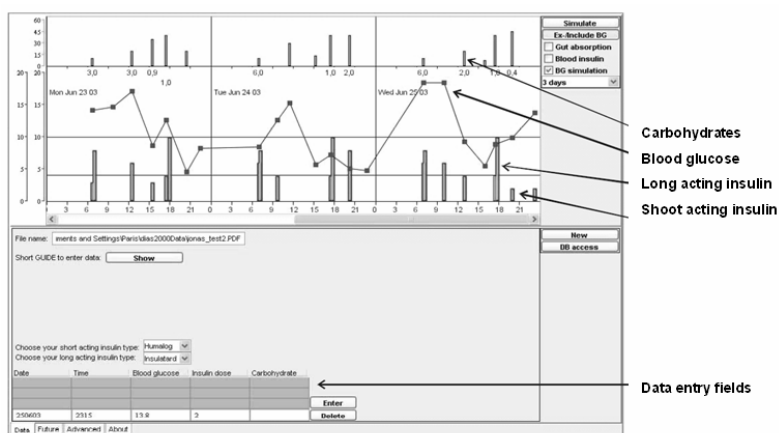


Figure 5-1 *DiasNet interface*

When data has been entered into the data entry fields they will be graphically displayed in the top half of the window. The bars show the carbohydrate content in the consumed meals, the intake of long acting insulin, the intake of short acting insulin, and the dotted line shows the entered blood glucose concentrations. Besides graphically illustrating the data for the single patient, the data can also be viewed and analysed by the professional diabetes team at the clinic. Based on this information, the diabetes team can provide feedback to the single patients regarding, e.g. the actual insulin and suggest changes long to the single patient's insulin regime if necessary. In addition, the DiasNet application can also be used to estimate the future blood glucose profile and

appropriate insulin dosages, based on already entered information combined with the information on expected future carbohydrate intake.

From a general market and software availability perspective there is a number of different software products available today, which let the diabetes patient enter: blood glucose readings, insulin dosages, carbohydrate grams, and exercise levels. Besides viewing the historic data most of these software applications also provide simulation tools that predicts the future insulin intake based on different parameters, which the users can enter into the software application (e.g. mobile platform based software: Accu-Chek Pocket Compass, esManager, Diabetes Pilot, Clucobase PDA, ClucoseOne, Loogbook DM and UTS Diabetes. Mac software: Diabetes Logbook X and Health Tracker. Windows software: Diabetes Pilot, Personal Diary, One Touch Software and HealthEngage Diabetes). In relation to the above commercial products currently available on the market, the uniqueness of DiasNet is the connection to and involvement of the diabetes team. Only the DiasNet application has incorporated and is based on interaction and communication with a local diabetes team, which the diabetic actually knows and meets at regular consultations.

Summarising the experience gained from deploying DiasNet so far is overall very positive, both regarding the professional diabetes team and each individual diabetes patient that have been using DiasNet. The results of a previous conducted evaluation of DiasNet are summarised below in Table 5-2 and Table 5-3 highlighting the perspectives and lessons learned from the diabetes team and the diabetes patients (Dinesen, Andersen et al. 2004). Based on the experience gained from running the DiasNet application at the hospital in Frederikshavn (Denmark) and Bournemouth Hospital in the UK, it is clear that the DiasNet service is meeting a need with the users (patients and diabetes team). However, based on the evaluation of the DiasNet application and diabetes team setup there are also room for considerable improvements, especially in relation to the limitations a web browser interface restricts on the users in relation to being online almost continuously. This is not a problem for a number of people, however, it is an issue for people not working in front of a computer all day. Also the lack of mobility within a web browser solution is considered to be a significant barrier to a larger number of the diabetics, as this somehow also restricts their mobility, if using the DiasNet application continuously.

In addition to the above Danish experiences and observations the UK DiasNet has been tested on a small number of patients in relation to using SMS functionality for entering data. Although some found it useful, compared to the solely web-based version, the SMS user interface leaves much to wish for regarding functionality, and many users

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found it somewhat troublesome in daily use. A common complaint was that SMS is designed for text and not numbers, i.e. you cannot use word prediction on numbers and on most phones it takes more time to get numbers right than letters. Also using the decimal separator takes some extra time for some patients not used to write mobile phone text messages. However, it is convenient that data can be entered directly without having to be near a networked pc (Dinesen, Andersen et al. 2004)

Diabetes patient	Patient experience with DiasNet
Patient #1	<ul style="list-style-type: none"> Greater well-being Diminished insulin dose Unable to run DiasNet at another hospital Feels safe about emailing to the diabetes team Enhanced trust and closer contact with the diabetes team Improved diabetes self-management – experiences better self-control Increased awareness of carbohydrates and blood glucose regulation Makes extensive use of IT, e.g. the Internet Enhanced knowledge of blood glucose values DiasNet is a good tool Learned from the other patients
Patient #2	<ul style="list-style-type: none"> Greater well-being Insulin dose diminished by one half Weight loss of 12-14 kg. Learned from the other diabetes school attendants Closer contact with the diabetes team Emails facilitate quicker responses from the staff ‘Leads two lives’ when testing blood glucose for DiasNet and when not Better knowledge of counter-regulation, diet, etc. Improved insight to correlations between diet, exercise and BG levels Carbohydrate counting provides certain freedom 3-monthly reviews unnecessary Improved diabetes control Got to know the other patients and was inspired by them
Patient #3	<ul style="list-style-type: none"> Greater well-being Diminished insulin dose Better knowledge of counter-regulations Improved diabetes control DiasNet has difficulties “handling” physical activity Emails provide better reporting with diabetes team

Table 5-2 Patient experiences and observations²⁷

²⁷ Based on (Dinesen, Andersen et al. 2004)

Diabetes team	Change in task and duties as a result of using DiasNet
Medical doctor	<ul style="list-style-type: none"> A more direct patient contact, but physical presence of patients is missing Ability to communicate with the patient irrespective of time and place Enhanced knowledge about counter-regulation The carbohydrate counting focus has gained prominence A closer patient follow-up programme is required
Nurses	<ul style="list-style-type: none"> Close monitoring of patients whose insulin doses are adjusted Better visualisation of blood glucose profiles New means of patient communications Enhanced competence of the nurses (e.g. insulin prescriptions) An increased number of work tasks More time at the computer screen Counselling increased focus on carbohydrates It has become 'legitimate' to spend time on 'screen' work. Documentation of treatment needs attention New working procedures and routines
Dietician	<ul style="list-style-type: none"> The 'healthy eating' element has become more prominent Carbohydrates have become the focus of attention We (nurse, doctor and patients) spend more time talking about carbohydrates Food has become a matter of more pronounced interest to all parties
Secretary	<ul style="list-style-type: none"> More direct and swift patient communications A higher number of IT related tasks Secretary more visible to the patients Stronger impression of being part of the diabetes team

Table 5-3 *Diabetes team experiences and observations*²⁸

5.3. User involvement in the innovation process

Based on the diabetes and DiasNet description and analysis in the previous sections, this section will focus on actually retrieving user needs and requirements from diabetics, which will serve as input to future diabetes service and application concepts within a Personal Network setting, i.e. the diabetes and DiasNet descriptions and analyses will provide the common ground for further developments. A user centred innovation workshop approach will be deployed to gather and derive user needs and requirements in combination with the mobile system requirement and mobility perspectives.

²⁸ Based on (Dinesen, Andersen et al. 2004)

5.3.1. User centred innovation workshop

The theoretical framework consists of the user involvement in the innovation process approach, with particular focus on tools and techniques for collecting user needs and requirements, i.e. the lead user method, decoding of sticky information and the deployment of toolkits which provides the overall theoretical basis for the approach developed and deployed in relation to the diabetes case.

As previously described the four step integration of lead users into the innovation process suggested by (Hippel 1986) is: 1) identify an important market or technical trend, 2) identify lead users within the selected trend, 3) analyse lead user data, and 4) project lead user data into the general market. The PhD project is as earlier explained mainly related to the second and third step, as the diabetes and DiasNet subjects were part of the project from the beginning; therefore no trend, market identification, and selection process has been necessary and conducted actively. However, potential products for self-management of diabetes have been analysed in order to establish a basic knowledge about current available commercial products. In addition, the expected increase in numbers of diabetes patients worldwide as described earlier makes the diabetes case attractive in relation to market trends, at least from a national healthcare and diabetes patient perspective. In this situation the term 'market trend' might be a fairly strong or even political incorrect word to use for a disease. On the other side, the companies providing different kinds of diabetes tools and products would see the general increase in the numbers of diabetics as an important marked trend. Also the concept and further development of the Personal Network concept could be viewed as an important technological trend. However, as all these aspects were given and as they were a dedicated part of the PhD project from the beginning, no real identification work in relation to identifying important markets or technical trends has been conducted.

In relation to step two, identifying lead users within the selected trend, the selection process has been done in cooperation with DiasNet and a local diabetes team in Northern Jutland, Denmark. The final selection was mainly based on the following parameters and qualifications; general technology awareness, DiasNet experience, diabetes experience, level of involvement in the development of the DiasNet application and set up, and finally on a genuine interest in contributing to the further development of DiasNet and other tools that could improve or make the life of a person with diabetes easier or more convenient, combined with the ability and personal drive to participate actively in the project. In addition to this, doctors and nurses were included to further broaden the scope of diabetes needs and requirements and thereby potential future diabetes tools, services and applications. This was done in order to get input from the healthcare system, as this is the second half of the equation, i.e. the doctors' and

nurses' experience and knowledge in relation to treatment and management of diabetes from a healthcare perspective, where the diabetes patients would provide the diabetic perspective. Based on these criteria, and the cooperation with DiasNet six diabetes patients, two doctors and two nurses were selected to join the project. The selected participants and the reasons for choosing them are described more in detail in section 5.3.2.

After identifying the lead users the next task would be to actually derive the needs and requirements of these participants. The main concept chosen for deriving the needs and requirements, i.e. decoding the sticky information and the knowledge these participants contain, is based on what could be characterised as a joint user–healthcare approach. Somewhat in line with the joint user-manufacturer development of new products described by (Herstatt and Hippel 1992). Within this joint user-healthcare approach the users are represented by diabetes patients, and the healthcare system by doctors and nurses. As already described, the main focus of this project is related to collecting and deriving user needs and requirements for the further development of the DiasNet service but also in relation to the DiasNet cooperation between diabetes patients and the diabetes team, which is a very unique characteristic. The user needs and requirements derived through this work are passed on to the actual development team, which based on this input are going to develop new services and applications for diabetes patients, and further expand the scope and functionality of the current DiasNet service. The actual software and hardware development process is outside the scope of this project.

The overall method to derive user needs and requirements from the participants is based on a workshop approach. The workshop approach was chosen as it emphasises problem solving, team work, creativity and active involvement of the participants. Furthermore the workshop approach was chosen in relation to incorporating environment dependent and context aware variables as traditional mobile development approaches lack these dimensions, according to (Kjeldskov and Graham 2003; Kjeldskov, Gibbs et al. 2004). Also (Orlikowski 2000) is advocating for a more user oriented approach, as there seems to be a need for obtaining a better and more elaborated understanding of user needs and requirements and afterwards to translate these into future products. From a general mobile system requirement perspective, that main components are related to drawing social aspects into the development process and thereby creating a higher level of user acceptance and usefulness in practice. Thereby designing and developing services and applications that actually support the users in their everyday tasks and lives, i.e. a requirement oriented approach (Hosbond and Nielsen 2005). Opposite the normal and more general approach, where most

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applications and services are developed and designed based on what is technologically possible, without much attention being paid to specific user needs. In relation to the research done by (Kjeldskov and Graham 2003) described earlier, there seems to be an apparent bias towards environment independent and artificial settings within mobile system development. Also the mobility context, as described earlier, is believed to be represented within the workshop approach, i.e. the mobility of the participants and the different contexts within which the participants are present will be drawn out through the active involvement of the participants.

The user centred innovation workshop approach is believed to provide an ideal setting for deriving user needs and requirements, and thereby provide valid, context, and social related dimensions combined with specific needs and requirements as input in relation to future services and applications, that support the context and social environment within which the users are present. In relation to Hippel's four step model, the fourth step has not been a significant part of this case, as the main focus has been related to identifying lead users and to decode their knowledge into transferable information, i.e. gathering and collecting user needs and requirements from the frontrunners within the diabetes segment. However, outside the scope of this project, but within the DiasNet domain, some preliminary trials have been conducted, which will be followed by more substantial trials and pre-launch tests. These trials and tests will briefly be elaborated on later.

Finally, it is essential to mention that since the workshop took place in Denmark and with Danish participants, it was considered to be most convenient and beneficial for all entities if it was conducted in Danish, as this was the native tongue of all participants. Using English could be a constraint for the participants. This also means that the written content and language in the pictures from the workshop shown to document the process are in Danish. All results and other material are translated into English afterwards.

5.3.2. Participants

In order to cover a broad range of aspects in relation to diabetes in general combined with more specific experiences and perspectives it was decided to involve the following groups of people and professionals in the workshop: people with diabetes; nurses from the diabetes team; and finally doctors from the diabetes team. All the participants should be very familiar with the DiasNet service and have used it and found it beneficiary from both their own perspective, and in relation to communicating with the other groups of people within the DiasNet domain. However, this could potentially also

result in a bias, towards the DiasNet application, but this is regarded as less of a problem compared to involving diabetes patients with no knowledge of the DiasNet service. Arguably, some self-management tool manufacturers could have been involved in the process; however it was not possible to find anyone that wanted to and had the time to participate, hence these are not represented in the development process. The chosen trinity of representatives, i.e. patients, nurses and doctors is believed to provide an informative and representative sample for the workshop.

Based on cooperation with DiasNet and a specific diabetes team, six diabetes patients (two female and four males), two nurses (female), and two doctors (male) were selected/voluntarily agreed to participate in the workshop. The six diabetes patients were all working persons, covering an age distribution from the mid 20's to the mid 60's. Furthermore, all participants had been diabetics for a long period of their lives. Both the two doctors and the two nurses had worked as part of a diabetes team for several years. In general, this group of participants already had a motivation for technology developments and different diabetes support tools, as they have been involved in the DiasNet development project. Therefore all participants had some kind of experience in thinking about technologies and how these might help them in managing their diabetes and how this could improve the communication between the diabetes patient and the healthcare system. Overall, this was viewed as a positive feature since this group of people was not too distant from the idea of participating and contributing to the workshop.

In relation to the lead user theory the involved participants could arguably be categorised as not being truly lead users according to the original definition; lead users face needs that will be general in the marketplace before most others and are positioned to benefit significantly by obtaining a solution to those needs (Hippel 1986). In addition, originally the lead user concept was developed in relation to very novel products or in product areas considered as rapidly changing. Later research have however shown that the lead user method also can be deployed in fairly low tech industries cf. (Herstatt and Hippel 1992) less fast moving industries cf. (Franke and Shah 2003; Lüthje 2003a; Lüthje 2003b) and within software development cf. (Morrison, Roberts et al. 2000; Franke, Hippel et al. 2006).

The selected participants are believed to be among a group of people that based on their prior experience with DiasNet, will be among the first to require additional tools in relation to diabetes self-management and communication with the diabetes team, i.e. they could be characterised as being on the leading edge in relation to self-management tools for diabetes, based on the more broadly defined lead user concept

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within this thesis. Furthermore, some of the participants have over time made several contributions to the DiasNet development project. In addition, the format of the workshop is also expected to further support and enhance the idea generation of novel concepts or ideas in relation to self-management of diabetes and communication with the diabetes team, minimising the functional fixedness constrains cf. (Adamson 1952; German and Barrett 2005). Overall, this indicates that the selected group of people could be considered as persons among the frontrunners regarding diabetes self-management tools, needs and requirements thereby well suited for participating and contributing to the future development of diabetes self-management tools.

In relation to the second characteristic, i.e. all the involved entities are positioned to gain from new and better solutions, which originally was fairly much related to economic parameters, but over time has somewhat moved away from being only economic centred. From an economic perspective, the public healthcare system will most likely be the only one to benefit economically, i.e. reducing consultations, more distance communication, and less diabetes related diseases for the diabetes patients, which all, to some extent would lower the expenditure of the healthcare system in relation to diabetes patients. The non economic benefits will be the huge improvement in this situation, i.e. enabling a better and easier life for diabetics as their self-management of the disease together with the increased knowledge about diabetes and its symptoms, could potentially improve significantly. From the doctor and nurse perspective, they would be able to support, help and monitor the different patients better and thereby assist them in whatever problem they encounter, whenever they encounter it, i.e. providing very personal and context aware support. Overall it is therefore expected that both the general health care system, specialised diabetes centres, nurses, doctors, and in particular the diabetic persons will benefit significantly by deploying new or improved services and applications.

All in all the workshop participants are expected to provide valuable insights in relation to the innovation process and thereby the development process for new and more well suited services and applications based on: their current needs and requirements; their previous involvement in the DiasNet development process; the pre-existing knowledge of different technologies and tools to support self-management of diabetes, i.e. being among the frontrunners regarding the usage and deployment of diabetic support tools.

5.3.3. Workshop preparation

The basic setup for the workshop was based on a combined introduction and brainstorming session to get all participants actively involved in the workshop from the

beginning, contributing and discussing in relation to already known self-management tools for diabetes patients, combined with the doctor and nurse perspectives on the tools and DiasNet services. This would then be followed by a much more interaction and innovative oriented group work and group interaction regarding future needs, requirements, complications, challenges, and DiasNet in relation to being a diabetes patient. Allowing and supporting all participants to participate equally and having their views, needs and requirements discussed, commented and built on by other group members. In the group session, the participants were divided into two groups each consisting of three diabetes patients, one nurse, and one doctor thereby creating two fairly small groups, which allowed all participants within the group to work closely together and discuss possible future requirements.

Besides the invited participants, there was an overall workshop facilitator, one workshop note taker, two group facilitators and two group note takers. The group facilitators and group note takers were allowed to participate in the work of the group. However this participation was not to take over the ideas of the participants but mainly to secure that a process took place and that the relevant themes, user requirements, and ideas were discussed. In Table 5-4 the overall roles and responsibilities of the facilitators and note takers is described.

Roles	Responsibilities and tasks
Workshop facilitator	Conduct the overall presentations and introductions for the day and the task of the workshop Secure that creative ideas are used as basis for the group discussions Facilitate the plenum discussion on the existing diabetes tools Put an effort in strictly following the phases and the timing in the workshop Make sure that the two groups approximately follow the same scheme Can contribute to the group discussions by providing new ideas to the group/group facilitator
Group facilitators	Present the tasks for the group and ensure that the group follow a process in the right direction Ensure that everyone contributes - almost equally Make sure that the discussion is not dominated by one or two persons Make sure that the facilitator does not in any way dominate the discussions Is expected to participate to the group discussions to a certain level – providing ideas, examples, suggestions etc. when necessary Support the group to do the work and conclusions themselves Support the group in reflections and in construction of the life context landscapes Make sure to have contact with the workshop facilitator to keep track of time and to ensure that the life context phases are followed

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Workshop note taker	<p>Take notes and pictures of the whole workshop (not too many pictures; 5-10 pictures for each group and for the plenum sessions)</p> <p>Ensure that the overall process of the day is reported and documented</p> <p>Have a solely documentary position</p> <p>Must document both on the results of the plenum activities as well as the process of the workshop</p> <p>Must document in pictures the results of each group work and must therefore go between the groups when group work is carried on</p>
Group note taker	<p>Take notes of the group discussion and process</p> <p>Concentrate note on documenting both the results and ideas of the workshop as well as the process of the work in the group</p> <p>The group note taker is encouraged to participate in the group discussions following the lines for the group facilitator – by providing ideas, and constructive suggestions which may contribute to supporting the process – but should not act in a dominating way</p> <p>Support the group in the physical construction of the life context landscape</p>

Table 5-4 *Roles and responsibilities at the workshop*

5.3.4. Workshop toolkit

Overall the user centred innovation workshop is based on a high level of user involvement, which also can be seen in the toolkit developed. The toolkit is mainly based on creating a very interaction and innovative environment where the user involvement aspects are put forward and emphasised. During the development of the process and the toolkit, some inspiration has been found within the fields of human-computer interaction, participatory design, and creativity tools cf. (Osborn 1957; Kensing and Munk-Madsen 1993; Kyng 1995; Millar 1995; Gaver, Dunne et al. 1999; Iacucci, Kuutti et al. 2000; Amabile, Hadley et al. 2002; Kensing 2003; Gaver, Boucher et al. 2004; Higgins 2005; Boehner, Vertesi et al. 2007). In relation to the diabetes case, the user innovation and workshop toolkit consists of different elements and tools which will be used throughout the workshop in order to derive user needs and requirements from the participants in an innovative and effective method. The content and function of the toolkit provides to a large extent the solution space in relation to future need and requirements, however as the toolkit in this case is not completed deterministic for the outcome, there is room for needs and requirements outside the solution space. Within the diabetes case, one could argue that the toolkit also is related to the workshop process, i.e. the way and the purpose with which the workshop is conducted. The toolkit process, elements, and tools are explained in detail below.

The life of a diabetes patient is expected to be very different, depending on the age of the patient, and thereby also in relation to the different needs for self-managing tools or help regarding the usage of diabetes tools, which are expected to be very different over a life time. This implies that the needs and requirements of diabetes patients most likely will vary considerably over a life time. In order to include that dimension into the workshop and thereby into the future needs and requirements, the workshop groups had to create a diabetes life context landscape, consisting of four different phases in a diabetes patient's life: child, teenager, adult, and elderly person. Depending on the age of the child, some of the responsibility for diabetes self-management could maybe be left to the child, but some tasks will have to be done by or monitored by adults. However, the overall responsibility will still be with the parents, adults or different kinds of care takers. Being a teenager generally means being in a phase where they feel the need to declare their independence and individuality in many different ways and furthermore feel the need to belong to a group(s), e.g. group of friends sharing common interests, classmates etc. In the adult context the responsibility of self-management and consultations on a regular basis is your own responsibility, however the most prevailing demand could be related to actually retaking control of your own life in relation to the diabetes disease. In addition, an adult might have children or an old relative with diabetes, which they would like to 'monitor' or somehow keep an eye on. From an elderly perspective, the need for more surveillance might be an issue, due to various mental or physical conditions or weaknesses, which can be general health issues or complications linked directly to the diabetes illness.

Overall, the needs and requirements are believed to be very different, depending on age, therefore it is believed to be vital to be aware of these differences, hence the four life context phases. The workshop groups should therefore describe, be innovative, generate ideas and discuss how they could envision, predict, would like to experience being a person with diabetes or see future diabetes tools within these four life context phases. The same is valid to the nurses and doctors, i.e. what kind of tools could they imagine would help them in their future work with diabetes patients within these four life context phases. From a practical workshop perspective, a particular life context phase was determined to be related to a sheet of A3 format paper, i.e. each life context phase should be constructed or build on a sheet of A3 format paper, by using different kinds of tools and elements. Each group had to construct four A3 format life context phases, which was placed on an A0 format sheet of paper, thereby completing the group's life context landscape, which together with the discussions from the group work provided the output and thereby the results of the workshop.

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In order to make sure that as many topics as possible would be covered during the group workshops a list of questions divided into different themes was developed. The themes and questions within each theme should be used as inspiration and guidelines to what is believed to be important considerations in relation to future self-management tools for people with diabetes. However, these should not be seen as the only or right themes and questions, but as workshop instruments in order to get as broad a picture of expected needs and requirements as possible. Furthermore, these are also thought of as toolkit instruments, which the group facilitators could use as inputs to further discussion, if the group is somewhat stuck or has a hard time moving forward. Practically, the group facilitator had the themes and related questions on 'cue cards' each containing a theme and its related questions, which the group facilitator could give to the group members or simply ask them. The themes and related questions are listed below.

Usability

- How often will you use a diabetes related tool and in which situations (parties, travelling, at home, at work, at a café)?
- How easy should it be to use the tool?
- How much help should be available?
- Is it necessary with a high understanding of the processes and technology?
- How standardised must the tool be? Must it be compatible with other technical devices and systems?
- Should you yourself be able to solve technical problems with the tool?
- Should it be possible to use the tool without a manual?

Personalisation

- What kind of personal information must be included in the tool?
- Do you want the tool to recognise specific situations and help in the situation?
- Must the tool be an individual tool?
- Would you like to be able to find information about food in the tool?
- Do you like to be able to find other information in the tool?
- Do you want the tool to be anonymous?

User experience

- Which demands do you require of the tool?
- Must it be fun, smart, and trendy, with fun colours?
- Who should like the tool?
- Must it always be with you and always function?
- Are you willing to help when you are looking for information on the tool?

- Would you like the tool to warn you if you eat too much fat and sugar?
- May the tool suggest that you exercise more?
- Would you like the tool to be part of you as clothes or would you prefer to take it with you in a bag?

User interface

- How would you like to use the tool? By speech? Tabs? Touch screen? Advanced watch or bracelet? Build into your clothes? Intelligent band aid? Buttons?
- How large do you think the screen must be? The buttons, tabs?
- Which data would you like to find?
- Do you want to be able to see graphs? Pictures?
- Do you want to be able to make searches on the internet or other places?
- In which situations would you require extra information?
- What extra features would you like from the tool?

Economy

- Who should pay for the tool? And for the maintenance and usage?
- How much are you willing to pay for it yourself?
- How often do you find it fair that you can receive economic support from the society?
-

Ethical issues

- Who must/should know which information?
- Who must know that you have diabetes?
- Who must know about your treatments?

Security

- Who do you want to have access to your data?
- Who must/should know that you have contact with the doctor or that you find information on the internet?
- Who do you want your data sent to?
- Do you want your data to be sent to anyone automatically?
- How do you want your data to be saved?
- Is it important for you that the tool is safe for your health?

Legal issues

- Do you think your data should be secured and protected by laws and regulation?
- Must there be laws preventing your data to be linked to you if they are used for research purposes?

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Daily control

- How do you want to be checked at the hospital?
- Would you like to be able to have consultations from your home?
- Do you want to have access to the tools and data your doctor/nurse has?

Surveillance

- How much surveillance do you want - in terms of what you drink, eat, inject of insulin, etc?
- Do you want more surveillance of children at the kinder-garden and in schools?
- Do you think that more surveillance of the elderly people would secure a higher flexibility to do things on their own?

Emergency

- Which tools do you think are relevant when you have an emergency situation?
- Would you like to be alarmed when it is close to an emergency situation?

Education

- How would you like to learn more about diabetes? Teaching at schools, e-learning, books, Internet, diabetes communities?
- Could you imagine other ways to learn more about diabetes?

Community

- How much do you rely on support from organisations and communities in dealing with your diabetes?
- Do you want to have access to more support?
- What would you like to use such a supporting community for?
- Which tools do you think you can use together?
- Do you think that particularly diabetic teenagers would benefit from having more close contact to other diabetic teenagers?
- What about parents with diabetic children?

Mobility / Travelling

- How much do you want to be able to use your tools when travelling?
- Do you want to have mobile access and the same facilities as you have at home?
- What is most important when travelling?
- Do you need different tools/information in different contexts?
- Device versus personal mobility.

Societal support

- Do you think it is fair that you have to pay for your own tools or must the society support you financially?
- How and how much do you think that your self-payment should be?
- Would you like to be able to communicate electronically with the society to apply for financial support for diabetes tools?

Furthermore, and to bring out the more creative side of the participants a number of image elements were used to simulate different objects, situations and contexts. The image elements should serve as input to the different life context phases, representing different situations and contexts and furthermore representing different components and tools. To the workshop, each image element was made in several copies and cut out in order for the participants to glue these into the relevant A3 life context phase. The image elements are shown in Table 5-5 and Table 5-6.

Image elements				
				
				
				
				

Table 5-5 Image elements I

Image elements				
				
				
				
				

Table 5-6 *Image elements II*

In addition to the already described life context phases, the themes and related questions, and the image elements the workshop toolkit included a number of post-it notes, which the participants could write anything on and place on the different life phases. Furthermore the toolkit included a number of pens, colour pens, scissors, scotch tape, different sizes and coloured sheets of paper, modelling wax (plastine), and yarn. All included, so that the participants could think outside the box, draw, write comments, place pictures etc. and do whatever came to their minds, without any restrictions in order to construct the overall life context landscape. All participants were informed from the beginning to think outside the box, i.e. not to think that 'I cannot or will not tell/suggest this idea', 'that or this is a stupid idea' or something like that. Instead they were told to believe and think that everything is possible and that there is no such thing as a stupid idea, need, or requirement.

5.3.5. Workshop programme

The workshop was scheduled to last a day, starting at 10:00 and ending at 16:00, making it not too time consuming for the invited participants. Overall the workshop was divided into four main parts, which are briefly described below.

Welcome and introduction: Informing the participants about the overall goal and purpose of the workshop, and a general outline of the day and what they could expect as participants combined with a short round of presentation, where everybody gave a short description of themselves and their role in the workshop.

State of the art tools of today: Plenum user evaluation of the different diabetic self-management tools available today and how these fulfil the current needs and requirements of a diabetes patient, i.e. the pros and cons to these different tools. This approach was chosen in order to start the workshop on a very familiar and well-known topic to all the participants, so that they would feel comfortable and gain confidence in contributing to the workshop. Furthermore, the plenum session should also be seen as a first step in the process of creating a common language and common ground where all the involved entities can communicate, based on a mutual understanding of the domain in question.

Group work: The participants are split into two groups (three diabetics, a nurse and a doctor in each group) and given a thorough introduction to the life context landscapes they are supposed to create and the toolkit they should use to create these landscapes with, which all are laid out on the two group work tables. The two groups are told to start building the adult context phase, as they all themselves are within this phase. Furthermore they are told that there are allocated approximately one hour to each life context phase, and that it is the group facilitators responsibility that the two groups each build the four landscapes.

Presentation and summarising: After finishing the four life context phases and thereby the diabetes context landscape each group is told to present, to the other group, the most important findings, results, and discussions they have had during the group work session regarding the creating of these four life context phases.

5.4. Results from the plenum brainstorm session

The plenum session started out with an introduction by the workshop facilitator. After the introduction, the common brainstorming process began regarding all existing diabetes related tools, devices, technologies, discussion forums, health care situations, etc. In other words everything that makes a diabetic's life just a little bit different from

a non-diabetic's was brought forward and written down on a large whiteboard for later inspiration.

As expected the brainstorming activity yielded many viewpoints on different kinds of issues related to the life of a person with diabetes. In general, all the patients were very keen on managing and controlling their disease themselves by utilising different tools, services, devices, and technologies in doing so. This to some extent proved that the selected diabetes patients were not average users, but among the frontrunners or lead users within their field and in relation to the definition applied within this thesis, as expected in relation to the selection process. This assumption was confirmed by the two nurses and two doctors involved in the workshop, based on their extensive contacts to other diabetic persons. Furthermore, the patients' involvement, knowledge about, and contribution to the DiasNet project over time contributed to this observation. Overall, this confirms that the selected patient participants were among the lead users within the diabetes segment and in relation to the lead user definition applied within this thesis. During the brainstorm, the below main categories or areas were identified in relation to the patients' current situation.

5.4.1. Insulin pen

The insulin pen as we know it today was by the participants mentioned as one of the greatest breakthroughs within diabetes, as it is easy to carry around, easy to use, and it is easy to administer the correct insulin dosage. On the flip side, the pen is physically, a little too big. The insulin itself is hard to keep and handle in cold and warm environments, for instance when at holidays it is a nuisance always having to bring a thermo box around, when outside the recommended temperature range of insulin. Insulin has to be kept at temperatures between 0 - 25 degrees Celsius to work properly and thereby according to expectations.

5.4.2. Blood glucose meter

In general most blood glucose meters are working quite similarly. Most of the meters are able to save a number of measurements so the measurements can be read out in batches, e.g. to computer applications, mobile phones, or PDAs. Some of the meters are also able to calculate the minimum, maximum and average blood glucose concentration based on different entered parameters.

Many diabetics carry the blood glucose meter with them all the time. It is necessary when a snapshot of the blood glucose concentration is needed, e.g. before or after a

meal. The result has to be reliable and quick. The amount of blood needed is important; the best meters do not need very much blood to do an accurate measurement. The meters are generally very reliable, i.e. a measurement does not differ significantly and therefore only few repeated measurements are needed. A major drawback is that drawing blood requires pricking with a needle, which is irritating because it is sometimes done up to ten times a day. Especially in relation to children and teenagers, this can be a problem.

5.4.3. HbA1c

HbA1c is a subgroup of the red blood corpuscles. It would be preferred to be able to measure HbA1c with standard blood glucose meters, as it gives a measure of the summed value of the blood glucose concentration during approximately the last three months. However, this is not currently possible.

5.4.4. The professional diabetes team

All agreed that it is very beneficial that they are associated with only one diabetes team because it makes the communication and relations between the patients, doctors, and nurses more personal. Furthermore this also means that the diabetes team knows more in detail about a patient's background, history, and attitude towards the disease and the self-management of it. With DiasNet the communication between the diabetes team and the patient has improved, because data is continuously uploaded and better communication and thereby information means that a larger utilisation of DiasNet could potentially substitute some of the current consultations that diabetes patients have with doctors and nurses.

The main drawback in relation to the diabetes team is that with the current consultation frequency, most consultations are unnecessary and feels like a waste of time, as the diabetes team already has the necessary information through the deployment of DiasNet. Consultation booking issues are also mentioned as a problem, because it is hard to get an appropriate time slot and very often the medical doctor is for some reason delayed.

5.4.5. Diary

DiasNet has almost replaced the diary that diabetes patients normally use. All relevant data can be entered into DiasNet except notes and comments for specific measurements or days. Therefore, it is still necessary to note down special

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events/irregularities so they can be discussed with the diabetes team later on. The best thing about DiasNet is the blood glucose graph, which makes it much easier to view the concentration during a given time span. The insulin and carbohydrate bars are also very informative. It was suggested that DiasNet should be improved by incorporating functionality for entering physical activities and different kinds of sports activities. Furthermore, DiasNet can only handle two different insulin types, but as more types exist and are used by the workshop participants, hence in the future it would be preferable if DiasNet could handle more types of insulin.

In general the participants do not use DiasNet for entering only one measurement, because it is too tedious to start up the software (read: computer) sometimes up to ten times a day. In effect, the data are entered in batches, but the drawback of doing so is that it is sometimes hard to remember the associated time of day and other context relevant factors, besides the measurements themselves. DiasNet could be improved by having a SMS or mobile application functionality where it would be easy to enter just one piece of data at the time; then the data could be entered from anywhere at anytime.

5.5. Results from the two workshop groups

This section describes the results from the two workshop groups in relation to the four life context phases: adult, elderly, teenager, and child. The discussions, work carried out, and results within the two groups were fairly similar. The results from the two groups are therefore combined and described in relation to the four life context phases. At the end the most significant findings are summarised together with some general design, economy and security aspects that were discussed within the two groups.

Before starting on creating the future context phases the two groups were asked to describe what an average day in an adult diabetic's life is like using the different elements, pictures and office supplies described earlier, i.e. a current adult life context phase. Similar to the brainstorming session, this approach was chosen to get the participants started on something they were familiar with, i.e. building the first life context phase based on their current situation. Overall, the tools in focus were the insulin pen and the blood glucose meter, where the main focus was related to the blood glucose results that via a web-browser were entered into DiasNet, where DiasNet replaced the usually applied diary. Furthermore the computer is used to search for diabetes related information on the Internet, and information is also gathered through magazines about diabetes. The diabetes team is also considered a source to information, lectures, education, and advice, especially in the case of irregularities and

complications. In addition, the diabetes team is also mentioned as an important factor in relation to support in general family matters somewhat related to diabetes, contact to other persons with diabetics and in relation to the Danish Diabetes Organisation. In relation to diabetes the diet is an important aspect, as persons with diabetes have to be very aware of the food they eat, which also was a central element in the discussion.

Upon reflection on the participants' current situation and the current adult context phase created, the groups were asked to envision the near future. They were asked to imagine what possible new aids or tools they would potentially have and how these different aids and tools could help them in their everyday lives and self-management of diabetes, i.e. no strings attached, just imagine, predict, or fantasise as everything was possible. The four future context phases are described and summarised below in relation to user needs and requirements.

5.5.1. Adult context phase

Overall the groups seemed to agree that freedom and increased self-control are both key elements to a diabetic as their present freedom and self-control is limited by the equipment they have to use due to their diabetes condition. Both insulin and the blood glucose meter are sensitive to too high and too low temperatures with an approximately working range between 0-25 degrees Celsius. Furthermore they always have to carry the equipment with them, which sometimes can be fairly inconvenient, however this is a necessity. In addition, they need space (privacy) and have to allocate time to inject insulin two to three times per day and measure their blood glucose concentrations eight to ten times per day. This poses both a challenge to their memory, e.g. did or did they not take their insulin, how much insulin and what was the last blood glucose reading, as well as expose their condition and needs to their surroundings.

One of the initial ideas developed was a device that would be fastened or worn close to or in connection to the skin and would continuously measure the blood glucose level throughout the day. Initially the ideas were either a wristwatch kind of device or an intelligent patch like device. This would save the diabetic from measuring and thereby drawing blood out manually several times per day. The watch like device would display the blood glucose level at any time, as would the patch device through a small display. Where the watch was a more permanent solution, the patch could be a one off patch that was used for one measuring, or a one day patch which was attached in the morning and replaced the next morning. The idea evolved into the possibility of getting an alarm prior to the blood glucose level either getting too high or too low, such that the diabetic could react accordingly.

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Furthermore the discussion added the possibility of giving insulin or sugar water according to the alarm given, such that the diabetic would not have to do so manually several times a day. However, it was then agreed that if insulin was given continuously and as needed, sugar water would not be necessary, since the insulin level would then never get too high. One of the participants pointed out the problem of having a device the size of a wristwatch or bigger giving insulin, since the insulin would require more room and mechanics, than what could be fitted in either of those devices. This spawned the idea of connecting the intelligent measuring device with an internal insulin pump that would then administer the insulin, and also the possibility of this internal insulin pump actually measuring the blood glucose levels. This way the internal pump would communicate with an 'outside' device, informing about current blood glucose levels (possibly alarm) and the intelligent device would then respond with the amount of insulin that the pump should administer accordingly. This separation into two devices also opened up to the idea that the intelligent outside device could be a mobile phone allocation.



Figure 5-2 *Adult context phase*

To the question, whether the group could imagine other functions in this intelligent device, several ideas emerged. Today the blood glucose levels are plotted into DiasNet, but usually the diabetics collect the results from up to three days at a time or maybe even longer, and then enter the results into DiasNet in bulks. If this intelligent device already is receiving blood glucose levels from the internal pump or some kind of measuring device, it would be convenient if this intelligent device could pass the results on to DiasNet automatically, so it wouldn't be necessary to type the results manually anymore, i.e. some kind of synchronisation between the device or mobile phone application and DiasNet. Considering whether the results should also be sent to the diabetes team, the group agreed that this should be managed through some personal

settings, since the disease is the responsibility of the diabetic and not the diabetes team. Thus, if the results were to be sent automatically to the diabetes team, this would decrease the self-control of the diabetic.

In relation to the current available blood glucose meters it is not possible to enter carbohydrate and insulin intake into the device. However, if the blood glucose meters were extended in functionality, so that carbohydrate and insulin intake could be entered, the most relevant data could be entered and gathered in one device, so that the diabetics do not have to take temporary notes and then later on enter the data. In addition, a graphical illustration of the different values would be beneficiary to most diabetics. Or as one participant said, a mobile version of DiasNet, where the data from the blood glucose meter could be directly transferred or synchronised between the meter and a mobile phone version of the DiasNet application. This would mean no more entering of data and an instant graphical view of the current situation on a mobile phone. Finally there was a general agreement that the intelligent device should have a nice design.

5.5.2. Elderly context phase

After having considered what the future could be like given the participants current age, they were asked to consider what the future could hold for elderly people. Initially the groups started brainstorming about how the needs of an elderly diabetic would change compared to the needs of an adult diabetic. One of the first issues that came up was the complications resulting from living a long life with diabetes and the possibility of detecting these complications much earlier than it is presently possible, so that they can be treated at a much earlier stage. One example could be an eye scanner, scanning the eye of the diabetic for early signs of spots, which is a very common diabetes complication among elderly people. It is unclear, however, at what age these complications will start to show, if the diabetes is as well regulated as would be the case with the insulin pump and the intelligent device suggested in the adult phase landscape, or if they will show at all. One participant suggested that it would be very beneficial if it was possible to detect future complications individually at the stage where the diabetic is diagnosed with diabetes since not all get all of the complications. That way each individual would only have to worry about the complications that would arise later, specifically for her/him. This spawned a discussion of ethics, since the participants disagreed whether or not it was something that the diabetic should/would like to know. Some argued that the earlier you know it, the earlier you can start treating it, while others argued that it would result in a life lived in fear of when the next complication would arise, so they would rather not know in advance.

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The participants also discussed the possibility of the intelligent device being able to inform possible rescue or emergency personnel with the information they would need in the treatment of diabetics in case of unconsciousness or other emergency situations. This information could be; the fact that the person is a diabetic, but also the type and amount of insulin currently being infused, the blood glucose level, who to contact in case of an emergency etc. If such a device could detect unconsciousness, it should be able to send an alert and get help, and the position could be given via GPS coordinates.



Figure 5-3 *Group discussion at the life context landscape*

Furthermore the discussion was also related to and around care taking situations i.e. nursing homes, and how the contact with relatives could be improved and how this is related to the diabetes situation. In addition, many retired people travel substantially enjoying their retirement, which again led to the temperature issue regarding insulin. However, also the contact and communication to the diabetes team and DiasNet was considered especially valid when a long way from home and particularly in different emergency situations abroad, where the language can be a problem.

5.5.3. Teenager context phase

Upon exploring the future as an elderly person the groups were asked to go back from their current age and imagine what the future could be like for teenagers with diabetes. One of the participants actually had a son who is diabetic and as such he had experienced what problems lies in having a diabetic teenager. One of the main concerns is the rebellious tendencies that most teenagers encounter at some point, since this rebelliousness often expresses itself in an urge to ignore the disease in order to be just like every other teenager. The result is that the disease most likely is less well regulated and that is of course a concern to the parents. The parents will often try to

monitor the teenager, not with the purpose of checking up on their child, but only with the intent to monitor the regulation of the diabetes. This can often result in a conflict, since the teenager will fight such monitoring.

In case of the introduction of a intelligent device, it would be less obvious to other people that the teenager is diabetic, since the insulin infusion and the measuring of blood glucose levels will be automated and therefore not visible to others. Thus the intelligent device should be similar to some common device that a non-diabetic teenager would wear/own, like a wristwatch or a mobile phone. To further camouflage that it functions as a regulation unit for diabetes the watch should show the time like any ordinary watch. Furthermore the device will regulate the diabetes automatically, meaning that there are less issues for the teenager to deal with, and thus the risks will be less grave. Before this will be commercially available, if ever, the deployment of a mobile phone version of DiasNet as described earlier is believed to be very attractive to teenagers, especially if the readings from a blood glucose meter could be directly transferred to a mobile DiasNet application.

This will in return lessen the need for the parents to check on the teenager in order to monitor the diabetes. If the parents would like information on their teenager's diabetes anyway, which could be the case with especially newly diagnosed teenagers (as one participant mentioned 'when your child is diagnosed with diabetes, it hits not only the child; the whole family is diagnosed with diabetes'), this could be done by having a receiving device for the parents and then having the intelligent device communicate key results to the parents continuously. Alternatively, the parents could get access to the measurements on the teenager's device. That way the teenager would not feel as being under surveillance, since the parents would not need to know where the teenager is at, who the teenager is with, what the teenager is doing, etc. but only the key results of the diabetes data. At the same time the parents would have less reason to worry, since they would be able to detect anything out of the ordinary via the results. Thus this could create a less stressed environment for both the teenager and the parents.

Another possibility would be to avoid unnecessary confrontations, between teenagers and parents by providing the teenager with the possibility of having a fairly close contact to the diabetes team via the device. This would support the independence of the teenager in relation to the parents, while at the same time encourage the teenager to act responsibly regarding their diabetes. In addition the device should also contain trivia knowledge about diabetes, as this could aid teachers, coaches, and other adults in daily contact with the teenager. This information should be easily accessible to non-diabetics, whenever it could come in handy during their dealing with the teenager. This would also

ease the parents' fear of sending the teenager off on camp, vacation, staying at a friend's house, at sports, school etc. since those responsible for the teenager during this time would have readily accessible information about the disease and possibly even contact with the teenager's diabetes team.

Some participants suggested the possibility of the intelligent system having a GPS system built in, and sending the location of the teenager to a parents device. The participants however disagreed on this since some thought it would be too much surveillance, while others thought that since it was a much less intrusive way of keeping track of the teenager, it would be ok. Overall the teenagers' social life was discussed extensively, as it is very important for a teenager not to be different in any way compared to their friends. Therefore, the diabetes devices have to be as discrete, non-intrusive and non-obstructive as possible so that it is not readily noticed that a person has diabetes. Of course, this is also desired in the other life context phases, but it probably has the biggest social impact and importance in the teenage years.

5.5.4. Child context phase

In the final phase, the child context phase, the participants mainly considered in what way new innovations could aid young children coping with diabetes in relation to making blood glucose measurements and injecting insulin without actually having to sting the child. Since young children do not understand what it means to have diabetes, being stung by a needle many times a day is very unpleasant, both for the child but also for the parent or adult who has to do the stinging. Therefore avoiding needles would be a high priority and this could be done with the patch or watch like device described earlier together with some kind of automatic insulin injection device also described earlier. In addition, measurement of the body temperature would also be considered an important feature within child diabetes devices.

For young children with diabetes the contact between the parents and the diabetes team and also between the child and the diabetes team is very important. Therefore the possibility of doing consultations with the diabetes team over video connections would make it easier for the parents since they would not have to 'travel' to see a specialist, every time in doubt. At the same time the diabetes team, since they would be able to view the child, combined with information regarding the diabetes measurements have a much better basis for deciding if it is necessary for the parents to bring the child physically to the clinic or if the parent can handle the situation with some guidance from the diabetes team.

As with the teenagers, monitoring a child's diabetes figures is very important for the parents in order to make sure that everything is as it is supposed to be. In addition, the possibility of tracking the child if something is wrong is considered to be a wanted feature among the participants. And opposite the teenager context, this does not seem to pose a problem regarding privacy. From a parent perspective, a diabetes community for parents with diabetic children for instance in relation with DiasNet is also considered to be a very welcome service, where the parent can exchange information and experiences with others in the same situation.



Figure 5-4 *Child context phase*

5.5.5. Other considerations

At the end of the group work session both groups were asked to consider other related issues that they found important in relation to especially the cue cards handed out or other things that had not yet been discussed, but found important. Four main topics were discussed; design, functionality, economy, and security. The content and results of these discussions are described below.

In relation to design, the participants agreed that it would be imperative that the look could be individually adapted. The reason being that diabetes is a disease that can occur in all age groups and that each group has unique taste and is present in very different contexts. Children might want something more colourful, maybe looking like a toy, while teenagers might look for the more hip, fashionable, and cool looking devices. Adults might go for a more professional look. Furthermore the two genders might favour different designs as well. The way to wear a device can vary too, since some might prefer a wristwatch like device, others a belt clip or a mobile phone like kind of device and yet others might prefer to have it in a chain around the neck.

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In relation to functionality, the functionality of an intelligent device was discussed, and the participants agreed that it of course should be easy to use. How this was achieved, however, the participants disagreed on. Some thought that one should be able to do everything on the small device directly (in order to maintain the freedom and self-control discussed earlier), while others would rather have only the most needed functions on the device itself, while all the individual settings and functions used more rarely could be available through connecting it to for instance a computer. Essentially the discussion was the dilemma between wanting total self-control on the device and not having enough room on the small screen of the device. The compromise was that the primary screen should support all the functions that you would need on trips, vacations, when going out or doing sports and everyday situations, while the functions that you either use rarely, that only needs to be set once or that you only use when you have the spare time to do so, should be in a second layer, that could be administrated when connecting the device to a computer.

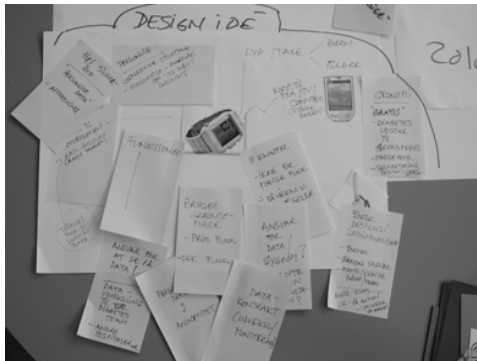


Figure 5-5 *Design considerations*

Possibly this could also be done by connecting the device to a PDA or mobile phone, which would still ensure the freedom. Furthermore it should have sound for the most common functions and the possibly of speech recognition (speech to written or written to speech functionalities) to cater to young children who can't read, people who cannot hear or see, i.e. enhance the user interface with the speech recognition functionality for improved convenience for many different kinds of users. In addition, it should be personalised and act intelligently according to the results the device is receiving from the insulin pump, and it should also contain a memory to help the diabetic remember meals, consultations etc. Last but not least it should be able to communicate with other devices and with the diabetes team.

From an economic perspective and in relation to who should finance such a device, the participants agreed that since such a device with the basic functions regarding diabetes could save the health system a lot of money due to a much better regulated group of diabetics, the device should be paid for by the state. One participant even envisioned that since it could potentially introduce massive savings, it would not even be a voluntary thing to use, but would be the default device, and a diabetic wanting to use the 'old' system would have to pay for that. Therefore the device would also have to be free of charge for the user, and would have to come with some form of training in using it. On the other hand, if the diabetic choose to have some of the many extra functions, this would have to be paid by the diabetic. This would work much like today's mobile phones, where the models with the most functionality and the fanciest design often cost the most, while the mobile phones with only basic functionality and design is affordable to most people.



Figure 5-6 **Complete life context landscape**

The security of the information in the device and during communication should be very high, the participants all agreed on this, since it is sensitive personal data, which the diabetic wants to control. This also includes deciding who gets the information, how much of it they get, when they get it, if it is linked to a name or is anonymous, and what the information may be used for. Aspects were discussed around the possibility for hacking information and using it for blackmail. That was not wanted of course. The participants agreed that as long as the data was anonymous, they had no problem with it being used in a context of, e.g. research or statistics. They also agreed that it could be an advantage to them that all hospitals had access to the data, since it would probably ensure them a faster and more correct treatment, in case of the diabetic not being in a condition to give the information. In relation to security, the participants also discussed where the data should be stored, and who should be responsible for

maintaining and securing these data and for how long the data should be stored. There was no clear answer to these questions, but in general terms, the participants expected the security issues to be handled very professionally. The discussion furthermore raised some ethic topics: Who, if any, is responsible for monitoring the incoming data, and react in cases of abnormal data? When do you have an official consultation with the diabetes team if they continuously receive data? Is the consultation also ongoing? Who is to blame if the data is not viewed and as a result the diabetic gets ill? The participants agreed that these definitely were issues that would need to be addressed.

From inkjet technology to micro needle drug patch

Researchers at Hewlett Packard laboratories have together with Irish Crospon (a medical device developer) engineered a drug patch that painlessly delivers medications through the skin via tiny micro-needles based on Hewlett Packard's inkjet printer technology. The patch is outfitted with hundreds of micro-needles and could potentially deliver multiple drugs at pre-programmed intervals, without the pain and hassle of conventional needles. Opposite for instance nicotine patches, which are based on skin absorbing drugs, the new patch penetrates the outer layer of skin and thereby delivering a given drug directly to the underlying capillary bed without triggering nerve endings located deeper in the skin. The prototype patch, which is about one inch square, contains 400 cylindrical reservoirs, each less than one cubic millimetre. Each reservoir is connected to a micro-needle, and the whole array is fuelled by a low-power battery and controlled by an embedded microchip that's programmed to heat up any given reservoir to deliver a specific drug. The patch could for instance be used to painlessly deliver insulin, to people with diabetes or the possibility of delivering multiple drugs through a single patch, over a long period of time. The array is also scalable, and it can be designed to contain tens or even hundreds of reservoirs, depending on its intended therapeutic use. Down the line, the patch may be customized to the patient. For example, tiny sensors embedded in a patch could detect when medication is needed and treat an asthma attack in the middle of the night or a patch could automatically deliver insulin when it detects that glucose levels are low.

(September 2007)(<http://www.technologyreview.com/Biotech/19365/page1/>)

Table 5-7 From inject technology to drug patch

5.6. Workshop process discussion and conclusion

This section contains an overview of the results from the user centred workshop in relation to the participants' evaluation of the workshops, the deployed toolkit, and a discussion of the different toolkit elements. Furthermore the most important results, i.e. ideas, needs, and requirements drawn out and generated at the workshop will be highlighted and summarised. Also the overall user involvement framework applied within the thesis will be analysed in relation to the entire workshop process, user involvement, workshop approach, toolkit, solution space, and the user developed ideas, needs, and requirements generated in relation to future service and application concepts.

At the end of the user centred innovation workshop, all participants were encouraged and asked to give their opinion on the workshop and the results derived. In general, all participants found the workshop very inspiring and appealing in relation to generating ideas and discussing these ideas. Especially the fact that both diabetes patients and members of the diabetes teams, i.e. nurses and doctors were represented was mentioned as a great advantage, as it gave a very realistic and practical perspective on many of the generated ideas and discussions. Also the concept of the life context landscape was mentioned as important, as there are very diverse needs and requirements depending on where a diabetic patient is in their life. The toolkit, i.e. image elements, post-it notes, cue cards, pens, lift context phases, etc. were also emphasised as inspiring and easy to work with, as the participants could just write an idea on a post-it note and others would comment on it, further build on it, elaborate on the idea, or use a picture to illustrate a given context. Overall the participants were all very positive in relation to having been part of the workshop and the process within the workshop.

From a planning and execution perspective, it was clear that the participants found the developed toolkit stimulating and the participants generated a lot of good ideas and had some fruitful discussions among each other. In general and as already mentioned under the participants' evaluation part, it was obvious that the diabetic / diabetes team participant combination had a positive spillover effect on the idea generation process and in relation to how the two groups could and would like to interact and communicate in the future. Starting the workshop with a plenum discussion and brainstorming session on the participants' current situation and the self-management tools they use as diabetes patients and the pros and cons of these tools, seemed to get everybody involved in the process. Furthermore, and as expected, it created a common ground for further work within the groups. On the negative side, some more time could have been allocated to plenum brainstorming session, as it was stopped somewhat abruptly in

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order to keep the time schedule and therefore proceed to the next topic. Some additional time would certainly have drawn out more situations, concerns, and facilitated more discussions in relation to the participants' current situation during the brainstorming session. However, most of what was not told and discussed during the plenum session due to time constraints is expected to have come up within the generation of the life context landscapes.

In relation to the developed life context phases, it is also believed that this was a very well suited tool for making the participants think about and generating ideas for diabetes patients in different life contexts, as was also stated by the participants themselves. Letting the participants start with generating their current life context phase, was a natural continuation of the plenum session and the participants started right away. Thereafter, the work continued on the four future life context phases, thereby creating a complete life context landscape. Also the cue-cards worked out well, especially in relation to having as many topics as possible covered and discussed during the group work. Furthermore they also worked out well in relation to the facilitator introducing something new, if the idea generation process and discussion was coming to a stop, i.e. if the participants got stuck or needed some new input to get going again. However, on the negative side, there were probably too many cue-cards and some of the cue-cards had too many questions on them, which sometimes resulted in what could be termed as information overload for the participants. Furthermore the number of cue-cards also resulted in that not all cue-cards were used in creating the different life context phases.

The different image elements within the toolkit were well received and used to indicate different situations or contexts in relation to the different life context phases. However, from a planning and execution perspective, a large amount of thoughts have to go into actually selecting these image elements, as it was obvious that the image element depicting a fancy wristwatch were used extensively by all participants. From a participant perspective this image element was seen as a very intelligent almost 'everything is doable' device and one can only speculate about, if the results, discussions, and ideas generated would have been any different if this particular image element had not been included in the toolkit. On the other side, when using image elements as in this case, there will always be some image elements that are more popular than others. Therefore, it could be viewed as a trade off between using image elements where some most likely will be over represented, compared to not using or using very similar image elements. All in all, it is believed that the selected image elements represented a wide variety of situations and contexts and that they inspired the participants to construct the life context phases.

Somewhat in relation to the impact a single image element can have, it is also paramount that the facilitator is very aware of her/his role, within the group, as this was carried out in fairly small groups. This implies that a 'strong' facilitator can have a very significant impact on the discussions, idea generation, and results within the group, whereas a 'weak' facilitator might not be able to steer the process. Overall, this did not seem to be a problem throughout the workshop, but the different roles were also well defined beforehand. The same is valid for the note taker roles, as they were also allowed to somewhat participate in the process.

The below bullet points randomly highlight the most important user needs and requirements derived from the user centred innovation workshop both in relation to fairly short term improvements and in relation to more long term and more futuristic solutions, needs, and requirements. In addition, it should be mentioned that user tests have been carried out in relation to a mobile version of DiasNet, which was developed based on the old web-based version combined with some additional functionalities based on input from the workshop. The intention of the people behind DiasNet is to further develop the mobile version of DiasNet in relation to the user needs and requirements gathered through the workshop combined with actual test results.

- All measuring devices should be able to measure ketones and HbA1c levels. In addition, these devices should have a fairly large storage capacity for measured data, so the measurements can be read out in batches, if necessary or preferably.
- The measuring device should be able to display the current measurement in numbers, graphical display of measurements and also graphical display of historic data.
- The measuring device should be able to communicate with other devices, e.g. computers, mobile phones, DiasNet, PDAs etc. via wireless or wired connections and thereby transfer the measurements to one or more preferred devices based on predefined settings, i.e. synchronisation functionality.
- If the measurement device and insulin pump are separate entities, there should be a wireless communication between the two, allowing the insulin pump to administer the correct amount of insulin compared to the current reading. Furthermore, there should be a wireless connection to a tired device, e.g. a mobile phone, PDA etc.
- Most current insulin pens are a bit too large, somewhat smaller physical devices would be preferable from a diabetic perspective.

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- The design of the measuring devices should be appealing and tailored to the different life context phases, and furthermore very robust with regards to physical impacts from the environment.
- Insulin should be more temperature independent, i.e. it should have a larger functional temperature range compared to today's 0-25 degrees Celsius range.
- If possible, no needles should be needed to draw out blood. In an ideal world the measurement device should be able to continuously measure the wanted reading, without having to use needles to draw out blood, i.e. a patch or wristwatch like devices or an internal device which communicate with an outside device, e.g. a mobile phone.
- Continuous readings of blood glucose levels etc. are a preferred feature, as this would allow the diabetic to constantly monitor the current levels, which together with alarm functionality, would allow the diabetic to control and manage their blood glucose level perfectly and thereby most likely avoid some of the related symptoms of diabetes. In addition, automatic injection of appropriate amounts of insulin, from an internal insulin pump or external patch like insulin pump, based on the above readings would be highly preferable to all diabetics.
- The communication and interaction with the diabetes team, could be improved significantly through a more sophisticated and mobile version of DiasNet, allowing the diabetic to constantly and automatically (based on predefined preferences) upload information regarding readings and related information to DiasNet and the diabetes team. Furthermore, more interaction between the diabetic and diabetes team should be supported by different devices, e.g. mobile DiasNet application. In addition, extended diary functionality, commenting fields, usages of different insulin types, community based functionalities to support communication and interaction with other groups of diabetics, entering of physical activities, and the possibility of searching for diabetes related information would be preferred within the DiasNet domain.

In relation to the overall user involvement framework deployed within this thesis, there is no doubt that the extended, active and at the same time independent user involvement from the different participants has provided both valid and substantial ideas, user needs, and requirements in relation to future service and application concept within the diabetes domain. Furthermore it is clear that the future service and application concepts are very context and support related, thereby supporting the

diabetics in their every day lives. This confirms that the users with relatively simple tools and methods can be actively involved in and contribute to the innovation process, and that the result is a more comprehensive and in depth understanding of user needs and requirements in general and particularly in relation to within which context the users have these needs and requirements. The user involvement in the innovation process is in this thesis defined as a high level of user involvement, which also is the truth in the diabetes case, as the users have been actively participating in the workshop, i.e. the brainstorming session and the following group work where the different context phases were constructed.

From a lead user perspective the selected diabetes participants can be categorised as frontrunners or lead users in relation to the definition deployed in this thesis, which is somewhat broader compared to Hippel's (Hippel 1986) original definition. The selected participants all seemed to be very eager to participate and give their input to the workshop; one of the participants actually asked when they could expect their ideas to have materialised into commercial products they could buy. In addition, the participants also seemed to be very knowledgeable and well informed about diabetes in general, but also in relation to the different tools used by diabetics, especially in relation to available software applications, blood glucose meters and insulin injection devices. This broad and also very specific knowledge underline the assumption that the selected participants were among the frontrunners within their field. This was also confirmed by the two doctors and two nurses that participated, based on their knowledge from the diabetes team and general knowledge about diabetes and diabetes patients.

From a theoretical lead user perspective, one could argue that some participants should have been found outside the diabetes environment. Furthermore, it would have strengthened the output if one of more participants from a blood glucose meters or insulin pen manufacturing company (R&D departments) would have participated in the workshop; however this was not possible at the time. Nevertheless, it is expected that the generated ideas, user needs, requirements, and concepts to some extent will be incorporated into future products, services, or applications, or at least provide substantial input to future products, services, or applications within DiasNet and diabetes domain.

The developed toolkit for deriving user needs and requirements has proven its potential based on the diabetes case and the derived results, i.e. decoding and transforming the sticky information, which the participants contained into less sticky and transferable information. The overall workshop process has provided an innovative environment for the participants, which combined with the content of the toolkit have provided a both

active and user involvement intensive process. Furthermore the toolkit has emphasised the importance of drawing in social and context related parameters in order to develop future services and applications that are actually based on real user needs and requirements and thereby support the users in a given context. The mobility context aspects have also been highlighted as important, i.e. when mobile, the user can be in various contexts and thereby have different needs and requirements at any given time. However, there are also some elements that should be improved or rectified, or that one needs to be very aware of in relation to the deployment of a similar toolkit as described earlier. Nevertheless and based on the diabetes case study the overall conclusion reached, underline and support the usefulness of an extended user involvement in the innovation process, the concept of lead users, and the deployment of a relatively simple innovation toolkit within a not too fast moving industry.

5.7. Summary

Based on ongoing research within the field of diabetes and in particular regarding an existing diabetes service called DiasNet, the main objective of the diabetes case study has been to collect and derive user needs and requirements in relation to self-management and preventive treatment of diabetes and diabetes related symptoms. The derived user needs and requirements serve as input to developing future service and application concepts that would support diabetic persons in their everyday lives.

This has been done by applying the lead user and toolkit method within the user involvement in the innovation process framework and based on conducting a workshop with diabetic patients, nurses, and doctors. The overall purpose of the workshop was first to get a current picture of the tools and equipment that diabetics deployed and how these fulfilled the current needs and requirements of a diabetic patient, i.e. the pros and cons of these tools. This was done by conducting a brainstorming session. Second, it was to derive user needs and requirements in relation to future service and application concepts that would support diabetic persons in their different life contexts. This was done by developing and deploying a so-called workshop toolkit, which was based on a very interactive and user intensive environment within which the participants had to create four life context phases representing different life stages of a diabetic person: child, teenager, adult, and elderly. The four context phases were chosen, to derive context specific user needs and requirements, as the life of diabetic patients was expected to be very different, depending on the age of the patient. In addition to the life context phases, the toolkit consisted of: cue-cards with specific themes and related questions, image elements, post-it notes, and a number of pens, scissors, scotch tape, etc. All included, so that the participants could think outside the

box, draw, write comments, place pictures, etc., and do what ever came to their minds, without any restrictions in order to construct the life context phases.

In relation to the results, the brainstorming session yielded many viewpoints on different kinds of issues related to the life of a person with diabetes and what makes the life of a diabetic just a little bit different from a non-diabetic. In general all the patients were very keen on managing and controlling their disease themselves by deploying different tools, services, and devices in doing so, which to some extent confirmed that the selected patients were among the lead users within the diabetes segment. This was also confirmed by the nurses and doctors participating in the workshop, based on their experience. In relation to the developed life context phases, and thereby the deployed toolkit, a number of potential future service and application concepts were developed and suggested by the participants. The life context phase generation process provided an innovative environment for the participants, which combined with the content of the toolkit, supported both an active and highly user involvement intensive process. Furthermore the toolkit emphasised the importance of combining social and context related parameters in order to develop future service and application concepts that actually are based on real user needs and requirements and thereby support the users in a given context. Also the mobility aspects has been highlighted as important, i.e. when mobile, the user can be in various contexts and thereby have different needs and requirements in relation to these contexts.

6. Journalist case

6.1. Introduction

The main objective of the journalist case study has been to derive and collect information on user needs and requirements for journalists in general and especially for sports journalists by applying the theoretical user involvement in the innovation process framework. This has been done by applying the lead user method and a toolkit all within the user involvement in the innovation process framework and in relation to mobile system requirements and mobility. In other words, the main goal has been to collect and draw out user needs and requirements regarding journalists in order to provide input for future services and applications, which support journalists in their everyday working environments, based on an extended user involvement in the innovation process.

The journalist case has been conducted in collaboration with the sports department at a large Danish broadcasting company. The overall focus of the journalist case has been to gain an insight into the demands of professionals working in a highly mobile environment, with very demanding system requirements. The highly mobile and communication intensive environment implies that the design of efficient and supportive service and application concepts in this context is rather complex.

Based on the overall theoretical framework for user involvement in the innovation process, the lead user, sticky information, and toolkit method have been deployed in order to derive user needs and requirements. These methods have been deployed through: participatory observation of the lead user journalists; a survey among the sports journalists to obtain a more detailed and quantitative understanding of their current use of information and communication technologies and their level of mobility; and a mobile toolkit, which has been developed and deployed in relation to obtaining user needs and requirements in a very mobile environment.

Overall, this chapter is divided into the following four sections. First there is a general description of the case background, i.e. the sports department at the broadcasting company. The second section describes the overall setup of the user involvement in the innovation process and how the journalists are involved in the project and how the user needs and requirements are expected to be extracted from the users, i.e. decoding the sticky information through the use of a mobile innovation toolkit, participant observation, interviews, and a general survey. The third section describes the process and work conducted in relation to the survey, mobile toolkit, and participatory observation, together with the results derived from the work carried out within the three methods applied. The fourth and final section summarises the results and evaluates the tools deployed and the overall process.

6.2. Case background

The case study has mainly been carried out within the sports department, which is part of the news department at the broadcasting company. However, as mentioned in the introduction the journalist case study is an aggregated case study, which contains part of a MAGNET related case study and the sports journalist case study. As the main emphasis is on the journalist aspects, and in particular the sports journalists and as there were a significant overlap between the two cases, this case background description will only concern the sports journalist case and thereby also the broadcasting company.

Overall the sports department is working within very tight time schedules and with very strict and specific deadlines. The journalists and other personnel therefore have to deliver a certain amount (minutes) of sports news for most major broadcasting schedules throughout the day, particularly for TV and radio broadcasting. In addition, they also have to deliver different kinds of sports news, results, and extended background information made available via the Internet, TTV, and mobile platforms. Besides delivering sports news, mainly in relation with major news broadcast programs and in relation to dedicated sports programs, the sports department is also responsible for broadcasting from both national as well as international sports events. Furthermore, the sports department is responsible for broadcasting from major national sports events throughout the week, e.g. weekly TV and Radio transmissions from the Danish premier league football tournament, premier league handball, etc. In addition, the sports department is also producing documentary like productions, i.e. specific sports programs mostly on hot topics, in-depth programs on different aspects, or programs on specific sports profiles.

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The news desk in the sports department is the central point in relation to news gathering from different news sources. The main sources are information from news agencies, news and stories from the journalists and of course from specific sports events, e.g. a football match, major sports tournaments, and sports events of all kinds. The news desk is physically a roundtable, where personnel from all output platforms are represented (mainly TV, radio and Internet) collecting, sharing, and distributing information for the different platforms. Some people might have the responsibility for several output platforms at the same time and it may happen that some level of competition between the different output platforms occur, regarding being able to bring the stories first. However, there might be some prioritisation regarding which output platform should bring a specific news story first, and normally it is coordinated among the persons around the news desk or by a news director. A certain part of the information collected at the news desk is distributed directly to the different platforms, meaning that news is forwarded from the news desk to the persons responsible for a specific output platform and they then edit the story and broadcast it via TV or radio or make it available on the Internet, TTV, or mobile platforms. A second part is researched further and elaborated on by journalists or other personnel. Finally, some news stories and bulletins are just disregarded as not important or left out due to an already packed output platform/program.

Regarding priority of output platform, TV and radio are the two most important output platforms. During morning hours they are more or less equally significant, whereas radio is the most important during the daytime. During late afternoon and evening hours TV takes over as the most important news media. The Internet, mobile, and TTV platforms are somewhat secondary media platforms, but still important. These platforms are mainly used to support the TV and radio platform, e.g. bringing the whole story, elaboration on a story, or news that are not broadcasted via TV or Radio. In addition, the Internet, mobile, and TTV platforms are used for broadcasting sport results and news bulletins and in particular the mobile platform is used for distributing personalised information to the end users.

Output for the Internet, TTV, and mobile platforms are mainly based on news gathered from the news desk together with TV and radio productions from the sports department and local TV and radio productions from the different regional offices that are converted into the right output formats. It is rarely the journalists or personnel producing the original story that actually transforms it to the other output platforms. In these situations personnel with specific competences within a specific output platform convert the original story, based on the original material, to the new output platform with whatever alterations necessary. This could, e.g. be shortening the story, expanding it,

twisting the viewpoint, etc. to make it fit the new output platform and content. This also means that almost all productions are primarily made for TV or radio, and afterwards converted and secondly made available via the other platforms. Only very few news stories are made primarily for the Internet, TTV, or mobile platform. However, this is, according to the news director, one of the things they would like to change, i.e. making the specific stories, programs, and features for the right platform the first time. This means that the journalists should, besides producing the primary TV or radio stories, also should produce a secondary Internet or mobile platform story, thereby avoiding the process of transforming and converting TV and radio stories into the other platforms at a later time.

One of the major goals of the sports department is therefore to implement cross media competences among journalists, photographers, reporters, and other personnel in order to strengthen the spread of news across platforms and at the same time shorten the time to market, as stories from idea to final story are produced to several platforms initially, i.e. cross media competences. The cross media perspective can be viewed from both an outward and inward perspective, where the outward perspective is related to the end users, i.e. focusing on cross media promotions, cross media news, etc. to enhance the added value to the single user. Inward cross media competences are related to focusing on cross media productions, by involving and producing to different platforms from the beginning and thereby incorporating a cross media routine to enhance the efficiency of the organisation. In addition, the inward cross media competences are also related to a new division of labour, where employees will have to work with several output platforms. The vision is, that they will also have to fulfil different tasks/functions within these output platforms (Petersen 2007).

From a sports journalist perspective, most of the sports journalists in the broadcasting company are very mobile as they have to follow and report from a number of sports events around the country and internationally, mainly via the TV or radio platforms. In addition, most sports journalists are highly specialised and have a primary branch of sport that they follow and report from, and which takes up a significant amount of their working time, i.e. during research, following the branch of sport in general, specific teams, etc. In general, most sports journalists travel from one sports event to the next, using the major part of the time between the events to prepare for the next one combined with obtaining general knowledge of their primary branch of sport, e.g. talking to players, coaches, etc. In addition, the sports journalists also have one or a few secondary branches of sports that they have to cover for the broadcasting company, which mainly are covered by producing written material for the Internet and TTV platform combined with the radio platform.

Both the sports journalists' personal level of mobility and the demands for the mobility of deployed equipment are extreme, as the journalists are more or less constantly on the move between sports events and preparing for their next assignment. Therefore, the mobility aspect of sports journalists is believed to be a significant parameter, both in relation to personal, equipment, services, and application mobility and thereby also in relation to the needs and requirements of sports journalists cf. the different mobility aspects described earlier. In other words, sports journalists are believed to be highly context dependent, obviously in relation to a specific sports event but also from a mobility, user need, and requirement perspective.

6.3. User involvement in the innovation process

This section focuses on actually retrieving user needs and requirements from a journalist and nomadic professional perspective, which will serve as input to future journalist services and applications. Overall, this will be conducted deploying three different approaches: 1) a general questionnaire within the sports department, which is expected to provide some general information on the current tools and communication patterns of the sports journalist; 2) deployment of a mobile toolkit within a group of nomadic professionals, which is believed to provide a somewhat general picture of user needs and requirements from the perspectives of nomadic professionals in very mobile environments and at the same time testing and validating the concept of the mobile toolkit; and 3) participatory observation of sports journalists and reporters in relation to a major sports event, which is expected to provide valuable insights into the work and work processes of sports journalist in particular. The combination to these three methods of collecting user needs and requirements are expected to provide a well balanced trinity, which will provide valuable insights into the journalist and nomadic professionals sphere. Furthermore, combining the above trinity, with the mobile system requirement and mobility perspectives described earlier, it is expected to provide a strong and powerful approach for collecting and drawing out user needs and requirements.

As described in chapter two the four step integration of lead users into the innovation process suggested by (Hippel 1986) is: 1) identify an important market or technical trend, 2) identify lead users within the selected trend, 3) analyse lead user data, and 4) project lead user data into the general market. Overall the PhD project is as earlier defined mainly related to the second and third step, as the journalist and nomadic professionals cases were part of the project from the beginning; therefore no trend and important market identification and selection process have been conducted actively. However, potential needs and requirements, i.e. potential future products, services, and

applications for journalists and other highly nomadic professionals are believed to provide valuable insights to the future needs and demands of more traditional users. In the past, the device, service, and application development has mainly been driven by demand within the business segment, however not always based on needs and requirements. Therefore the needs and requirements, i.e. trends within the journalist and nomadic professional segments are believed to provide important aspects in relation to future and more general use. Also the concept and further development of the Personal Network concept could be viewed as an important technological trend. However, as all these aspects were given and as they were a dedicated part of the PhD project from the beginning, no real identification work in relation to identifying important markets or technical trends has been conducted.

In relation to step two, i.e. identifying lead users within the selected trend, the selection process was given for the journalist part as the people from the sports department was a given group of people. However, based on interviews with managers and other key people at the sports department, a few journalists and reporters were selected as the lead users among this group of people and identified as key persons, i.e. the persons to best fit the previously defined description of a lead user. Within the nomadic professional case, the selection was done in relation and cooperation with the MAGNET project. Here the selection was mainly based on the following parameters and qualifications; general technology awareness, journalist or nomadic professional, a genuine interest in contributing and giving input to future products, services, and applications that support journalist and nomadic professionals in their everyday tasks, combined with the ability and personal drive to participate actively in the project. After identifying the lead users the next task would be to actually derive the user needs and requirements of these participants. The three main methods chosen for deriving the user needs and requirements are: 1) the deployment of a mobile toolkit; 2) participatory observation of sports journalists and reporters; and 3) a general survey combined interviews with key people within the sports department. The two first approaches are based on the theoretical framework of user involvement in the innovation process and methods and a more general quantitative and qualitative approach for the last method. The three approaches and methods are described more in detail within the following sections.

The user involvement in the innovation process theoretical framework is expected to provide a suitable method for deriving user needs and requirements, and thereby provide valid context and social related dimensions combined with specific needs and requirements as input in relation to future service and application concepts, which as a result actually support the context and social environment within which the users are

present. In relation to Hippel's four step model, the fourth step has not been a significant part of this case, as the main focus has been related to identifying lead users and to decode their knowledge into transferable information, i.e. gathering and collecting user needs and requirements from the frontrunners. Finally, it is important to mention that since the tasks and work took place in Denmark and with Danish participants, it was believed to be most convenient and beneficial for all entities if it was conducted in Danish, as this was the native tongue of all participants. Using English could be a constraint for the participants. The material and results presented have been translated into English afterwards.

6.4. Survey

The overall purpose of conducting a survey at the sports department was to obtain a more detailed and quantitative understanding of the current use of communication technologies and the different levels of mobility, in particular in relation to the journalists and reporters, i.e. deploying a quantitative research approach to obtain additional information concerning specific characteristics within a particular sample. The usages of communication technologies are in this context closely related to the affordance of these, i.e. how useful and supportive are these communication technologies in relation to the specific tasks (Whittaker 2003). The level of mobility is related to the mobility of the journalists and reporters, i.e. how much time do they spend away from the office. Both the current technology affordance and the level of mobility among the journalists and reporters are believed to be important parameters, which have to be taken into account when developing new services and applications. This implies that it is important to understand the current use of technologies and the usefulness of these, combined with the level of mobility among the journalists and reporters as most of these are highly mobile.

6.4.1. Technology affordance

The different concepts and levels of mobility have been described earlier. Therefore this section will briefly focus on the affordance of communication technologies, before going into details regarding the results of the survey. Different communication technologies come into play, given the limitations of face-to-face communication, i.e. the distance within which speech will be audible and thereby understandable and the distance within which gestures and behavioural expressions will be viewable combined with the fact that these do not persist over time. In one category we have the phone, videoconferencing, instant messaging, and similar communication tools allowing for synchronous communications independent of distance. Another category is e-mail,

letters, fax, etc. allowing for asynchronous communication independent of time and distance (Whittaker 2003).

However, as these tools and technologies differ in their usefulness and support of communication in various contexts, it is important to understand the different capabilities and limitations of the tools and technologies used to facilitate communication, i.e. the affordance of these. ‘...the term affordance refers to the perceived and actual properties of the thing, primarily those fundamental properties that determine just how the thing could possibly be used. A chair affords (‘is for’) support, and, therefore, affords sitting’ (p. 9)(Norman 1998). The affordance of different mediated communication technologies varies depending on the content and context of the communication. Whittaker has defined the affordance of different technologies based on mode and the interactivity of the technologies (p. 245)(Whittaker 2003).

Affordance		Interactivity	
		Interactive	Non-interactive
Mode	Linguistic	Phone Audio conference Chat Instant messaging	E-mail Answering machine Voicemail Fax
	Linguistic and visual	Video conference Video phone Shared work space	Video mail

Table 6-1 Technologies and their affordance²⁹

The first distinction is related to the different modes that a particular technology supports. Here Whittaker distinguishes between linguistic mode and linguistic and visual mode. The linguistic mode is related to different kinds of spoken and written communication and the linguistic and visual mode adds the visual dimension to the communication. Second, Whittaker makes the distinction between interactive and non-interactive communication, where the interactive is related to synchronous communication allowing for immediate feedback. Opposite is the non-interactive dimension, which is related to asynchronous communication and does not allow for immediate feedback (Whittaker 2003).

²⁹ Based on: (p. 245)(Whittaker 2003)

6.4.2. Questionnaire

As stated earlier the overall purpose of the survey was to get a broader and more elaborated understanding of the communication tools used at the sports department, and furthermore an indication of the level of mobility among the journalists and reporters. The questionnaire was sent out to all employees at the sports department and 42 (65.6%) respondents completed the questionnaire, 6 (9.4%) respondents partly completed the questionnaire, and 16 (25%) did not respond to the questionnaire at all, not even after a second reminder. Including the partly completed respondents this gives a response rate of 75 per cent. The 6 partly completed answers might be attributed to the fact that all participants were told to continue to the next question, if they did not know the answer or how to answer a specific question or if a particular question was not relevant for them or their position. This approach was chosen to encourage and to make sure that as many employees as possible answered the questionnaire.

The questionnaire was distributed via email to all the respondents and based on a web-based system for conducting and analysing different types of questionnaire based surveys. SurveyXact³⁰, the name of the system used, is developed by Rambøll Management³¹ a large Danish consultancy company. The participants received a distribution email containing a short description about the PhD collaboration with the sports department, the overall purpose of the questionnaire, my contact information if they should have any questions, and a link, which would lead them to the online questionnaire. In relation to the distribution email, every participant were given a unique id, making it possible to only answer half the questions right away, and return later to finalise the questionnaire. Ten days after receiving the questionnaire, the respondents who had not yet responded received a reminder, politely asking them to fill out the questionnaire. In order to get as many responses as possible, the director of the sports department informed all employees about the questionnaire before it was distributed, thereby making sure that it was legitimate and furthermore encouraged all employees to answer.

6.4.3. Results and discussion

Looking at the results from the questionnaire in relation to the sports department and the primary working tasks and job functions among the employees, there is a clear overrepresentation of journalists/commentators and journalist/reporters among the respondents. See Table 6-2. One reason for this high response rate among these two groups could very well be related to a high degree of collaboration with persons from

³⁰ <http://www.surveyxact.com>

³¹ <http://www.ramboll-management.com>

these two groups. Thereby, they might have felt more obliged to respond to the questionnaire, compared to other groups of employees where the collaboration was less intensive. In addition, and from an overall perspective, the journalist/commentators and journalist/reporters are physically overrepresented within the sports department, which also contribute to the explanation and overrepresentation.

Primary work functions/task		
Work function	Respondents	Per cent
Administration	2	4.2
Assistant	1	2.1
Photographer	2	4.2
Journalist /commentator	7	14.6
Coordinator/planner	2	4.2
Producer	2	4.2
Editorial manager	2	4.2
News editor	1	2.1
Journalist/reporter	22	45.8
Host/anchor	3	6.2
Technician	2	4.2
Other	2	4.2

Table 6-2 Primary work functions/tasks

The mobility perspective reflects how much time a person is spending outside the sports department’s main office. In general, the employees are fairly mobile and thereby spending a certain amount of time outside the office, i.e. more than 68 per cent spend above 21 per cent of their time outside the office and more than 45 per cent spend above 41 per cent of their time outside the sports department office. This indicates that the employees are relatively mobile. See Table 6-3.

However, looking at the journalists/commentators and journalists/reporters segments the mobility level is significantly higher, compared to the general level of mobility in the sports department. See Table 6-4. However, one aspect that actually might lower the mobility level of this combined segment, could be attributed to the fact that online reporters (journalists and reporters that mainly work with online media) are also included in the journalists/reporters segment. However the online reporters are fairly static and located at the sports department’s main office. This means that the 4 journalists/reporters in the 0-20 percentages category and partly some of the 7 journalists/reporters in the 21-40 percentages category most likely are online reporters. Assuming this would raise the mobility level considerably, as most of the remaining

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journalists/commentators and journalists/reporters would then have a mobility level of more than 41 per cent, i.e. being outside the office above 41 per cent of their working time.

Mobility / percentage of work outside office		
Percentage	Respondents	Per cent
0-20%	15	31.2
21-40%	11	22.9
41-60%	16	33.3
61-80%	2	4.2
81-100%	4	8.3

Table 6-3 *Mobility of sports department employees*

Mobility / percentage of work outside office			
Percentage	Journalists/ commentators	Journalists/ reporters	Per cent
0-20%	1	4	17.3
21-40%	--	7	24.1
41-60%	5	8	44.8
61-80%	1	1	6.9
81-100%	--	2	6.9

Table 6-4 *Mobility of journalist segment*

Looking at the results regarding communication methods the data show a very high usage of face to face, phone, and email communication whereas videoconference, teleconference and Instant messenger technologies are rarely used. In between is SMS/MMS usage, which is used fairly often. See Table 6-5. The high percentages of face to face and phone usage is in line with what the technology affordance theory predicts as described above, whereas the high percentages of email is somewhat in contrast to the technology affordance theory. One explanation for this could be the fact that email actually is an integrated part of the work procedure, i.e. for documentation. Another reason might be the high levels of mobility among these people, i.e. the time they spend outside the office, allowing them to communicate via email independent of time and place, thereby being less intrusive than phone communication.

How often do you use these communication methods in relation to your collaboration with other persons from the sports department				
	Several times a day	Daily	Weekly	Rare
Face to face	85.4%	7.7%	2.4%	4.9%
Office phone	57.1%	16.7%	14.3%	11.9%
Mobil phone	65.9%	14.6%	14.65	4.9%
SMS / MMS	28.2%	15.4%	25.6%	30.8%
E-mail	76.2%	14.3%	9.5%	--
Instant messenger	2.7%	13.5%	27.0%	56.8%
Teleconference	--	2.9%	--	97.1%
Videoconference	--	--	--	100%
Fax	--	--	--	100%

Table 6-5 **Communication methods inside the department**

According to Whittaker's (Whittaker 2003) model the above data actually shows that linguistic and interactive mode is the preferred (phone). Second is the linguistic and non-interactive mode (email) which supports his statement, that adding or removing other modes has little effect compared to adding or removing the speech mode. Looking at the communication with people outside the sports department the data is similar. Here the linguistic and interactive mode is also the preferred (phone) and second is the linguistic and non-interactive mode (email). See Table 6-6. It is evident that the speech mode is the preferred mode within the sports department, which according to (Whittaker 2003) suggest that the adding of any additional mode has little or no effect, which can be confirmed according to the data. However, an important notion is that one could argue that the collected data cannot test the efficiency of the communication, but only the frequency of the usages, which to a certain degree is correct.

Which communication methods do you use, when communicating with the persons you cooperate with the most located outside the department					
	Person 1	Person 2	Person 3	Person 4	Person 5
Face to face	38.1%	20.0%	23.5%	31.2%	18.8%
Office phone	4.8%	15.0%	11.8%	12.5%	12.5%
Mobile phone	38.1%	40.0%	47.1%	31.3%	37.5%
SMS/MMS	--	--	--	6.2%	--
E-mail	9.5%	15.0%	11.8%	12.5%	25.0%
Instant messenger	--	--	--	--	--
Other	9.5%	10%	5.9%	6.2%	6.2%

Table 6-6 **Communication methods outside the department**

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Finally, turning to the satisfaction of the current communication tools and thereby indirectly how well the current communication tools support the work tasks of the sports department employees. In general, most participants are satisfied with their current tools, as more than 90 per cent of the respondents are satisfied or very satisfied with their current communication tools. See Table 6-7. In relation to the user involvement in innovation process, the lead user concept, and the selection of the lead users within the sports department, one could anticipate and hope that the less satisfied respondents are the lead users, as these would have the largest incentive and thereby motivation to actively contribute to the development of new and better tools supporting the journalists and reporters in their everyday working tasks.

How good do your current communication tools support your daily work		
	Respondents	Per cent
Very good	11	26.8
Good	27	65.9
Neither/nor	2	4.9
Bad	1	2.4

Table 6-7 **Satisfaction with current communication tools**

In general, the survey has provided both a fairly broad and at the same time detailed understanding of the sports department in relation to the employees' usage of communication technologies, communication tools, and levels of mobility. It is important to underline that not all results from the questionnaire has been presented; only the most relevant have been presented in the above section. The survey results have provided important and valid input in relation to deriving user needs and requirements from a user involvement in the innovation process perspective, and in particular in relation to the journalist and reporter segments. The data and results from the questionnaire will be incorporated into the ideas, user needs, and requirements in relation to the toolkit and participatory observation data collection approaches deployed and described in the following sections.

6.5. Mobile toolkit

The framework for the mobile toolkit is based on the user involvement in the innovation process theoretical framework, as within the diabetes case study, and will mainly focus on the development and deployment of the mobile toolkit as a tool and technique for collecting user needs and requirements from very mobile users in very mobile environments, i.e. testing and using the developed toolkit to transfer and decoding the

sticky information of the users. This section, and thereby the development of the mobile toolkit, is partly based on the following publications and reports (Olesen, Jiang et al. 2005; Saugstrup, Sørensen et al. 2005; Schultz, Tan et al. 2006; Larsen, Proschowsky et al. 2007) where the current author has been a co-author and one of the driving forces behind the work and development of the methods presented and deployed in relation to gathering user needs and requirements, i.e. the mobile toolkit.

The toolkit is developed to identify user needs, requirements, and ideas among journalists and nomadic professionals, which can be characterized as being highly nomadic and thus potential users of mobile and ubiquitous services and applications. When planning and developing the toolkit, the participatory design approach was considered a source of inspiration. However, looking at the participatory design methodology approach, one could argue that the well established participatory design approach in general does not take the mobility of the users into account, which is very essential in this setting (Schuler and Namioka 1993; Kensing 2003; Bodker, Kensing et al. 2004). From a participatory design approach, this calls for developing a new approach for gathering user needs and requirements in mobile environments, both in relation to the new services and applications, and in relation to the level of personal mobility among the users. What was essentially needed was a toolkit that facilitated the process of capturing the needs and requirements of the users, in very different contexts and in highly mobile environments, and which at the same time was easy to use and carry around.

In relation to the development of the toolkit and the particular toolkit requirements, the deployment of diaries seemed an obvious choice as the users would be able to carry these around and take notes on the go, in whatever situation they found themselves, i.e. documenting their activities and needs during a certain period of time. Furthermore, the diary approach would also provide very well documented, credible, and solid descriptions. In general, diaries are mostly used in ethnographic approaches in order to capture activities in context, feelings of the participants, understanding needs and motivations related to use of technology, and to collect needs and requirements for different designs (DeLongis, Hemphill et al. 1992; Robinson 2002). However, the big challenges of this approach lies in the motivation of the users and in the analysis of the open and subjective entries. A somewhat related approach is the experience sampling method, which is used to study the quality of subjective experiences. Within this approach, the users are given an electronic paging device, which randomly asks the users to write down, e.g. what they are doing, where they are, how they feel, answer a given question, etc. (Csikszentmihalyi 1991). Also the concepts of probes, which was briefly described in chapter two, is highly related to this research approach, i.e.

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providing the participants with different tools, which they can use to document, reflect on, and express their thoughts in relation to specific actions and the environment. In addition, the creative approach also briefly described in chapter two, is also somewhat related to collecting needs, requirements, and ideas from the users. According to Amabile et al. 'all innovations starts with creative ideas' (p. 1154)(Amabile, Conti et al. 1996).

A contextual and dynamic self-documenting mobile innovation toolkit has been designed and developed for the purpose of the journalist case study based on the user involvement in the innovation process theoretical framework, the above mentioned considerations, and with inspiration from especially the toolkit used by Jeff Hawkins in the design process of the original Palm Pilot (Bergman and Haitni 2000), and from mobile probes (Iacucci, Kuutti et al. 2000; Hulkko, Mattelmäki et al. 2004). In addition, and to validate the overall concept of the mobile innovation toolkit, a small test project was conducted with a somewhat similar approach, but with a larger size and more simple toolkit (a regular note book), among a closed group of academics. The result of the test project was successful and a large number of ideas, needs, and requirements were generated within the test project (Larsen, Saugstrup et al. 2006). Based on the successful test and the feedback obtained during and after the test project, a new toolkit was developed. Dealing with very mobile users both in relation to personal mobility, service, and application mobility is a significant challenge when it comes to design and identification of user needs and requirements. However, this was dealt with by making the toolkit mobile as well, both in relation to personal mobility and service and application mobility, i.e. contextual mobility. The basic idea was to let a toolkit 'follow' a group of journalist and nomadic professionals in order to identify their ideas, needs, and requirements based on problems and situations they encountered in everyday situations.

When designing the original Palm Pilot, Jeff Hawkings had an interesting and innovative approach in relation to the design dimensions of the Palm Pilot, but especially in relation to the collecting and gathering of user needs and requirements. He simply carved out a piece of wood that would fit in his pocket, and used it as a 'pretending to be' future Palm Pilot device, i.e. pretending that it was the Palm Pilot device, and how and for what he would like to use this new device, e.g. enter information, lookup addresses and phone numbers etc. In this way he was able to 'record' his own user needs and requirements in context related situations, based on a simple piece of wood and the simulated use of the device, as a real life device (Bergman and Haitni 2000).

Similarly, the mobile toolkit was developed in order to capture ideas, user needs, and requirements for journalists and nomadic professionals in a contextual and dynamic self-documenting approach. This facilitates idea generating in everyday situations and at the same time provides a tool for collecting and gathering needs and requirements as they would come about. As the mobile toolkit was developed and deployed within the MAGNET project, it was named the IDE-MAGNET. The toolkit is a small notebook (7x11cm) with a metal cover and an integrated pen. The relative small size, but at the same time easy to write on toolkit were important parameters, as the users were expected to carry the toolkit with them most of the time. Furthermore, two sets of bright colored post-it notes were placed on the inside metal cover, for ‘important’ notes or special notes. In addition, ‘bumper sticker’ notes were placed on the back side of every few pages, providing inspiration and guiding the users when flipping over a page to write an idea, a need, or a requirement down. See Figure 6-1.



Figure 6-1 Mobile toolkit

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According to (Hulkko, Mattelmäki et al. 2004) one of the main challenges with different kind of probes is related to the motivation of participants, especially to motivate participants to complete the tasks within a mobile context. However, this is believed to be necessary in order to document and collect real user needs and requirements in an interactive and context aware form. In addition (Hulkko, Mattelmäki et al. 2004) argues that probes often seem to work in a retrospective mode, thereby implying that the users tend to document the behaviour and interactions after the situation is over and they have returned home. Based on this, it was important that the developed toolkit could be used and represent different contexts and situations on the go and not retrospectively, i.e. developing a contextual, dynamic, interactive, and user-documenting toolkit. The toolkit approach was also chosen to cover as broad and varied user contexts and situations as possible, but at the same time it should be a very self-explaining and easy usable toolkit.

The first page of the toolkit had an inspirational and explanatory text, to help the participants remember the overall purpose of the exercise and guiding them in relation to what and how they should be using the toolkit, should they be in doubt or forget. Overall, the challenge of applying such a toolkit was to make people document their thoughts, feelings, actions, needs, and requirements while they were on the move, i.e. providing the contextual and dynamic dimensions of needs and requirements. This is where the bumper stickers come into the picture, combined with text messages that were sent to the participants' mobile phones.

The bumper stickers were meant as an reminding instrument and were placed on the backside of every few pages and thereby revealing 'itself' as the participant turned a page to write something. The bumper sticker texts served the purpose of reminding the participants of certain aspects in relation to daily activities and furthermore as sources of inspiration for thinking about future needs and requirements, i.e. a kind of motivation and inspirational input. Also the text messages, which were sent to the participants' mobile phones every second day or so served as reminders, but they were also used to convey certain issues or aspects that the participants should keep in mind or be aware of during the period of deployment. Table 6-8 lists the bumper sticker texts and text messages sent to the participants mobile phones during the period of usages.

Bumper sticker texts	SMS texts
Technology is not everything but how can it help you?	What are you doing right now?
Personal travel assistant, always on hand. Recognising you and your habits, preferences, flights, trains, etc.	What or which kind on information would you like to have right now?
Task-manager or calendar, extremely personal. Who should have permission to look at it or make changes? What will you do if you lost it?	What are you doing today, what needs to be planned and what kind of information do you need?
I like to write but not on my mobile phone.	Is security something you think about when using communication technologies? Who can see what information and who can use this information?
Technology is not everything but how can it help you?	What are you working on/with right now and how could different technologies, services, or applications support your work processes?
Curious as to what the news is right now.	Have you experienced situations today, where you could imagine that technologies, services or applications could have helped/supported you?
Virtual work where anything can be done anywhere. Meetings, documents and colleagues, let us communicate and exchange ideas.	What kind of situations are you in right now and what kind of information would you like to have?
How and when should this future device be used, and for what?	Are you sometimes hindered by technologies or find them bothersome?
An interview, what type of knowledge exists? Is knowledge employed freely or is it a personal contact that provides the entry to the information?	Call or SMS, what is easiest and most convenient in what situation?
The work place calls to say it is not possible to enter the building. What is necessary for the task at hand to be carried out?	What would you do if you lost me?

Table 6-8 Bumper sticker and SMS texts

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In relation to the participants, these were chosen in order to represent as broad and diversified a segment as possible, however all within the journalist and nomadic professional boundaries, combined with a genuine interest in contributing and giving input to future products, services, and applications that support journalists and nomadic professionals in their everyday tasks, and with the ability and personal drive to participate actively in the project. Based on these criteria and the willingness to allocate time and actively contribute by using the toolkit eleven participants were selected. Among the participants there was an equal distribution between the genders and with an age distribution between the early thirties to the late fifties. All participants worked within the journalism, broadcast, or nomadic professional segments, heavily depending on using information and communication technologies and information management in general. In relation to the lead user concept, not all of the selected participants could be categorised as lead users, however the participants could be categorised as frontrunners or at least above average users. The deployment of not truly lead users could be problematic, in relation to using the lead user theory and the user involvement in the innovation process. However, as this exercise was one of three combined methods and this particular approach was based on a somewhat broader ranging method, this was not seen or considered as problematic. In relation to the theoretical framework, the participants were actively involved in the process, even though not all of them could be categorised as lead users within the definition of this thesis.

6.5.1. Toolkit results

At an introduction meeting, the selected participants were introduced to the case study, the background information, the toolkit, the overall propose, and the process of the project. In particular the participants were instructed on how to use the mobile toolkit, what was expected of them and furthermore given a brief introduction to a later workshop where all their 'notes' would be presented and discussed. The workshop was planned to take place three weeks after the introduction meeting, giving the participants plenty of time use the toolkit, i.e. to write down their ideas, interactions, thoughts, needs, requirements, etc. In addition to carry around and using the toolkit, all participants agreed too receive a limited number of texts messages on their mobile phones as motivation, inspirational input, and questions. After using the toolkit for three weeks, the participants were invited to a workshop, where the participants should present their ideas, needs, and requirements generated by using the toolkit throughout the three week period. The workshop, started with a general discussion among the participants about their experiences with the toolkit. In general, the participants were very enthusiastic the first week or so walking around with the toolkit. However, after the first week, some of the participants felt that the toolkit became more of a burden.

The text messages sent to the participants' mobile phones were for some of the participants good as reminders and inspiration; while others felt that they throughout the period became more irritating, mainly because it gave them a bad conscience. However, all participants found the toolkit and idea behind the toolkit appealing and interesting. Especially the size and the simplicity of the toolkit were acclaimed, but also the bumper sticker concept was commented as a good thing. In addition, the toolkit also reminded some of the participants that it is important to be able to be off-line when they want. All participants wanted to keep the toolkit after the workshop and only handed in the sheets of papers they had written ideas, needs, or requirements on.

After the initial discussion about the toolkit and the participants' experience of using it, the participants were introduced to the activities of the workshop, where the plan was to have the participants present all their ideas, needs, and requirements to everyone and to let the other participants comment on and build upon the presented idea, concept, need, or requirement. This was done by letting one participant at a time present an idea, need, or requirements that this participant had written down in the toolkit to the other participants in the group. While the participant presented and explained the idea, need, or requirement the facilitator wrote down the basic content of the presented idea, need, or requirement on an A3 size of paper in the middle of the table. The other participants were then urged to comment, ask questions if they did not understand it, or build on the presented idea, need, or requirement by adding more post-it notes to the A3 piece of paper with their comments, ideas, needs, or requirements and place them together with the original one. All participants were equipped with plenty of post-it notes and pens, as they were expected to contribute significantly to the presented idea, need, or requirement. At the end of the workshop, all participants had presented a number of ideas, needs, or requirements, which had been commented and built on by the other participants, thereby ending up with a number of ideas, needs, or requirements, surrounded by a number of subsequent and related ideas, needs, and requirements as depicted in Figure 6-2. However, and mainly due to time constrains, not all participants presented all their toolkit generated ideas, needs, or requirements. During the workshop the participants had presented, discussed and commented on a multitude of ideas, needs, and requirements which they had been writing down during the three weeks they carried around the toolkit. The result of the three weeks of using the toolkit combined with the final workshop resulted in a large number of interesting ideas, needs, and requirements in relation to future products, services, and applications for journalists and nomadic professionals.

In more specific terms the eleven participants generated a total of 175 notes over the three week period using the toolkit. In general, the notes either seemed to have been

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triggered by a specific situation/context or based on results of a thinking process and related associations. Overall the 175 notes can be divided into three sub-categories: 86 needs and expectations related notes; 40 situation and context related notes; and 49 specific product, service, or application related notes. The 86 needs and expectations related notes were in broad terms related to or concerned with general needs, requirements, or expectations to future systems or devices, i.e. what the system, service, application, or device should be able to do or what general needs and requirements it should be able to fulfil. The 40 situation and context notes appeared to be related to specific situations/contexts, i.e. well described situations/contexts, which the user at a given time was present in, and to a certain degree followed by needs, requirements, or product ideas. The 49 more specific product, service, or application notes could be labelled as 'product ideas' describing future products, systems, services, or applications quite precisely. These were more specific than the previously described needs and expectations notes and often linked with an observed or experienced situation.



Figure 6-2 Discussion at the workshop

6.5.2. Workshop results

The workshop results, i.e. the participant presentation of an idea, need, or requirement from their toolkit followed by comments, questions, or built on by new or related ideas, needs, or requirements and a general discussion among the group are presented below. The presented results are therefore a combination of toolkit ideas, needs, and requirements and input from the workshop discussions, where the discussion can be based on other participants' toolkit ideas, needs, and requirements or new ideas, needs, or requirements suggested by one or more of the participants in the group all adding to the further development of related issues. Overall, the results are presented in tables with an explanatory title, i.e. the original presented toolkit idea, need, or requirement,

followed by related issues which developed during the discussion period. Only the most developed, i.e. the most discussed, developed and most related to the journalist and nomadic professional segments are listed. As the toolkit invited to a rather broad perspective on ideas, needs, and requirements, some of the toolkit generated ideas, needs, and requirements were not specifically related to the journalist and nomadic professional aspects, but rather to more general, broad, and family related aspects.

Transportation
<p>Situation/context:</p> <p>At home, the station, bus stop, airport</p> <p>Standing at an unknown place</p> <p>On a bus, a plane, a train, or in a car</p>
<p>Ideas, needs, or requirements:</p> <p>A map would be good to have</p> <p>Information about the time table, delays, cancellations, stops</p> <p>Actual situation/traffic information</p> <p>Journey planner using GPS</p> <p>Personalisation: How do I like to travel and what are my preferences?</p> <p>A day map and a night map (places look very different at night and in the day) maybe something incorporating landmarks</p> <p>Updates of flights - pull information from airport system</p> <p>Gate change announcements - pushed to device after check-in</p> <p>Update bus pass/train pass - to buy ticket through mobile device</p> <p>Subscribe to information on bus/train delays</p> <p>Estimated arrival time when on the bus, train... - based on current traffic situation</p> <p>Offer in a store when passing by on a bus or in car - advertisement based on information from user.</p> <p>Arrive at a new place and have automatic synchronisation of clock etc. based on personal preferences.</p> <p>Suggestions of different/alternative routes</p> <p>Location enabled services</p> <p>Re-booking if a new departure time is necessary</p> <p>Warning about delays and alternative routes (congested road between 7-9)</p> <p>Route and journey planning</p> <p>An alert or emergency service - when user approaches a danger zone.</p> <p>Device that is used as a boarding card, car rental voucher, hotel key and changes functionality depending on the context/situation</p> <p>Security is a concern</p>

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Document editing

Situation/context:

Read/ write/ edit documents with several authors (Simultaneous editing)

Exchange of ideas

Ideas, needs, or requirements:

Sound and video together (text and images)

Administration of rights - who is allowed to do what?

Simultaneous editing

Search function

Translation from text to speech or from speech to text.

Multi-media functionality (texts/images/sounds)

Online and offline changes - make them synchronised

Whose document should be the final one? Ownership and corrections?

Interactive layout process

Editor required

Be able to give feedback to other authors

Usable/accessible via different medias / applications

Should work fast/instantly (high bandwidth/data rates)

Dictionary

Situation/context:

Translation, simultaneous translation

Speech to text / text to speech in another language

Ideas, needs, or requirements:

The dictionary should translate words and sentences into different languages

In a foreign country in which you do not know the spoken/written language, the dictionary would help with supplying simple words

It is important for the dictionary to be fast and to have a large vocabulary

Should be adaptive (including slang) and updating the vocabulary constantly with respect to location and context.

Dictionary should support text to speech and speech to text functionalities

When in an emergency it should be able to translate a problem and to have this told to the police.

Context awareness to understand the particular situation the user is in and to adapt to it.

Community/network

Situation/context:

Exchange of experiences

Large displays in meeting rooms or meeting areas so anyone can just present something interesting at any time.

Ideas, needs, or requirements:

All devices should be able to talk to one another when they are in the vicinity of each other.

Multi-tasking should be possible with respect to video and speech, sound and text.

Several active communication channels at the same time sound, image, video, text.

Synchronizing of devices of the community- sharing data, sound, images

Access to experiences within a given area.

Sharing pictures, text documents, sound files etc

Where are the others - availability of other users in the community

Networking, find people with relevant competences/experiences/skills

Multi-player - device that is the master and distributes to slaves

Exchange business cards/information between two or more devices

Seeking advice from experienced sources

Backup / synchronisation

Situation/context:

Synchronisation between several devices

Lost device

Ideas, needs, or requirements:

Automatic backup and synchronization between devices

System makes backups but it is not obstructive - transparent and based on user preferences

Working on several devices in different environments

Security and safety is a must

If someone picks up the device, the security features should ensure that that person is unable to make use of it if not authorised

Backup should be simple and easy to use- almost invisible to the user

6.5.3. Discussion and evaluation

The development, deployment, testing, and results of the mobile toolkit have provided valuable experiences in terms of both specific and general usages. Overall the toolkit and the method applied with the toolkit over a three week period were well received by the participants and generated a number of ideas, needs, and requirements in relation to future products, services, and applications. The concept of using a mobile toolkit in relation to an extended user involvement in the innovation process and thereby deriving user needs and requirements can basically be evaluated from three different perspectives: 1) how was the toolkit method perceived and received by the participants; 2) what kind of results were generated and what was the quality of these; and 3) how generally applicable is the toolkit method in relation to derive real user needs and requirements.

In relation to how the toolkit method was perceived and received by the participants, it is clear from the feedback given by the participants that they in general perceived the toolkit method as inspiring and interesting. Concerning the toolkit itself, the participants generally expressed a genuine interest and enthusiasm regarding the toolkit, as they found the looks and size very attractive, combined with being easy to use. The fact that all the participants wanted to keep their toolkit after the exercise, could be seen as a motivation factor in relation to the participants actually using the toolkit in the three week period. In general, motivation has been identified and related to creativity, and research shows that in order to be creative, motivation and a general understanding of the domain and purpose are key parameters (Amabile, Conti et al. 1996; Amabile, Hadley et al. 2002). Therefore, motivation is an important aspect of the toolkit approach and thereby the overall method, and as a result the extent to which the participants would use the mobile toolkit. As already mentioned, the participants were generally motivated by the toolkit itself, i.e. the looks, size, and the ease of use.

The deployment of the bumper stickers, was thought of as a motivation and inspiration source, and was generally perceived as such by the participants, giving them additional motivation and inspiration regarding ideas, needs, and requirements. All participants were generally pleased with the bumper stickers. The text messages sent to the participants' mobile phones were as the bumper stickers also thought of as a source of motivation and inspiration. In addition the text messages were also thought of as reminders of the task the participants had agreed to take upon themselves and as input to additional aspects, thereby reflecting different contexts and situations within which the participant was present in relation to user needs and requirements. In the beginning of the three week period, the participants found the text messages received motivating, inspirational and reminded them of the toolkit and the task at hand. However, beyond

the first week around half of the participants were more or less annoyed by the text messages, as it provided them with a bad conscience, i.e. they were not doing as much as they would like to have done. The other half was generally pleased with the text messages throughout the three week period.

In more general terms, the participants indicated that they felt very motivated in the beginning of the three week period, and that it was during this period where most ideas, needs, and requirements were written into the toolkit. In the middle of the period, not that many ideas, needs, and requirements were generated. At the end of the three week period, the participants' activity levels were increasing, however, mainly due to a bad conscience about not having done enough in the middle of the period. During the second week, most participants simply forgot or gave the mobile toolkit low priority, due to other higher level priorities and to a certain extent they became less motivated and interested in the toolkit and the task of writing down ideas, needs, or requirements. From an evaluation perspective, the bumper stickers worked as expected, giving inspiration and motivation when using the toolkit. The text messages seemed to be useful as reminders for most participants at least in the first half of the three week period, however not all participants would agree to receiving text messages for three weeks again. The usefulness of the text messages as a motivation factor is less likely, maybe during the first week, but after that the text messages were more annoying than motivating for some participants. Receiving messages, which provide the participant with a bad conscience, will most certainly not work as a motivation factor, more likely the opposite. In summarising, one could state that the text messages worked well for the participants who enjoyed them, and found them motivating and inspirational. Based on these findings, a three week toolkit deployment period seems to be too much, whereas a one and a half or two week toolkit deployment period might be more suitable for the participants in relation to a motivational perspective.

In relation to what kinds of results were generated and the quality of these results, basically two kinds of results were generated: the toolkit ideas, needs, and requirements written down by the single participants during the three week period; and the workshop generated results, based on group discussion, comments, and additional but related ideas, needs, and requirements. The overall purpose of the toolkit was to derive user needs and requirements in a dynamic, contextual, and self-documenting way, i.e. by letting the users write down ideas, needs, and requirements as they encountered them. This approach is obviously very broad and open-ended, i.e. a large solution space, which also is reflected in the ideas, needs, and requirements generated by the participants. Also the fairly diverse group of participants indicates that the results most likely would be quite broad and open-ended. The purpose of the toolkit

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was to collect and derive a broad scope of ideas, user needs, and requirements from the participants, which should provide valuable insights into user needs and requirements within the journalist and nomadic professional user segments. In general, the results from deploying the mobile toolkit can be viewed or categorised as initial ideas, needs, and requirements, which serve as inspiration and input in relation to developing more user centred products, services, and applications for the journalist and nomadic professional user segments. Hence, the toolkit expectation was not to create highly detailed and specific user requirements, but a way of drawing out a broad range of ideas, needs, and requirements that combined with other more specific user needs and requirements could provide a better and more detailed understanding of the user needs and requirements within the journalist and nomadic professional segments.

In relation to how generally applicable the toolkit method is in relation to derive user needs and requirements, the toolkit used in this context is believed to have proven its worth. The eleven participants using the toolkit generated 185 ideas, user needs, or requirements over a three week period, based on a dynamic, contextual, and self-documented approach, i.e. the participants were enabled to formulate ideas, user needs, and requirements in any given context. It is truly believed that this toolkit approach could be deployed in a wide variety of contexts and situations, and provides a broad and fairly open-ended array of results in a relatively simple and easy deployable manner.

However, it is important to underline that the participants within this context were above or in front of the average user in relation to understanding and experience with the use and deployment of information and communication technologies. This probably had a positive influence on the number of ideas, user needs, and requirements generated throughout the three week deployment period. Whether this is a relevant observation or not needs to be proven by testing the method with other groups or participants. However, from a general perspective, the mobile toolkit approach is believed to be useful and applicable within a number of contexts and situations, as long as the results are not taken for final, but instead combined with other methods of collecting user needs and requirements.

6.6. Participatory observation

This section describes the participatory observation part of the user involvement in the innovation process method deployed in relation to the case study, i.e. the participatory observation of sports journalists and reporters primarily in relation to a major international sports event and secondary at several minor sports events in Denmark.

The participatory observation method, which emerges from the social anthropology field of research, is believed to provide valuable insights into the work tasks and work processes of sports journalists and reporters working in the field, thereby deriving future user needs and requirements within this segment.

From an overall perspective, the objective of the participant observation strategy is to gain a deeper and better understanding of a given group of individuals, and in particular how they function and practice within a given context or situation (DeWalt and DeWalt 2002). In the sports journalist case study, the approach is mainly related to observation, participation, informal interviews, and question and answer sessions, where the interviews and question and answer methods are used to get a more elaborated understanding of the subjects, entities, or processes observed, i.e. to support and elaborate on the observations and participation objects/processes observed. In relation to the sports department, approximately one hundred hours of participant observation have been conducted, where the main part was conducted at the 2006 FIFA World Cup in Germany, and a minor part at different sports events in Denmark, i.e. following and observing how the sports journalists prepared and researched before a specific sports event (match) and what kind of 'tools' they used doing this; how they worked during an event, and what kind of 'tools' they used; and what they did after the event.

From a user involvement and innovation process framework and especially the lead user approach, several interviews were conducted with managers and other key people at the sports department in order to identify key journalists and reporters, i.e. the frontrunners within the sports department. As a result, a handful of journalists and reporters were selected as the lead users within the sports department and identified as key persons, i.e. the persons that best fitted the lead user definition used in this thesis, or were among the leading journalists and reporters within the sports department. All the selected journalist and reporters agreed to be observed when preparing, commenting/transmitting from one or more sports events, and afterwards when wrapping up the work. Out of the hundred hours spent observing, participating in their work, interviewing, and asking questions about the work, approximately sixty-five hours were spent in Germany, following the journalists and reporters around at the FIFA World Cup and the remaining thirty-five hours were spent following the journalists and reporters in Denmark at different sports events, i.e. football, handball, and ice-hockey matches.

6.6.1. Participatory observation in Denmark

The participatory observation in Denmark is related to six sports events (two handball, two ice-hockey, and two football matches) all broadcasted via radio. The radio broadcast setup for these events is somewhat special, as it is not broadcasted in full length, but only in fractions. The basic setup is as follows; a number of journalists and reporters are present at a number of different sports events and every five to ten minutes or so, depending on the importance and intensity of the match/event, each journalist or reporter is broadcasted live for a few minutes. This leaves them with a very short time slot to summarise the match so far, i.e. telling the audience what has happened since the last live broadcast period. In between these live sports event updates, other sports related news, or music is broadcasted.

From the journalist and reporter perspective, this setup is also quite different compared to full length radio or TV broadcasts. In this setup the task of the journalist or reporter is very much related to summarising what has happened during the last period, i.e. the period without broadcasting, whereas the live full length broadcast transmission task is much more demanding reporting continuously from the match. The basic journalistic setup for these periodic broadcasting events can be divided into three main parts; preparations, match, and follow up. The preparation phase for these kinds of events is very much related to seeking information on the two team's websites, and from an online sports statistics, information, and database provider (infostrada.com)³², which the broadcasting company has an agreement with, allowing all journalists and reporters to use this service. This is combined with an extensive journalistic knowledge about the branch of sport and the teams within the particular branch of sport.

In relation to the technical setup, the live radio transmissions are carried over an ISDN connection available at all major sports facilities (stadiums, arenas, etc.) around the country. At the broadcast company the anchor person (the host of the program) switches between the different journalists and reporters, introducing them to the audience, before they each report live from a given event. At the event, the journalist or reporter basically have to devices; an ISDN mixer (GSGC5) and a headset/headphone. The GSGC5 ISDN mixer is an outside broadcast mixer well suited for outside studio events. Using digital bandwidth compression techniques it provides 7.5kHz bandwidth circuits between the studio and the outside broadcast site using a single ISDN2 B channel. Overall the GSGC5 is compact, flexible and easy to operate, and all the journalist or reporter needs to do is to connect it to an ISDN2 connection

³² <http://www.infostradasports.com>

and dial the studio and they are set to broadcast.³³ Connecting the combined headset/microphone to the GSGC5 provides the journalist or reporter with three different communication channels, between the journalist or reporter and the studio/anchor person. In the right side of the headset, the reporter can hear the live broadcasting signal, i.e. what is broadcasted to the audience. In the left side of the headset, the anchor person/studio can talk to the journalist or reporter via a second channel, i.e. when coordinating the next speak for the journalist or reporter or other relevant information that needs to be coordinated or communicated between the studio/anchor person and the on site journalist or reporter. This channel is also used if the journalist or reporter wants to communicate with the studio/anchor person. Finally, the microphone is used for recording whatever the reporter or journalist is saying, whether it is the live audio broadcasting signal or a communication interaction between the journalist or reporter and the studio/anchor person.

Through the thirty-five hours of participatory observation, some very general working methods and approaches in relation to the three phases have been observed and confirmed by the journalists and reporters. In relation to the preparation phase, the following sources of information were used by all journalists and reporters: infostrada.com; the websites of the two competing teams; the website of the specific league; and when on site before the match, interviews with players, coaches, assistant coaches, and team managers. Based on this information, the journalists and reporters make a so called preparation kit, which basically includes a team line-up, which includes statistics on each player, i.e. number of matches played, injured players, nationality of the players, goals scored, etc. and team statistics, i.e. league position, previous matches, coming matches etc. The preparation kit is used during the match, and when commenting from the match. During the match, all journalists and reporters continuously write down what is happening in the match, e.g. who is scoring, missing a penalty kick, getting a two minute detention for roughing, getting a yellow card etc. as it is important to remember this and convey it to the audience.

After the match, most journalists and reporters try to get some comments or interviews with some key players and coaches, which typically is recorded on a mp3 recorder and transmitted back to the broadcasting company via the GSGC5 mixer device. The recordings are either transcribed into text at the broadcasting company and published online, or used as audio files for radio broadcasts, especially in the hourly sports news broadcasts. Some of the journalists and reporters also write ten to 20 lines about the match, which they self-record using an mp3 recorder, and transmit it back to the

³³ <http://www.glensound.co.uk/GSGC5.htm> (June 2007)

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broadcast company where someone transcribes the recording for online publication, i.e. publication on the Internet or mobile platform.

Based on the thirty-five hours of participatory observation which include; the very informal interview and questions and answer sessions with the journalist and reporters regarding their tasks and ways of working before, during and after a match; combined with the expressed ideas, suggestions, needs, and requirements of the journalists and reporters; and the basic knowledge and information obtained via the survey conducted; the results from the deployed toolkit; the below list of future service and application concepts has been generated.

A standard preparation kit for each of the major sports branches would overall save the journalists and reporters a lot of time during the preparation phase and furthermore provide them with an easier and clearer understanding or overview of the material used for preparation and during a match. A standard preparation kit should include a team line-up with name, age, nationality, number of matches played for the current team, some basic injury statistics on each player, goals scored, penalty statistics, previous team, field position, and national team matches played. All these data should be updated and stored centrally, which the journalists and reporters can access from different devices. This would allow the journalists and reporters to access the database at any given time, through any given device and always get up to date information and statistics regarding the players of a specific team. A second part of the preparation kit should include team information and statistics: team name, physical location of the team, coach names, manager names, league information, league rank, previous matches played this season, coming matches this season, ten year historic league rank, and general team news. Third, the preparation kit should also, both in relation to the team line-up and team information and statistics part, contain some additional spaces, tables, lines, or columns depending on the final layout, which the single journalist or reporter can fill in and use as they wish or feel benefits them the most. However, it is important that these additional spaces, tables, lines, or columns are saved and stored in the database as well as in relation to the single journalist or reporter, so that this information is accessible and retrieved together with the other data. Overall, the preparation kit and the contained information should be displayed and presented in an easy and understandable format. Furthermore it should be available in a printable format, allowing the journalists and reporters to simply access the database, select a team and print out a preparation kit.

Time and match progress template. In relation to actually reporting from the different sports events it is very important that the journalists and reporters write down the

progress and actions as they occur throughout the match. This is done in order to be able to give the audience a clear, factual, and accurate reporting from the match. Today, the journalists and reporters simply write this information on a blank piece of paper, in very different and personal styles. However, when discussed with the journalists and reporters, they clearly indicated that a time and match progress template would be very useful to them, and it furthermore could improve the quality and the uniformity of the reporting. In general the time and progress template should be customized to all the major branches of sports, as the information written down is very different from branch to branch. Basically, the following entities should be included: time (a time column, which is used to indicate when something occurs), penalties, goals, and substitutions. In addition, the template should include two text fields, where the journalist and reporter after the match can write a 10-20 lines text about the match for the online platform and a 3-10 line text for the mobile platform, i.e. a text that explains the match and includes the highlights of the match. If stored in a database, the online editors can then select and publish the written texts on the relevant platforms. This text could then be used for all online platforms, providing a short resume of the match. The template should be stored in a central database, where journalists and reporters can access it from different devices when preparing or writing about the next match between the two teams. When stored in a database other persons at the broadcasting company can also access it if necessary in relation to perhaps writing a larger story or comment regarding the match.

News agent. Most journalists and reporters are highly mobile and spend a substantial amount of their working hours on the road, i.e. between sports events or at sports events. This sometimes leaves them in what could be called an information vacuity situation or context, which according to themselves constitutes a problem in relation to receiving and retrieving relevant information. Therefore, a personalised news agent would be highly appreciated among the journalists and reporters, i.e. a news agent that could be accessed from different devices and set up based on personal preferences. It should also be able to provide them with more general news and information from the broadcasting company. The news agent should be accessible from different devices, but should also be able to push news to the journalist or reporter, if this is preferred over a self access mode, all based on personalised profiles and preferences. The news agent should be able to provide very specific information, e.g. news regarding the major Danish football, ice-hockey, handball league, etc. As one reporter told, most public available news services simply over inform, i.e. one receive so much information that it basically is useless. It was therefore suggested, that the broadcasting company itself, should provide this service to the journalists and reporters, based on news bulletins, news flashes and other news received at the broadcasting company. In addition, the

news agent should be somewhat adaptive and intelligent, making it possible to continuously edit in the news receiving profile, and sorting in the incoming information. Furthermore, the news agent should have a search function, allowing the journalists and reporters to actually search in archived information. Finally, the news agent should also provide the journalists and reporters with general information and news from the sports department at the broadcasting company, as they sometimes are away from the broadcasting company for several weeks or even a month at a time. The fairly long periods of dislocation from the colleagues and the sports department, sometimes places them in an information vacuity, which the news agent could eliminate to a certain degree.

6.6.2. Destination: Germany – FIFA World Cup

The FIFA World Cup was the major sports event in 2006, where players, coaches, and accompanying personnel from 32 national football teams met in Germany to compete in the most prestigious football tournament of them all – the World Cup. Also millions of fans were following their national football heroes to Germany, hoping that their team would be able to claim the trophy and thereby the rights to be called world champions during the next four years. However, they were not the only ones travelling to Germany in 2006 for the World Cup. A whole army of journalists, reporters, photographers, technicians, etc. from around the world, together with loads of equipment followed the tournament intensely; watching and reporting from the matches, analysing every move or comment the players and coaches would make in between the matches.

In more specific terms, 240 TV stations and 220 radio stations were broadcasting live from the World Cup, to more than 200 countries around the world and 15.000 media persons were accredited. 50 media companies were transmitting live from the World Cup via the Internet or mobile platforms. Approximately 32.5 billion people have watched one or more matches from the World Cup, which is almost 4 billion more than at the previous World Cup in South Korea and Japan. From a historic perspective, the first World Cup tournament was arranged in 1930, where 13 teams participated. The first World Cup tournament to be broadcasted via TV was the 1954 World Cup played in Switzerland, at that time 16 teams participated and 26 matches were played. In Germany, 32 national teams participated, and they played 64 matches before the Italian national team could claim the trophy.³⁴

³⁴ Based on: 'Verdens største medicirkus' from www.berlingske.dk (June 2006)

Working together with the sports department of a large Danish broadcasting company, which transmitted from around half the World Cup matches either via radio or TV, provided a golden opportunity for participatory observation, i.e. collecting user needs and requirements during the World Cup through hands on experience and analysis. During the World Cup I followed five different groups of people around, observing what they were doing and how they did it, combined with asking questions and talking with them concerning their work in general and in relation to their specific tasks and work processes at the World Cup. This participatory observation approach, i.e. following the journalists and reporters around, led me to the international broadcasting centre, and four football matches where I observed how the journalists and reporters prepared for the matches, worked during the matches, and what they did after the matches in order to recap the match. In order to follow the journalist and reporters around, I was accredited like they were, providing me with access to the press areas and press centres, access to the different stadiums, a seat at the matches in the press area where I was seated right next to the journalists and reporters who were commenting the match via TV or radio. The collected information regarding user needs and requirements from the World Cup participatory observation period is described below, both in relation to the international broadcasting centre, where I spent two days observing and in relation to following and observing the journalists and reporters before, during, and after a match, together with whom I spent four days, i.e. following and observing the journalists and reporters at four matches.

6.6.3. International Broadcasting Centre

The international broadcasting centre (IBC) was located in Munich, and functioned as the nerve centre of the whole World Cup setup, from a technical perspective. The IBC contains: a press centre together with some general support functions and a briefing area; the main accreditation centre, where the 15.000 media persons receive their accreditation passes and World Cup information kit; the satellite farm, which mainly contains the uplink satellite distribution equipment; Host Broadcast Services (HBS), which is the host broadcast organisation producing all the TV and radio signals for all the World Cup matches and related events. In addition, HBS is also responsible for providing broadcast partners with production services and facilities for their specific and additional coverage; on-site service providers, i.e. general maintenance and support services regarding the technical setup and equipment; the unilateral broadcaster area, which is where all the different national TV and radio broadcasters covering the World Cup had their control rooms, main technical facilities, TV and Radio studios etc; the HBC production centre and master control room. The master control room is where the signals form the 12 venues, other non venue sites, and from general telecom interfaces

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(fibre optic or satellite) are monitored and distributed to broadcast partners; and a number of additional facilities and services to support and cater for the large amount of people located and working at the IBC.³⁵ Overall, these facilities covered an area of approximately 40.000 square meters.

The 12 venues are connected to the IBC via two pairs of protected WDM (wavelength-division-multiplexed) 2x20 Gbps fibres and backup satellite connections. The feeds from the venues' outside broadcasting van (HSB OB van) deliver the multilateral feeds in SDTV (standard definition TV) and HDTV (high definition TV). All multilateral video signals are transmitted in uncompressed format with up to eight embedded audio signals, where the SDTV is transmitted at 270 Mbps and HDTV in 1.485 Gbps.³⁶ See Figure 6-3 and Figure 6-4.

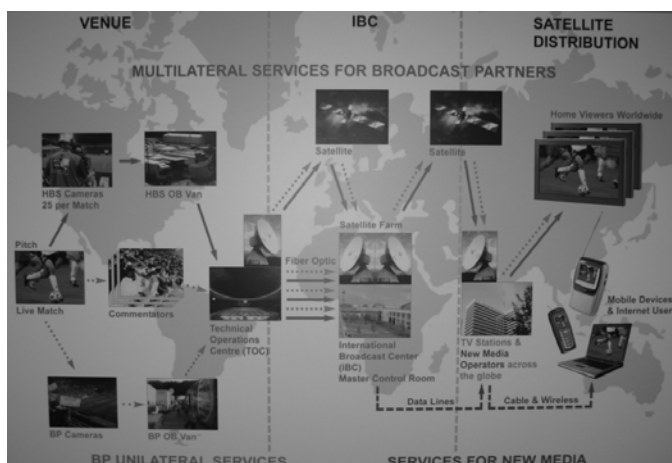


Figure 6-3 *Anatomy of broadcast operation*

Overall I spent two days at IBC, together with the broadcasting company's World Cup team leader and technical responsible person. The broadcasting company had a very small office/control room at the IBC, from where the two persons controlled and operated the video and audio transmission back to the broadcasting company. Basically, the team leader's task was to coordinate everything among the broadcasting company's personnel located in Germany, i.e. who is doing what and when. The main task of the technical responsible person was obviously to make sure that all the technical equipment and the technical setup was working properly including a 2x2Mbps fibre connection to the broadcasting company back in Denmark. Furthermore, and maybe

³⁵ HBS Handbook, 2006 FIFA World Cup Germany (page 59-82)

³⁶ HBS Handbook, 2006 FIFA World Cup Germany (page 84)

most important, the technical responsible person was responsible for connecting the journalists and reporters on stadiums to the home broadcasting company when transmitting from a match. This meant that at least one person should always be present at the broadcasting company's IBC office/control room, when transmitting from matches.

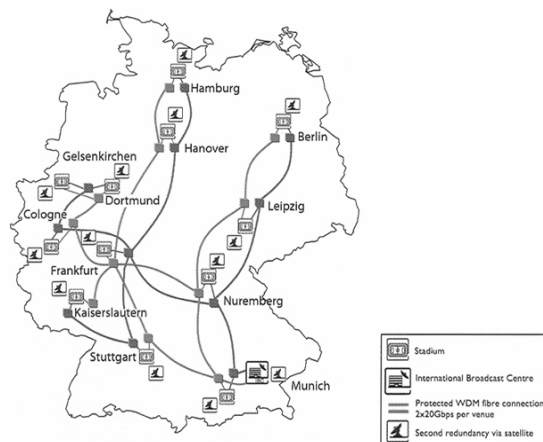


Figure 6-4 Fibre optic infrastructure³⁷

Besides the already mentioned tasks, the two persons located at IBC, also went around to the other TV broadcast stations present at IBC to exchange (obtain) general team TV clips, player profile TV clips etc. which they then sent home via the 2x2Mbps fibre connection, using the FTP protocol. Overall the team leader and technical responsible person were very pleased with their 2x2Mbps fibre connection, one for transferring TV clips back to the broadcasting company in Denmark, and one for normal office work, e.g. email etc. In addition, they also collaborated and shared information with other Nordic broadcasting companies present at IBC. According to the team leader, and as the Danish national team was not competing in Germany, it was fairly easy to get material from the other broadcasting stations regarding their national teams and players. The collected material was mainly used for pre-match studio productions, background information, or general information regarding the teams playing.

From an economic perspective, buying the 2x2Mbps fibre connection for the duration of the World Cup equals a 10-15 minute satellite time slot. First of all, this meant that they should not consider if the obtained material was relevant or not, i.e. from an

³⁷ HBS Handbook, 2006 FIFA World Cup Germany (page 84)

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economic and editorial perspective, they just passed it on to the home broadcasting company, where the editorial decision was made. At the same time, and because a satellite connection was much more expensive, most material transmitted via satellite was edited and finalised before transmitted via satellite, to keep the cost down. However, by using the fibre connection, this was not necessary from an economic perspective. In addition, this also saved the broadcasting company some money, as all the editing was done in Denmark, which meant that less people were needed in Germany.

6.6.4. On the job with journalists and reporters

In relation to following and observing the journalists and reporters before, during, and after a match in relation to deriving user needs and requirement I had the opportunity and privilege to follow and observe four two-person groups of journalists and reporters during a match day at the World Cup. During the World Cup, each match shown on TV in Denmark, broadcasted by the broadcasting company was commented on by two journalists or reporters, i.e. one with very specific football knowledge and one with more general football knowledge.

Basically, I met with the two persons in the morning during the match day, depending on when the match was to be played and followed them around the whole day, observing and asking questions in relation to what they were doing, how they did it, and why they did it in that particular way. However, before and during the match my work was mainly related to observing and trying not to disturb them too much in their preparation, as they were preparing intensely. After the match, they were much more relaxed, as their work was over in relation to that specific match and this led to some very interactive and fruitful discussions regarding their work before, during and after a match. During the World Cup I observed how the journalists and reporters worked in relation to four matches. See Table 6-9 below. However, as there were a great deal of similarity on how the different journalist and reporter groups prepared and worked during a match day, a general description of the typical course of a match day is given below.

6.6.5. On the job with journalists and reporters

In relation to following and observing the journalists and reporters before, during, and after a match in relation to deriving user needs and requirement I had the opportunity and privilege to follow and observe four two-person groups of journalists and reporters during a match day at the World Cup. During the World Cup, each match shown on TV

in Denmark, broadcasted by the broadcasting company was commented on by two journalists or reporters, i.e. one with very specific football knowledge and one with more general football knowledge.

Basically, I met with the two persons in the morning during the match day, depending on when the match was to be played and followed them around the whole day, observing and asking questions in relation to what they were doing, how they did it, and why they did it in that particular way. However, before and during the match my work was mainly related to observing and trying not to disturb them too much in their preparation, as they were preparing intensely. After the match, they were much more relaxed, as their work was over in relation to that specific match and this led to some very interactive and fruitful discussions regarding their work before, during and after a match. During the World Cup I observed how the journalists and reporters worked in relation to four matches. See Table 6-9. However, as there were a great deal of similarity on how the different journalist and reporter groups prepared and worked during a match day, a general description of the typical course of a match day is given below.

In general the journalists and reporters covering the matches broadcasted by the broadcasting company had some very intense weeks during the group matches, covering a new match every day and most likely in a new city. As the tournament progressed into the second round and final matches, the programme for the journalists and reporters became less stressful as there were some off days in between the matches in this period.

On location with journalists and reporters		
June 21 st	Ivory Cost vs. Serbia Montenegro	Munich
June 22 nd	Ghana vs. USA	Nuremburg
June 26 th	Switzerland vs. Ukraine	Cologne
June 27 th	Brazil vs. Ghana	Dortmund

Table 6-9 *Matches used for participatory observation*

However, in the beginning a typical day for the journalists and reporters would start fairly early, as they had to travel to a new city. After a match, the journalists and reporters would sleep at a hotel in the match city, where they had just worked. Therefore, the next morning, they had to travel to the city where the next match was being played, as they rarely stayed in the same city more than one day at the time, due

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to tournament schedules and match locations. In most cases all the travelling was done by train, as most journalists and reporters were given a mobility BahnCard from Deutsche Bahn (DB), which allowed them to travel freely with DB. During the train ride, they mainly spent their time reading newspapers and different material from Infostrada.com printed out at the hotels, to get updated on yesterday's matches and events and to start preparing for the match ahead. As there was no Internet available on the trains, the newspapers and printed materials from Infostrada.com were their main sources of information.

When arriving at the destination city, they generally went straight out to the stadium, where most of them preferred to be at least two hours before kick-off, however in most situations they were out at the stadium three hours before kick-off. When arriving at the stadium they went to the service media compound (SMC) where they continued preparing for the match, in order to 'get into the mind of the match' as one of the journalists put it. The SMC is a large room with a lot of chairs and tables, where all the journalists and reporters can prepare for the match. At the SMC all kinds of material and statistics were available from previous matches and in relation to the World Cup in general. In addition there was Internet access at all tables, however at a fairly high cost. At the SMC they all finalised their match setup plan, very similar to the preparation kit described earlier during the radio transmission setup in Denmark.

However, the match setup plan was much more detailed, mainly due to the fact that they were to comment the whole match live, not fractions of it. Basically, the match setup plan consisted of one ark of labels for each team, where they on each label wrote; the name of a player, jersey number, national matches played, goals scored in Germany, goals scored for the national team, age, and the football club the player played for. Information and different statistics from the Infostrada.com had been printed out at the hotel, and served as input to the match setup plan, together with material and statistics from the SMC. In several situations the journalists and reporters I was following were not sure about the pronunciation of one or more of the player names, and contacted/talked to some of the other journalists or reporters from the home country of the player, to get the pronunciation right. In addition, the journalists and reporters also talked to other journalists and reporters to exchange information and getting new input in relation to players, start line up, etc. Table 6-10 shows the main elements of a match setup plan: the handwritten labels, some individual notes and statistics, World Cup statistics regarding the two teams; and the official start list.

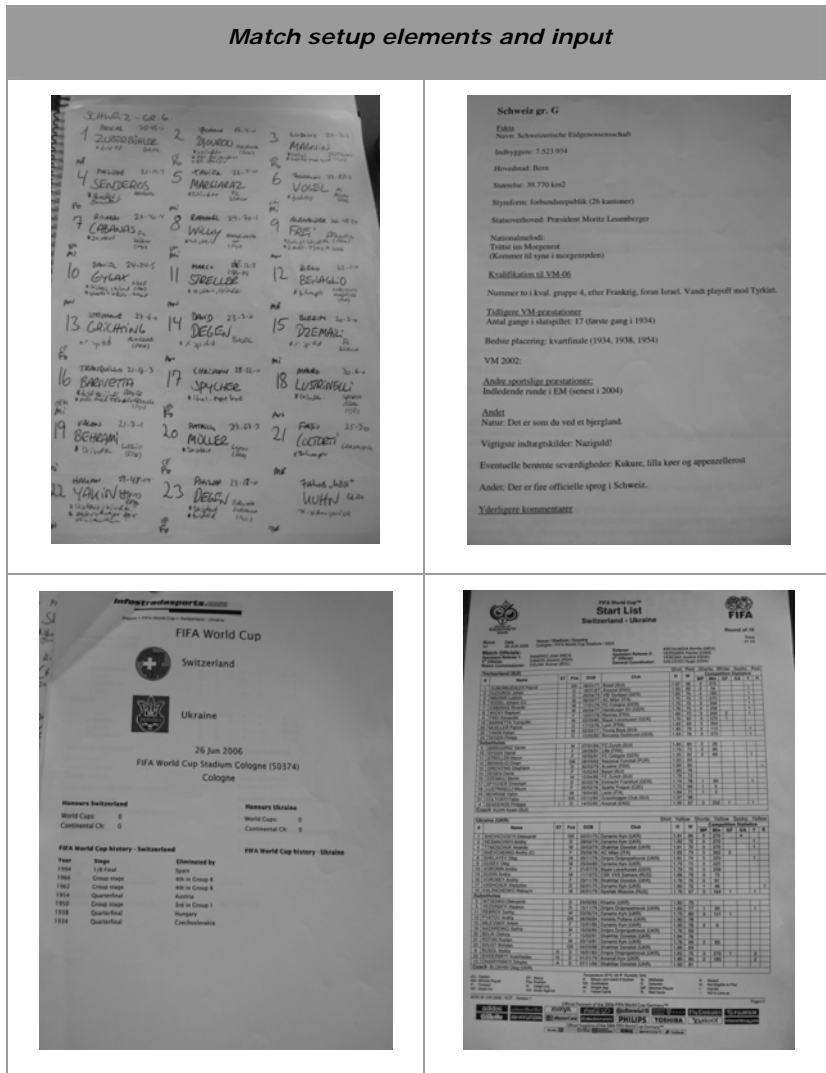


Table 6-10 Match setup elements and input

One hour before kick-off the official start list for the two teams were handed out at the SMC, which listed the eleven players that would be starting on the pitch for each team, their position, and the possible substitutes, together with a few statistics on each player in relation to the World Cup tournament. After the start list was released, the journalists and reporters finalised their match setup plan, by placing the labels made on a blank sheet of paper, placing the players according to their pitch positions. Figure 6-5 shows an example of a final match setup plan.

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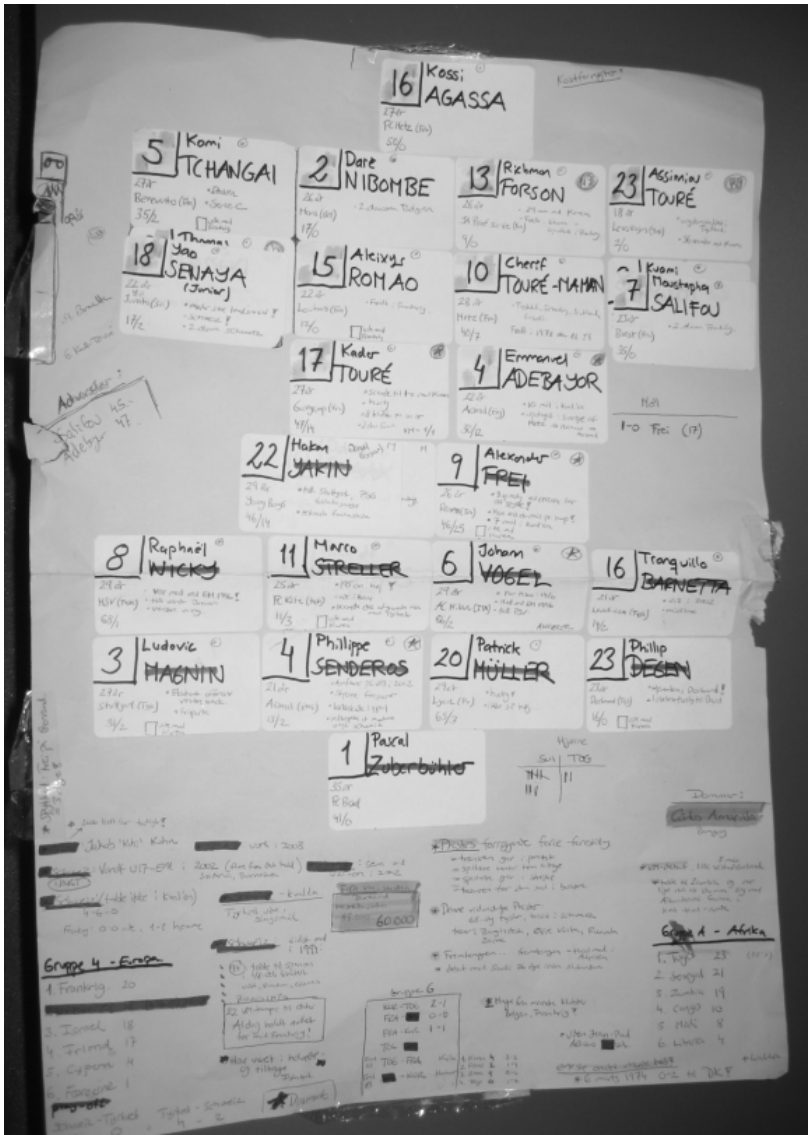


Figure 6-5 Final match setup plan

At half-time, half-time statistics were handed out on all media seats and five minutes after the final whistle had sounded, a match report containing the final statistics was handed out. Some examples of these different match statistics can be found in appendix. At each press booth on the different stadiums, there were two screens, one showing the live feed from the match, i.e. the pictures that were broadcasted to all the viewers around the world. The second screen contained the match statistics, making it easier for the journalists and reporters to keep track of the events that happened

throughout the match, i.e. goals, yellow and red cards, substitutions, and some general match statistics like shots on goal, time of possession, corners, off-sides etc. Figure 6-6 shows an example of these statistics, displaying a finished match statistics.



Figure 6-6 Statistics screen shot

6.6.6. Results, discussion, and evaluation

The potential service and application concepts described below has been generated based on: 1) the sixty-five hours of participatory observation conducted at the 2006 World Cup in Germany; 2) the very informal interviews and questions and answer sessions with the journalists and reporters regarding their tasks and way of working; 3) the expressed ideas, suggestions, needs, and requirements of the journalists and reporters; 4) the basic knowledge and information obtained via the survey conducted at the sports department; 5) the information retrieved based on the deployed toolkit; and 6) the results from the participatory observation conducted in Denmark, following journalists and reporters to sports events that were broadcasted via radio.

The coach board application concept was develop based on the many hours of participatory observation, combined with discussions with the journalists and reporters on approaches or ways that would make their work less tedious and repeating. At the same time, the work becomes more straightforward and uniform from match to match, thereby allowing them to focus more on their core competences, i.e. commenting and reporting from different sports event in the best and most productive and informative way, instead of spending a large amount of time on less important things.

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The coach board application should be viewed as a further development of the preparation kit already described. Besides all the general statistics and setup entities described in the preparation kit, the coach board application adds an easy to use, clear, and very informative interface, making it ideal for journalists and reporters commenting full time from live matches. In the traditional understanding, the coach board is a small white board depicting the pitch layout, which coaches use to explain match tactics, strategies, and player positions when preparing the players for a match or when changing the match tactics and strategies when the match is in progress, all in a very visual and easy to understand way. Furthermore, the coach board should be applicable in the major branches of sports covered by the broadcasting company, of course with some branch specific alterations, making the application fit the single branch of sport.

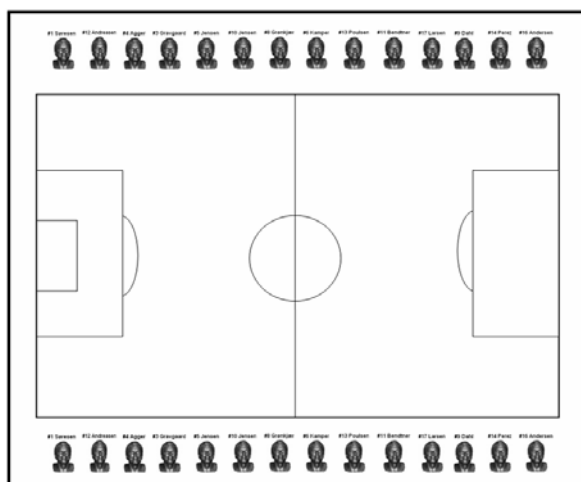


Figure 6-7 *Coach board screen shot at line-up position*

In general terms the coach board application concept consists of a pitch layout, in this case a football pitch, where the players from the two teams are lined up above and below the pitch, allowing the journalist or reporter to drag and drop the players into the wanted positions on the pitch. The overall concept idea is to make the coach board application as broad and universal as possible, without jeopardising the applicability of the conceptual application. Therefore, it should be developed to fit several branches of sports, where the most obvious would probably be football, handball, ice hockey, and other pitch related branches of sports. When starting the application the user should be able to choose: 1) different branches of sports; 2) international tournaments or national tournaments; 3) the specific international tournaments or national leagues; 4) selecting the two teams to be displayed in the opening team line-up view, e.g. football,

international tournaments, 2006 World Cup in Germany, Brazil and Ghana. Figure 6-7 shows a conceptual coach board screen shot at line-up position.

In the player line-up view, all the players are depicted with a photo, their jersey number, and last name, allowing the journalist or reporter to drag and drop the wanted players into their expected positions on the pitch. The drag and drop functionality allows the journalist or reporter to quickly change the selected setup, and thereby adapt the setup to altered conditions on the pitch. In addition, an extended information functionality should be activated by moving the mouse over a player or by double clicking on the player, i.e. highlighting and enlarging the view of the player and furthermore displaying a number of statistics regarding that particular player, i.e. name, age, club, national team goals, club goals, national matches, penalties, position, and name pronunciation. Figure 6-8 shows the coach board concept, with a highlighted player profile.

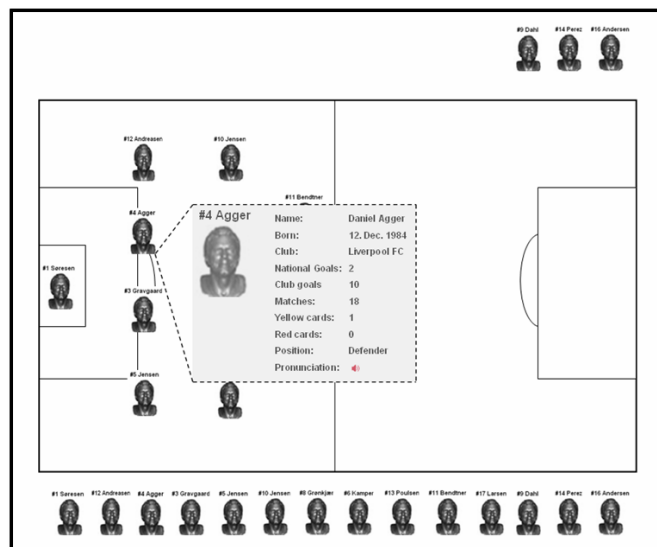


Figure 6-8 Screen shot with highlighted single profile

In relation to the technical setup and configuration of the coach board, all the statistics and information should be stored in a central database, and updated centrally. In addition, a local version of the database should be stored locally on a laptop or other mobile device, and then synchronised when updates are available and when the local device is online. Furthermore, a simplified mobile phone version could be deployed, at least regarding player statistics, thereby allowing the journalists and reporters to access

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the database remotely, or view stored statistics when on the move. Overall the presented coach board concept application is of course on an early and conceptual level. On the other hand, and based on feedback from journalists and reporters it is believed to have a great future. Especially, if it is customised to the most important branches of sports covered by the broadcasting company, and thereby making it a universal tool for all journalists and reporters.

News agent. In relation to the news agent already described the journalists and reporters located in Germany for the World Cup, strongly emphasised a wish for some more general news and information from Denmark as many of them would be away from home in up to four or five weeks. When away from Denmark in such a long period of time, it is really difficult to keep track on general news and what is happening in Denmark. Therefore the news agent, which in addition to the sports related news, should also provide the journalists and reporters with some general Danish news, would be highly appreciated. In relation to the news agent, also the search functionality was emphasised as important, mainly because when on the road for a substantial amount of time you might not have the time to read the news right away, hence, a search functionality could help in retrieving the right information at the right time. From a more general perspective and closely related to the high mobility level of the journalists and reporters and the different contexts they are present in, the mobile platform is clearly preferred as the future information and communication devices and platform. This means, that the more services and application that could be provided and used through a mobile platform, the more it would be appreciated and deployed, according to the journalists and reporters.

From an evaluation perspective, there is no doubt that the participatory observation approach in general provided a broad insight into the world of journalists and reporters and on how they work and operate within different environments and contexts, i.e. providing a very realistic and practical perspective on the world of journalism in general. From a user involvement in the innovation process perspective the same could be said, however, adding to the observation the interaction and discussion with the journalists and reporters clearly contributed to the innovation process, underlining that participatory observation alone most likely would not have given the same results. Hence the combination of the observation and the interaction, discussion, and maybe above all the openness and willingness of the journalists and reporters to contribute to the innovation process, combined with the different approaches applied in relation to deriving user needs and requirements ensured the results. First of all by agreeing to be observed and thereby having a researcher following them around observing whatever they did, and second by engaging actively in the innovation process by openly telling

and explaining about their work and giving substantial input regarding needs and requirements in relation to their work as journalists and reporters. Without the journalists' and reporters' engagement, openness, and interaction in the project, the results would not have been the same.

In relation to the lead user theory, the sports department and thereby the journalists and reporters working there were a given source of participants. Based on interviews with managers and other key people at the sports department, a number of the most progressive and forward looking journalists and reporters were selected as the lead users of the sports department. However, these might not be categorised as truly lead users, in the defined meaning of the lead user definition. This could constitute a problem from a theoretical perspective; however, this is not believed to be the case from a practical and user involvement perspective. Selecting the lead users of the sports department and involving them in the project, is believed to derive needs and requirements vital to the sports department and in the future this would benefit most people in the sports department. In other words, if the sports department is viewed as a sample, the needs and requirements of the lead users within this sample, if considered and developed, will in both the short and long run benefit the sample. On the other side, there is no doubt that involving a broader group of people, i.e. from other broadcasting companies and people from outside the broadcasting segment but working within similar contexts would, as the lead user theory predicts, have provided a more representative sample and more truly lead users from a theoretical perspective. However, this was not possible in relation to this project. At the same time, a larger and more representative group of users might not have provided such fairly specific results. Nevertheless, it is believed that the ideas, user needs, and requirements derived through the observation, interaction and discussion process with the journalists and reporters to some extent will or at least could be incorporated into future services and applications within the journalist and reporter segments. Thereby, supporting these users in their everyday working environment, by services or applications developed by involving the users in the innovation process.

6.7. Summary

A survey was conducted and provided both a fairly broad and at the same time detailed understanding of the sports department in relation to the employees' usage of communication technologies, communication tools, and their levels of mobility. The results from the survey have provided important and valid input in relation to deriving user needs and requirements in relation to the journalist and reporter segments. The information and results obtained through the survey have served as background

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information in relation to the toolkit and participatory observation data collection methods, and thereby been incorporated into the ideas, user needs, and requirements described and analysed in relation to the deployment of the toolkit and participatory observation data collection methods.

A contextual, dynamic, interactive, and user-documenting mobile toolkit has been developed and tested in relation to deriving user needs and requirements that support the journalists and nomadic professionals in their everyday tasks. The development and deployment of the toolkit was inspired by the approach used by Jeff Hawkings, when he designed the first Palm Pilot. Overall the toolkit was well received by the selected lead user participants, who expressed a genuine interest and enthusiasm regarding the toolkit itself and found the looks and size very attractive, combined with being easy to use. The deployment of bumper stickers within the toolkit as a motivation factor was in general also perceived as so by the participants. The deployment of sending text messages to the participants' mobile phones, also as a reminding and motivational factor, was found inspirational and motivating by some of the participants while others found them annoying and a burden beyond the first week.

Overall the participants felt most motivated in the beginning of the three week period, and it was mainly during this period most ideas, needs, and requirements were written into the toolkit. In the middle of the three week period not that many ideas, needs, and requirements were generated, however the activity level increased again at the end of the three week period. Two kinds of results were generated; the ideas, needs, and requirements written into the toolkit during the three week period and the workshop generated results. Overall the toolkit generated results covered a broad range of ideas, needs, and requirements, which were elaborated on at the workshop, providing valuable insights into user needs and requirements within the journalist and nomadic professional user segments. In relation to how generally applicable the toolkit method is in relation to deriving user needs and requirements, the toolkit used in this context is believed to have proven its worth. The eleven participants using the toolkit generated 185 ideas, user needs, or requirements over a three week period, where the participants were enabled to formulate ideas, user needs, and requirements in any given context. It is expected that this toolkit approach could be deployed in a wide variety of contexts and situations, and provides a broad and fairly open-ended array of results in a relatively simple and easy deployable manner.

In relation to the participant observation method and from an evaluation perspective, there is no doubt that the participatory observation method provided an insight into the world of journalists and reporters and how they work and operate within different

environments and contexts, i.e. providing a very realistic and practical perspective on the world of journalism in general. From a user involvement in the innovation process perspective the same could be said, however, adding that the interaction and discussion with the journalists and reporters clearly contributed to the innovation process. The openness and willingness of the journalists and reporters to contribute to the innovation process, combined with the different approaches applied in relation to deriving user needs and requirements have all contributed to and provided substantial input regarding needs and requirements in relation to their work as journalists and reporters. The generated service and application concepts are expected to be (or to some extent be) incorporated into future services and applications within the journalist and reporter segment, thereby supporting these in their everyday working environment, by services or applications developed by involving the user in the innovation process.

7. Conclusion and discussion

This thesis has analysed how users can be involved in the innovation process by deploying lead user, sticky information, and toolkit methods within two case studies, a diabetes and journalist case, with the main objective of deriving and collecting user needs and requirements within these two segments combined with a method development and deployment perspective. Three interrelated research areas have been deployed within the theoretical user involvement in the innovation process framework, which combined constitute the intertwined and complex interaction of people, context, and their use of information and communication technologies: mobile system requirements, mobility, and the concept of Personal Networks. The research has been conducted in order to obtain a better and more elaborated understanding of the user needs and requirements and convert these into service and application concepts, which support the users within the two mentioned segments in their everyday life, tasks, and context, all within an information and communication technology perspective. This chapter provides a summary of the research carried out and the main findings.

The case study methodology was chosen as it from a theoretical and method deployment perspective was viewed as the best method to analyse the contemporary, real-life, and complex context of user involvement in the innovation process, which consists of a fairly bounded system but at the same time emphasises the unity and wholeness of this system. Furthermore the method was regarded as the best approach within this context, as the researcher had no or little control over the events studied. However, the main advantages of the case study approach and method within this context and in general are the possibility of utilising and deploying several sources and approaches in relation to the information collecting and deriving process together with the triangulation of the collected data and methods. By combining the multiple empirical data, theories, and deployed methods it has been possible to overcome the weaknesses or intrinsic biases of relying on single data, theories, and methods. Overall the case method has provided a more elaborated understanding of the context and process of involving the users in the innovation process and how the different elements within this context and process influence each other, together with an in-depth understanding of the two cases: the diabetes and journalist cases.

7.1. Personal network

The main objective of this thesis in relation to Personal Networks has been to derive and collect real user needs and requirements. This is done in relation to the research and further development of the Personal Network concept, as the overall goal of the MAGNET project (within which the Personal Network concept is being researched and developed) is to develop and enable commercially viable Personal Networks that are affordable, user friendly, and beneficial to different kinds of users in all aspects of their everyday lives. This means that future services and applications should be adapted to the needs and requirements of individuals, by providing a high level of personalisation and context awareness. The two cases (diabetes and journalist) together with the Personal Network concept was an integrated and given part of the PhD project. However, both cases and the Personal Network perspective have provided substantial and valid input to the overall user involvement in the innovation process theoretical framework of this thesis combined with the information and communication technology perspective in relation to deriving user needs and requirements and transforming these into preliminary future service and application concepts.

7.2. User involvement in the innovation process

User involvement in the innovation process constitutes the main theoretical framework for this thesis, within which the user involvement in the innovation process is analysed and described, including lead users, sticky information, and the deployment of toolkits. Based on extensive user involvement in the innovation process this thesis has demonstrated how the users and their needs and requirements can actively be drawn into the process of developing better service and application concepts within the information and communication technology domain, which support the users in their everyday activities. Based on the lead user method, the concept of sticky information, and toolkit approach this thesis furthermore demonstrates what methods can be developed and deployed within the process of involving the users in the innovation process.

7.2.1. Innovation models

Appropriateness of innovation models or not, the reality is often more complex than any model can represent and it is therefore difficult to talk about pure technology push, market pull, parallel, or integrated models of innovation, as these pure models only seem to exist in theory. Overall it seems that all models of innovation exist in a wide range of forms and contexts, so it appears to be difficult to talk about dominant models

of innovation. However, within certain industries or in relation to certain products or product groups, there might be some general trend in relation to dominant innovation models. In most cases the innovation process is based on a combination of models reflecting the diversity and complexity of the: innovation process; the industry or sector in question; the products produced or services offered; and the people and organisations involved in the innovation process.

7.2.2. Lead users

Based on reviewed literature containing empirical examples, analyses, and discussions in relation to the lead user concept there seems to be a general support for the concept both in fast and slower moving industries, however, there are also some challenges that need to be resolved. Besides a general support for the lead user concept, there are also evidence and support for the two main assumptions behind the lead user concept, i.e. being ahead of time and obtaining significant benefits from potential solutions. However, the predictability of the lead user method can in some instances be questioned, especially where network effects are present, as these could potentially alter the lead user trajectories and thereby deviate the lead user path put forward, before reaching the average users. This highlights the problem of differences between very technology savvy lead users and early adopters compared to the less technology savvy or average user. Therefore, it is very important, that the deployment of the lead user concept is combined with general market knowledge and other approaches to innovation and new product development. Furthermore one could argue that the users' contextual situation, social situation, and personal experience are very important parameters, and that these can be very different within the lead user environment compared to the average user environment, potentially resulting in the failure of lead user predicted products.

7.2.3. Sticky information

In connection with the lead user approach, the concept of sticky information has been analysed and described in relation to deriving and collecting user needs and requirements within the user involvement in the innovation process framework. Basically, sticky information is related to the transferability of a given unit of information, i.e. the easier to transfer, the lower the stickiness and the higher the stickiness, the higher the cost of transferring. The stickiness of information can also be related to tacit and explicit knowledge and information combined with a variety of attributes of the knowledge and information holders and seekers and their capabilities of acquiring, absorbing, and distributing knowledge and information, which are all

important considerations when involving the users in the innovation process and trying to decode their needs and requirements in relation to future products, services, applications, and solutions.

7.2.4. Toolkits

In connection with the lead user approach and sticky information different kinds of toolkits and their appropriateness have been analysed and described in relation to deriving and collecting user needs and requirements regarding user involvement in the innovation process. In relation to the deployment of toolkits, the reviewed literature has through empirical evidence proven the validity and usefulness of the toolkit approach. The toolkit approach can be defined as an innovation process within which the users contribute significantly to the innovation process, based on a given solution space, thereby minimising the complex and time consuming task of deriving and collecting user needs and requirements and transferring these into actual products. Overall the deployment of different kinds of toolkits can be defined as transferring sticky information (user needs and requirements) into less sticky information and thereby shifting the deriving and collecting of user needs and requirements into the user domain.

7.3. Mobile system requirement and mobility

The overall viewpoint on mobile system requirements within this thesis is related to user needs, requirements, and more specifically to design studies and human-computer interaction perspectives. Based on reviewed and analysed research contributions and perspectives in relation to mobile system requirements there seems to be a need for a more user oriented research approach in relation to mobile system requirements, as only little research is actually done in order to establish real user needs and requirements, which do not only reflect mobile technologies but also the social context of mobility. Furthermore there seems to be a clear bias towards environment independent and artificial settings within the mobile system requirement area. This bias suggests more focus on case studies and alike, in order to get a more elaborated and context based understanding of the field in question, and thereby also a more user oriented approach to future research. Overall, there seems to be a need to acquire a better understanding of user needs and requirements and afterwards translate these into future service and application concepts, which support the context and social environment within which the users roam.

The term mobility has been described, analysed, and attempted conceptualised based on a literature review, in order to get a broader and at the same time more nuanced understanding of the mobility concept and the use of the term mobility. The review revealed that there are numerous concepts, understandings, and deployment perspectives of the term mobility. However, quite a few of these are also overlapping or almost identical. Based on the literature review conducted a mobility framework has been presented in order to categorise and conceptualise the term mobility in a user need and requirement perspective and at the same time a service and application development perspective. The developed mobility framework categorise the term mobility in relation to different types of users, their level of mobility, and the users' needs and requirements. Four different categorisations of mobility have been defined within the framework; spatial mobility, temporal mobility, context mobility, and social mobility and the four categories are important, each in their own setting, and very useful in relation to designing and developing new service and application concepts that are more supportive of the users' activities.

7.4. Diabetes case

The main objective of the diabetes case study has been to derive and collect user needs and requirements from diabetic persons in relation to self-management and preventive treatment of diabetes and diabetes related symptoms, based on an extended user involvement in the innovation process. This has been done by applying the lead user method and a workshop toolkit in relation to decoding the sticky information of the participants, i.e. diabetics, nurses, and doctors, in order to extract user needs and requirements in relation to future service and application concepts that would support diabetic persons in their everyday lives.

The research within the diabetes case is based on ongoing research within the field of diabetes and in particular regarding an existing diabetes service called DiasNet. The research was conducted based on developing and deploying a so-called workshop toolkit, which was based on an interactive and user intensive approach within which the participants had to create four life context phases representing different life stages of a diabetic person: child, teenager, adult, and elderly. The four context phases were chosen to derive context specific user needs and requirements, as the life of diabetic patients was expected to be very different, depending on the age of the patient.

In general all the patients were very keen on managing and controlling their disease themselves by deploying different tools, services, and devices in doing so, which to some extent confirmed that the selected patients were among the lead users within the

diabetes segment. This was also confirmed by the nurses and doctors participating in the workshop, based on their experience. In relation to the developed life context phases, and thereby the deployed toolkit, a number of potential future service and application concepts were developed and suggested by the participants. The life context phase generation process provided an innovative environment for the participants, which, combined with the content of the toolkit, supported both an active and highly user involvement intensive process. Furthermore the toolkit emphasised the importance of combining social and context related parameters in order to develop future service and application concepts that are actually based on user needs and requirements and thereby support the users in a given context.

7.5. Journalist case

The main objective of the journalist case study has been to derive and collect user needs and requirements from nomadic professionals in general and especially from sports journalists, based on an extended user involvement in the innovation process. This has been done by applying the lead user method, a mobile toolkit, a survey, and by participatory observation in relation to lead user journalists and reporters all in relation to decoding the sticky information of the journalists and furthermore in relation to mobile system requirements and mobility. The main goal has therefore been to collect and draw out user needs and requirements regarding journalists in order to provide input for future service and application concepts, which support journalists and nomadic professionals in their everyday working environments, based on an extended user involvement in the innovation process.

The survey conducted at the sports department provided both a fairly broad and at the same time detailed understanding of the sports department in relation to the employees' usage of communication technologies, communication tools, and their levels of mobility. The results from the survey have provided important and valid input in relation to deriving user needs and requirements in relation to the journalist and reporter segments. The information and results obtained through the survey have served as background information in relation to the toolkit and participatory observation data collection methods, and thereby been incorporated into the ideas, user needs, and requirements described and analysed in relation to the deployment of the toolkit and participatory observation data collection methods.

A contextual, dynamic, interactive, and user-documenting mobile toolkit has been developed and tested in relation to deriving user needs and requirements that support the journalists and nomadic professionals in their everyday tasks. Overall the toolkit

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was well received by the selected lead user participants, who expressed a genuine interest and enthusiasm regarding the toolkit itself and found the looks and size very attractive, combined with being easy to use. The toolkit generated results covering a broad range of ideas, needs, and requirements, providing valuable insights into user needs and requirements within the journalist and nomadic professional user segments. In relation to how generally applicable the toolkit method is in relation to deriving user needs and requirements, the toolkit used in this context is believed to have proven its worth. The eleven participants using the toolkit generated 185 ideas, user needs, or requirements over a three week period, where the participants were enabled to formulate ideas, user needs, and requirements in any given context. It is expected that this toolkit approach could be deployed in a wide variety of contexts and situations, and provide a broad and fairly open-ended array of results in a relatively simple and easy deployable manner.

Also the participatory observation method, in relation to observing lead user journalists and reporters, has provided a broad and at the same time specific understanding of how they work and operate within different environments and contexts, i.e. providing a very realistic and practical perspective on the world of journalism, and in particular in relation to deriving and collecting user needs and requirements within this segment. The openness and willingness of the journalists and reporters to contribute to the innovation process combined with the interaction and discussion during the participatory observation periods and the different approaches applied in relation to deriving user needs and requirements have all contributed to and provided substantial input regarding user needs and requirements. The generated service and application concepts are expected to be (or to some extent be) incorporated into future services and applications within the journalist and reporter segment, thereby supporting these in their everyday working environment, by services or applications developed by involving the user in the innovation process.

In general this thesis has shown how the deployment of the three methods (lead user, sticky information, and toolkit) combined with some more traditional approaches and in relation to the two case studies has provided a more detailed and context related understanding of the user needs and requirements within these two case segments. This has been done based on the user involvement in the innovation process and the three related and intertwined research areas; mobile system requirements, mobility, and the Personal Networks concept. The mobility and context related aspects of user needs and requirements have been deployed and incorporated into the gathering and collection process, and provided valuable insights in relation to the developed future service and application concepts, which are based on real user needs, requirements,

mobility, and contexts. All with the purpose of deriving user needs and requirements and thereby develop and describe the concepts for future services and applications, which support these users in their everyday lives tasks, and contexts – value innovation.

Based on the research conducted within this thesis and in relation to future perspectives the user involvement in the innovation process, the deployment of the lead user concept, sticky information, and toolkits are believed to be applicable within many industries, specific product segments, and products. However, it is important that the approach is tested further and evaluated, in order to further validate it within different industries, product segments, and products, as it until now mainly has been deployed within fairly fast moving industries. As mentioned previously, there could be a difference between the lead user needs and requirements, and the later average user needs and requirements, especially if networks effects are present, implying that the lead user method cannot stand alone. In relation to this some further research and empirical evidence in relation to the success rate vs. failure rate of lead user trajectories would be beneficial, as there seems to be a tendency to focus on the positive research and aspects of the lead user method. Only a very few academic contributions on negative or less positive lead user experiences have been found during the research for this thesis.

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9. Appendix



FIFA World Cup™
Start List
Côte d'Ivoire - Serbia & Montenegro



Group C

Match 38 Date 21 JUN 2006 Venue / Stadium / Country Munich / FIFA World Cup Stadium / GER Time 21:00

Match Officials:
 Assistant Referee 1: CAMARGO Jose Luis (MEX) Referee: RODRIGUEZ Marco (MEX)
 4th Official: GUEZZAZ Mohamed (MAR) Assistant Referee 2: LEAL Leonel (CRC)
 Match Commissioner: ASFURA Alfredo (CHI) 5th Official: DUEZZAR Brahim (ALG)
 General Coordinator: MAYNE-NICHOLLS Harold (CHI)

Côte d'Ivoire (CIV)						Shirt: Orange Shorts: Orange Socks: Green											
#	Name	ST	Pos	DOB	Club	H	W	Competition Statistics				GA		Y		R	
						MP	Min	GF	GA	Y	R						
22	BARRY Boutacar	GK		30/12/79	Beveren (BEL)	1.80	69										
2	AKALE Kanga	M		07/03/81	Auxerre (FRA)	1.78	73	2	78								
3	BOKA Arthur	X	D	02/04/83	Strasbourg (FRA)	1.66	67	2	180								1
5	ZOKOHA Didier	X	M	14/12/80	Saint-Etienne (FRA)	1.83	78	2	180								1
8	KOUASSI Blaise	D		02/02/75	Troyes (FRA)	1.82	75										
9	KONE Adama	F		11/11/83	PSV Eindhoven (NED)	1.82	85	2	88								
15	DINDANE Aruna	F		26/11/80	Lens (FRA)	1.74	76	2	65								
17	DOMO-SALIO Cyrille (C)	D		22/07/71	Creteil (FRA)	1.80	80										
18	KEITA Kader	M		09/08/81	Lille (FRA)	1.84	78	1	76								
19	TOURE Yaya	M		13/05/83	Olympiakos (GRE)	1.89	79	2	180								
21	LEBOUE Emmanuel	X	D	04/06/83	Arsenal (ENG)	1.78	72	2	180								1
Substitutes																	
1	TIGER Jean-Jacques	GK		07/09/72	Esperance (TUN)	1.83	80	2	180			4					
4	TOURE Kolo	D		19/03/81	Arsenal (ENG)	1.83	78	2	180								
7	FAE Ernest	M		24/01/84	Nantes (FRA)	1.74	71										
8	KALOU Bonaventure	F		12/01/78	Paris St-Germain (FRA)	1.62	77	1	54								
10	YAPI YAPO Gilles	M		30/01/82	Young Boys (SUI)	1.71	63	1	29								
12	MEITE Abdoulaye	D		06/10/80	Marseille (FRA)	1.85	82	2	180								
13	ZORO Marc	D		27/12/83	Messina (ITA)	1.82	75										
14	KONE Bakary	F		17/08/81	Nice (FRA)	1.63	61	2	90	1							
16	OUANLI-OUAN Gerard	GK		12/02/79	Montpellier (FRA)	1.82	77										
20	DEMEI Giv	M		13/03/81	Hamburger SV (GER)	1.81	83										
22	ROMAHO	M		04/09/83	Le Mans (FRA)	1.87	89	1	61								
11	DROGHA Didier	N	F	11/03/78	Chelsea (ENG)	1.80	84	2	180	1							2
Coach: MICHEL Henri (FRA)																	
Serbia & Montenegro (SCG)						Shirt: Blue Shorts: White Socks: Red											
#	Name	ST	Pos	DOB	Club	H	W	Competition Statistics				GA		Y		R	
						MP	Min	GF	GA	Y	R						
1	JEVVIC Dragoslav	GK		06/07/74	Ankaraspor (TUR)	1.88	82	2	180								
2	ERGIC Ivan	M		21/01/81	Basel (SUI)	1.85	84	1	45			7					
4	DULJAI Igor	M		29/10/79	Shahtar Donetsk (UKR)	1.75	72	2	180								
6	GAVRANVIC Goran	X	D	02/08/79	Dynamo Kyiv (UKR)	1.91	84	2	180								1
10	STANKOVIC Dejan (C)	X	M	11/09/78	Inter (ITA)	1.81	75	2	180								1
11	DJORDJEVIC Predrag	M		04/08/72	Olympiakos (GRE)	1.84	75	2	180								
14	DJORDJEVIC Nenad	D		07/08/79	Partizan (SCG)	1.83	78	1	42								
15	DUDIC Milan	D		01/11/79	Crvena Zvezda (SCG)	1.83	77	1	90								
19	ZOGIC Nikola	F		25/09/80	Crvena Zvezda (SCG)	2.02	96	1	45								
20	KRSTIC IC Miladin	X	D	04/03/74	Schalke 04 (GER)	1.91	81	2	180								1
22	ILIC Saša	M		30/12/77	Galatasaray (TUR)	1.78	72										
Substitutes																	
3	DRAGUTINOVIC Ivica	X	D	13/11/75	Sevilla FC (ESP)	1.84	86	1	90								1
9	MLOSEVIC Stevo	F		02/09/73	Ossuna (ESP)	1.87	81	2	114								
12	KOVACVIC Oliver	GK		29/10/74	CSKA Sofia (BUL)	1.86	88										
13	BASTA Jovan	D		18/08/84	Crvena Zvezda (SCG)	1.83	72										
17	HAJDU Anđel	X	M	29/10/74	Partizan (SCG)	1.74	72	2	155								1
18	VUKIC Vojimir	M		19/07/79	Partizan (SCG)	1.82	72	1	21								
23	STOKOVIC Vladimir	GK		28/07/83	Crvena Zvezda (SCG)	1.95	92										
7	KOROMAN Ognjen	N	M	19/09/78	Portsmouth (ENG)	1.79	71	2	97								2
8	KIZMANI Mateja	N	F	12/04/79	Atletico Madrid (ESP)	1.80	71	2	130								1
5	VIDIC Nemanja	A	D	21/10/81	Manchester Utd. (ENG)	1.88	83										
16	PETKOVIC Oustan	A	D	13/06/74	OFK Beograd (SCG)	1.88	80										
21	LIJUBOJA Danijel	A	F	04/09/78	VfB Stuttgart (GER)	1.87	80	2	65								
Coach: PETKOVIC Bica (SCG)																	

(C) Captain ST: Striker Temperature: 28°C / 79°F Humidity: 55%
 X: Missed next match if booked M: Midfielder A: Absent
 Min: Minutes Played Pos: Position GK: Goalkeeper D: Defender N: Not Eligible to Play
 F: Forward W: Weight (kg) Y: Yellow Cards MP: Matches Played I: Injured
 GP: Goals For GA: Goals Against Y: Yellow Cards R: Red Cards L: Not in Line-up

WED 21 JUN 2006: 19:42 - Version 1 Page 1/1

Official Partners of the 2006 FIFA World Cup Germany™



Official Suppliers of the 2006 FIFA World Cup Germany™





FIFA World Cup™
Match Report



Round of 16

Brazil - Ghana

3:0 (2:0)

Match Date: 27 JUN 2006
Venue / Stadium / Country: Dortmund / FIFA World Cup Stadium / GER

Time: 17:00
Att.: 65,000 sold out

Match Officials:
Assistant Referee 1: SLYSKO Roman (SVK)
4th Official: SHIELD Mark (AUS)
Match Commissioner: FIGUEREDO Eugenio (URU)

Referee: MICHEL Lubos (SVK)
Assistant Referee 2: BALIKO Martin (SVK)
5th Official: GIBSON Nathan (AUS)
General Coordinator: TINOCO Rafael (GUA)

Goals Scored:
RONALDO (BRA) 5', ADRIANO (BRA) 46', ZE ROBERTO (BRA) 84'

Brazil (BRA)

- [1] DIDA (GK)
- [2] CAFU (C)
- [3] LUCIO
- [4] JUAN
- [5] EMERSON (-46')
- [6] ROBERTO CARLOS
- [7] ADRIANO (-61')
- [8] KAKA (-83')
- [9] RONALDO
- [10] RONALDINHO
- [11] ZE ROBERTO

Substitutes:

- [12] ROGERIO CENI (GK)
- [13] CICINHO
- [14] LUISAO
- [15] CRIS
- [16] GILBERTO
- [17] GILBERTO SILVA (+46')
- [18] MINEIRO
- [19] JUNINHO PERNAMBUCANO (+61')
- [20] RICARDINHO (+83')
- [21] FRED
- [22] JULIO CESAR (GK)
- [23] ROBINHO (A)

Coach: PAIREIRA Carlos Alberto (BRA)

Ghana (GHA)

- [22] KINGSON Richard (GK)
- [3] GYAN Asamoah
- [5] MENSAH John
- [6] PAPPOE Emmanuel
- [7] SHILLA Iliasu
- [10] APPIAH Stephen (C)
- [11] MUNTARI Sulley
- [14] AMOAH Matthew (-70')
- [15] PANTSIL John
- [18] ADDO Eric (-60')
- [23] DRAMAN Hamiru

Substitutes:

- [1] ADJEI Sammy (GK)
- [2] SARPEI Hans
- [4] KUFFOUR Samuel
- [9] BOATENG Derek (+60')
- [12] TACHIE-MENSAH Alex (+70')
- [13] MOHAMED Habib
- [16] OWU George (GK)
- [17] QUAYE Daniel
- [19] PIMPONG Razak
- [20] ADDO Otto
- [21] ISSAH Ahmed
- [8] ESSIEN Michael (N)

Coach: DUJKOVIC Ratomir (SCG)

Cautions:

APPIAH Stephen (GHA) 7', MUNTARI Sulley (GHA) 11', ADRIANO (BRA) 13', PANTSIL John (GHA) 29', ADDO Eric (GHA) 38', JUAN (BRA) 44', GYAN Asamoah (GHA) 48', GYAN Asamoah (GHA) 81'

Expulsions:

GYAN Asamoah (GHA) 81' 2Y

Additional Time:

First half: 3 min., second half: 3 min.

N: Not Eligible to Play I: Injured A: Absent 2Y: Second Yellow Card
C: Captain AL: Attendance AE: After extra time GK: Goalkeeper PSO: Penalty shoot-out

TUE 27 JUN 2006, 11:54 - Version 1

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Official Suppliers of the 2006 FIFA World Cup Germany™
[Logos for various suppliers]


**FIFA World Cup™
Statistics**

Brazil - Ghana

Round of 16

3:0 (2:0)

Match Date
55 27 JUN 2006Venue / Stadium / Country
Dortmund / FIFA World Cup Stadium / GERTime Att.
17:00 65,000 sold out

Brazil (BRA)	Statistics	Ghana (GHA)
11	Shots	18
10	Shots on Goal	7
18	Fouls	24
3	Corner Kicks	4
1	Direct Free Kicks to Goal	1
0	Indirect Free Kicks to Goal	0
0	Penalty Kicks	0
5	Offsides	4
0	Own Goals	0
2	Cautions	6
0	Expulsions	1
48%	Ball Possession	52%
27	Actual Playing Time	29

Man of the Match: 11, ZE ROBERTO (BRA)

Brazil (BRA)												
#	Name	Pos	Min	GF	GA	SG/S	PK	Fouls		Y	R	
								FC	FS			
1	DIDA	GK	90						3	1		
2	CAFU (C)	D	90			1/1						
3	LUCIO	D	90			1/1						
4	JUAN	D	90			1/1		3	2	1		
5	EMERSON	M	45					1				
6	ROBERTO CARLOS	D	90			2/2			2			
7	ADRIANO	F	90	1		1/1		3	2	1		
8	KAKA	M	90			2/2		2	6			
9	RONALDO	F	90	1		2/2						
10	RONALDINHO	M	90			1/2		1	1			
11	ZE ROBERTO	M	90	1		1/1		3	2			
Substitutes												
17	GILBERTO SILVA	M	45					1				
19	JUNYHO PERNAMBUCANO	M	30									
20	RICAIDINHO	M	8					1				
Totals				3		10/11		18	22	2		
Ghana (GHA)												
#	Name	Pos	Min	GF	GA	SG/S	PK	Fouls		Y	R	
								FC	FS			
22	KINGSOON Richard	GK	90		3							
3	GYAN Asamoah	F	90			2/5		3	3	2	1	
5	MENSAH John	D	90			1/1		3				
6	PAPFOE Emmanuel	D	90									
7	SHILLA Ilasu	D	90					1	2			
10	APPIAH Stephen (C)	M	90			0/3		2	2	1		
11	MUNTARI Sulley	M	90			0/1		4	1	1		
14	AMOAH Matthew	F	69			1/2		3	1			
15	PANTIL John	D	90			1/2		3	1	1		
18	ADDO Eric	M	59					2	3	1		
23	DRAMAN Hamisu	M	90			1/3		4	1			
Substitutes												
9	BOATENG Derek	M	31					2	1			
12	TACHIE-MENSAH Alex	F	21			1/1						
Totals				3		7/18		24	16	6	1	

AET: After extra time
D: Defender
R: Red Cards
Y: Yellow Cards

PSO: Penalty shoot-out
M: Midfielder
GA: Goals Against
SG/S: Shots on Goal/Shot

(C): Captain
F: Forward
PK: Penalty Kicks (Goals/Shot)

Pos: Position
Min: Minutes Played
FC: Fouls Committed

GC: Goalkeeper
GF: Goals For
FS: Fouls Suffered

TUE 27 JUN 2006 18:54 - Version 1

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Official Suppliers of the 2006 FIFA World Cup Germany™



FIFA World Cup™
Statistics
 Half-time



Group C

0:0

Netherlands - Argentina

Match 37 Date 21 JUN 2006 Venue / Stadium / Country Frankfurt / FIFA World Cup Stadium / GER

Time 21:00

Netherlands (NED)	Statistics	Argentina (ARG)
1	Shots	5
1	Shots on Goal	2
14	Fouls	10
3	Corner Kicks	8
0	Direct Free Kicks to Goal	0
0	Indirect Free Kicks to Goal	0
0	Penalty Kicks	0
0	Offsides	2
0	Own Goals	0
2	Cautions	0
0	Expulsions	0
57%	Ball Possession	43%
13	Actual Playing Time	10

Netherlands (NED)

#	Name	Pos	Min	GF	GA	SG/S	PK	Fouls FC FS	Y	R
1	VAN DER SAR Edwin (C)	GK	45							
2	JALIENS Kew	D	45					2		
3	BOULAHROUZ Khalid	D	45							
7	KLUYT Dirk	F	45			1/1		4 2	1	
8	COCU Phillip	M	45					2 1		
9	VAN NISTELROOIJ Ruud	F	45					1 2		
10	VAN DER VAART Rafeel	M	45						2	
13	OOIJER Andre	D	45					1		1
15	DE CLER Tim	D	45						1	
17	VAN PERSIE Robin	F	45					4	1	
20	SNEIJDER Wesley	M	45							
Totals						1/1		14 9	2	

Argentina (ARG)

#	Name	Pos	Min	GF	GA	SG/S	PK	Fouls FC FS	Y	R
1	ABBONDANZIERI Roberto	GK	45							
2	AYALA Roberto (C)	D	45					3 1		
5	CAMBIASSO Esteban	M	45					1 1		
8	MASCHERANO Javier	M	45					2 1		
10	RIQUELME Juan	M	45			1/1			1	
11	TEVEZ Carlos	F	45			0/1		1 2		
15	MILITO Gabriel	D	45					1 1		
17	CUFRE Leandro	D	45					1 3		
18	RODRIGUEZ Maxi	M	45			0/2			2	
19	MESSI Lionel	F	45			1/1				
21	BURDISO Nicolas	D	23							
Substitutes								1 1		
4	COLOCINI Fabricio	D	22							
Totals						2/5		10 13		

AET: After extra time | FSD: Penalty shoot-out | C: Captain | Pos: Position | GK: Goalkeeper
 D: Defender | M: Midfielder | F: Forward | Min: Minutes Played | GF: Goals For
 R: Red Cards | GA: Goals Against | PK: Penalty Kicks (Goals/Attempts) | FC: Fouls Committed | FS: Fouls Suffered
 Y: Yellow Cards | SG/S: Shots on Goal/Shots

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Official Suppliers of the 2006 FIFA World Cup Germany™



FIFA World Cup™
Match Report
Half-time



Group C

Netherlands - Argentina

0:0

Match Date: 21 JUN 2006 Venue / Stadium / Country: Frankfurt / FIFA World Cup Stadium / GER Time: 21:00

Match Officials:
Assistant Referee 1: GIRALDEZ CARRASCO Victoriano (ESP)
4th Official: CHANDIA Carlos (CHI)
Match Commissioner: NICHOLAS Tai (NZL)
Referee: MEDINA CANTALEJO Luis (ESP)
Assistant Referee 2: MEDINA HERNANDEZ Pedro (ESP)
5th Official: GONZALEZ Rodrigo (CHI)
General Coordinator: WANGEL Lennart (FIN)

Goals Scored:

Netherlands (NED)

- [1] VAN DER SAR Edwin (GK)(C)
- [2] JALIENS Kew
- [3] BOULAHROUZ Khalid
- [7] KUYT Dirk
- [8] COCU Phillip
- [9] VAN NISTELROOIJ Ruud
- [10] VAN DER VAART Rafael
- [13] OIJER Andre
- [15] DE CLER Tim
- [17] VAN PERSIE Robin
- [20] SNEIJDER Wesley

Substitutes:

- [4] MATHUSEN Joris
- [5] VAN BRONCKHORST Giovanni
- [6] LANDZAAT Denny
- [11] ROBSEN Arjen
- [12] KROMKAMP Jan
- [14] HEITINGA John
- [16] MADURO Hedwiges
- [18] VAN BOMMEL Mark
- [19] VENNEGOOR OF HESSELINK Jan
- [21] BABEL Ryan
- [22] TIMMER Henk (GK)
- [23] STEKELENBURG Maarten (GK)

Coach: VAN BASTEN Marco (NED)

Cautions:

KUYT Dirk (NED) 28' , OIJER Andre (NED) 42'

Expulsions:

Additional Time:

First half: 1 min.

Argentina (ARG)

- [1] ABBONDANZIERI Roberto (GK)
- [2] AYALA Roberto (C)
- [5] CAMBIASSO Esteban
- [6] MASCHERANO Javier
- [10] RIQUELME Juan
- [11] TEVEZ Carlos
- [15] MILITO Gabriel
- [17] CUFRE Leandro
- [18] RODRIGUEZ Maxi
- [19] MESSI Lionel
- [21] BURDISSO Nicolas (-24')

Substitutes:

- [3] SORIN Juan
- [4] COLOCCINI Fabricio (+24')
- [6] HEINZE Gabriel
- [7] SAVIOLA Javier
- [9] CRESPO Hernan
- [12] FRANCO Leonardo (GK)
- [13] SCALONI Lionel
- [14] PALACIO Rodrigo
- [16] AIMAR Pablo
- [20] CRUZ Julio
- [23] USTARI Oscar (GK)
- [22] GONZALEZ Luis (I)

Coach: PEKERMAN Jose (ARG)

N: Not Eligible to Play E: Injured A: Absent 2Y: Second Yellow Card
C: Captain AET: After extra time GK: Goalkeeper PSO: Penalty shoot-out

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Asahi, ENJO, GINSENG, JACOBSON, JAGUAR

