Usability Development of Nokia N900 Mobile Computer

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Abstract:

Usability development is nowadays part of almost any product development process. The goal of usability is to improve and guarantee the efficiency, effectiveness and satisfaction with which a product is used.

There are varying reasons why usability of a product may not be up to standards. Methods, their selection, organizational design principles and strategy-level decisions all affect the outcome of usability development. The first ones are within influence of the usability team; others are constraints within which they operate.

The goal of this Master's thesis is to discover how usability development of Nokia's N900 mobile computer has succeeded. The analysis material from development phase comes from Nokia and from post-sales phase from my research. Of particular interest are matters that are related to the user interface.

The results reveal some, but not significant, discrepancies between development and post-sales phase results. According to the results, it seems that multitasking on a mobile device brings along user interface issues related to controlling multiple applications.

Keywords: Usability, UCD, N900, Mobile computer, Smartphone

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Tiivistelmäteksti:

Käytettävyyden kehittäminen on nykyään osa lähes jokaista tuotekehitysprosessia. Käytettävyyden tarkoituksena on parantaa tehokkuutta, tuloksellisuutta ja tyytyväisyyttä, jolla tuotetta käytetään.

Käyttävyyskehityksen epäonnistumiselle on olemassa monia selityksiä: metodit, niiden toteutus ja sisäiset heikkoudet, organisaation suunnitteluperiaatteet ja strategiaan liittyvät ratkaisut liittyvät tuotteen lopulliseen käytettävyyteen.

Tämän diplomityön tavoitteena on etsiä onnistumiset ja epäonnistumiset Nokian N900:n käytettävyyden kehityksessä, ja mitkä tekijät ovat niihin johtaneet. Nokia on luovuttanut materiaalia analyysiä varten, minkä lisäksi osana tätä työtä on kartoitettu käyttäjien näkemyksiä. Erityisen mielenkiinnon kohteena on ohjelmistopuolen käytettävyys.

Tulokset paljastavat eroavaisuuksia kehitysvaiheen ja käyttäjien näkemyksien välillä. Tulosten valossa näyttää siltä, että moniajo aiheuttaa mobiililaitteen käyttöliittymään monimutkaisuutta johtuen useiden ohjelmien kontrolloinnin tarpeesta.

Avainsanat: käytettävyys, käyttäjäkeskeinen tuotekehitys, N900, Mobiilitietokone, Älypuhelin

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Figures and Tables

Key concepts

Capacitive touchscreen

Capacitive touch screens need finger-contact (or other conductive object) to function. Due to size of fingers, the drawing accuracy is limited. (Lee & Zhai, 2009)

Maemo

Maemo is a software platform developed by Nokia for mobile devices, and is based on Debian operating system. Maemo is mostly based on open-source code. In 2010 Maemo and Moblin (an optimized Linux platform for mobile devices) merged to become MeeGo, a new open-source project. (Nokia, 2010a)

Mobile computer

Mobile computers are the latest evolution that has seen mobile devices evolve from cell phones to smartphones and, now, to mobile computers (e.g. Nokia's N900). (Nokia, 2010a) (Lendino, 2006)

N900

N900 is a mobile computer launched in 2009 by Nokia. It is 80% open-sourced device and is targeted for technology enthusiasts. (Nokia, 2010a)

PDA or Personal Digital Assistant

PDA is a portable device that offers at least basic office functionalities. In reference to older models, PDAs don't have mobile telephone capability. (Lendino, 2006)

Usability

"The extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use" (ISO, 1998)

UCD

User-centered design is an interdisciplinary design approach that is based on usability of the design from the users' point of view. (Jokela, 2002)

Usability inspection

Usability inspection is a generic name for a set of methods that are based on evaluators inspecting the system. Typically inspections are done at an early phase of the design. The methods include: heuristic evaluation, cognitive and pluralistic walkthrough,

feature inspection, consistency inspection, standards inspection, and formal usability inspection. (Nielsen & Mack 1994)

Usability testing

Usability testing consists of wide array of usability methods to which common nominator is that they all involve real users. (Nielsen J. , 1993)

Resistive touchscreen

Resistive touch screens are not as responsive as capacitive touch screens because they require pressure to be activated. They can be activated by any medium (e.g. fingernail or stylus). (Lee & Zhai, 2009)

Smartphone

Smartphones are an extension of mobile phones. Smartphones have adopted features from PDAs and usually also have entertainment features in them. (Lendino, 2006)

Abbreviations

HW	Hardware
ISO	International Organization for Standardization
OS	Operating System
PDA	Personal Digital Assistant
SW	Software
UCD	User-Centered Design
UI	User Interface
UEM	Usability Evaluation Method
UX	User Experience

1 Introduction

The mobile devices of today feature a multiplicity of different operating systems (OS): Symbian, Android, iPhone, Maemo and many more. To a common user, however, the operating system itself is a secondary worry or no worry at all. The overall functionality of the device is what generally matters. In other words, the users want devices that accomplish their goals: offer easy ways to access relevant information, business or leisure, on the go and facilitate communication (Cox, 2010) (Sohn, Li, Griswold, & Hollan, 2009).

In the focus of this thesis is the N900, Nokia's mobile computer from late 2009. It is a Maemo device as opposed to most Nokia's devices that have Symbian as their operating system (OS). The N900 is a finger-usable touch screen device that also offers a keyboard. In addition to finger-usability, the N900 differs from other N-series devices in that it has telephone-functionality which has increased the attention the device has received in comparison to previous N-series devices. The N900 is marketed as a mobile computer and a high-end device in terms of quality and price, which has created more expectations and interest regarding it. One part of the user experience (UX) is the device's usability which forms the core of this thesis.

Usability has many descriptions: According to International Organization of Standardization (ISO) it is the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use (ISO, 1998). According to Nielsen (1993) usability has five dimensions: efficiency, learnability, memorability, lack of errors (or recovery from thereof) and satisfaction. All the definitions aim to explain that a product that fulfills the criteria, is satisfactory for the user. In order to achieve good usability in a product, the usability should be developed and controlled during product's development. Usability can be investigated by two distinct means: usability inspections and usability evaluations whose main difference is that inspections are conducted by experts solely, and evaluations involve real users who are observed by experts. Inspections are generally easier and cheaper to conduct but evaluations provide the view of the user.

Usability of any product is nowadays important; in mobile device markets it has become especially pronounced with Apple's iPhone that has presented a highly simplified user interface (UI). Simplicity and ease of use have emerged more strongly as competitive

factors emphasizing the importance of getting usability development right. It is common practice that usability is assessed well before a product reaches markets because it is cheaper to make changes when the product isn't yet manufactured. Naturally testing is also more difficult without the real product, which causes some differences between early test results and feedback from the markets. (Dumas & Redish, 1993) (Holzinger, 2005) (Rosenbaum, 2000)

From a process perspective, and for the purpose of this thesis, the collection of usability data can be divided into two phases: development phase and post-sales phase. The separating factor is the moment the product starts selling in the stores. Both phases have their distinct characteristics that enable and restrict analyzing the product's usability. For example, in the development phase, there isn't any ready product to test early, and during later stages making changes is usually difficult and costly. In the case of N900 the gap between development phase and post-sales phase is pronounced because there hasn't been any prior similar Maemo device. It implies that the development phase testing has been conducted with users who haven't had any previous experiences with the device.

In this thesis the post-sales feedback has been collected from two sources: Internet research and interviews. The blogs and articles from Internet have been the main source of data and the interviews have served to verify and deepen those findings. The material from development phase for comparison has been provided by Maemo UX design team in the form of documents and discussions. The comparison between the findings from different phases was conducted by categorizing the findings in groups that reflected the opinions of users and focal points of development as well as possible. From these categories were extracted the issues that were deemed to affect software usability the most.

The main objective of this thesis is to find out how Maemo UX design team has succeeded in developing the usability, and especially software, aspects of Nokia's new mobile computer, the N900. Although the focus of this thesis has been on software usability, many of the findings are related to other things like the hardware of N900. However, the relationship between hardware and software is sometimes blurred so that the reasons behind some usability problems are not clear. As a consequence also issues other than strictly software usability are also taken into account. Of special interest to Maemo were the deviations of post-sales feedback from their preconceptions about the

device. Additionally the degree of deviation was deemed important. In other words, the Maemo UX design team has made decisions about the usability design, and some of the decisions were known to be risks. The question is how well the risks have paid off.

1.1 Structure of the thesis

At first, the research questions are presented in chapter 2 before moving on to introduce some background in the form of a superficial recap from general history of PDAs (Personal Digital Assistant) via Nokia's strategy to its competitors. In order to get acquainted with user-centered design (UCD) and usability methods; the theory is described in chapters 4 to 5 and problems with usability testing along with practical issues are taken into account in chapter 5.4. The Nokia mobile computer N900 is presented in chapter 6 after which the research results are depicted in chapters 7.1 to 7.4. The results and their and an alternative user interface configuration are discussed in chapter 8. Conclusions are presented in chapter 9.

2 Research Questions

This work will evolve around Nokia's new mobile computer, N900, and its usability and user experience (UX). Of particular interest are usability and UX test results from development phase and post-sales tests. How do the post-sales feedback on the N900 compare with the usability results from development phase? This question can be broken down to three parts:

- How does the post-sales feedback compare with the test results from the development phase?
- Are there usability problems that haven't been identified during the tests?
- What are the success factors and reasons for failures?

This work goes onto describe the theories of UCD and usability methods but it has to be kept in mind that practice is very much different from that. Matching pre- and post-sales results with each other shows what has gone awry but does not answer why and at which point the mistakes or decisions were made. The usability methods are not perfect and have flaws from a scientific point of view. These are considered and taken into account when the reasons for possible poor UX are considered.

3 Background

For years the mobile phone market has been dominated by Nokia in terms of market share. However, in the recent years the amount of platform owners has increased, especially in the United States. Most prominently, Apple and Google have implemented platforms of their own, iPhone and Android, respectively (Canalys, 2009). By increased competition, the traditional platforms have found themselves in need of change in order to cope with the rivalry after a few quieter years.

3.1 Introduction to mobile devices

In a space of a few years the smartphones have become inseparable part of people's lives. There was, however, a time when there were cell phones adept only at placing calls and sending text messages and running only a few basic games. Regardless of the lack of functionality compared to smartphones of today the old "bricks" became popular. The smaller and cheaper they got the more they spread into people's everyday lives. While the large masses were served smaller phones with basic functions, PDAs (Personal Digital Assistant) with more evolved functionality, but often lacking the telephone, were developed for business use. In the late 1990s cell phones and PDAs more or less converged to become smartphones when Handspring Treo integrated the telephone into the PDA. Nowadays terms PDA and smartphone are used quite interchangeably. Even a third term, mobile computer, has been added into the mix to signify emergence of a mobile device capable to compete with desktops. (Lendino, 2006) (Nokia, 2010a)

In this work the term PDA refers to PDAs of old days and 'smartphone' refers to more evolved devices that have telephone functionality as their centerpiece. Mobile computer refers to devices like N900 that offer much more than just a phone and don't necessarily emphasize the existence of telephone.

Features between PDAs and smartphones have varied a bit but with iPhone and Nokia E series the smartphones have become to look very much like typical olden PDAs; smartphones using QWERTY-keyboard and/or touchscreen like PDAs have done for their entire lifespan. Both have nowadays push e-mail, internet capabilities, synchronization (calendar, contacts etc.) and other work-related features. (Apple Inc., 2010) (Nokia, 2010b)

As there used to be a gap between devices (PDAs and phones) there is nowadays gap between the image with which a device is marketed. iPhone is all about usability and flamboyance: people tend to marvel at the ease of use and the simple and elegant look of the device. Blackberry seems to be very corporate in that it offers no-nonsense functionalities and has focused on, among others, e-mail capabilities. Nokia's phones, for example the N-series, have taken something of a middle ground. They are among the most advanced in technological sense but lack the trendy look and image of iPhone.

The most popular mobile operating system in terms of market share from second quarter of 2009 is Symbian (50,3%) with RIM BlackBerry (20,9%) and Apple iPhone (13,7%) coming some way behind. The most prominent manufacturer within Symbian OS is Nokia with its S60 OS, which is incompatible with UIQ (User Interface Quartz) that is used in Eriksson's and Motorola's phones. Although Android is probably the most flexible and programmer-friendly platform available, it hasn't taken any significant share of the world market (2,8%). (Canalys, 2009)

3.2 Evolution of mobile devices

The first PDAs were developed in 1980s but the term 'PDA' was coined only in 1992 and used in relation to Apple's Newton, which was also the first PDA to get rid of the keyboard and use stylus and large touch-sensitive screen instead. Unfortunately, the writing recognition wasn't what it should have been and initial enthusiasm was transformed by reality to disappointment. However, in 1996 Palm Computing created its PDA that became much more successful than its predecessors and still lives on. Also in 1996 the mobile phone and PDA were first combined in Nokia Communicator which went on to be enormously popular business phone. Around 1998 PDAs were presented with flash memory that allowed OS upgrades and storage of applications. At that time the capacity was in the region of 2MB. In next models capacity naturally increased and more features and functionalities were added. For example in 2002 Blackberry smartphone was released. It offered e.g. push e-mail, mobile telephone capabilities and web browsing distinguishing particularly with e-mail functionalities. Gradually, and at times in leaps, the PDAs have been evolving towards computers, and mobile phones similarly have taken features from PDAs and computers. Based on development of mobile industry so far it seems possible that PDAs, mobile phones and computers could converge into one mobile device (Nashville, 2009). The newest phones are already

developing into more than only phones. They have so much computing power and as a result features that enable them to replace many other devices in everyday use. Today there are among others RIM Blackberry, Nokia N- and E-series, and Apple's iPhone. They all support basic corporate needs: reading and sending e-mail, browsing web pages and making calls. Small differences separate these from one another. iPhone's multi-touch interface functions quite naturally with slight touches. For example, zooming in and out works by moving two fingers apart or towards each other on the surface ("pinch and zoom"). On the other hand Blackberry is a more serious and corporate-like device with focus on e-mail.

There is on-going process of merging different devices into one. The smartphones already have cameras, music players, video and other stuff. For example, Apple's iPod was at first just a good music player. Gradually it has gained more features like ability to show pictures, then video, and actually developed into the iPhone. Such seems to be the goal for most mobile entertainment and business devices: offer all in one (Manjoo, 2009). In the words of Steve Jobs: "-- I think the general-purpose devices will win the day --" (Jobs, 2009).

3.3 Future of mobile devices

What will become of PDAs and smartphones is anyone's guess. The technological advancement is highly difficult to predict. In short term, it seems that keypads are a dying breed when touch screens and keyboards are taking over. A keypad is a set of buttons arranged in a block which presents digits and usually a complete set of alphabetic arranged so that each button accommodates three letters. In comparison keyboards have one button for each letter. The reason for keyboards' growing popularity seems to be that applications of social media require a lot of typing. Also successes of RIM's BlackBerry and Apple's iPhone have accelerated the development (Canalys, 2009). The trend is also to reduce the number of gadgets that non-professional (vs. e.g. professional photographers) users need to carry along by offering them all-in-one package. Cameras, music players, work-related functionalities, internet browsing, and countless apps and widgets (a software component that can be embedded onto a web page or application to provide functionality (Mäkelä, et al., 2007)) to facilitate using internet are already offered in smartphones. (Manjoo, 2009)

One area where progress is all but guaranteed is internet connection bandwidth. The question is what will happen when broadband connection is enabled on handheld devices. This so called fourth generation (4G) of mobile phones would enable transmission streams of 2,5Gb/s (Piraro, 2009). This could mean that landline connections of today would become obsolete in many places, and mobile devices could become the primary connection point for consumers.

Virtualization is a very interesting concept that could become reality: a phone that would have two separate operating systems on it via a code block managing the phone resources between hardware and software layers. For consumers separate operating systems would enable business and private profiles that needn't mingle. (Piraro, 2009)

User interfaces seem to be developing into supporting more human-like interaction, more natural way of using programs. For example, iPhone's multi-touch interface could be the first step towards a natural interface; one that would use gestures and other innate movements to take orders (Selker, 2008). It is unclear how far this approach could be taken with mobile devices since they are by default small and thus pose restrictions on interpreting movements.

The adoption of mobile devices into various walks of life would be greatly facilitated if the myriad of user interfaces ceased to exist and only a few remained. At the moment the user is forced to learn a new UI with every new device, at least if the manufacturer is different. If UIs and input techniques remained the same across platforms more users and businesses would be able to step in. The variety currently gives the user the freedom of choice but also confuses people switching from one device to another. (Wobbrock, 2006)

3.4 PDAs at Nokia

After creating successfully the Communicator range, it was Nokia's goal to develop devices for web-browsing. However, before Internet Tablets came up there were Media Devices that were powered by S90, which exists only in two of Nokia's devices. These devices had problems with touch input and overall speed. Only after the disappointment, sales-wise, of Media Devices the Internet Tablets were brought up. (Murtazin, 2008)

The Nokia 770 was the first Nokia device to run Linux as its operating system. It used Hildon as its UI. Hildon, in turn was a project at Nokia originating back to 2002, or so. There was intention to use it on Symbian platform but that idea was never realized. Thus, the Hildon project evolved into S90, which was only used in Nokia 7700 and 7710. Finally, the Hildon found its way to the Nokia 770 and Linux based Internet tablets. The N800 was next in line but it seemed, since there were a lot of hidden features, that it was just a stepping stone towards N810. In 2007, Nokia released the N810 which had a lot of the same look and feel. Only N900, released in 2009, changed the way the device works, interacts with the user and is controlled. (Murtazin, 2008) (Jerz, 2009)

3.5 Mobile strategies

Openness, meaning how much of the source code is disclosed to third party developers, is a hot topic in mobile devices' business at the moment. There are two kinds of openness in mobile industry that can be distinguished: open-source applications and open-source platforms. The platforms used to be the major differentiating factor between companies, and still are but to lesser extent. Mobile applications have risen to be a formidable business during the last couple of years with Apple's AppStore as a driving force.

Many companies rely heavily on third-party developers on application development. The dilemma for all the companies is to attract the brightest developers to their platform. As long as most of the platforms aren't interoperable the developers must choose a primary platform which they support. Common criteria for selection are development environment, monetary reward (i.e. delivery channel, revenue sharing, cost of development and size of audience), and freedom. (West, 2003)

3.5.1 **Open vs. proprietary**

There are two distinct strategies in mobile platform industry: proprietary and open (West, 2003). A fully proprietary company holds all the cards in its hand so that it protects itself from imitation and allows itself to simplify business and technical decisions because they don't have to interoperate with others. Proprietary approach also allows a company to maintain better price margins and lock in users via high switching costs (e.g. in desktops Apple has used different proprietary peripheral interface

standards in order to make them inoperable with other vendors' products). However, proprietary strategy poses a threat because it relies heavily on innovation and being a market leader. Too low a market share may cause problems for the upkeep of heavy internal R&D activities. There is also possibility that an open standard becomes widely accepted: if a product or solution is successful enough, it may become the de facto standard of an industry, like VHS due to successful marketing in its time and QWERTY keyboards due to it being used in the most popular typewriters. If the strategy fails, the transition to embrace open standards may be difficult because they lose their competitive advantages. For a company to move towards openness there have been two common strategies: opening parts while retaining full control of other layers, and disclosing technology under restrictions that make it difficult for competitors to use. (West, 2003)

With many different platforms (Symbian, Maemo, iPhone, Android etc.) rises a problem for the developers: every application has to be re-written for each platform. Generally, the developers may seek their target platform by regarding either monetary reward or ideological fulfillment as criterion. The level of openness on a platform attracts some developers because it offers freedom. On the other hand, monetary reward is important for many, meaning that a good delivery channel and large consumer base provide a tempting alternative (Raythattha, Moore, Lu, & Yang, 2009). It may be argued that for the majority of developers openness is important to the extent that it allows them to make enough money (Mace, 2009). A proprietary approach also offers monetary reward, the primary example of which being Apple's iPhone. Apple also offers sufficient consumer base and reliable delivery channel. However, actually publishing an application and making profit is not easy on Apple's AppStore (Dokoupil, 2009) as is discussed in chapter 3.5.3.

A proprietary approach allows software developers to know exactly what kind of device their applications are run on, which makes it easy to optimize the performance and UI (Asay, 2010). An open-source platform becomes easily a moving target for developers because there are many different instantiations of it, thus hindering the application development. This, in turn, becomes a true problem because manufacturers won't adopt a free platform because it's free, but because they aim for the overall package: primarily community, and existing and potential applications. The proprietary platforms may offer more in terms of finished and vertically functioning package but they are also

often different from the rest of options which increases changing costs to another platform. (West, 2003)

Quite often technologies tend to develop in a direction that encourages standards simply because it makes life easier for developers and reduces consumers' confusion over devices that don't work with each other. Open-source projects are one way to create some level of standardization (Raythattha, Moore, Lu, & Yang, 2009). However, openness itself brings little to the table for the regular users. The question is what attributes (e.g. reliability, lower cost or expanded variety of complementary features) openness enables for them. For example, concurrent debugging efforts by the developer community are much appreciated by other users. The main reason for open-source projects' failure is most commonly the lack of user-contributor community that has driven e.g. Linux to be successful to some extent. (West, 2003)

3.5.2 **Nokia**

Put shortly, Nokia's strategy is as follows: "Nokia's strategy is to build trusted consumer relationships by offering compelling and valued consumer solutions that combine beautiful devices with context enriched services." (Nokia, 2008)

Open source development is one of Nokia's future traits when development work is considered (Nokia, 2009b). For example, over 80% of Maemo is comprised of standard open-source components (Nokia, 2010a). This approach enables Nokia to focus their efforts on the differentiating layers like applications, user interface and services. In order to further attract developer talent, Nokia is making Qt the standard toolkit for both Maemo and Symbian (Nokia, 2009b). Qt is an application and UI framework that allows writing the program code once and then compiling it onto many platforms (Qt, 2008). From application developer's point of view this approach leads Nokia to Apple's footsteps; with Qt, comparable to Cocoa Touch framework with Apple, Nokia makes the OS more of a hardware engineering decision. The idea of Qt is simply to allow developers program once and run everywhere: a recompilation of the code should suffice if the target platform is compatible with Qt. At the moment Qt supports Symbian, Maemo (in future, MeeGo) and Windows Mobile and some desktop platforms (Windows, Apple OS X and Linux) providing a basis for further interoperability (Nokia, 2010a), which is generally appreciated by application developers.

Whereas Maemo began as an open-source project, Nokia has transformed Symbian from a closed project to a completely open one. There is a non-profit organization, Symbian Foundation, which is in control of developing Symbian now. The S60, however, remains a closed OS. Thus, the Symbian Foundation develops Symbian as a whole, which benefits all companies employing Symbian, and the parts that make S60 unique remain Nokia's. A non-profit foundation has a completely different mindset from that of a corporation that owns its OS. The focus is on developers, not on the outfit itself, which makes the situation appealing for developers. There is no incentive to make money off the developers, but it is important to point out that it is the same case with any other organization that has other sufficient streams of revenue. One strategy for a non-profit foundation to compete is to starve others from their profits: in this case applications are significant source of money. If it would be possible to create a universal runtime layer for mobile web apps it would benefit Symbian-based companies and detriment commercial OSs (Mace, 2009). However, it is unclear whether that is realistically possible now or in the near future.

3.5.2.1 Platform

Nokia's software strategy states the company's will to address needs of different customers in various markets. The price of Nokia's phones ranges from about 20 Euros (e.g. Nokia 2180) to 500 Euros (e.g. N900). At the moment the three platforms supported are Series 40, Symbian and Maemo. In fact, at the last stages of this work Maemo and Intel's Moblin were merged forming MeeGo (Nokia, 2010a), but that is left out of this discussion due to its timing. The Figure 1 shows the placement of each platform as a function of image of the phone and price range. The Maemo platform is the narrowest of the three in its offering but it also answers the needs of a narrower consumer segment than Symbian or S40, namely technology leaders. Symbian phones range from high-end smartphones to regular mobile phones that offer basic functionality at a lower price. (Nokia, 2009b)

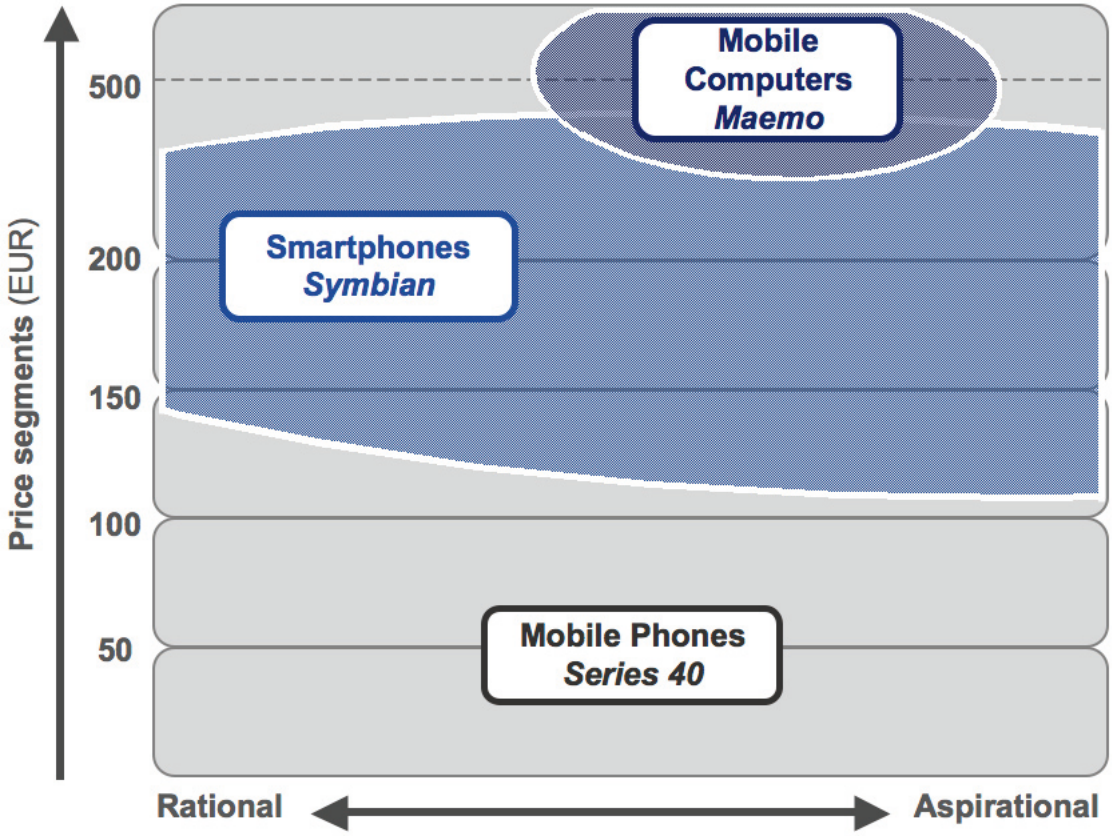

Figure 1: Nokia's platforms shown in price segments (Nokia, 2009b)

The goal for Nokia is to drive the Maemo platform to include the high-end smartphones and Series 40 to remain at the lower end of the price range. In fact, Nokia is marketing the N900, and presumably also next Maemo devices, as mobile computers (Nokia, 2009b). Symbian, in the middle, should be able to bring smartphones to a wider range of people by offering lower prices than Maemo (Nokia, 2010a).

In user experience aspects Nokia is focused on bringing the latest technology with Maemo 6 platform, released in 2010, that enables multi-touch, which is absent in Maemo 5 and N900 (Nokia, 2010a). Maemo is focused on bringing the latest technology and hardware to users who want the best (Nokia, 2009b). Case in example, the N900, is marketed as a mobile computer and directed to technology enthusiasts (Nokia, 2010a), comparable to early adopters described by Rogers (1995) (see Figure 2). The Symbian platform is similarly trying to develop its user experience by investigating single tap interaction throughout the interface, multi-touch, and multiple home screens (Nokia, 2010a). New features and technologies are developed but at the same time Symbian is the key for Nokia to hold on to multiple consumer segments and markets in smartphones (Nokia, 2009b).

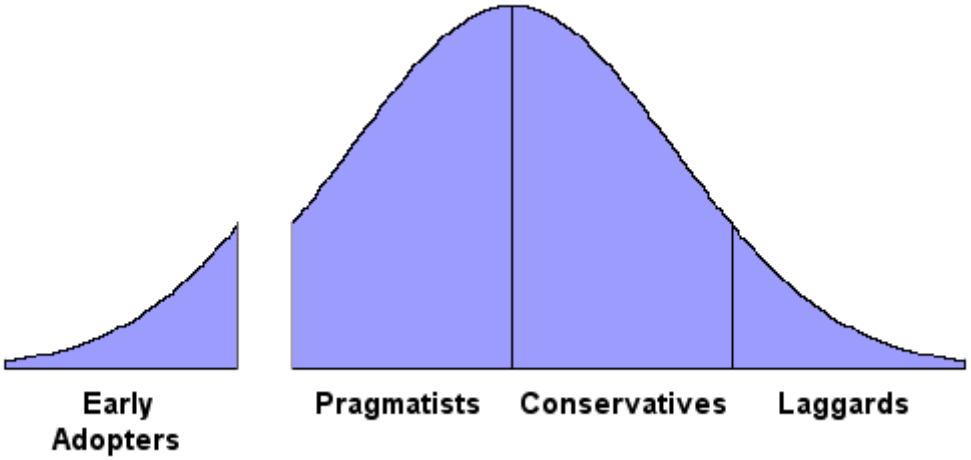

Figure 2: Innovation adoption curve (Rogers, 1995)

3.5.2.2 Services

Ovi store is Nokia's application distribution channel where third party developers can sell their products. In case of N900 applications are also available via other channels like Maemo community's sites (e.g. maemo.org). Symbian and Maemo are both driving forces in bringing Ovi services (Ovi mail, Ovi Maps, Ovi Store, Ovi Music etc.) to the fore (Nokia, 2009d). The Ovi concept is designed to improve user experience on Nokia's phones so that the mobile services relevant to the user would be available via Nokia (Nokia, 2009b). The revenue sharing for applications sold via Ovi store is the same as Apple's (70% to the developer) (Pitkänen, 2010). Ovi also offers services like e-mail, calendar and maps.

3.5.3 Competitors

Whereas Nokia is moving towards openness, like Google Android, in their development work, Apple and RIM are sticking with a more proprietary approach to integrate hardware, software and services. Whereas closed-shop approach grants a company full control of what is developed, what has to be maintained and what is not supported, open approach loosens the control on those aspects. In other words, focusing the device on certain market segments, and guaranteeing quality and support is easier when full control is maintained. Open-source approach grants more freedom to developers and lets them to explore and concentrate on their areas of interest, which can be seen as good or bad thing. Different hardware configurations create a lot of maintenance work

for the OS company, or the company has to place boundaries on what works on the platform, thus limiting openness. Additionally, openness in itself actually matters only to a small portion of consumers who generally are more concerned with the functionality of the product and its predictability. The maintenance issue brings forth the possibility of unreliable devices. For example, Apple's iPhone is a highly reliable device, which makes anything less reliable unacceptable in users' eyes. (Sigal, 2009)

3.5.3.1 Apple

Apple's strategy is to offer optimal integration between software and hardware: taking limitations into account, and designing accordingly. Notable is that there is essentially only one device that is sold across many market segments; this contrasts starkly with Nokia's approach which is to create devices for each segment. Additionally, claiming the developers' mindshare by presenting an easy development platform, simple delivery channel and revenue for developers on 70/30 basis has resulted in (yet) unrivalled software offering in quality and quantity. Strictly controlling what is made available in the AppStore, Apple facilitates the users' dilemma whether some application is any good or not since there are fewer poorly designed applications. On the flipside, the strict control may discourage developers if there will be a competitive platform because at the moment they can spend time and money developing an application that won't even be allowed in the AppStore. The sheer quantity of applications at the AppStore also makes is extremely difficult for developers to reap profit at all (Dokoupil, 2009). At the moment Apple has the first mover advantage with its AppStore, amount of customers and consequently developer community, especially in the US. However, other companies are building application stores of their own, some of which are likely to become popular and seriously compete with Apple AppStore. Emergence of competitors would also result in competition over developers' minds, especially if iPhone developers are struggling to make profit. Thus, openness and standardization are aspects that may lure developers away from Apple's closed shop policy. (Gartenberg, 2009) (Raythattha, Moore, Lu, & Yang, 2009) (Dokoupil, 2009)

3.5.3.2 Google

Google's Android has adopted more open policy than Apple, which it hopes will reduce the switching costs for developers to Android. Google's multi-platform operating system runs on many hardware configurations, which will spread Android across

different market segments without Google needing to create a wide array of models. In other words, companies or developers can adopt Android and mould it into their needs. Multi-platform approach brings along issues with security, quality and hardware because Google won't be able to test and control everything across all the different hardware platforms. (Raythattha, Moore, Lu, & Yang, 2009)

Google's strength lies in its existing web services that are already highly popular. They have Google Earth/Street view that could be utilized in navigation systems, Google docs that offer online office software, and Gmail that has over 90 million users. They should be able to leverage these services by integrating them into their mobile platform. Another remarkable difference from other manufacturers is that a significant portion of Google's revenues comes from advertising via its web services. Basically, getting more people use Google's free services brings them more revenue. This, in turn, encourages Google to offer integration to other platforms (Raythattha, Moore, Lu, & Yang, 2009).

4 UCD

The goal of this chapter is to describe a theoretical framework for user-centered design that can be used in the final analysis to help identify causes for problems or positive findings. Designing usability tests and downfalls of the methods are discussed in upcoming chapters.

As is discussed in coming chapters the development process starts with identifying users, and the context of use. User information should be used to create usability requirements that describe target levels of usability which, in turn, should compare to any existing system so that the new system would have better usability. In ideal case all gathered information is used as a basis for interface design, i.e. the design activities don't begin before the preliminary research is more or less finished. As the design evolves into more detailed prototypes, the design is measured against the requirements that were decided earlier. (Jokela, 2006)

4.1 Usability attributes

The usability attributes should reflect different aspects of usability as it is seen by users. The usability requirements should be created based on these attributes. The ISO 9241-11 states effectiveness, efficiency and satisfaction as main attributes (ISO, 1998). There are many different sets of usability attributes that a practitioner can use. For example, according to Nielsen usability has five dimensions: learnability, efficiency, memorability, error rate and satisfaction (Nielsen J. , Usability Engineering, 1993). For instance, effectiveness can be measured as number of errors users make in a process of completing tasks (Marshal, Foster, & Jack, 2001), efficiency as a time the user dwells on certain parts of the display (Burns, 2000), and user satisfaction with a questionnaire about how (s)he felt about using the system (van Kuijk, Kanis, Christiaans, & van Eijk, 2007).

The selection of correct attributes should be based on user profiling and task analysis so that the attributes relevant to a certain situation are selected (Wixon & Wilson, 1997). The attributes should then be expressed so that they can be measured. Regardless of the attributes chosen, the hardest task is to conduct tests that measure the right attribute and give out comparable and valid results. Completely new systems pose particular challenges since there is a lack of reference for the design (Nielsen J. , 1993).

4.2 Usability requirements

Usability requirements, or usability goals, are targets that the project, or whatever undertaking that deals with usability issues, should realize once finished. Setting the requirements should be a collaborative effort so that the whole project organization is committed to reach the goals. Knowing the target audience is essential because that knowledge enables the usability team to provide appropriate requirements and select corresponding measures. According to Wixon & Wilson (1997), after determining usability attributes, relevant measures and measuring instruments are decided on and a performance level is set for each attribute. For example, four performance levels can be set for each attribute and finding out what the current level (e.g. time to accomplish a task) is provides foundation for setting other levels. New systems pose a problem because a reference level is harder to determine. If there is an existing system, albeit different one, even if it isn't in use in the company or institution in question, it can be used as a reference. (Wixon & Wilson, 1997)

Lauesen and Younessi present six different approaches to specifying and measuring usability requirements: performance, defect, process, subjective, design and guideline approaches. These are listed separately but in practice they should be used to complement each other because different angles provide more diverse, thus better, results covering more painstakingly all the usability attributes. For example measuring solely performance would mean forgetting about subjective satisfaction and understandability which could be measured by questionnaires and interviews (Lauesen & Younessi, 1998). The requirements should also be seen as project goals that are monitored and in part define the project's success. Thus, there is a need to define the requirements realistically for different situations. Benchmarking, (i.e. comparing to relevant, often the best, competitors) former versions, competitors and other existing products is a good way to find out what is required of the product. Testing these benchmarks provides measurable limits as to how the new system should perform. Studies of usability provide some kind of reference what the limits might be, be it time, number of errors or something else. Official guidelines, such as MS Windows guidelines, offer possibility to keep various interfaces functionally similar. The scope of these guidelines can prove to be problematic if there are hundreds of issues that should be taken into account. (Lauesen & Younessi, 1998) (Jokela, 2006)

At the time of determining the requirements, it may not be essential to know exactly how to measure them. Even without that knowledge, they provide vision and direction for designing the interface (Wixon & Wilson, 1997).

4.3 Measuring usability performance

There are many measures of usability, but only few can be used in any given project. Generally, it is easy to distinguish the right tasks for time- or error-critical systems, when slowness or inadvertent errors may imply great costs. More commonplace and popular products are more difficult to assess because there are more possible alternative ways of use, contexts and most importantly many different users with unique preferences. (Nielsen & Levy, 1994)

There are traditional quantitative measures that provide basic information about how easy the interface is to use. If the three usability measures, effectiveness, efficiency, and satisfaction, described in ISO documentation (ISO, 1998) are considered, there are quite straightforward ways to appraise them. Efficiency can be measured by timing how long it takes test users to accomplish certain tasks. Repeating that test also reveals how easy or hard the interface is to learn; if the measured times drop learnability is good, if they remain the same either learning the UI is difficult or the first time use is easy, which is revealed by comparing results to reference results. As all the systems are flawed in some respects, testing recovery from errors is a healthy way to ensure the users have escape routes. In terms of efficiency, time spent on recovering measures error tolerance whereas effectiveness may be assessed by number of errors or percentage of errors reported by the system. Effectiveness is defined as the accuracy and completeness with which the user users achieve specified goals. In practice effectiveness may be a measure of number of successfully completed tasks. Satisfaction is measured by interviews, questionnaires and frequency of reuse if there are alternative systems for the users to select from. (ISO, 1998)

Regarding performance in usability testing a question about its validity compared to user preference can be posed. Simply asking users how they like a user interface is an economical way to evaluate a UI. It seems that in most cases the user preferences and tested performance of the user interface correlate, but there are some cases when an interface with poor test performance gained praise from users (Nielsen & Levy, 1994). The study by Nielsen and Levy showed that there is a strong connection between user

preferences and efficiency of the interface but couldn't explain why sometimes users preferred interfaces that weren't optimal to use. In 25% of the cases the users preferred to use systems that weren't as efficient with as its counterpart. However, in strict sense the study is applicable only for situations where there are two complete (or at least functioning) systems available and the choice is between them. Thus, when designing systems these results are applicable only when two systems are developed in parallel or a nearly complete system is tested against an old system that the new one should replace. Thus, objective testing provides a way to get results that aren't tainted by opinions that, in some cases, can even mislead the designers. (Nielsen & Levy, 1994)

4.4 ISO Standards

Two ISO standards, ISO 13407 and ISO 9241-11 are presented in this chapter. The ISO standards are overviewed in order to put the conjectured UCD process (see chapter 7.1) at Maemo into context. Both of them describe user-centered design but the first one from the viewpoint of a process and the second one describes use of a product on a context.

4.4.1 **ISO 13407**

ISO 13407 standard (see Figure 3) defines user-centered process as an iterative process consisting of following steps: specifying the context of use, specifying requirements, producing design solutions and evaluating designs. The whole process starts when someone in an organization realizes the need for user-centered design. The first step of the iterative process is identifying where, when, who use the product, and what they use it for. After context of use is clarified, the business constraints and corporate policies are taken into account whilst user goals are shaping the usability requirements specification. Designing solutions is a process itself and has different stages (e.g. see Figure 4); as a result, a complete design should emerge. If the design meets requirements the process can be ended, if not, the iterative part is restarted. (ISO, 1999)

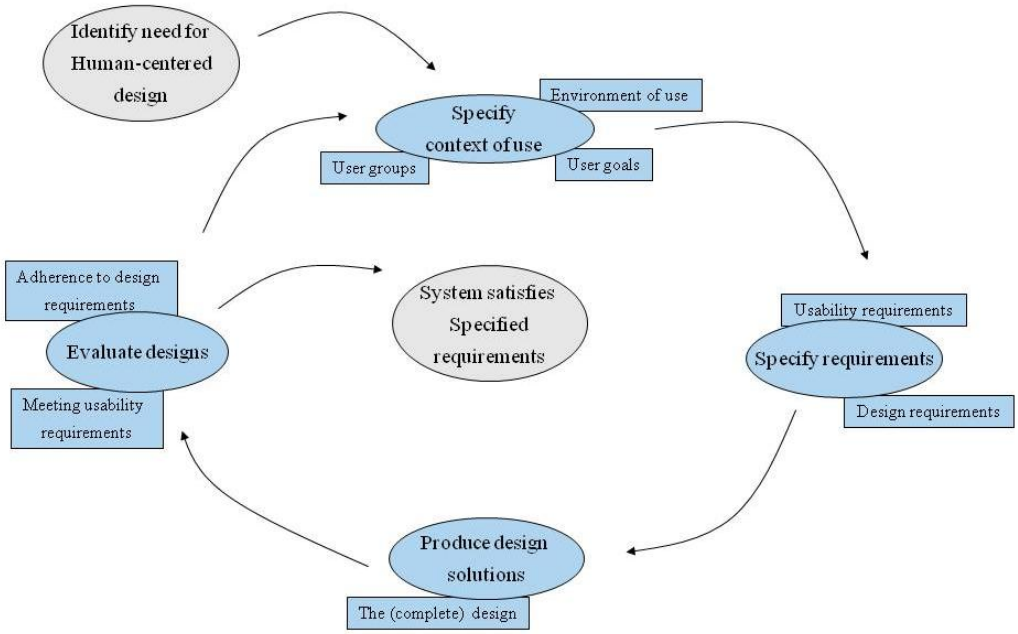

Figure 3: ISO 13407: Human-centred design process (adopted from: (ISO, 1998) and (Jokela, 2002))

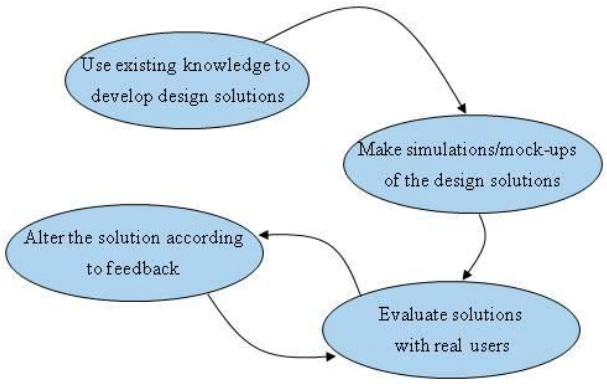

Figure 4: Designing solutions (ISO, 1999)

In general there are four phases: analysis, design, implementation and deployment. When analyzing the field, it is important to meet the relevant people to get a grasp of the real situation and to look at things from different perspectives, which are achieved by assembling a multidisciplinary team. Benchmarking competing products gives a good snapshot of how things stand at that moment and also provide a standpoint for comparisons. The analysis of context of use is followed by specifying the requirements which should be fulfilled once the product is ready. (ISO, 1999)

The requirements should reflect the results from context analysis so that at least the aspects deemed important by the users are included. Predicting what the users could want but don't know about yet is more difficult: for example, text messaging in mobile phones wasn't a big deal for users or developers before it was implemented as an additional feature. Proper user analysis can give hints as to what hidden needs there are but generally a stroke of luck is needed to uncover such features. Clear requirements provide at least goals and direction for development if not anything new. In most projects, there are business needs that limit the money and time that can be dedicated to user-centered activities, and that should be reflected in the requirements. (ISO, 1999) (Jokela, 2002)

Designing and testing the product should start when mistakes are not very costly. Considering several alternatives is more convenient at the beginning of the project because discarding pen-and-paper prototype is easy monetarily and psychologically. Drawing simple screen flow or navigational charts is a budget-friendly way to test designs at an early phase. After the alternative designs have been limited to a few, more detailed prototypes can be considered and more complex usability tests run on them. (Jokela, 2002)

For implementation, one of the designs has to be selected, although in some cases it is known that two different solutions have been developed in parallel. However, that is rare especially in business world where time and money are scarce. As it is developed further, usability evaluations should still be done continuously so that small changes can be done when necessary and also progress monitored. Immediately when possible, usability testing should be conducted to ensure that implementation matches the prototypes in terms of usability. (Jokela, 2002)

The process that ISO 13407 presents finishes when the product is ready, but in practice there usually is some kind of follow-through so that useful information for the next product can be gathered. After the product is in the market, user feedback can be collected through surveys or interviews in order to make modifications to next versions. Feedback also reveals whether the use scenarios depicted in analysis phase were correct or not. (ISO, 1999) (Jokela, 2002)

4.4.2 **ISO 9241-11**

ISO standard ISO 9241-11 defines usability and explains what information is necessary to take into account when specifying or evaluating usability of a visual display terminal in terms of user performance and user satisfaction (ISO, 1998). The components of usability, according to the standard, are presented in Figure 5. According to the framework, a product's context of use is composed of the environment, equipment, tasks and user. The user, in turn, defines intended outcome, in terms of usability, that represents the users' needs. On the other hand, the outcome of use, i.e. the product in real life, may deviate from the optimal state of affairs. The gap between realized and optimal usability is evaluated via usability measures that can be divided into categories; in this case those categories being efficiency, effectiveness and satisfaction. (ISO, 1998)

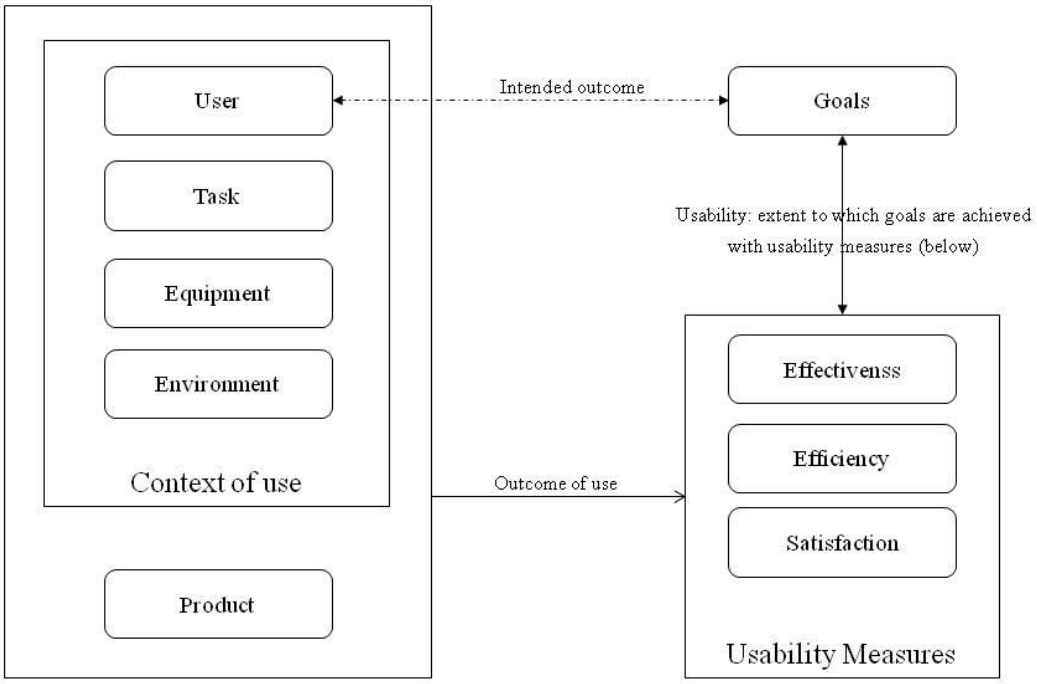

Figure 5: ISO 9241-11 usability framework (ISO, 1998)

The ISO standard being a framework, the implementation is left for the practitioner. Somehow the usability activities should be integrated into the product development process. ISO 13407 describes human-centered design process for interactive systems that helps linking UCD and product development processes.

5 Usability Methods

There are a host of usability methods from which the practitioner has to choose. Some of the methods, called usability evaluations, involve real users, others, called usability inspections, are conducted solely by usability experts. The goal of these methods is simple: to measure the success in terms of usability. (Nielsen & Mack, 1994)

There is a difference what kind of information is attained from a usability expert and a user: experts tend to produce more applicable suggestions that are more precise on the problem. Users, on the other hand, encounter the real problems but cannot necessarily tell exactly what is wrong. (Nielsen & Mack, 1994) (Holzinger, 2005)

5.1 Usability methods in development phase

The development phase here refers to the time before a product is launched and sold in the stores. This chapter describes the theory of some of the most common usability methods. The way methods are applied in practice is not necessarily the way they are described in theory, which is discussed in chapter 5.4.3.

5.1.1 Heuristic evaluation

Heuristic evaluation is an expert evaluation method which is performed by a usability expert who critiques the system's usability based on commonly accepted guidelines like the ones by Shneiderman (1998) or Nielsen (1993). The expert goes through the interface or system step by step with one heuristic rule (e.g. use users language) in mind and writes down where the system doesn't follow the heuristic rule. The expert then does the same for every heuristic on the list; a table of usability issues can be created as a result. Heuristic evaluation is most cost-effective when three to five evaluators are used. (Nielsen J. , 1992)

5.1.2 Cognitive and pluralistic walkthroughs

In cognitive walkthrough a usability expert mentally goes through the system step by step and asks him/herself certain premeditated questions at each step. To accomplish this successfully a task analysis is required in order to clarify what steps the user has to go through. Typical questions asked at each step are (Wharton, 1994):

- **Will the user try to achieve the effect that the subtask has?** Does the user understand that this subtask is needed to reach the user's goal?

- **Will the user notice that the correct action is available?** E.g. is the button visible?
- **Will the user understand that the wanted subtask can be achieved by the action?** E.g. the right button is visible but the user does not understand the text and will therefore not click on it.
- **Does the user get feedback?** Will the user know that they have done the right thing after performing the action?

Pluralistic walkthrough involves many participants such as end users, usability specialists and developers going through a task scenario discussing usability issues that emerge at each step (Nielsen & Mack, 1994). If this method is implemented with positive attitude towards creating a better product there is valuable information to be gained. However, mixing three types of participants may create problems: e.g. developers not appreciating end users criticizing their design. At best, there is possibility to get early design right and avoid unnecessary redesigning. (Wharton, 1994)

5.1.3 Prototyping

Prototyping can be done at various stages of development process. Prototypes can be categorized into two types: low-fidelity and high-fidelity prototypes. The former include paper mock-ups depicting the action-flow in the system, wizard of Oz –technique where there is a human acting as the system (i.e. doing what the system would do, for example showing screenshots at user's request), and storyboards and scenarios that show how the system could be used. High-fidelity prototypes include real functionality and are closer to a real product. However, there is a danger that the prototype takes too much development time if too much effort is put in to make it look like a real product. (Dumas & Redish, 1993)

The low-fidelity prototypes are typically used in early stages of development to test the workflow or basic functionality of a product. For example, paper prototypes help test users form opinions of layouts, buttons, and order in which screens are shown. A more interactive software prototype can be used in place of paper prototypes; it has been researched that software prototypes help to uncover more major usability problems than plain paper prototypes. Although these prototypes do not give the users the touch and feel of a real product, the development ideas and change suggestions are cheaper to implement at this early stage of development than later. (Dumas & Redish, 1993)

5.1.4 Focus group

A focus group is a structured discussion session with approximately eight to twelve people that represent the desired audience. The selection of participants is important so that the discussion would be easy: mixing novices with experienced users may not be ideal if use experiences and improvements are to be discussed. In a successful focus group some probing questions should suffice to guide the conversations; also a separate discussion leader can be utilized. It should be noted that focus groups don't discover how users would do something but are a way to find out about their beliefs, attitudes and desires. In that respect focus groups are useful in early phases of the design when there isn't any sophisticated testing prototype available (Dumas & Redish, 1993)

5.1.5 Usability test

Usability testing aims to achieve following five goals: improve product's usability, involve real users in testing, give the users real tasks to accomplish, enable testers observe and record actions of the participants, and enable testers analyze the data obtained and make changes accordingly (Dumas & Redish, 1993). Usability tests with real users are a primarily used in the final stages of development, and after product launch (Jeffries & Desurvire, 1992), when there is a working prototype or almost finished product available. A usability test includes different protocols some of which are shortly presented below.

Thinking aloud method involves an end user using the system and simultaneously telling what he/she is doing and thinking. The goal is to get insight into the users' views at the moment when problems occur. Usually the test is complemented with an interview where the instructor can ask additional questions to elaborate on interesting or unclear occurrences. (Ericsson & Simon, 1984)

Co-discovery method is quite similar to thinking aloud but it involves two users performing tasks on the system. When the users are talking to each other the interaction is more natural and as a result the users usually feel more at ease to speak their mind. (Dumas & Redish, 1993)

Active intervention is a technique that involves a member of the usability team to ask the test participant questions in order to gain insights and understanding of his/her actions. The idea is to get a grasp of user's evolving mental model as she/he is using the

product. This technique is usually used on the early stages of design when there are prototypes available. There is, however, a risk that the questions asked lead the participant to think in a certain way; therefore, it would be essential to plan the questions carefully. (Dumas & Redish, 1993)

5.2 Usability methods after product launch

After the product is released onto the markets, data from real customers can be collected. The main difference from development phase testing is that now the users have been using the product in their real lives for some time and have developed habits that may contradict the design of the device. At least some deficiencies usually come up. Information from real users may also bring misconceptions about the users into consciousness of the designers. (van Kuijk, 2007)

5.2.1 Customer Service Feedback

Customer service feedback means information that is collected from people dealing directly with customers. That information comes from people dealing directly with the customers, which means that they are a step closer to the real world than developers. The customer service deals with real complaints and problems all the time so that the developers would gain useful insights from them. (van Kuijk, Kanis, Christiaans, & van Eijk, 2007)

The main problem with this kind of information is that getting it can prove tricky and slow, and there is plenty of it. Without a solid link to customer service people collecting the data usually is not organized, which results in unstructured data that is difficult to analyze. Even when the collection is regular the amount of the data can prove to be too huge to handle. The final concern about dealing with customer service feedback is that the customers don’t on average complain unless there really is something wrong, thus smaller but still significant usability problems don’t necessarily come up at all. (van Kuijk, Kanis, Christiaans, & van Eijk, 2007)

5.2.2 User surveys

Conducting surveys is one of the most common ways to collect user feedback. Nowadays web surveys, e.g. via e-mail, are an easy way to reach a wide audience.

Although the response rate is usually low (around 20%), the distribution is so easy that sufficiently many participants can be acquired. (Dillman, 2000)

Surveys are always self-reporting which means that it's not credible because users tend to modify their thoughts to match how they currently feel about a product. For example, there may have been problems using the product at first but after overcoming them the user might conclude that there haven't been any difficulties. The large numbers, however, make up for other inaccuracies, and the surveys are usually analyzed statistically. Although the results aren't as accurate as with other usability methods the positives achieved by getting quite cheaply loads of answers outweigh the negatives. (Zhang, 2000)

There has been criticism directed towards web-based surveys because there is lack of control in them (Azar, 2000). The main risk is that the practitioners cannot know for sure who is answering the survey meaning that the information gained from the assumed users would not be applicable. Additionally, the respondents can answer untruthfully or many times to distort the results, if they wish to do so. However, it has been shown that web surveys don't vary greatly from regular mail surveys in terms of reliability and can be used to collect information as long as the surveys' deficiencies are taken into account. (Gosling, Vazire, Srivastava, & John, 2004)

Surveys require some expertise to be designed correctly. Questionnaires, for example, are an indirect way to collect information, which means that people answering the survey may be relying on their memory (Holzinger, 2005). Most often this means that recent memories get preference unless there has been a truly stunning occurrence (Norretranders, 1999).

Of immense importance is focusing the survey correctly. The design team has the best knowledge on the most problematic areas on which the focus should be. Wording the questions is important because it's easy to lead the user astray or include questions that are easily misinterpreted. Before going live with the survey testing actions should be conducted to ensure that there are no mistakes. Actually completing the survey in authentic circumstances or walking through it are valid ways to test. A good survey method will target a sample of the target population, by sending a notice, then the survey itself, and following up on non-responders with reminders or second copies of the survey. (UsabilityNet, 2006)

5.2.3 **Interviews**

Interviews are an additional, qualitative method that provides a way to discuss with the user and shed light onto actions or answers that might have caught the practitioner's eye. Interviewing individuals serves as a good way to elaborate on earlier findings and gain insights into how the user thinks. There are many forms of interviews most common of which are open, semi-structured and structured. (McNamara, 1999)

The individual interview serves as a good follow-up to a survey, although like the survey, the interview tells you little about actual user behavior (McNamara, 1999). Interview is best carried out in a conversational way but there should be a script to follow. The interview can take place face to face, on the telephone, or even online via chat software (Pace, 2003). Face to face interviews are, however, the best alternative because the interviewer can play off the interviewee's reactions and rephrase questions or modify the interview's outline accordingly (Nielsen J. , 1993).

Contextual interview is actually more akin to the usability test than to the traditional interview. Contextual interview takes place in a setting with which the user is familiar, such as an office or computer lab; there, the interviewer observes and listens to actual user behaviors; thus, being much more natural than a formal usability test. The dialogue can be informal, as long as purely qualitative results can be usefully applied afterward. The contextual interview sheds light on the actual context of use that might remain hidden in a formal usability test, such as restrictions (e.g. modem speeds, physical space limitations, browser preferences, and the like) or something else. While maintaining an informal air, interviewers should make careful notes either during the session or immediately after it. (Pace, 2003)

After finding out whom to interview, and what information is needed, an interviewing instrument is developed. The instrument ensures that the various interviews are comparable, i.e. are as much like each other as possible. The changing variables should be minimized so that the interviewees would understand the questions similarly, feel free to talk and give their actual opinions without any kind of leading on by the interviewer. The beginning and the end of the interview should be premeditated as well as the method of taking notes (notes, audiotape, or both). The trunk of the interview should consist of at maximum of fifteen main questions. Naturally, the kind of questions

leading to yes/no answers should be avoided and necessary clarifying questions thought of in advance. (Boyce & Neale, 2006)

5.2.4 **Field Studies**

Field studies involve usability experts to go out into the real world to see how their product is actually used. Field studies provide qualitative data that is especially useful in definition of user requirements to start up the development (see Figure 3) (Abras;Maloney-Krichmar;& Preece, 2001). By observing users in their normal working environment experts gain insights into how the product is used in its real context in real situations with needs that are not given by a researcher. The primary benefit from field studies is that they can bring the user and customer experience to the design teams. The difficulty for the tester is to remain an outside figure so that the user doesn't alter his/her behavior (UsabilityNet, 2006). It is also important to recognize the outside factors that influence the outcome (Kaikkonen;Kallio;Kekäläinen;Kankainen;& Cankar, 2005); for example incoming text message or e-mail may distract the user from the original task using the product. Although those distractions are usually normal in every-day use, they can to tilt the results away from the product itself. These kinds of distractions are absent in laboratory-testing (Kaikkonen;Kallio;Kekäläinen;Kankainen;& Cankar, 2005).

At best, field studies really give great insight as to where the problems are of what is missing. However, at times it's difficult to observe correctly what people are doing since the tasks and motives vary greatly as opposed to laboratory environment where everything is planned and deductions from users' behavior are more easily made. Conducting field studies is also very labor-intensive and time-consuming. It takes usually days to make enough observations about users and analyzing the data is also more difficult because the observations are almost always different between two subjects. (van Kuijk, Kanis, Christiaans, & van Eijk, 2007)

The cost of the field study, both monetary and time, dictates that the planning should be immaculate. The whole study must be aligned with the requirements of those who will use the results. This means establishment of objectives and information requirements; will the study be conducted in breadth or in depth, covering a wide spectrum of subjects or delving into only a few (UsabilityNet, 2006). Also complementary methods should

be thought of: for example, interviews are effective to highlight why the user did something in a certain way.

5.3 Usability in Mobile Phones

Mobile phones pose restrictions and difficulties for usability engineering. Usually, especially in software development, the user interface is the center of attention because there isn't much else to focus at. In developing mobile phones, however, there is the question of small screen, small keyboard were it physical or on-screen, possible touchscreen, and other constraints like mobile context (versus office or home) that aren't encountered with desktop computers. (Venkatesh, Ramesh, & Massey, 2003)

Mobile phones can be, and are, developed by copying existing products which minimizes the need for usability engineering. Nevertheless, the phones are a result of co-operation of many teams and individuals which spawns errors that can be corrected by a proper usability process. With more complex phones or completely new products usability engineering is essential to create a successful product. The complexity dictates that sooner or later working only on hunches and common sense goes amiss. In practice the usability engineering process is tied to the product development process and lives through resources and timetables defined by it. (Jokela, 2006)

Internet use, for example, is very different on a mobile device than on desktop computer. The small screen and awkward ways of navigation pose unique problems for designers. Just shrinking the existing pages to fit smaller screens is not sufficient because users achieve constant access to the Internet via mobile devices, thus using them in various environments and contexts. The designers should adjust their thinking beyond the assumption of a desktop computer being the primary vessel for internet use. Only that way the structure, layout, and usability of menus and such will develop to an acceptable level. Also a thing to bear in mind is that there is quite often some time or location critical task at hand like acquiring driving directions. (Venkatesh, Ramesh, & Massey, 2003)

An inherent characteristic of mobile devices is using Internet's various sites, like Facebook or weather forecast sites, via specific applications and widgets that make user identification and getting the information faster. With growing number of apps and widgets the phone's home screen easily becomes filled. Especially touch screens are

vulnerable to congestion because the icons require certain space to be finger-friendly. (Venkatesh, Ramesh, & Massey, 2003)

5.3.1 Effect of multitasking on UI complexity of mobile devices

The theory on how enabling multitasking on mobile devices affects the user interface design is scarce. Most of the research has focused on the multitasking of the user (e.g. (Jameson & Klöckner, 2006)) and interruptions caused by more common multitasking capabilities (e.g. (Nagata & van Oostendorp, 2003)) like incoming messages. These studies describe how users' attention is distracted and ways to return the user to the original task after the interruption. The effect of tactile feedback on enhancing the user experience on a mobile device has also been researched (Leung, MacLean, Bertelsen, & Saubhasik, 2007) but no clear results have been obtained: the tactile feedback seems to improve usability in general but no specific observations regarding multitasking were made.

The mobile devices' user interfaces generally lack the capability for use and management for multiple open applications (Horodetzky & Heinziger, 2009). Horodetzky et al. (2009) describe in their patent application a way to gain control of multiple open applications (see Figure 6). For this discussion only a portion of the patent is included, namely the switching of applications. For example, handling interruptions like incoming calls is omitted and the focus is on opening, closing and switching between applications.

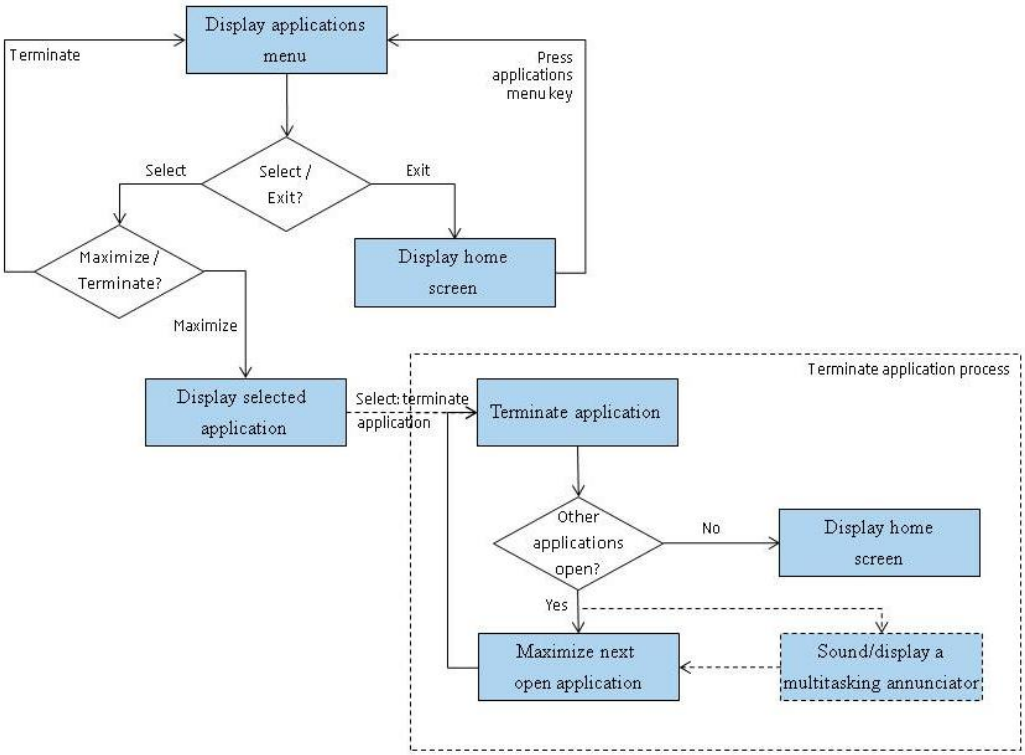

Figure 6: Facilitating multitasking as shown in (Horodetzky & Heinziger, 2009) (modified)

The patent describes one way to switch between applications so that if an application is closed next one is maximized onto the display (terminate application process in Figure 6). There is also an application menu that shows the running applications and can be used to switch between or open and close applications: it has to be entered separately from home screen. In the applications menu an application can be selected or the menu exited: if a selection is made the user can choose between terminating and opening the application (the implementation depends on whether the device has a touch screen or keyboard/keypad). In case the application is terminated, the user is returned to the applications menu. In case there are no running applications on the background the user is led to the home screen. However, if the user opens the application (maximize) and then closes it, the next application is automatically shown or the user is returned to the home screen (no applications running). (Horodetzky & Heinziger, 2009)

5.4 Potential pitfalls in usability evaluations

Although generally beneficial, usability evaluations are prone to certain discrepancies and even errors. The usability evaluations aren't exact science in the mould of mathematics, which makes it a blossoming field for debate. When an individual or a

group achieves usability results, no-one can exactly point out the process and thus exactly replicate the results. There are simply too many variables that can and do change during the tests: the environment, the test subjects, the evaluators, and many small things how certain aspects of the tests are handled. (Gray & Salzman, 1998) (Olson & Moran, 1998)

5.4.1 Failure of methods

It is well known that different teams of usability evaluators using the same established methods get different results from the same material (Kessner, Wood, Dillon, & West, 2001). The question is if this is a failure of the methods, and do they allow more problems go unnoticed, or are evaluators themselves inconsistent in different studies (Hertzum & Jacobsen, 2003). The usefulness of usability evaluation methods, and subsequently their inherent problems, has also been a subject for discussion (Gray & Salzman, 1998) (Olson & Moran, 1998).

Goal analysis is a neglected aspect of some common usability evaluation methods, namely thinking aloud, cognitive walkthrough, and heuristic evaluation. They lack a focus in setting goals and generally selecting what are essential parts of the system, which is particularly important when the analyzed system is complex. Setting goals can be done separately but it is not forced by the method. In other words, sometimes complexity dictates that all aspects cannot be tested, which means that it would be vital to find the most critical parts in the system. However, this is not the case and much of the analysis is left for the evaluator's discretion. There are also noticeably vague procedures in these methods. In heuristic evaluation and cognitive walkthrough there is clearly proven effect called anchoring (Jacobsen & John, 2000) at work skewing the results gained from them. It means that the usability expert substitutes his beliefs in place of the hypothetical real user whose mindset he should be simulating. The same effect can be traced even in thinking aloud protocol although it is based on monitoring a real user. Still, the evaluator can, and generally does, make inferences and observations that are derived from his preconceptions. Additionally, there quite rarely are any accurately defined boundaries for the evaluation criteria that are used. Obscure statements, e.g. example used by (Hertzum & Jacobsen, 2003) "match between the system and real world" leave room for interpretation which more or less guarantees variation between different evaluators' results. Some evaluators interpret something as a

problem whereas others don't, which understandably causes confusion. However, making the evaluation process more formal poses great obstacles. Formalizing the process means making it more tedious and repetitive, which, in turn, creates possibility of mental slips in the process. (Hertzum & Jacobsen, 2003)

The usefulness of usability evaluation methods in general has been questioned (Gray & Salzman, 1998). Gray and Salzman discuss four kinds of validity that can be under threat in traditional experimental studies. They state statistical conclusion validity and internal validity as cause-effect issues, and construct validity and external validity as generality issues. The former two describe threats that can spoil the cause-effect deductions in a study, whereas the latter two deal with the question how the results can be generalized. Their worry is that the results gained from usability studies are not academically valid enough to further develop the field, which would lead to general usability evaluation methods being inadequate for their stated purpose. Most of the issues that Gray and Salzman discussed would be theoretically relatively easy to correct but practical issues pose some problems (Olson & Moran, 1998). Statistical conclusions would be made valid simply by increasing the number of participants and using multiple sessions in tests, but the resources are scarce in terms of specialists and, even more critically, time. Internal validity of the test is achieved by maintaining randomness in participant selection and assignment. Severity ratings for found problems can be done by outside evaluators, and the setting of the test should be kept the same. Construct causal validity means the threat posed by how the method is understood by different researchers and how does the terminology change over time. External validity deals with generalizing the test results to particular target persons, settings, and times and generalizing across types of persons, settings, and times. In other words, a study that generalizes to a heterogeneous group of people cannot be interpreted to mean the subgroups individually. (Gray & Salzman, 1998)

The criticism directed at Gray and Salzman's research has focused around the fact that usability evaluation is a practical discipline, and that they require too academic approach to be fit for nature of the usability evaluations. It would be possible to employ strictly scientific methods and extract some scientifically valid information but in essence usability is a practical field. In that perspective, scientific studies into some part of UEMs are not in the interest of wider community. Scientific approach would enhance

the methods but the improvement would be very slow and its benefit uncertain to the practitioners. (Olson & Moran, 1998)

The question how accurately UEMs can be academically studied and improved remains somewhat unanswered. The research has three dimensions that it should control: generalizability, precision in control and measurement, and realism. The problem is that maximizing on one of these reduces the other two. In that way the scientific studies can never truly answer all the questions that UEMs pose. Field studies, for example, are highly realistic but they lack severely on control and generalizability. Thus, the only way forward, for scientifically valid research, seems to be comparing results from various studies, which have been conducted in similar environments, with each other. (Olson & Moran, 1998)

In summary, the usability evaluations are not a theoretically perfect way to find usability problems. They are applied in different settings that provide their problems which are discussed in chapter 5.4. Factor in the effect that people behave differently: different evaluators get varying results although they would use exactly the same methods (Hertzum & Jacobsen, 2003) and different users provide also varying results (Nielsen J. , 1992). The theoretical framework is good to exist, and it has to be developed further, but the real audience and their benefit of these methods has to be kept in mind (Olson & Moran, 1998).

5.4.2 Usability testing vs. inspection

The difference between usability testing and inspection is that the first employs real users while the latter involves usability experts. Obviously, usability testing provides information on what aspects of a system are problematic to the real user as opposed to expert-based inspections that inevitably reflect the experience and background of the expert evaluator (Jeffries & Desurvire, 1992). If the test is run with real users the environment in which the test is conducted becomes all the more important. Although laboratory-based test settings are artificial removing incidents that occur on the field from the equation, they reduce the disturbing aspects of field testing letting the test user concentrate on a particular task. (Been Lirn-Duh, Tan, & Hsueh-Hua Chen, 2006). Jeffries and Desurvire (1992) have compared methods of finding usability problems. It seems that testing with real users tends to uncover problems that are on the high end of severity scale. Additionally, real users have a greater effect on developers for whom

seeing a user get stuck while using the system provides more convincing proof of a problem than opinion of a usability expert. Testing also brings out ways of use that cannot necessarily be imagined by a usability expert. Jeffries and Desurvire discussed mainly heuristic evaluation in their paper but the mindset that the evaluators use in a usability inspection session is applicable to all inspection methods: they are still experts, not end users (Hertzum & Jacobsen, 2003). Due to incorrect mindset experts may encounter non-problems whose correction could make the system even worse because they are not real problems in the eyes of the user (Jeffries & Desurvire, 1992).

The duration of the test, and more critically the amount of time the user has spent with the system, affects the end result (Dillon, 2001): Often usability testing is conducted in short periods with predefined tasks to accomplish. If the users are not familiar with the product, the timeline in the sessions prevents the users from getting used to the product thus restricting them from finding certain type of problems concentrating primarily on learning aspects. Feedback of real use of from real world can be collected after the product is being sold. The trouble here is that the damage has been done in terms of the product in question; smaller modifications (e.g. updates on mobile phone's software) can be made but the main point of the feedback collection is to ensure success of the next product (van Kuijk, Kanis, Christiaans, & van Eijk, 2007). However, according to van Kuijk et al. (2007), if there is an existing, similar, product on the market, as often is the case, it can studied to gain insights already in the development by using e.g. field studies.

5.4.3 **Practical limitations**

The practical deployment of usability evaluation methods is very different from theory: there are limitations in man-power, time and money; additionally the scope of these studies is not on theoretically optimal use of UEMs but on getting the results. The goal is to produce as quickly as possible, a successful product that meets the specifications with minimal resources and risks (Wixon, 2003).

There has been discussion about number of users required to gain optimal results from usability evaluations. As common sense dictates, with increasing number of evaluators the number of problems found increases (Hertzum & Jacobsen, 2003). Practicality, however, restricts greatly the resources that can be used. Nielsen has suggested that five evaluators would be sufficient to uncover most of the usability problems; additionally,

after five evaluators the number of usability problems that are found doesn't increase radically (Nielsen & Landauer, 1993). From a purely mathematical perspective the results are naturally the better the more evaluators are used (Hertzum & Jacobsen, 2003), but a line has to be drawn between what's practical and what is excessive. It seems that the industry is following Nielsen and Landauer's suggestion, on benefit versus cost basis, and using optimally three to five users (Rosenbaum, 2000).

Another defining characteristic for usability testing in business world is that implementation of the methods isn't exactly scientific (Wixon, 2003). Thus the usability work is more focused on finding problems in a product than quantifying them or benchmarking different solutions because the nature of business puts priority on effective and fast solutions (Rosenbaum, 2000). The methods may be applied superficially: for example heuristic evaluation is theoretically conducted in many cycles inspecting the system using one heuristic at a time but in practice experts tend to take an overall look relying on experience to find the problems. The discrepancy that follows from the gap between theory and practice is that neither benefits from either. According to Wixon (2003), the most deep-rooted problem of scientific approach to usability evaluations is that it doesn't take the practical limitations into account: First, findings problems is just the first step towards improving a product's usability. Second, the integration of the method into the whole team and development process is mostly lacking. Wixon's final point, limited resources, has already been discussed. The first two points imply that in theoretical discussion the usability methods have been observed as isolated from other world and thus diminishing the relevance of scientific work for the applied settings. However, the methods used in practice are also far from perfect. According to Rosenbaum (2000) the danger is that most observations focus on ease of learning and out-of-the-box experience. The context of users' work is also omitted, and often the heterogeneity is forgotten from these tests.

6 N900 overview

The purpose of this chapter is to explain what N900's perceived and marketed functionality is before it has started selling. Most of the information is gathered outside Nokia, meaning blogs and Nokia's marketing material to get the picture which is available to all.

The story of Maemo began with OS2005 along with Internet tablet 770. It included the Opera web browser, Flash 6, basic Email and RSS clients, audio and video players, and PDF and image viewers. OS2006 was released also for 770 including improvement on performance and stability. OS2007 was released with the N800 featuring mainly bug fixes and general enhancement: the biggest being instant messaging, VoIP audio and video calls. N810 came with OS2008 that brought about a new Mozilla-based browser, MicroB, along with numerous improvements on user interface. Maemo 5 is the operating system in N900. Compared to previous operating systems, the Maemo 5 is on another level. Main differences are inclusion of a phone application, new hardware and 3D acceleration.

The greatest difference of N900 compared to its predecessors, however, is the redesign of the UI to be completely usable with fingers as opposed to being used by a stylus. There is a stylus included in the sales package but according to Maemo UX design team the N900 is intended to be fully usable with fingers. In addition to the touch screen and finger-usability, another prevailing component of N900 is the hardware keyboard. It implies that the prevailing mode for input is the landscape alignment.

Maemo is a software platform developed by Nokia for mobile computers (N900) and internet tablets. The platform comprises of Maemo operating system and Maemo SDK. Maemo is based on Debian GNU/Linux and much of its GUI, frameworks and libraries are drawn from GNOME project. The N900 user interface has three main areas: home screen, dashboard and main menu. There are four separate home screens that can be used and switched between by sweeping a finger across the screen. These home screens are customizable to users' preferences and are also possible to be disabled so that only one or more is in use. The user is allowed to tack both custom shortcuts (contacts, applications, files etc) and widgets (showing, say, weather forecast in real time) onto the home screen. Unlike e.g. other Nokia product from 2009, N97, there are no predefined slots for elements that the user places onto the interface. (Jerz, 2009)

The N900 was launched on 2nd September 2009 at Nokia World. N900 runs Maemo 5 Linux as its operating system and is Nokia's first Maemo device that includes phone functionality. The user interface in N900 is somewhat S60-like in naming conventions and structure. There is "Applications" menu, for instance, and Menu screen shows icons in a familiar 5 by 3 grid. The experience on the device, however, is supposed to be unique (Murtazin, 2009).

6.1 Design & keyboard

The design paradigm is somewhat different from Nokia's S60 smartphones: the N900 is not centered on the phone function. There isn't default phone access from the home screen; there aren't any physical answer- or hang up-buttons. The telephone is just another application on N900. Additionally, there is a three-axis accelerometer that allows orientation of the screen to change between portrait and landscape (Nokia, 2009c), but the N900 is designed primarily to be used in landscape mode; only selected applications support the portrait mode (e.g. phone, web).

N900 has a 3.5 inch resistive touchscreen with a resolution of 800 × 480 pixels which is the best display measured by pixels per inch (ppi): N900's 267 ppi as opposed to 167 ppi (iPhone 3Gs), 210 ppi (Nokia N97) and 265 ppi (Motorola Droid). The LCD screen is transreflective so that it is usable in varied lighting environments (from daylight to dark). The Nokia N900 has an ambient light sensor that adjusts the display brightness and activates the backlit keyboard. For the touchscreen, haptic input is provided by small vibration or sound that can be turned off. Also a stylus is provided for more precise touch input and to facilitate accessing smaller elements of the interface (Nokia, 2009c). There are, however, opinions that the stylus is not generally needed (e.g. (Nguyen, 2009)). Nevertheless, using web is easier and generates fewer mistakes with the stylus than with fingers.

In addition to touchscreen there is a three-row slide-out keyboard. The keyboard has posed some problems to users as it has three rows, as opposed to more conventional four-row-keyboard, and has quite small buttons. The N900's slide-out keyboard seems to be quite solid construction (Jerz, 2009). The keyboard is faster to type with than the virtual keyboard also on offer. Due to the sliding keyboard, and the amount of other features, the design of N900 is quite bulky when compared to its competitors (see Figure 7). Otherwise the physical design is very clean.

Figure 7: iPhone on the left, N900 on the right (picture from: (Nguyen, 2009))

6.2 User Interface

The N900's user interface is designed around the dashboard: a place where all the running applications are shown (see Figure 8). The dashboard is reachable from any place in N900 because there is button on the top left corner that always brings the user there, if there are running applications. Going back from a menu is accomplished by tapping outside the active screen, which is facilitated by the background going out of focus. Alternatively, within applications there may be a back arrow on the top right corner of the screen that allows the user to take a step back within the application.

Figure 8: Dashboard in N900 (Nokia, 2009a)

Another central place for navigation is the four home screens that the user can customize as he/she wishes. Those screens can contain shortcuts to applications, widgets, RSS feeds or contacts. The home screen's customizing options are brought up by tapping onto an empty space and then onto appearing icon. On the home screen the icon on the top left corner takes the user to dashboard (or main menu, if there are no running applications) from which the main menu is accessible via icon on top left corner. Going back to the home screen is accomplished by tapping the empty space on the dashboard (same as from the main menu to dashboard) which might be a bit difficult if there are a lot of applications running (see Figure 8).

In Figure 9 is shown how applications are managed in N900. Whenever a user is in an application and chooses to do something else (e.g. switch to another application), the user may press on either top left corners to enter dashboard ("minimize" in Figure 9) or top right corner to close the application ("terminate"). If there are any applications running the user is taken to the dashboard. If user closes the last application, he/she is guided to the home screen. From the home screen the user can launch a new application, or a running one for that matter if there is a shortcut on the home screen, or enter the dashboard.

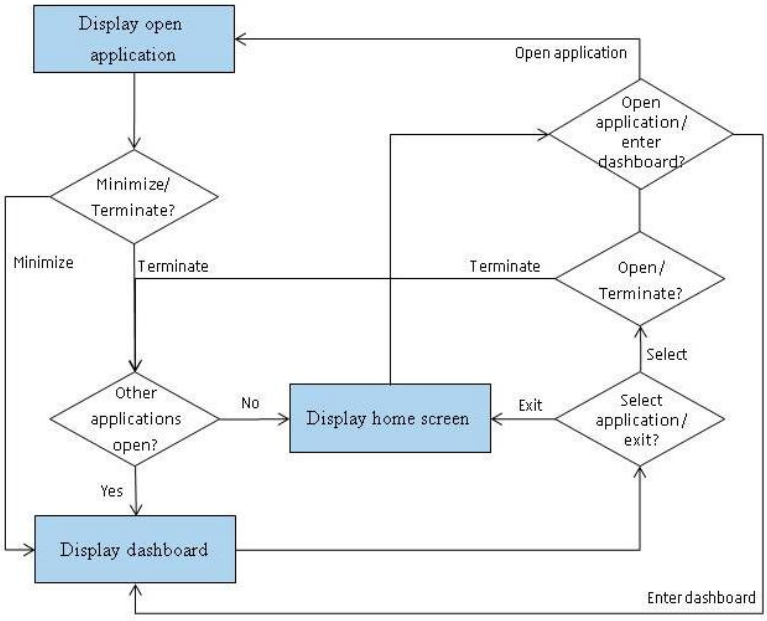

Figure 9: Nokia N900 application management

6.3 Applications

Taking into account that this is the first Maemo device from Nokia, the offering in applications is understandably limited. For social software there is a Facebook widget (Nguyen, 2009). There is an office application, Docs to go, available on trial but it doesn't offer capability to edit documents. A PDF-viewer is also included. There are also a couple of games: Chess, Mahjong, Marbles and Blocks.

Given time, there will probably be a lot more applications available. The fact that N900 is Linux-based and mostly open-source brings some huge benefits. There are countless Linux developers around who can, with some learning, start developing applications for N900. In addition, existing Linux applications can be ported to N900 with some UI re-designs (Jerz, 2009). Thus, there are good odds that application development for N900 will start well despite it being the first Maemo device with telephone. In fact, being a first device of its kind may bring some benefits: as the first Maemo device the N900 doesn't have the burden of history heaped on it. As a result the developers don't have to consider other phones' hardware requirements. Usually the developers try to reach as wide audience as possible to sell their application which means that they have to take into account what the older phones are capable of. In the case of N900 the applications that are developed will be designed to utilize its full capabilities. (Jerz, 2009)

The N900 is an open-source device which means that the developers can freely create new applications. Although there is an applications store (Ovi Store), there is not a controlled publication process like Apple's, might bring troubles: first of all, the gain for developers wouldn't be monetarily significant, secondly, the quality of the applications remains mystery, and thirdly, the distribution channels may vary which would not be appealing to consumers who don't like to spend time searching for and then trying out applications.

6.4 Communication

Although N900 is in some ways an internet tablet turned into a mobile computer, the telephone functionalities work well. The phone application offers a possibility to make a regular phone call or a call via a VOIP service, e.g. Skype. The e-mail support in N900 is quite extensive, and when using one of available mail services, only the login information is needed to make things work. The N900 uses common naming "Conversations" for SMSs and Ims. E-mails are a separate application. Currently, the

N900 supports the following IM services: Ovi, Skype, Google Talk, Jabber and SIP. Although N900 supports threaded messaging, the different conversations are not contextually related in any way; conversations on different services always show as two separate threads even though they would be with the same person right after one another.

The N900 doesn't have a call log in its traditional sense: the phone application shows the recent communication as a list. Additionally, there is quick access to the phonebook from the phone. The phonebook itself is very simple presenting the contacts as a list that can be sorted alphabetically by first, last or nickname. There are blocks of the alphabet on the right side to access a portion of the contacts. Searching contacts can be also done by gradual typing from the hardware keyboard that searches for corresponding contacts: this can be done already at the home screen.

The contact cards present all the communication mediums (GSM, e-mails, IMs) that have been added to the contact. There is also availability notification for instant messaging so that the availability of other contacts is easy to check.

6.5 Web

The N900 uses Maemo web browser which uses Mozilla's technology. The N900 offers Flash 9.4 support which means that e.g. YouTube videos should work, albeit slower than on desktop computer. Without multi-touch, zooming is can still be done in three ways: a spinning motion zoom, using hardware volume buttons to zoom, and double-tap on a certain area. In general, all the web sites are usable with N900 but complex (heavy use of Flash or Ajax) pages can be slow (Nguyen, 2009). Copy-paste shortcuts are the same as in desktop PCs: the text is selected by sweeping move across the screen and text copied and pasted via familiar shortcuts (ctrl-v, ctrl-c) on the keyboard. In the browser, there isn't a traditional back button but a visual history that shows screenshots of visited pages.

6.6 Maintenance

One of the most important aspects for the everyday user is the battery life of the device. Battery life on N900 is somewhat of a mystery: it has been debated after the device has been launched and sold in stores, probably mainly due to different ways of using the device. The battery is used in other phones as well, but the screen resolution and N900's multitasking capabilities surely consume the battery relatively quickly. (Nguyen, 2009) (Jerz, 2009) (Murtazin, 2009)

Updating the N900 should be easy: over-the-air (OTA) updates are supported so that the user would only have to accept the incoming update.

7 Experimental part

In later chapters the results from both phases are compared with each other; in this chapter the results are presented. The feedback on N900 was obtained in two phases: post-sales feedback was collected from real users by interviews and Internet research and the development phase results were investigated via interviews and discussions with Maemo UX design team. The results are categorized into groups (see Table 1) that reflect the focus areas of development and issues that were accumulated from post-sales feedback.

Table 1: Categorization of findings

Category	***Description***
Design (physical)	Form, size, look and feel etc.
Applications	Applications, their usability, user experience etc.
Hardware-software interaction	Includes all the problems/positives that stem from poor touch recognition or misinterpretation of touch; portrait-landscape issues etc.
User interface	Includes navigational issues, and uniformity and understandability of UI and its elements
Keyboard	Refers to the physical/software keyboard
Maintenance	Includes updates, recharging, downloading apps etc. i.e. all that is needed to make the device work properly
Web	Web experience
Multitasking	Running multiple applications at once
Communication	SMSs, IM services, phone
Related services/features	Anything not directly involving the device itself: e.g. community related or support

7.1 UCD at Maemo

At Nokia there are many processes running in parallel when a new device is developed. Presented in Figure 10 is a high-level framework for user-centered design at Maemo which is used to guide the development process. There are, however, separate processes for e.g. software and hardware development.

The user needs for a product are gathered by traditional means of conducting user studies but also by using information from previous products. The segmentation of consumers at Nokia helps focusing the research at the right people. Concept definition and selection are iterative processes in which many possibilities are tested for example by paper mock-ups (see chapter 5.1.3). Usability requirements are developed at this point and thereafter the suggested concepts are tested and discarded or approved. In this phase, corporate policies (e.g. UI guidelines) and business drivers (e.g. resources) are taken into account and shape the requirement definition.

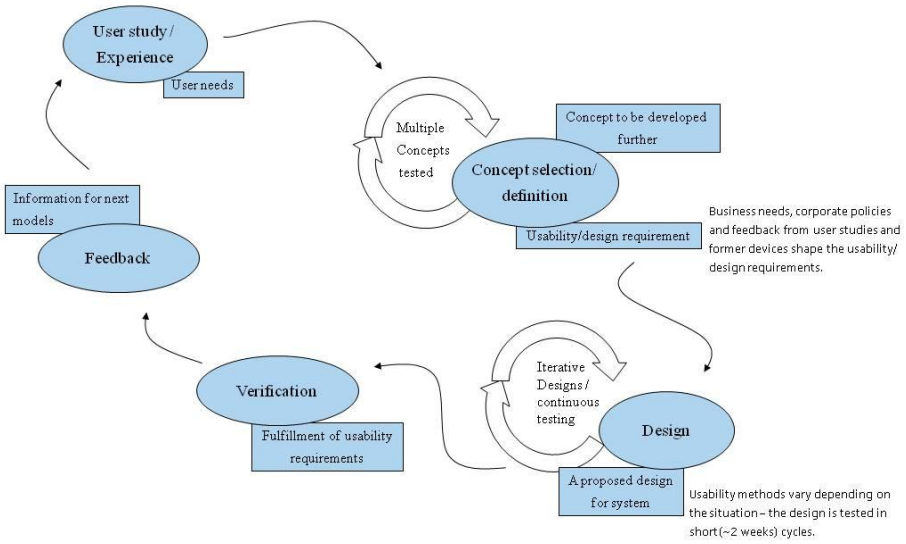

Figure 10: Maemo UCD process framework (processes in ovals, outcomes in boxes)

The design phase should bring forth a proposal for possible solution. Usability testing is conducted in short cycles so that the proposed design is updated regularly and development can be measured and compared to requirements from the earlier phase. Evaluations on a bigger scale are conducted more seldom, a couple of times during the phase, and their goal, in addition to find flaws in the design, is to keep the design is kept on right track also in global context, in case the developed product will be global as usually is the case. In the verification phase, the product is checked against the usability

requirements. The iterative phases before should have made sure that any major deviations from requirements haven't occurred. Once the product reaches the markets, feedback is collected in order to gain knowledge for the next product (see chapter 7.2).

7.2 Post-sales feedback of N900

The release date for a device is not the end of the development process. The released phone is still kept under scrutiny to gain insights for making fixes, and even more importantly to get experience for the next model. In the case of N900 and this work there are three sources of post-sales information: blogs and internet, web-based consumer feedback surveys, and interviews. The N900 has provided both pleasant surprises and disappointments to reviewers. Many aspects are debatable and some solutions work for other people whereas others find them intolerable. It is important to keep in mind that the target segment for N900 is early adopters and technology leaders i.e. those who are ready and capable to go into some trouble to make their phone work.

7.2.1 **Blogs / Internet**

A good way to get opinions nowadays is via blogs and articles that are found aplenty on the internet. Everything that is said there is naturally opinion-based and subjective so that those views have to be taken with a pinch of salt. However, trends can be observed by reading multiple views on the matter and finding out problems and achievements in the device that various bloggers notice. The following results have been obtained by reading many previews and reviews of N900. In the focus were findings of what did or did not work on the device, and what was the general opinion of things like navigation on user interface.

The results described below were collected from 18 blogs or reviews between September 2009 and March 2010 with emphasis on earlier reports; the basic information about the reviews is presented in Appendix B. Most of the reviews (13/18) were made in the late 2009. In the first reviews in September a pre-production device was used for evaluation, which brought up problems that were fixed even before the N900 went into stores. Also later updates on N900 brought fixes to some problems that were encountered by the reviewers.

The reviews were read with open mind to take any significant problems or successes related to N900. However, due to unreliable nature of Internet-based sources some care

was exercised on choosing findings for further investigation. Basically, if something significant came up even just once (e.g. N900 crashed during update) it was picked up; findings of lesser significance were taken on if there were multiple (at least two) mentions of them. The more reviewers mentioned the same finding the more significance it gained. The most important findings are presented in chapter 7.2 and all the findings in Appendix A along with references to reviews.

7.2.1.1 Design & keyboard

The first thing almost everybody notices about N900 is its size: it is big and especially thick (Ali, 2009) (Beavis, 2009) (Hanlon, 2009) (Malik, 2009). In other dimensions it's not different from other similar devices but the thickness accounts for uncomfortable bulging when the device lies in pocket (Ziegler, 2010). Some bloggers have pointed out that the N900 is actually marketed as a mobile computer and is thus reasonably sized (Ziegler, 2010) (Nguyen, 2009), but, be that as it may, N900 competes for the same consumers as the slicker mobile devices do (Ritchie, 2009). However, most of the size is the result of physical keyboard whose existence may be deemed good (GSMArena Team, 2009) (Miller, 2009) (Jerz, 2009) or bad (Malik, 2009), based on personal preferences. Another smallish design issue is the location of hardware key for screen lock: it requires some searching to be found (Krish, 2010) (Beavis, 2009).

The physical keyboard has drawn attention to itself because it has only three rows and the location of the space bar is quite unconventional (Ziegler, 2010). However, some reviewers liked the new placement even better than the regular (Beavis, 2009) (Guim, 2009) (Miller, 2009) but others think that it is weird (Ritchie, 2009) and the keyboard is generally too packed (Malik, 2009) (Jerz, 2009) (Nguyen, 2009). It adds unnecessary adoption time (Jerz, 2009) (Ziegler, 2010) to already otherwise new device with learning required on other aspects (Hanlon, 2009). The packed keyboard unavoidably results in pushing accidentally wrong buttons. The upper row is also quite close to the screen which leaves little room to use those buttons (Jerz, 2009) (GSMArena Team, 2009) (Miller, 2009) (Ziegler, 2010).

In order to justify the size, N900's internal hardware is considered impressive by all the reviewers (GSMArena Team, 2009). The hardware on N900 suffices basically for anything as far as mobile devices are concerned. For example, the N900 has 1GB of operating memory which consists of two parts: actual 256MB of operating memory and

another 768MB of virtual memory (Jerz, 2009). There is 32GB built-in storage memory with possibility to add 16 GB via a micro-SD card. 2GB of this amount is dedicated to third-party applications (Nokia, 2009c). To summarize, the hardware is on par with or even better than its competitors'.

7.2.1.2 User interface

The user interface has drawn mixed comments: some find it intuitive and easy to use (Lynch, 2010) (Jerz, 2009) (Miller, 2009) (Malik, 2009) whereas others take too much time to get used to it and think it's a little disjointed meaning that the experience is not uniform (Wright, 2010) (Ali, 2009) (Murtazin, 2009). The common opinion seems to be on the positive side, the negative feeling being that the time to learn how to operate the UI is not the shortest.

It has been appreciated that the design of the home screen is somewhat free of preconceptions, i.e. the user can modify the home screen to his/her preferences (Unwiredreview, 2009). On the other hand, this brings also the need to modify and maintain the home screen in order to be able to use the N900 fluently (Ritchie, 2009). The UI of most phones is quite linear, but the one on N900 has been described as cyclical so that the user is not always returned to the previously visited place (Ziegler, 2010) which is new but learnable (Miller, 2009). For example launching an application from home screen, and then closing it, takes the user to the dashboard, if there are applications, where the running applications are shown. To dismiss context menus, which are brought up by clicking on corresponding icons on the screen, only a click outside the menu suffices. After realizing how it's done it is intuitive and fast (Miller, 2009) (Murtazin, 2009), but some mistakes can occur: accidentally tapping outside on the background makes the window disappear (GSMArena Team, 2009) and in packed areas finding free space may be difficult (Ziegler, 2010). Additionally, moving back from a screen may seem confusing at times (Mobilementalism, 2009) For all the unfamiliarity, the interface is deemed quite fast to master (Nguyen, 2009) (Miller, 2009). Once the user figures out the interaction between desktops, task manager and applications menu, the interface starts making sense and is deemed easy to use (Miller, 2009).

It seems that the whole navigational model has confused quite many users, especially when starting to use the N900 (Ali, 2009) (Murtazin, 2009) (Wright, 2010) (Nordgren,

2009). The crux of the problem might be that the concept of multitasking adds unnecessarily to the complexity of the UI (Nordgren, 2009). The central place to navigation is the dashboard that is reachable from anywhere. However, the user is burdened with the task to make many decisions to accomplish any given task (Nordgren, 2009): from the dashboard there are always three ways in which to go (home screen, a running application or main menu) which requires the user to scan the running items and, if the desired application is not running, remember what is on the home screen and make a decision whether to go to main menu or home screen.

In addition to inconsistencies and problems there are things that are absent but would make the UI more user-friendly. After the learning period the advanced users would possibly like to use shortcuts to hasten navigating the interface (GSMArena Team, 2009). In the main menu it is not possible to rearrange the icons or add folders, which makes using it unnecessarily slow and tedious (Jerz, 2009) (GSMArena Team, 2009). On the bright side, the dashboard was thought to be an easy way to switch applications (Beavis, 2009) (Ali, 2009) (Jerz, 2009) and customizing the home screen extensive enough to provide the user a personal way of use (Ziegler, 2010) (Jerz, 2009) (Unwiredreview, 2009).

7.2.1.3 Hardware-software interaction

Touch interaction in general has been debatable. Resistive screen requires more pressing to function (Lee & Zhai, 2009). On the other hand resistive screens can be used via other means than fingertips as opposed to capacitive ones. The only agreement among bloggers seems to be that it is substandard compared to iPhone and requires more pressure to register touches (Malik, 2009) (Ali, 2009). Whereas some claim it to be continuously unresponsive (Ali, 2009) (Murtazin, 2009) (Ritchie, 2009), others seem to get used to it after a while (Guim, 2009) (Jerz, 2009) and even enjoy it immensely (Unwiredreview, 2009). It is commonly acknowledged that as a resistive screen N900's is top notch (Nguyen, 2009) (Beavis, 2009) but it still doesn't register every touch which may be irritating (Ritchie, 2009). The screen is also quite sensitive to getting dirty (Wright, 2010) and also worries of vulnerability to scratches have been raised (Jerz, 2009).

The lack of portrait mode with the exception of few applications has been noticed widely by e.g. (GSMArena Team, 2009) (Krish, 2010) (Murtazin, 2009) (Nguyen,

2009). People familiar with the latest mobile devices are getting used to using their phones in landscape and portrait modes depending on the situation (Ziegler, 2010). Many would like to read text messages in portrait, and most importantly use the phone in situations where two-handed use is impossible or suboptimal, like walking or standing on a bus. Favoring landscape mode also means that in most cases (barring those when portrait is supported) the keyboard must be slid out for typing. Additionally, some users would possibly like to operate without any physical keyboard whatsoever (Malik, 2009), which is impossible with N900. However, many reviewers are guessing that more support for portrait mode is being developed (Ali, 2009) (Murtazin, 2009) (Nguyen, 2009).

7.2.1.4 Applications

There is a considerable lack of applications for N900. It is well understood among reviewers that N900 is the first Maemo device with phone, and that accounts for a developing community (Beavis, 2009) (GSMArena Team, 2009) (Nguyen, 2009). However, if the application development doesn't start well, there is a risk that consumers will avoid N900 and especially its successors. There are reasons why the 3rd party development for N900 could start well (Jerz, 2009): The device offers freedom that many other handsets don't, which attracts different people than mainstream consumers to use the phone. The Linux platform, powerful hardware without the burden of old phones and without any Symbian Signed- or Apple AppStore-deterrent that would disapprove applications, should encourage developers to start creating applications for the N900. The existing developer-base for Linux is already formidable and getting some of those developers interested about N900 is not beyond imagination (Jerz, 2009). However, if average consumers are hoped to get interested, it has been argued that the ease of use must be improved in many aspects: for example full set of applications and more clearly marked UI navigation (Ziegler, 2010).

Small things that are lacking in N900 range from equalizer in music player to MMS messages. Generally, the software offering will be lousy for N900 at first. More precisely, the lacking or inadequate applications that have been repeatedly mentioned include office, media, navigation and communication, according to e.g. (Beavis, 2009) (GSMArena Team, 2009) (Guim, 2009) (Miller, 2009) (Ziegler, 2010). There is no application to edit office documents (Nguyen, 2009). In navigation the OVI maps has

been criticized and additionally there is no voice navigation (GSMArena Team, 2009). The Ovi Maps on N900 is nowhere near Google Maps in terms of usability, functionality, quality and amount of maps (Miller, 2009) (Ziegler, 2010). In media section there is no pre-installed FM-radio (it has to be installed separately) and no equalizer in the music player. A voice recorder is also missing altogether. (Jerz, 2009) However, given time the community and Nokia can make up for those deficiencies; the iPhone started without MMS, for example, but now has very extensive features. (Jerz, 2009)

To counter the small deficiencies, there are also small successes. The FM transmitter is received well: it is handy to listen to music or podcasts via car stereo while driving (Miller, 2009). Grouping SMSs and instant messaging into "Conversations" seems to be a good choice, according to e.g. (Wright, 2010) (Ali, 2009) (Krish, 2010) (Ziegler, 2010). The reviewers like the fact that there are multiple possibilities for communication to choose from.

For all the defects and lacking applications, a common theme among bloggers has been N900's potential. A common opinion seems to be that the N900 has the potential to build up a community that can develop 3rd party applications for the device. (Lynch, 2010) (Wright, 2010) (GSMArena Team, 2009) (Jerz, 2009)

7.2.1.5 Communication

Although Nokia markets the device as a mobile computer, the wider audience (i.e. less technology-savvy) is buying it because it has the telephone feature. Using the phone application is somewhat tedious because the N900 was not designed to be phone (Ali, 2009) (Beavis, 2009); it is just another application (GSMArena Team, 2009). There was an option to enable the phone application when the device is turned upright, which was generally liked (GSMArena Team, 2009), but it reportedly doesn't work always (Ali, 2009).

Otherwise the communication options were liked; especially integration of different alternatives (IMs, SMS, and GSM) facilitated use of device (Jerz, 2009). Although conversations via different mediums are shown as separate threads (Guim, 2009), the conversations are easy to use and threaded within single exchange (Jerz, 2009). Notifications about missed calls and SMSs are implemented well in N900 so that they don't restrict using the device but show very visibly on the screen, according to e.g.

(Ziegler, 2010) (Wright, 2010) (Beavis, 2009) (Krish, 2010) (Jerz, 2009). Also the status indicator is liked (Miller, 2009) (Murtazin, 2009).

Although the contact card view was praised as functional and thought to present enough information while being simple (Beavis, 2009), finding contacts is not that easy due to the lack of smart dialing from software keyboard (Jerz, 2009) (Beavis, 2009) (Jerz, 2009).

7.2.1.6 Web

One feature appealing to consumers in N900 is its web browser. It offers almost desktop-like web experience according to e.g. (Ziegler, 2010) (Ali, 2009) (Krish, 2010) (Guim, 2009) so that the applications most mobile devices require to access web services are often unnecessary. Additionally, the web services that don't offer mobile applications or widgets whatsoever are still usable via N900 (Guim, 2009). The web browser on N900 supports Flash and JavaScript although the performance of e.g. videos from other sites than YouTube isn't optimal (Murtazin, 2009). The thing here is that the user can go to the original sites, designed for desktop computers, and use those as opposed to mobile phone optimized versions that may lack information or functionality (Nguyen, 2009). The truly unique feature is support for plug-ins and extensions (Murtazin, 2009) which makes the browser customizable. For example there is a module that will automatically authorize all OVI services, or an extension that will get the device's whereabouts from the bundled GPS chip and allow developers to implement location-based services (Murtazin, 2009). However, there have been complaints that it slows down if the phone isn't rebooted at times (Murtazin, 2009). Also the ability to multitask takes up resources of the browser because there are applications running on the background as opposed to being stopped (Ritchie, 2009), which eventually slows down the N900 (Murtazin, 2009). Sometimes pages previously loaded take around 10 seconds to reload for some reason (Murtazin, 2009). Copy-paste function is a success: one only needs to select a fragment on the screen with fingers and then use a combination of shortcuts on the keyboard to copy it (Murtazin, 2009) (Jerz, 2009).

The visual history, which shows little screenshots of visited pages, of N900's web browser was thought of as a good idea (Ali, 2009) (Beavis, 2009) but it was also remarked that it shouldn't slow things down, which it occasionally does (Beavis, 2009).

7.2.1.7 Multitasking and battery life

Multitasking is a feature that divides opinions, partly because Apple has limited the feature in iPhones. The N900 has desktop-like multitasking capabilities so that it can actually run (as opposed to stopping others and running one) multiple applications at the same time. Some users cherish the chance to run many applications at the same time and use the device's power to the maximum. However, there have been differing reports on the performance. Some claim that there isn't any noticeable slowing down (Jerz, 2009), whereas others claim even significant slowness while running many applications at once (Murtazin, 2009). Nonetheless, the general opinion is that the device can, at least to some extent, really handle desktop-like usage (GSMArena Team, 2009). Using the device's multitasking capabilities to the fullest naturally affects battery life, which is the greatest single restriction.

A headache with virtually every evolved mobile device, the battery life on N900 has been criticized almost without exception. Those who usually recharge daily, and live in a way that makes it possible, weren't that bothered with it. However, the battery doesn't last much longer than a day which causes problems if recharging is not possible. Additionally, heavy users may drain the battery even faster so that they would have to be able to recharge in the middle of the day. However, it is notable that the reported battery life varies wildly between reviewers. The battery life also seems to improve after a while for some reason that is not exactly clear. (Miller, 2009) (Guim, 2009) (Nguyen, 2009)

7.2.1.8 Maintenance

The mobile devices nowadays are released quickly, which usually results in bringing in updates to fix bugs and otherwise improve the device. In that respect, the update process should be as easy as possible for the users. The N900 supports bringing updates over the air, when only accepting the update, and possibly rebooting the device, suffices (Wright, 2010). However, there are some cases when the user is required to connect to PC and update via Nokia Software Updater (NSU) which is a Windows application (Lynch, 2010). For Linux users it may be difficult to understand why there is no option for NSU. As for the update process itself, the phone froze in this particular case (Lynch, 2010) leading to the need to flash the device. For an average user doing that would have

been very difficult. Nevertheless, back-ups on N900 seem to work very well, so that flashing the device didn't erase those files (Lynch, 2010).

7.2.1.9 Other

Compared to more matured mobile devices, N900 comes short in many of these small areas that can be significant to some people. For example, lack of D-pad, as in previous N-series tablets, makes gaming difficult (Jerz, 2009). There are also some common features, like timed profiles, voice dialing and Java support that are lacking.

The question for consumers is whether the benefits can overcome the deficiencies and provide value for money. At 500 Euros, the cost is higher than any of its predecessors, and comparable to a pay-as-you-go iPhone. Cheaper Android phones will offer a more accomplished and error-free package. Therefore, it's essential that the design is at least as good as its competitors' – competing with price isn't an option. Being a new phone without masses of existing users, applications and community, means that the price may very well be a deterrent for many a consumer.

The general opinion seems to be that the N900 suits people who are interested in maintaining and tweaking their phones'. There is a philosophical difference between iPhone and N900; and between Apple and Nokia. Whereas Apple has been focused on bringing ultimate ease of use by predicting what users want and need, Nokia has offered almost everything there is and let users decide what to use (Jerz, 2009). Often the result is that Nokia's phones seem messy and disoriented compared to Apple's. The iPhone has reached masses by offering minimal need to fine-tune the phone, but at the same time restricting those who want to do more with their phones (Ritchie, 2009). N900 provides a contrasting philosophy: it allows the user to do practically anything on it (Jerz, 2009). For those who favor optimal out-of-the-box user experience and don't want to go into any trouble to make their phones work, the N900 isn't the best choice. The openness of the platform increases the psychological appeal of the device for developers. (Miller, 2009)

7.2.2 Interviews

The goal of the interviews was to gain insights how the users of N900 have experienced their time with the device. The interviews were conducted to three Finnish young adults (20-30 years old) who have owned the N900. The interviews were half-open so that the

interviewee had room to tell about his experiences freely. The interviews were conducted in environments that were familiar to the interviewee. The interviews were taped with the consent from interviewees so that afterwards they could be listened to and details gathered. Notes were also taken during the interview to facilitate extracting the findings later on and keep track of what had been said. The list of questions is presented in Appendix C; it has to be kept in mind that the actual interviews varied depending on the subjects that the interviewees brought up as is their nature. The interviews were conducted in Finnish. The Table 2 below summarizes the basic information of the interviews.

Table 2: Basic information of the interviews

Interview	***Date***	***Duration(h)***
1	7.3.2010	1:03
2	17.3.2010	0:24
3	17.3.2010	0:25

7.2.2.1 Design & keyboard

The size of the N900 was mentioned by every interviewee but it didn't seem to matter too much. The only way it came up was that interviewee #3 mentioned pulling the device out of the pocket resulted in accidentally answering or rejecting a call. Interviewee #1 complained that the placement of physical unlock key is not optimal when he takes the device from the pocket: he has to turn the device in his hand before finding the key.

There was surprisingly little overlap in interviewees' answers: only the screen's sensitiveness to getting dirty and importance of powerful hardware were mentioned by all. Everyone would have welcomed a slimmer device but two interviewees liked the physical keyboard and accepted the size as a result; interviewee #2 would have preferred a slimmer device with a good software keyboard. Based on these interviews the design of N900 has succeeded pretty well given the amount of features.

7.2.2.2 User interface

Based on the interviews the user interface seems a bit illogical to users. Interviewees #1 and #2 said that they had trouble navigating through the interface at first. Although the problems have decreased with more experience, there are still aspects that confuse the users. For example, the distinction between back arrow (top right corner in applications) and dashboard icon (top left corner) was not intuitive to interviewee #1 (see Figure 12 on page 65). In other words, there is confusion between navigation buttons of the whole UI and those that are used to navigate within an application. Additionally the existing multiple ways of navigation (tapping empty area, tapping out of focus area, dashboard icon, back arrow, close button) require learning to be used fluently and without hesitation: interviewee #1 had to pause to think about his next action even after months of using the N900. The navigational model was intuitive after first day of use only to interviewee #3 but the other two did have problems learning the UI. Tapping empty spaces to dismiss menus can also be difficult at times: interviewee #2 said that clicking outside the active screen is difficult in main menu where there is not much free room. The inconsistency between the native UI and applications' interfaces was mentioned by two (#1 and #2) interviewees. Interviewee #2 remarked that there should be designed elements for developers to use, which would guarantee uniformity.

The main menu, where all the applications are located, was found guilty of two defects in the interviews: the path to get there is thought to be too long (interviewee #1) and there is no option to rearrange the icons there so that the users would find their favorite items more quickly (#1, #2 and #3). Since there is no apparent categorization of items the menu seems quite haphazard so that the user has to scan through items one by one until the right one is found.

The home-screens drew some comments, for the good and the bad. Templates were hoped by interviewee #2 in order to reduce the need for customization: for example a template that would include all the social media shortcuts by default. The way editing menu was brought up (just clicking somewhere on the home screen) was criticized by interviewee #2 but also learned after the first time by him.

There were a lot of small issues that were mentioned by one of the interviewees: the long list of findings is presented in Appendix D. The interface got positive mentions by

two interviewees on its general appearance and finger-friendliness, e.g. the size of buttons.

7.2.2.3 Hardware-software interaction

The touch interaction was on an acceptable level, although it was generally agreed that it could be better. Especially annoying for interviewee #1 was that the display did not register every touch. For example, going back by tapping outside active area was difficult in packed areas. He had adopted a habit of clicking right on the left top corner (in landscape) of the display to take a step back.

The landscape bias was noticed but irritating to only one interviewee. The interviewees could live without it but its introduction was wished for. Interviewee #1 wanted to use his phone while walking and traveling which would be facilitated greatly if one-handed use was enabled. He told that writing text messages, surfing the web or reading e-mails were his primary actions that would be easier in portrait mode.

In order to improve the touch recognition, a calibration mode was hoped for by interviewee #2. He didn't know if there was one but he hadn't found it: he hoped that calibration would be part of the start-up sequence. Interviewees #1 and #2 had problems with the touch recognition at first but after learning to employ enough pressure the situation improved. However, both remarked that it should be better, as even after longer use there have been problems, and work properly without a learning period. As opposed to other participants, interviewee #3 had no trouble whatsoever with the touch screen from the start.

7.2.2.4 Applications

On the positive side, potential of the N900 is undoubted in interviewees' minds, but the realization is lacking. According to interviewee #1, there aren't a lot of applications and even fewer useful ones. Being an open-source device, the N900 offers applications via different delivery channels: Ovi store is Nokia's official channel but there are many applications available at Maemo community's site. For interviewee #1 this was somewhat confusing because he has grown accustomed to getting mobile applications from one place. On the other hand, interviewee #3 had used only maemo.org as his channel whereas interviewee #2 had not downloaded anything at all.

7.2.2.5 Communication

The integration between SMSs and instant messaging was one of favorite features for interviewee #1. He liked especially the assumption that all the calls (GMS, Skype etc.) are handled equally. Interviewee #3 would have liked to see a possibility to separate at least Skype from the rest. Interviewee #2 would have liked to see e-mails integrated as well. Additionally, the way the contact information is shown was appealing to him.

A common problem for each at first was to find the phone application. All of them have grown used to phone being the primary function in their mobile devices, which means that they expected the same from N900. Now accessing the phone application separately was thought to be unnecessary burden. However, after customizing the home screen and learning to use smart dialing from physical keyboard, interviewee #3 had no troubles with the phone.

7.2.2.6 Web

One of the features that have received almost unconditional praise, the web experience was also appreciated by the interviewees. The browser's ability to show web pages as they were intended was regarded highly. The problem with N900's browser is its slowness: interviewees #2 and #3 remarked that it loads the pages for too long. It was suggested that there should an option to exclude pictures from rendering, or show pages only in ASCII mode.

The only feature about the browser that was criticized was zooming. The circular motion was not used at all, and the camera zoom was the most popular way. Double tap was thought as a good way by interviewee #3, but the touch recognition would have to be better: now the double tap was occasionally interpreted as a single tap according to interviewee #1. Interviewee #2 remarked that double tap is not a logical way to zoom because in his mind it signifies opening applications. Interviewees #1 and #2 liked iPhone's pinch and zoom the best when asked about the best possible; interviewee #3 had no clear opinion.

7.2.2.7 Multitasking

Interviewee #1 stated multitasking as an important and cool feature. He gave the impression that multitasking erased barriers from him to use the device as he likes. He presented an example that he could use GPS while driving and at the same time listen to

music (media player) via car stereos (FM-transmitter). However, he remarked that using multitasking, i.e. realizing the potential it offers, could be facilitated but he couldn't give any exact suggestions.

While running many applications at once can be useful and enable new ways to use the device, it also presents some problems for battery life. Applications that are left onto the background may drain the battery quite quickly; interviewee #3 suspected that the web browser might be the greediest application.

7.2.2.8 Maintenance

Interviewee #1 had some problems with one firmware update, but was unable to specify what the problem was. Other updates went smoothly for him. Interviewee #2 had not updated the device but interviewee #3 had no problems with any updates. Interviewees #1, #2 and #3 reported random crashes: #3 presumed that those were troubles with overburdening the device and software bugs.

Battery life was another headache for interviewees #1, #2 and #3 at first: #1 thinks that the firmware update improved that aspect along with changing continuous Wi-Fi network searching off. He and #3 also remarked that they are fine with the responsibility to refrain from overburdening the device. #3 suggested that there should be a button that would stop the applications in the background, and #1 would have found useful a place where the battery consumption would have been shown.

7.3 Summary of Internet research / interviews

In this chapter the most important results from two previous chapters are summarized and focused on in more detail. For the summary, results have been divided into three groups: problems, positive findings and other findings. The problems and positive findings describe issues that are somehow related to usability, and the rest of recurring findings are summarized in other findings. The selection for further analysis has been based on three issues. If a finding has been present continuously in Internet entries, or if it has come up in both Internet and interviews it was included. Additionally, if some, even isolated, finding has seemed important it was included. For example, the lack of indicator for Fn-key (whether it is on or off) was mentioned only in one interview.

7.3.1 **Problems**

Table 3 summarizes the most important problems that were encountered in post-sales feedback. Most of the problems were primarily related to first time use of the N900 and only a couple issues came up in longer term use: this indicates that either the users altered their behavior to match the N900 or the features were easily learnable. Many of the features listed below require the user to learn something before being able to operate the N900 fluently. The question here is whether the amount of learning and the time it takes is justifiable or does it burden the user too much.

Table 3: Problems in post-sales feedback that were deemed important

Problem	***Interviews***	***Internet***	***First use***	***Long term use***
Lack of smart (from SW keyb.)/voice dialing	-	x	Apparent if user has been using the feature earlier	-
Phone app a little tedious to use	x	x	Difficult to find	Has to opened separately – slow
Size		x	Scares at first	For some, it becomes justified, for others not
Resistive technology	x	x	Especially noticeable at first	Some related problems (e.g. panning, selecting) are continuous
Screen gets dirty	x	x		Takes some time to get dirty
Location of screen lock key	x	x	Has to be found	Small problems after finding the key
Touch recognition	x	x	Requires learning	Improved but inferior to the best
Lack of portrait mode	x	x	After one app works in portrait user expects others to works as well	User adjusts to the situation but may be annoyed
Trouble writing with the physical keyboard	-	x	Requires learning	Not all learn at all
Keyboard: Position of the space bar	-	x	Requires learning	Few have problems later
Finding and using special characters and numbers	x	x	Requires learning (finding Fn-key)	Using Fn-key tedious
No indicator if Fn is on	x	-	Not noticed right away	Might be noticed after some use
Navigational model	-	x	Requires learning	Usable, even easy, once learned
Going back: clicking outside the active screen	x	x	Requires learning	Easy once learned; some problems may occur in packed areas
UI shortcuts for advanced users	-	x	Not noticed	Once UI is mastered, shortcuts would be welcome
Calendar view not informative enough	x	-	Noticed	Is not improved
lack of manual rearranging of menu items (in main menu)	x	x	N/A	N/A
Finding user guide	x	-	Not found	Not needed
Browser: zooming	x	x	Requires learning	Certain problems even after learning

Next, short descriptions of the most important problems are presented. The lack of smart-dialing (i.e. searching for contacts by gradually typing a name) from software keyboard means that the user has to use the physical keyboard. The problem here is the lack of choice and the burden of sliding out the physical keyboard and possibly turning the device ninety degrees (if it's in portrait, e.g. in phone application). The tediousness with the phone application is related to the fact that it is not the central function in the N900: the phone application has to be opened separately (if the user doesn't use smart dialing from HW keyboard) every time a call is made. Additionally, the phone application is a bit difficult to find for first time users because it is in the main menu, one or two steps away from the home screen.

The resistive technology is not directly a usability issue but it affects many other features in the N900. For example, the whole UI seems harder to use if the user has problems with touch recognition. The touch recognition generally requires some learning so that the users learn to apply the correct amount of pressure. Another hardware design decision is the size of the device which affects the way N900 is held and carried. Whether the size, especially thickness, is deemed a hindrance or accepted as justifying the power and amount of features depends on the evaluator; most (3/18 found it positive; 9/18 justified) of the reviewers and 2/3 interviewees felt that the size was justified. Also the location of the physical screen lock key may be good or bad depending on the way of use: for one-handed use it is not optimally located because the device must be rotated in hand to find the key.

The physical keyboard is one of the more problematic parts of N900. Being a three-row keyboard (see Figure 11), it has an Fn-key that allows entering special characters and numbers. In the post-sales feedback it appeared that at first finding the right key was somewhat problematic, and after that using it was tedious. Additionally, there is no notification whether the Fn-key is on or off (double tap keeps it on for the moment) which may occasionally result in inputting wrong characters. Other complaints involved the device not opening wide enough (i.e. the upper row of characters is too close to display), position of the space bar (although more people liked it than didn't like) and long-pressing not inputting the same character multiple times.

Figure 11: N900 physical keyboard and contact card view; modified from (Nokia, 2009a)

The user interface has some aspects that require the user to learn. The navigational model is new as are some of the actions. The interaction between home screen, dashboard and applications is the most important entity of the UI. After realizing that the dashboard, as opposed to home screen, is the central place for navigation to which the user is led time and again, the UI may be used fluently. Also navigating (meaning the actions taken to move) within the UI requires learning because there are basically three ways to move away from an application. Sometimes there is a back button on top right corner, sometimes a tap outside the active area is required, and at some occasions the user has to use a button on top left corner in order to exit (to dashboard in this case), which all are used in different settings and have slightly different functionality. In Figure 12 the options include going to dashboard and keeping the application running (top right corner) or closing the application (top left corner) whereas in Figure 11 the top right corner offers a way to move back within the contacts application. In Figure 14 the user's options include selecting a running application, pressing top left corner to enter main menu and tapping on an empty space which would take the user to the home screen. Once the UI is mastered, some users could want to use shortcuts to reach some places (e.g. main menu or home screen).

Eight of 18 Internet reviewers stated clearly that the UI requires learning before being able to navigate fluently; only three were immediately familiar with the UI. Of the remaining seven, two had no opinion, one concentrated on the restrictions posed by the resistive screen and the rest described somewhat obscurely that it was pretty good. Only one of them mentioned using the shortcuts described above. All of the reviewers learned the UI after some time: they did not mention any exact timeline. Of the interviewees one was able to use the interface from the start, but the other two had some problems, mainly pauses in action, after 1-2 months of use.

Figure 12: Moving back from an application in N900; modified from (Nokia, 2009a)

7.3.2 **Positive findings**

On the positive side, there are two entities that seem to be very successfully developed: the conversations integration and browsing experience. Both were praised in reviews and interviews, although some (3 reviewers and 2 interviewees) commented that the browser is somewhat slow and slower than iPhone's. The essential ingredient in the browsing experience is that it is comparable to that of a desktop computer with the obvious exception of the screen size. The conversations integration brings together different popular ways of communicating which was thought to be handy. Related to communications, other successes are the notification system (see Figure 13) which drew only positive comments and the contact card view (see Figure 11). The notification is shown in yellow bubble on the top of the screen and pressing it takes the user to the message. The contact card shows all the related communication means and additionally shows whether the contact is online or not and lets the user choose easily which call or messaging service to use.

Figure 13: The N900 notification for incoming messages (Ziegler, 2010)

The user interface got a positive reception in a sense: after initial confusion over the navigation logic almost everyone liked the UI. However, the adoption time for the UI varied among users. Some understood the logic at once, whereas others took even weeks to get used to it. On interviewee had to pause to think for the next action at time even after couple of months with N900. The dashboard as a central place for navigation was thought to be handy after the cyclical navigation model was acquainted with. The interviewees had similar problems to those of Internet reviewers at first: namely the confusion over moving backwards and returning to the home screen in the UI. After overcoming those difficulties the UI has functioned fine.

Figure 14: The dashboard in N900 (Nokia, 2009a)

The extent to which the home screen was customizable was appreciated by reviewers. At first the menu for customization has to be found: just tapping on the screen to bring it

up is not intuitive if it is not known beforehand. However, once the menu is found the first time it is easy to find again.

Table 4: Positive findings in post-sales feedback

Positive finding	*Interviews*	*Internet*	*First use*	*Long term use*
Threaded SMSs and IMs	x	x		
Notifications of missed calls etc.	x	x	Good	Good
Conversations integration very good	x	x	Good	Good
contact card view is nice	x	x		
status notification is handy	x	x		
tactile feedback from screen	-	x		
UI intuitive and easy to use	x	x	Requires learning	Becomes easy and intuitive
Dashboard an easy way to switch applications	x	x	Requires learning	Once learned, easy to use
home screen customizing	-	x	Requires learning	Very easy
Browser shows pages as in desktops	x	x		
Visual history	-	x	Back arrow may be desired	May slow down browsing
Flash support	x	x		

7.3.3 Other findings

There were some issues that got a lot of mentions in the post-sales feedback but were not related to usability (see Table 5). The hardware and potential the N900 offers were noticed practically by everyone. Being a device that has the power to run any mobile applications and provide desktop-like web experience, a lot of expectations are built up for the future. According to reviewers the current situation is, however, that the amount and quality of applications for N900 doesn't measure up with the best. For a regular consumer, who would like to get applications downloaded with minimal fuss, this may be a barrier. The potential, in terms of hardware and community, were noticed by the reviewers. However, the biggest challenge that the community poses is keeping the third party applications uniform with the rest of the user interface.

The other three findings have one thing in common: they are very frustrating for the user if they are not in order. The update process should be reliable by default, which is true in most cases for N900. However, those few occasions when things have not gone smoothly greatly affect those persons' view of the device and possibly whole company. Battery life should be such that it enables users to work with their device without altering their behavior to save battery. Usually the browser is also expected to function without unnecessary delays and quite quickly. In case of N900, it seems that the browser is somewhat slower than iPhone's. However, it have to be kept in mind that N900's browser renders basically all the content on a page whereas iPhone's leaves out e.g. Flash content. There are also pages that have been optimized for iPhone particularly which facilitates its usage: for user this is good but from a developer it requires additional work.

Table 5: Other findings than usability problems (positives in *italic*)

Finding	***Interviews***	***Internet***	***Impact***
Lack of applications	x	x	May be a problem for those who would not want to go into any trouble acquiring apps
Potential	x	x	Gives users hope and raises expectations; it may be challenging to keep the UI's of 3rd party apps uniform with the rest of N900's UI
Hardware	x	x	Enables developers
Battery life	x	x	Hinders the way the N900 can be used
Update process	x	x	Important to get it right
browser too slow	x	x	

7.4 Maemo's view

Maemo's view on the most important findings is summarized in Table 6. These views were collected by discussing with and interviewing Maemo UX design team members. There were four sessions in all and additionally correspondence regarding unclear issues after and between the sessions.

Many of the usability problems in N900 have their roots in hardware. These hardware decisions are not in the hands of Maemo UX design team and they are starting points

for the usability development. The biggest hardware design decisions in N900 are the screen technology and inclusion of the hardware keyboard. The resistive screen affects all the interaction with the device and thus is a major component in how the users experience N900's overall usability. Mistaken taps here and there may amount to considerable annoyance for the user; according to the post-sales feedback the touch recognition varied between users. Mainly those familiar with capacitive screens hoped for a better screen. For example, tapping on the contacts in phone application brings up a menu from which the means of communication (e.g. GSM, SMS) is selected. According to Maemo UX design team this was the result of poor panning in development phase which resulted users making accidental calls. Thus, the menu was added as a safety measure.

The other major decision, inclusion of physical keyboard, affects two aspects of the N900 of which the size is invariably noticed at first. Whether the size is justified or not depends on the way the consumer wants to use his/her mobile device. Based on the feedback, it is clear that basically all of the users would like to have a slimmer device, but the feedback also reflects that many are ready to sacrifice the smaller size for a physical keyboard. Thus, it is important to know the segment to which the device is targeted and their needs and goals, and design accordingly. The other impact the keyboard has had on N900 is that basically everything is designed to support it. In other words, the landscape mode is the prevailing design starting point. Only the phone application is designed first and foremost for one-handed use in portrait mode.

It has been observed that one way to facilitate and hasten navigating in the UI would be offering shortcuts (GSMArena Team, 2009). In fact, according to Maemo UX design team there are shortcuts but they are not apparent so that every user doesn't notice them. Most often the complaints from feedback have focused on the unnecessary step involving the dashboard if the destination is the main menu or the home screen: however, these shortcuts are implemented. Main menu and home screen are reached from any application by long-pressing and double-tapping the Tasks-button, respectively.

Table 6: Maemo UX design team's view on the most important problems in post-sales feedback

Problem	*Maemo's view*
Lack of smart (from SW keyb.)/voice dialing	Landscape: keyboard deemed to be enough Portrait: search based on the alphabet (groups of three) for one-handed use
Phone app a little tedious to use	The phone was designed to be one application among others; the N900 is a mobile computer, not a phone
Size	It was known that size will get some criticism. However, the size is the smallest possible with the HW / feature set of N900.
Resistive technology	Hardware decision
Screen gets dirty	Related to hardware; a known problem
Location of screen lock key	Hardware configuration compromise
Touch recognition	SW-HW interaction; SW was improved until late development
Lack of portrait mode	Portrait offered for phone which was considered to be natural orientation for one-hand usage. For other applications landscape has been considered primary orientation, due to HW keyboard and device concept in general.
Trouble writing with the physical keyboard	Keyboard is a hardware decision; on the other hand four-row keyboard would be bigger affecting the size of the device
Keyboard: Position of the space bar	See above
Finding and using special characters and numbers	Hardware design: the three-row keyboard poses restrictions
No indicator if Fn is on	Not noticed
Navigational model	Known to require learning but was deemed a risk worth taking
Going back: clicking outside the active screen	The difficulty for first-time users was known and tested in development phase and a calculated risk taken when implementing this.
UI shortcuts for advanced users	Shortcuts to Home screen and Main menu are there (long-pressing and double-tapping "Tasks"-button in application view, respectively)
Calendar view	A question of space and finger-friendliness: in order to squeeze the view to show a week's activities the functionality of the calendar is lost; also the explanations in the calendar would become too small
lack of manual rearranging of menu items (in main menu)	Known; the main menu is sorted so that icons deemed important are in places that are easy to tap; additionally categorization for a mass of users is difficult
Not a scrollable main menu; "more…" button unnecessary step	Known; it was thought that having the applications deemed most important on one view would be good
Finding user guide	Known; it is hidden
Browser: zooming	Algorithm / resistive screen issues

The phone application is one of the most important features in N900. However, many small problems or things that are lacking have been stated after the N900 was released.

Those issues are presented in Table 7. Although the phone functionality is quite easy and the layout nice with sufficiently sized buttons, these small issues amount to bigger annoyance for users who are used to operating their phone in a certain way. Perhaps the most glaringly missing part of the phone UI is the call logs that are usually present on phones. Therefore, many users have grown accustomed to using the logs as a contact book when dialing a recent contact and using the contact book mostly for contacts that are not used very often. That way a more traditional, "tried & tested", design for the phone application could have resulted on fewer complaints about it.

Partly related to touch recognition, and therefore design decisions, the extra taps on the phone application frustrate some users. Especially when clicking on a contact a menu is brought up instead of just calling the number is deemed surprising because the user is already in the phone application and would thus expect to make a call. Additionally, there isn't even an option to call the contact directly. To make things worse, the touch recognition lets some users down and they are forced to apply a tap multiple times. According to Maemo UX design team, the pop-up window was designed to prevent the user from making accidental calls; again, due to unreliable touch recognition.

Table 7: Findings related to the phone application

Problem	***Maemo's view***
Lack of smart (from SW keyboard)/voice dialing	Landscape: keyboard deemed to be enough Portrait: search based on the alphabet (groups of three) for one-handed use
Phone app a little tedious to use	The phone was designed to be one application among others. N900 was designed to be a computer with phone functionality rather than a smartphone with computer functionality although it was known that many people will see the device primarily as a phone.
Proximity sensor doesn't always work	Known problem
Selecting a contact in phone application does not trigger a call to the contact but brings up a dialog	Panning problems in development phase testing resulted in accidental calls – this design reduces them
No separate logs for called/missed/received calls	Call history was deemed enough
Clicking the call button (without a selecting a number) should open call log	The software buttons on the phone are not designed to be used as in regular phones
Rotation from landscape to portrait (sometimes) quite slow	Known
Accessing contacts while calling	Contacts can be accessed
Conferencing in other people	Found in view menu
Putting person on hold	Found in view menu
Showing the caller's number	

In the interviews some suggestions for improvements were made (see Table 8). These were not result of any elaborate thinking but quick ideas that came up as a part of the interviews. Regarding the user interface a button which would take the user straight to the home screen was hoped for; similar to the dashboard button that is always available in the top left corner. As it turns out, this shortcut is already implemented: long-pressing the tasks-button (top left corner) takes the user to the home screen. Also, a button or switch that would stop all the background applications if the user wanted to focus all the resources to one application or preserve battery without having to close everything was in the wish list. However, the Maemo UX design team regarded this as kind of a band-aid over the possible real problem: insufficient processing power or battery life. While discussing whether the amount of home screens (four) is sufficient, it was suggested that instead of four home screens it was suggested that there could be one that expanded based on the amount of shortcuts and other stuff on the screen. Having only one screen would make the maintenance and customizability much more difficult according to

Maemo UX design team: now there are separate areas that can be modified but with one desktop the same settings should apply for the whole area.

Table 8: Improvement suggestions from interviews and Maemo UX design team's view on them

Suggestion	***Maemo's view***
could open the screen lock when stylus is pulled out	Unclear what kind of hardware configuration it requires
Calibration of the touch screen should be part of start-up	The start-up was designed to be as short and smooth as possible; it's a question of compromises; also, the display is calibrated in the factory – there should not be need to do it again
A freeze button that would stop background apps	A "band aid" over the real problem, i.e. performance or battery life
No "show desktop" button	It is actually implemented: long-pressing "Tasks"-button in application view takes the user to Home screen; it is hidden but was deemed important by Maemo
ready-made elements for everything (incl. 3rd party apps)	With open-source development there is a kind wish that they would follow guidelines
could be cyclical desktop	Brings problems to customizability

8 Discussion

In the post-sales feedback came up 131 relevant findings, a small portion of which was analyzed further. Most findings reflected problems and successes the user interface and hardware design and these are the main aspects for discussion and conclusions. There was a difference between development phase testing and post-sales testing (see also chapter 9.2). All the development phase tests were conducted with users who had only short period of time (couple of hours) to get used to the device. The post-sales feedback, on the other hand, was collected from users who have used the device significantly longer: weeks or months. Thus, there is bound to be variation, which aspects the results concerned. The way how people use the N900 was brought up in the post-sales feedback, which is natural because in the development phase testing the users don't have time to develop their personal way of handling the device and have to accomplish specific tasks as opposed to natural use.

8.1 Reliability of results

Most of the participants in the post-sales feedback are technologically oriented which doesn't necessarily reflect how the majority of people use their phones: based on the Internet research, the early users of N900 have been somewhat similar to the early adopters of the theoretical model of Rogers (1995). In terms of future development of Maemo devices this may have to be taken into account if the devices are targeted to regular consumers who are not as adept at and interested in fiddling with their mobile devices.

One question is whether the research methods enable uncovering a sufficient amount of the problems and do they focus on "wrong" problems, i.e. problems that are not important to users. Nokia won't disclose exact methods that were used in the development but the methods were generally known and used as is standard in corporate work. The standard appliance of usability methods is discussed in chapter 5.4.2. According to industry standards (see chapter 5.4.3 on page 37) the amount of users employed in the usability tests and evaluations was more than enough and conducting the tests in globally in key target markets brought some cultural variety into play. The limitations of usability methods and their practical use are discussed in chapter 5.4.

Especially data gathered from blogs is subject to personal biases, even commercial influence, and most importantly lack of wider perspective and validity if they are looked at individually. Thus, the findings that are included in the list were either mentioned multiple times or were directly related to usability. Some problems turned out to be already fixed, some non-problems (i.e. only the one reviewer mentioned it) and some were kept along for further investigation. Almost all the problems presented in Table 3 (page 62) were also found in interviews, which implies that they were valid findings.

8.2 Successes and failures

There are a couple of glowing successes in the N900's UI, namely the notification system, integration of different communication means and contact card view. These features are purely user interface designs without straight links to hardware design or anything else. Being developed until quite late stages along with touch recognition, the notification system was one focus area and was expected to do well. Iterative design seems to have worked well for notifications as the small details (like the power and color of notification light) were refined through many cycles.

One particular area that has received criticism is the phone application. The best piece of advice regarding the phone UI seems to be that for some parts it has become quite standardized and people have developed habits accordingly, so following these conventions would not hurt. Separate call logs (missed, received and called numbers), and some basic elements on the phone while calling (hold-button, entering contacts, the caller's number) are expected to be there. Deviations from the expected design seem to be received with confusion and irritation.

Only one feature was completely missed by Maemo UX design team: the notification light if the Fn-key is on the physical keyboard is on or off. There are features that are lacking in N900 but this one is the only clearly usability-related issue. It seems that the UCD process at Maemo covers quite well the overall usability of a product because basically all aspects have been known and considered. However, finding problems is only the first step; achieving the right design is more difficult.

Many of the failures have their roots in hardware design. For example, the resistive screen affects all the interaction with N900 in terms of touch recognition. Unregistered taps create a pause in the interaction with the device, which may produce a discontinued experience for the user. At least the poor touch recognition hinders adoption of the

device and adds to the learning time. However, hardware decisions are not only driven by usability aspects – it is only one factor in decision making. The key thing is to make sure that when HW decisions are made the implications of the decisions on usability are really understood by the decision-makers.

8.3 The need for multitasking

On desktop computers multitasking is a practical feature that allows the user to leave tasks onto the background. The processing power and screen size allow its implementation without adding any complexity to the UI (Gartenberg, 2010). On mobile devices the benefits of multitasking are not so clear: without it the UI would be much simpler and more linear, which would be more in line with the current view of a mobile UI. The question here is why users would need multitasking. Most often cited reasons for avoiding multitasking are the lack of real benefits, insufficient processing power in mobile devices and battery drainage. Regarding the benefits, there are a couple of common use cases (Wilcox, 2010) (Gartenberg, 2010):

- Execution of tasks that take long but do not require user interaction
- Tasks which need invocation based on a special stimulus (email, GPS based notification)
- Playing music
- Switching between applications, although it can be performed by starting and stopping applications without user noticing it
- Switching applications while waiting another application to finish processing something

All of these use cases can be fulfilled by multitasking. However, allowing free multitasking also places responsibility in the hands of the users and application developers so that they would not overburden their devices and design applications not to be greedy, respectively. There are, however, alternatives to employing full multitasking: at the moment iPhone supports multitasking only for its native applications meaning that for example listening to music while surfing works if both are iPhone's native applications. Starting and stopping applications fluently already works in iPhone so well that most users don't even notice the difference between that and real multitasking. A more difficult use case is that the user may want to do something else (e.g. browse Internet) while waiting for another application to finish processing.

Multitasking is the easiest way to realize this use case but the related problems may put doubts into users' minds. Another way round this would be to give some special permission to some to applications so that the negative effects of multitasking would remain restricted. However, based on the feedback on N900 it seems that the real problem with multitasking arises with the user interface, which has received a two-fold reception: it is generally liked but deemed to require varying amount of learning. The user interface implementation is discussed in more detail in chapters 8.4 and 9.1.

As was discussed in the beginning (chapter 3.3), evolving into multitasking devices and mobile computers probably is what will happen over time, and the task for interface design is to keep the user up to the task of managing a mobile device with many limitations. With N900 it seems that the early adopters have embraced its multitasking capabilities, and if the adoption curve follows the theory (Rogers, 1995) average consumers will follow. As opposed to a computer, where much more information can be presented on the screen, mobile devices become easily complex and unusable. Although relatively quickly learned, employing a simple procedure in N900, switching between running applications, i.e. the dashboard that is comparable to alt-tab combination in PC, creates a lot of confusion and an additional step in a mobile device. More research on the usefulness and UI design regarding multitasking on a mobile device is required.

8.4 User interface

Concerning the UI, there are practically two questions that have to be asked: what creates the confusion and is the learning time short enough (for the latter see chapter 9.1). Multitasking as a concept brings along the need to control (open, close, switch between) multiple applications which in turn adds to the complexity of the UI. In N900 controlling running applications is achieved by using dashboard (see Figure 14, page 66) as a central place that can be accessed at any time. In N900 there are always many possibilities what the user can do: going back (or closing the application) and returning to the dashboard (see Figure 11 on page 64 and Figure 12 on page 65). From the dashboard the user can then go to home screen, main menu or select one of the running applications. The problem that seems to arise almost without exception is that these sequences are not intuitive at first, or even after a few moments with the device (Nordgren, 2009). Compared to iPhone, where there are only two functions that the user can do (press something visible on the screen or return to home screen) the mental

processing required in N900 is much more extensive. In other words, with iPhone the user doesn't have to think more than one step ahead whereas with N900 the user has to think more (Nordgren, 2009). However, after longer continuous use the UI has started to make sense (e.g. (Miller, 2009) (Nguyen, 2009)). So, for most reviewers the learning time has been justified but shortening the adoption period would not hurt.

In chapter 5.3.1 on page 32, an option for implementing a way for managing multiple applications on a mobile device was presented. In Figure 15 that and the same functionality for N900 (see also chapter 6.2 on page 41) is depicted. Compared to Horodetzky's et al. (2009) model the functionality offered by N900 is more diverse. The main difference here is that in N900 the dashboard (applications menu in Horodetzky's model) is clearly the central place for navigation whereas Horodetzky's model is more home screen –centric because it does not force the user to enter the applications menu continuously. However, Horodetzky's model does not seem to be any easier on superficial examination. To users of N900 the dashboard has caused some headache but without it the control of running applications remains difficult.

The problem with both models seems to be that the place for controlling running applications is separate from the home screen which would otherwise be the centerpiece of the device. In other words, having two distinct main areas in the device forces the user to move back and forth between them. The best solution would be integrating the control of running application to the home screen but the limitations of a mobile device make this difficult. Perhaps a separate home screen to be accessible by scrolling, as others are on N900, could accommodate running applications, thus dispensing of the dashboard. However, more research is necessary if any applicable suggestions are to be made.

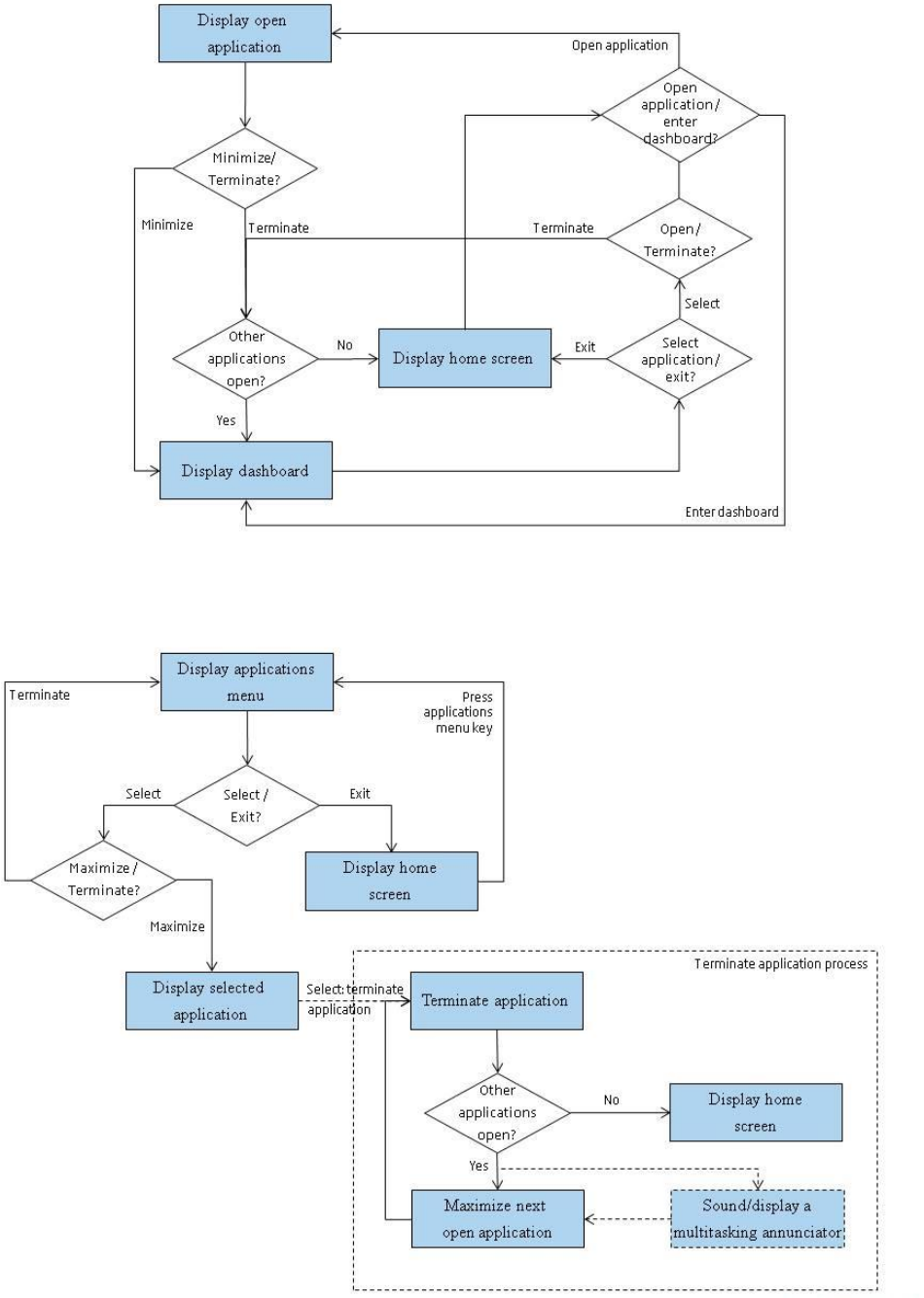

Figure 15: Controlling applications on N900 (top) and on the bottom modified from (Horodetzky & Heinziger, 2009)

An alternative suggestion for controlling applications is presented in Figure 16. In this model the dashboard-function is integrated with the home screen dispensing of the extra step that is the dashboard in N900. The model is presented here with four home screens, one (namely the fourth) of which is the dashboard; however, the number of home screen is restricted by practicality, not the model. Different home screens would be accessed by scrolling left or right; the so called dashboard would be just like the other home screens but accommodates the running applications and is not customizable by default. This

model would allow the home screen to be the one and only central place for navigation relegating the control of multitasked applications a step down in the pecking order. This model removes the cyclical nature of N900's UI and thus diminishing the confusion users have experienced with N900. However, the greatest stumbling block in N900, the learnability, is a question mark with this model. It would have to be tested with users before anything solid can be said.

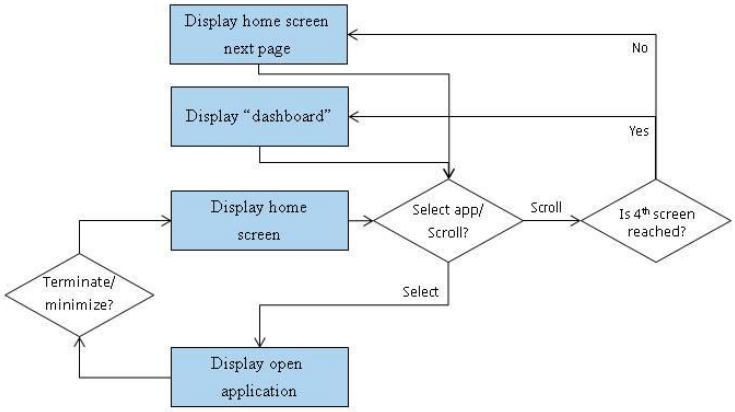

Figure 16: An alternative model for implementing the dashboard and controlling applications

8.5 Implications of hardware design decisions for Maemo UX design team

The hardware design decisions that are out of Maemo UX design team's influence have effects on their work. The hardware design decisions that are partly out of Maemo UX design team's influence have effects on their work. In case of N900 these design decisions are collected into Table 9. The discussion of the implications is based on the post-sales feedback, i.e. the way these design decisions affect the user, and discussions with Maemo UX design team. There are deeper implications to the way how certain aspects of the interface must be designed for e.g. certain screen technology (e.g. button size and alignment of elements) but these not in the scope of this study.

Table 9: Hardware design issues affecting the usability of N900

Design issue	***Impact on usability work***
Screen technology	Affects touch interaction
Decision on the keyboard (SW vs. HW)	Design principles
Layout of the keyboard	Affects the overall usability
Location of hardware keys/switches	Affects the overall usability

First of all, the screen technology requires users to learn to exert the correct amount of pressure onto the display. Even then the display does not always respond and the action must be taken again. The repetition of e.g. selecting something becomes irritating very quickly, especially if it seems to an irrelevant step. For example, making phone calls straight from the phone application is not possible: the user has to select a contact and then select what kind of call or message she/he wants to make. Many would like to just make the call since they are already in the phone application. Based on discussions with Maemo UX design team, this was implemented because the development phase testing revealed the panning unreliable so that the test users made accidental calls. However, it would require more research than this to make any conclusions about screen technology.

The physical keyboard on the N900 has implied that it should be used in landscape mode rather than portrait. However, being a mobile device the post-sales feedback revealed that many users would like to have it designed also for one-handed use. Part of the reason for inclusion of the hardware keyboard may be the resistive screen that would be quite unreliable to be solely trusted on for input. However, many users would like to have the option for one-handed use which is not implemented for any other application but the phone.

9 Conclusions

The objectives for this thesis were to investigate how Nokia's Maemo UX design team has succeeded in their work on N900: what kinds of problems have gone unnoticed in their testing in development phase, and what are the reasons behind the successes and problems. It turns out that completely unnoticed aspects are scarce in the UI: only Fn-key indicator was such. The lack of clear misses from Maemo's part indicates to the success of their methods in finding usability problems. However, great deal of the findings has been related to the UI and its logic.

9.1 User Interface

As was discussed in chapter 7.3.1, many reviewers (8/18) noticed that some time to learn the UI was required. After a while with N900, all the reviewers conceded that the UI had become easy to use. Naturally, the learning time should be minimal but in the case of N900 multitasking was emphasized, which resulted in the implementation of the dashboard. However, based on post-sales feedback there are two aspects that would improve the experience users get from the UI: bringing up the shortcuts in the UI and employing a capacitive touch screen. The shortcuts, or another visible way to return to home screen, would also reduce the sense of being lost during the learning period because it would offer the user a surefire and quick way to get back to the starting point. If the shortcuts remained unintuitive to use and hidden as they are now, they could either made more visible or introduced to the user more clearly. Due to screen size adding any markings onto the UI is probably unfeasible, but the shortcuts could be brought in by adding them to the introduction video which already is there. Also actively advertising in the community would spread the word. A capacitive screen could enable more fluent and carefree use for all the users; although some users didn't have any problems with a resistive screen, others did have problems, and those familiar with iPhone's capacitive screen wondered why such is not in N900. However, it has to be noted that the user experience regarding the touch screen is the result of interaction between the display and underlying software. The resistive screen may also emphasize some UI features that could go unnoticed on a capacitive screen; validating this, however, would require more research.

As has been discussed, the feedback on the UI has been mixed because the users have had to balance their needs for multitasking against the time required to learn the new

interface. Based on the feedback, the design of the UI is justified since the common opinion is that the UI is simple once the logic is learned. However, the learning time should be shortened for two reasons. First, almost all the reviewers noted that learning time is required more than normally. Second, the UI is new and offers different functionality (multitasking, navigation and customizability) than what most of the users have become to expect from a mobile device. The latter point is highlighted by the fact that practically all the reviewers were technologically advanced and used to operating different devices. If UI similar to N900's is targeted to the common consumers, i.e. those who are not bothered to find out the little quirks about their devices but just want them to work, studies on learning time should be conducted with them.

Based on the interviews users cannot make clear distinction between pop-up menus, applications and native UI intuitively: the changing way of stepping back is confusing. Based on feedback from Maemo UX design team, the UI is designed to be consistent but some users cannot intuitively recognize the correct way of going back. Reducing the mental processing needed to figure out the correct action would go a long way making the UI more attractive to all users. In the improvement suggestion presented in Figure 16, on page 80, the dashboard is integrated to the home screen: considering the same model here, brings forth the change that the dashboard icon (tasks-button) on N900 would be changed to a button that takes the user to the home screen. Regarding other buttons it should be considered is some way is removed in order to achieve consistency in the minds of users. For instance, the tap on the empty area for moving back could be omitted and the back arrow implemented throughout the UI.

It would be essential to shorten the adoption time of the UI. It seems that the requirement for controlling multitasked applications has brought along the complexity to the N900. Alternative possibilities for full multitasking were shortly discussed in chapter 0, and those ideas could be worthy of further research. Another point of thinking over is whether the UI should be designed around the dashboard, as it is now, or the home screen. This is discussed in chapter 8.4, where also an alternative UI model is presented.

In the case of N900 Maemo UX design team has succeeded in creating a user interface that allows users to utilize multitasking quite easily and customize their experience on the device. The most negative aspect of the UI is the associated learning time. If a

similar UI is planned to be taken to other devices, it could be beneficial to investigate the learning time further and find out ways to shorten it.

9.2 Methodology

Based on the discussions with Maemo UX design team members and post-sales feedback on N900 it seems that the greatest problems with usability testing in development phase are the restricted amount of features that can be tested and short duration of the tests. In case of N900, there was no existing user base when the device was in development phase that could be delved into to get users who have had experience with the device. Thus, all the time the users had with the N900 was the couple of hours, at maximum, that the tests lasted. During that time, in a test situation, establishing a personal way to use the device is not possible, thus leaving room for surprising ways of use when the consumers get the device in the real world. Although nothing of great significance came up in the post-sales feedback, reflecting success in usability development when finding and correcting errors is concerned, there are many issues related to the way people use their mobile devices that have not been implemented: more support for one-handed use, features like templates for home screen, and UI issues like easy and visible access to home screen. Quite simply, this highlights that post-sales feedback reflects the way users really behave in the real world and development phase testing is more focused on certain aspects and features, which has been pointed out in previous literature (Rosenbaum, 2000) (Wixon, 2003). In order to test the correct features, the importance of user study and knowing the users' needs and behavior are emphasized when the development phase testing is conducted. The post-sales feedback from previous products is useful user study material for the next product, which implies the importance of the link between two separate product development cycles. The essential part is also how the information is distributed to the relevant stakeholders so that also other people than usability experts could realize how various factors (like hardware) affect usability and user experience.

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Appendices

Appendix A. **All findings from post-sales feedback**

Findings: *positive*	Interviews	Blogs/Internet	Grouping	Reference
Lack of applications	x	x	applications	Krish, GSMArena, Guim, Unwired, Hanlon, MM
FM-radio: why it has to be downloaded from Nokia Store?	x	x	applications	GSMArena, Miller, Murtazin
No equalizer	x	x	applications	Jerz, Murtazin
OVI maps is poor		x	applications	Beavis, GSMArena, Guim, Miller, Nguyen, Unwired, Ziegler
Search application		x	applications	Ziegler
Handwriting recognition		x	applications	GSMArena
No voice recorder		x	applications	GSMArena
No voice navigation		x	applications	GSMArena
Potential	x	x	applications	Beavis, GSMArena, Nguyen
installing apps easy	x		applications	
Lack of smart (from SW keyb.)/voice dialling		x	communication	Beavis, GSMArena, Jerz
No threaded e-mails	x	x	communication	Beavis
Cannot switch methods of communications on the fly (vrt. Palm Pre)		x	communication	Beavis
Phone app a little tedious to use	x	x	communication	Ali, Beavis
phonebook too basic		x	communication	
ability to customize special ring tone for each one in my Contacts		x	communication	GSMArena
ability to send files directly from File Manager		x	communication	GSMArena
phone difficult to find	x		communication	maemo.org
not enough info in phone app	x		communication	maemo.org
e-mails should be integrated as conversations	x		communication	maemo.org
conversations integration confusing	x		communication	maemo.org

entering contacts while on call		x	communication	maemo.org
call logs are missing (all grouped into one list)		x	communication	maemo.org
clicking on call button should open call log		x	communication	maemo.org
proximity sensor has some bugs		x	communication	maemo.org
conferencing in other people		x	communication	maemo.org
putting caller on hold		x	communication	maemo.org
should be able to add more numbers to a contact	x		communication	
No MMS	x	x	communication	GSMArena, Jerz, Murtazin, Nguyen
Threaded SMSs and Ims	x	x	communication	Beavis, Miller
Notifications of missed calls etc.	x	x	communication	Krish, Beavis, Jerz, Wright,Ziegler,
Blocks of alphabet instead of entire list on the phonebook		x	communication	Ali
Conversations integration very good	x	x	communication	Krish, Ali, Guim, Jerz, Malik,Unwired,Wright, Ziegler
The way conversations are shown is cool	x		communication	
saving number fluent			communication	
contact card view is nice	x	x	communication	
reject calls with SMS		x	communication	Miller
status notification is handy	x	x	communication	Miller, Murtazin
Size		x	design	Ali, Beavis, Hanlon, Malik, MM, Nguyen, GSMArena, *Jerz, Miller, Ritchie*
Back side not very stylish			design	
Resistive technology	x	x	design	Ali, Ziegler
No D-pad: gaming difficult	x	x	design	Jerz
The hotswappable memory is concealed	x	x	design	
Screen gets dirty	x	x	design	Wright
Location of screen lock key	x	x	design	Krish, Beavis
no multitouch		x	design	see resistive technology
screen scratching		x	design	Jerz
finding power button	x		design	
USB cord is 'upwards'	x		design	
weather durability?	x		design	
camera: lens gets smudgy	x		design	
lens cover makes device wobbly on surface	x		design	

Hardware	x	x	design	Ali, Beavis, Jerz,Hanlon
Camera		x	design	Jerz
feels solid and durable			design	
keyboard important	x		design	
could open the screen lock when stylus is pulled out	x		design	
Touch recognition	x	x	hw-sw interaction	Ali, Malik, Ritchie, Ziegler, *Nguyen, Unwired*
Scrolling/panning		x	hw-sw interaction	Ali,Ritchie
Accidental calls (related to panning interaction)			hw-sw interaction	
Lack of portrait mode	x	x	hw-sw interaction	Krish, GSMArena, Miller, Murtazin, Nguyen,Unwired
Rotation in other applications	x	x	hw-sw interaction	above
hardware volume key and software one don't adjust each other	x		hw-sw interaction	
tactile feedback from screen		x	hw-sw interaction	Jerz
no calibration of touch screen	x		hw-sw interaction	
Usage without physical keyboard	x	x	keyboard	
Trouble writing with the physical keyboard		x	keyboard	Jerz
Keyboard: Position of the space bar		x	keyboard	*Beavis, Guim, Miller*, Ritchie
Finding and using special characters and numbers	x	x	keyboard	GSMArena, Jerz, Malik, Wright
No indicator if Fn is on	x		keyboard	
Physical keyboard: not a good touch and feel		x	keyboard	Malik
Slow booting			maintenance	
Battery life	x	x	maintenance	Beavis, GSMArena, Guim, Miller, Nguyen, Wright, Ziegler,
Update process	x	x	maintenance	*Jerz, Wright,* Lynch
Random crashes / reboots	x		Maintenance	
The device doesn't power up	x		maintenance	
transferring contacts between phones	x		maintenance	
Multitasking: apps easily burden the device if not closed	x	x	multitasking	Murtazin
using multitasking could be easier	x		multitasking	
Multitasking enables cool ways to use N900	x		Multitasking	

OVI store difficult to use	x	x	maintenance	
the whole system is too slow	x			
Graphical appearance	x		UI	
Menu icons not consistent with rest of the graphics		x	UI	Murtazin,Wright
Going back: clicking outside the active screen	x	x	UI	Beavis, GSMArena,Ziegler, *Murtazin, MM*
Navigation: the user is lead back to the Home screen / Dashboard as opposed to the place he came from	x		UI	
Option to create a contact was difficult to find		x	UI	
Adding extra fields to contacts requires many steps	x		UI	
Homescreen editing (especially in USA)	x		UI	
Multiple ways to go back / close applications	x	x	UI	
Photos go into many different folders	x		UI	
The phone shows only called numbers; new ones has to be accessed via phonebook	x		UI	
Calendar view is not informative enough	x		UI	
Shortcuts for advanced users		x	UI	GSMArena
lack of manual rearranging of menu items (in main menu)	x	x	UI	GSMArena, Jerz
Four homescreens too few		x	UI	Unwired
removing active desktops	x		UI	
saving state of removed desktops	x		UI	
finding manual	x		UI	
naming of the folder (in Finnish)	x		UI	
cannot scroll main menu	x		UI	
no categorization of apps in main menu	x		UI	
lack of templates for home screens	x		UI	

information when screen locked (missed calls, date, time)		x	UI	Nguyen, Unwired
should be uniform way to navigate UI	x	x	UI	
A freeze button that would stop background apps	x		UI	
No "show desktop" button	x	x	UI	Hanlon
ready-made elements for everything (incl. 3rd party apps)	x		UI	
UI intuitive and easy to use		x	UI	Jerz, Miller
Dashboard an easy way to switch applications	x	x	UI	Ali, Beavis, Jerz
home screen customizing		x	UI	Jerz, Unwired, Ziegler
Pretty graphics	x	x	UI	Krish, Ali, Jerz, Ziegler,
should be a button to freeze all apps in the background	x		UI	
could be cyclical desktop	x		UI	
Locking the screen	x		UI/design	
Closing applications	x	x	UI	
Browser: zooming	x	x	Web	Beavis, Murtazin, Nguyen
Browser: no back button		x	Web	Beavis
Browser supports UTF8-encoding but there are mistakes	x		Web	
browser's icons not understandable	x		web	
browser too slow	x		Web	*Beavis*, Murtazin, Nguyen
should be options to remove pictures in browser	x		Web	
Browser shows pages as in desktops	x	x	Web	Krish, Ali, GSMArena, Guim, Malik,Unwired, Ziegler
Visual history		x	Web	Ali, Beavis
Flash support	x	x	Web	Krish Ali, Beavis, GSMArena, Jerz, Nguyen
Browsing is easy	x	x	Web	Krish
No Java support	x			
Lousy profiles (no profile changes according to time)	x	x		Jerz
set of features is impressive	x			

Appendix B. Sources of Internet research

Author	***URL***	***Posted***
Ali	http://tech.tbreak.com/2009/11/nokia-n900-smartphone-review/	25.11.2009
Beavis	http://www.techradar.com/reviews/phones/mobile-phones/nokia-n900-655862/review?artc_pg=1	4.12.2009
GSMArena	http://www.gsmarena.com/nokia_n900-review-421.php	26.11.2009
Guim	http://thenokiablog.com/2009/11/13/nokia-n900-review/	16.11.2009
Hanlon	http://www.cnet.com.au/nokia-n900-339298197.htm	19.12.2009
Jerz	http://my-symbian.com/other/preview_n900.php	Oct.09
Krish	http://www.fonearena.com/blog/2010/03/25/nokia-n900-review.html	25.3.2010
Lynch	http://danlynch.org/blog/2010/01/flashing-n900/	Jan.10
Malik	http://gigaom.com/2009/10/19/nokia-n900/	19.10.2009
Miller	http://blogs.zdnet.com/cell-phones/?p=2752&tag=col1;post-2752	23.11.2009
MM	http://mobilementalism.com/2009/09/14/hands-on-nokia-n900-review-the-best-nokia-smartphone-yet/	14.9.2009
Murtazin	http://www.mobile-review.com/review/nokia-maemo5-en.shtml	26.9.2009
Nguyen	http://www.ubergizmo.com/15/archives/2009/11/nokia-n900-review.html	1.11.2009
Nordgren	http://log.andie.se/post/245404042/nokia-n900-experiences-and-whats-in-the-iphone	16.11.2009
Ritchie	http://www.tipb.com/2009/12/18/nokia-s60-n97-mini-maemo-n900-review-smartphone-robin/	18.12.2009
Unwiredreview	http://www.unwiredview.com/2009/10/13/nokia-n900-review-part-1-first-impressions-things-i-really-liked/	13.10.2009
Wright	http://www.brighthand.com/default.asp?newsID=16050&review=Nokia+N900+Maemo+OS	18.1.2010
Ziegler	http://www.engadget.com/2010/01/19/nokia-n900-review/	19.1.2010

Appendix C. **Interview outline**

- (experiences) How has it felt using N900?
    - Initially, what kind of problems/annoyances has there been?
        - Clarity of UI, touch interaction, design
        - Navigational issues (e.g. going back)
    - In the long term, how has the device functioned?
        - Reliability, cleanliness of display, battery life
        - Horizontal/vertical use,
- (multitasking) What kind of benefit/hindrance have you experienced due to multitasking?
    - Understanding the concept
    - Closing applications (is it intuitive, does it require effort?)
- (homescreen/desktop) How are you using the homescreen(s)?
    - Modifying the homescreen (finding settings and using them)
    - Opinion of panorama desktop
    - Which apps/shortcuts are used on the homescreen?
- (phone) How does it feel to use the phone app?
    - Finding the phone application / using it
    - Call log (what is preferred grouping?)
- (conversations) How do you like SMSs and IMs being grouped into conversations?
    - What do you think of the way conversations are presented?
- How much have you used Internet via N900?
    - Interaction while browsing, speed?
- Have you updated the phone?
    - How did it go / Why not?
- Related services for the phone?
    - Apps, helpdesk, communities
- What would you change in N900?

Appendix D. **Interview Results**

Interview #1

- Use
  - outside Finland: phone/calendar/notebook/camera
    - upload pictures via Bluetooth to laptop (needed a SW download – should be out-of –the-box)
  - help from Maemo.org & other forums
  - data connection to read mails; otherwise off
    - regularly reads mails in a bus
- Home screen
  - file manager / calendar / calculator / flashlight / e-mail / SMS / maps / contact book / phone / amount of data / facebook / Google calendar
    - syncing gmail requires 3rd party SW – why?
- First use
  - pretty graphics
  - felt like a disconnected entity (like Nokia didn't have full control)
  - phone app didn't open by tilting the phone (salesman had shown that)
  - Navigation
    - from left corner to app manager – not clear how to get back
    - combination of somewhat poor touch recognition and somewhat poor logic
    - dashboard is a good idea
    - pushing empty space to get back was difficult to learn
      - many ways to move back
    - sometimes returning to arbitrary (feeling) place
    - part of apps on home screen, part in app manager
  - pictures go into folders "kamera", "kuvat" and memory card (arbitrary)
  - firmware update seemed to improve touch interaction
    - mistakes about 1/5min; probably 1/2min
- Long term use
  - SW development slow; Ovi store was long time "coming soon"
    - resulted in trust issues with Nokia
  - Maemo.org provided some apps
    - lot of nonsense
  - important apps
    - Japanese related (e.g. drawing Japanese marks)
      - iPhone can do all this out-of-the-box
    - training diary
  - at first crashed a lot; improved due to updates
    - seems like N900 shuts itself down at times
    - still crashes randomly
  - display is prone to smearing
    - is easily cleaned
    - important to Japanese that it would be clean
- Landscape/Portrait
  - needs portrait
  - opening screen-lock difficult with one hand
    - he takes the device from left pocket to left hand

        - would want to read internet / write messages while walking
- Positives
    - Multitasking
        - e.g. in a car gps – music – fm-transmitter
        - experience could be easier but works already
        - rarely many apps open that use processor
            - gets slow in complex web use
        - apps are forgotten into the background
            - not serious
            - a button to close everything
            - a button to minimize everything (comp. win+D)
        - closing applications to be uniform!
    - Potential
        - no implementation yet
        - more software
    - Web pages are shown as they are
        - zooming could be easier (uses camera zoom, sometimes double click; circular zoom too difficult)
            - double click is sometimes interpreted as a single click
            - part of the pages difficult to navigate using fingers (partly because of zooming)
            - Supports UTF8 encoding: can read Japanese; there are mistakes: part of the marks are Chinese
    - Conversations
        - Skype-gtalk-messenger intergration = wau!
            - experience with Skype similar as in normal call
        - good way to group conversations
        - phone app shows only called persons
            - to access new ones contact book has to be used
        - calendar view is not informative enough
            - cannot be used with one glance
- Updating
    - Downloaded apps, widgets etc. go to random locations
    - Firmware update had problems
        - didn't remember exactly what
- Battery life has improved
    - at first had too much going on
    - a place to look how much battery is used could be handy

Interviewee #2:

- Use: Video, music, Internet
    - At work; testing applicability for social media
- Not logical: cannot go back easily (main menu) – hitting empty space difficult
- Active desktops: removing difficult; settings disappear from those that were removed

- First use: finding power button; manual; naming in the folders (dokumentit is not Finnish); no calibration in touch screen; cannot scroll main menu; no clear categorization of apps; phone difficult to find
- Long term use: random crashes; touch screen not responsive; easily smears; phone app doesn't provide enough info (e.g. no mute-button)
- Positive: powerful; phys. Keyboard (no D-pad, though); a good software keyboard would suffice (but no stylus)
- Home screen: phone, weather; OVI store difficult to use (=credentials); finding options to edit difficult; ready-made templates (e.g. social media shortcuts)
- Conversations: threaded conversations good; e-mails should be there too
- Web: a well-sized for a mobile device but too small nonetheless (min. 1024*X); browser's icons 'magical'=not understandable; good browser if doesn't know of better; not as good as iPhone's (it is faster) – Nokia's best (support for Flash etc. – feels more like real internet)
- One way to navigate within UI (scrollable/non-scrollable; ready-made elements in applications for developers to use; consistent logic)
- Phone application to be more important ("nice toy but it is used because of the phone")
- Ready-made templates to active desktops
- OVI store to function without credentials

Interviewee #3:

- Use: phone; uses everything – loading from maemo.org
- Experiences: ok; it could be smaller (slimmer)
    - Good: potential; power
    - Bad: it is too slow - guesses it is SW side problem; accidental answering when taking out of pocket (not himself but relatives/friends)
- First use: "no problems"
    - Learned without instructions (found the manual later)
    - Touch screen has small problems
- Long term
    - Background apps eat the battery
        - Phone / computer to be diverse
    - Crashes: apps have caused – booting suffices
        - Too many apps open – the resources don't suffice
    - The display smears but it doesn't matter
    - Lot of features
- Multitasking
    - Two different groups: normal and hackers – a button to freeze other apps / self-control
- Home screen: all apps that he uses
    - The path to main menu too long
    - Main menu not editable: they should be in one folder

    - 4 home screens enough: cyclical desktop (expands when needed)
- Phone:
    - Difficult to find at first
- Conversations
    - Skype works well
    - Integration: he would have separated them; wants choice
    - Notifications good
- Web
    - 4-5 e-mail accounts
    - Can answer quickly but not more; it is enough
    - Nokia's browser is better than this: "too lazy" = it takes all resources and is too slow
        - Would want to use Firefox but it doesn't work
        - Should be option to remove pictures
- Updates: worked fine
    - Installing applications easy
    - Installing Firefox was difficult – the icon didn't show up
- What to change
    - A carrying cord into the box
    - Camera: easily smudgy pictures – the lens gets dirty
    - Battery life: web consumes most of it (recharges every night)
    - Cannot see to which account incoming emails come
    - USB-cord points "upwards" when recharging
    - Could open the screen lock when stylus is drawn out
    - Weather durability? Froze in subzero temperatures
    - 4-5 reboots/week "not too much"
    - No idea if Fn button is in use (i.e. normal/special characters)
    - Should be able to add as many numbers to a name as wanted (= "salesman" number)
    - Transferring contacts from a phone to another
    - N900 is a bit slow!