
Managing Privacy, Security and Sharing
Settings through
a Statements based Interface

Master Thesis by

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Abstract

With the rapid development of information and communication technologies, the number of devices, which are surrounding a person, is expected to increase. This requires that new solutions for profile management, which will assist the user in configuring these devices, need to be considered. The goal of the project has been to design an application for profile management in a network of devices, which can communicate with each other, through a statements based interface. The application is intended to be primarily used on mobile devices. A new concept – *statements* is presented in the project. Statements are used for managing settings of devices, including privacy, security and sharing settings, when the user is doing different activities.

The design process of the application has focused on user-centered design and using interaction design and creativity methods. The process has been iterative and it has involved conducting different user sessions for identifying user needs, development of low-fidelity paper-based prototypes and a hi-fidelity electronic prototype, as well as evaluations of the prototypes. Ethical and social issues related to using the designed application are also investigated.

The main result of the project is the development of an interactive hi-fidelity electronic prototype, implemented in *Flash*, which represents the concept of using statements for managing settings in different situations. This prototype has functionalities, which provide the user with an easy and quick way to configure settings when the user's activity changes. Based on the results of the evaluations, it is concluded that the application is useful and can help the user in managing his/her devices, as well as it provides good user experience and usability.

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Abbreviations

3GPP – 3rd Generation Partnership Project
APPEL – A Privacy Preference Exchange Language
DECIDE – Determine Explore Choose Identify Decide Evaluate
CARD – Collaborative Analysis of Requirements and Design
ETSI – European Telecommunications Standards Institute
GUI – Graphical User Interface
GUP – 3GPP Generic User Profile
HCI – Human Computer Interaction
ICT – Information and Communication Technology
IP – Internet Protocol
MAGNET – My Personal Adaptive Global NET
P3P – The Platform for Privacy Preferences
PAN – Personal Area Network
PICTIVE – Plastic Interface for Collaborative Technology Initiatives through Video Exploration
PIN – Personal Identification Number
PDA – Personal Digital Assistant
PN – Personal Network
UI – User Interface
URL – Uniform Resource Locator
W3C – World Wide Web Consortium
WAP – Wireless Application Protocol
WLAN – Wireless Local Area Network
XML – Extensible Markup Language

Definitions

The following terms are described how they should be interpreted in relation to this thesis:

- **Application** – a software program which provides the user with a capability for performing certain tasks.
- **Device** – a physical item which provides certain functionalities, e.g. mobile phone, computer.
- **Product** (*interactive product*) – an entity which is being designed (or the result of an interaction design process) to support the users in their everyday lives. A product can be an application, a device, or a system.
- **Service** – provides functionalities to the end user or an application. The users usually have to subscribe to a specific service in order to receive the specific functionality.
- **System** – a group of components which interact together to perform a task. The term system is referred to *computer system* (hardware and software components which are connected together) and *information system* (a system which collects and manages data).
- **User** – a person who is using applications, devices and/or services.

Introduction

1.1 Motivation and objectives

With the rapid development of information and communication technologies it is expected that people are going to use more devices in their everyday lives in the future than they do today. These devices will be able to communicate with each other through wireless and other technologies without restrictions on distance. All devices, which are surrounding a person, require configuration and management of different settings which can be a very complicated task. This is the main motivation to create an application that allows easy and quick configuration of devices in different situations. This application is a new solution for profile management, where a profile can include settings of devices, user information and preferences.

The design of such an application is based on the assumption that the devices can communicate between each other. They can be connected in a network, such as a Personal Network (PN). A PN includes all of a person's devices, which are capable of connecting in a network (see Figure 1.1). In a PN the user interacts with different embedded and invisible computers, which can potentially be situated anywhere. The user can also interact with other people through the PNs. This leads to communication and federation of PNs. The concept of PNs has been developed by the *MAGNET* and *MAGNET Beyond* projects, where *MAGNET* stands for My Personal Adaptive Global Network [MAGNET D1.2.1'06]. *MAGNET's* vision is that the PNs will support users in performing their professional and private activities without being obtrusive and while safeguarding

their privacy and security. The PNs should also be attractive, affordable and beneficial for the users.



Figure 1.1: Personal Network

In order to design an application, which facilitates a quick and easy configuration of devices, for example the devices in a PN, a new concept is introduced. It is related to using statements. *Statement* is a phrase or a sentence, which can express a user's activity, a situation the user is in, the user's emotional state or mood, or the user's status. For example a statement is "I am at a lecture", "I am busy", "I am bored", etc. The idea of using statements based profile management is to provide the user with possibilities to configure and easily change the settings of their devices in the network when switching between different activities, situations and moods. The statements based interface also gives possibilities to control the devices in a network from one application or one device. An example of how a statement can be used is shown on Figure 1.2.

This project focuses on the design of a statements based interface for supporting users in configuring the settings of their devices, including privacy, security and sharing settings, when the users are doing different activities. The devices are considered to be in a PN and can connect to other PNs.

The objectives of this project are:

1. To look at the concept of using statements for managing settings from the user's point of view – to find out if the user feels comfortable to use statements, if he/she will trust the device and feel in control when using statements, what kinds of statements he/she would like to use and in which situations.

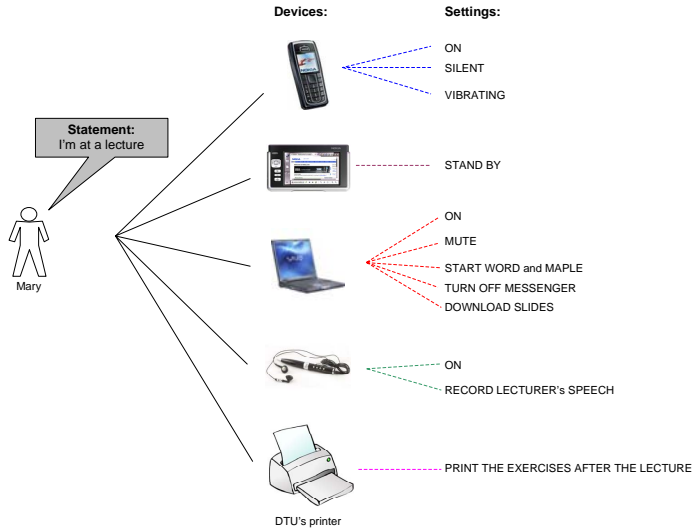


Figure 1.2: Example of a statement

2. To find out how the statements can be managed – including how the statements should be formulated, how many statements can be used, how the statements can be navigated, how the statements can be presented in a GUI, and how it would be possible to change settings of a particular statement.
3. To put focus on social and ethical aspects in using statements – how using statements affects the user's own life.
4. To design a statements based profile management application for managing settings in a network of devices.

1.2 Application Design Process

Figure 1.3 shows an overview of the different steps, performed in order to design the statements based application and to complete the stated objectives. The process is presented in the sequence it has been performed.

The design process was preceded by a literature study on concepts, such as user profiles, security, privacy and sharing. This was done in order to gather knowledge in related areas to this project. A literature study has also been performed on interaction design and creativity methods, which has helped in

applying the appropriate approaches and methods in the design process. Different existing applications have been looked through in order to see how the applications configure settings and what types of settings are managed.

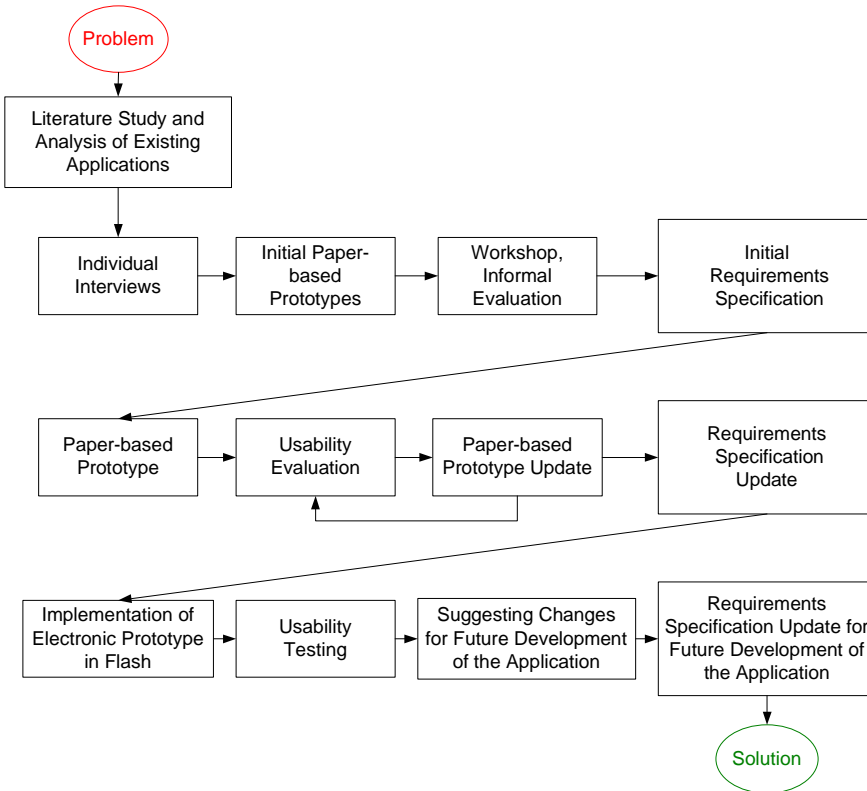


Figure 1.3: Steps in the process of designing statements based application

The design process has been based on user-centered design, by involving users in the different steps of the design process. The users have been involved via interviews and a workshop, via Participatory design and via the evaluations of the prototypes.

The application is intended to be used in a mobile context and therefore it is designed for a mobile device. The device used in this project is a PDA device Nokia 770. In the design process different scenarios for configuring statements, low-fidelity paper-based prototypes and a hi-fidelity Flash prototype of the application have been developed. All prototypes have been evaluated by the users and the results of the evaluations and the users' comments have been

taken into consideration when developing and updating the requirements specification. The hi-fidelity prototype presents a solution of configuring settings through a statements based interface.

1.3 User domain

When designing an interactive application, it is important to focus on the target user group, that is going to use the application. In this way, the designers can create better applications, which meet the users needs and requirements.

In this project the intended users for the designed application are students in universities, who are between 18 and 40 years old. The users can be technically experienced and non-experienced, because there are different studying directions and some users need to use more technologies than others. The users can also be concerned about privacy and security in different levels, which affects the design of the structure of privacy and security settings.

The students are chosen as a target user group because they are more likely to have different types of devices and can therefore benefit from the application. They can also see different opportunities for using the application. Nevertheless, students from different study fields can have diverse approaches to technologies and thus, some users can be limited in envisioning the possibilities of using the new technologies. There are different types of users, but one typical user can be described as the following:

Maria is a student in Telecommunications at DTU. She likes new technologies and always tries to buy new devices and explore their options. This is why, Maria considers herself experienced in using technologies. She is also very privacy and security concerned. She is aware that her privacy can easily be violated and that there are many security threats nowadays. This is the reason that she always checks the security and privacy settings of her devices. Maria would like to perform well at the university, but sometimes the success of performing different activities is related to easy and quick managing of settings of devices. She sometimes has problems for example printing the reports for the projects, which can be very important if the deadline is approaching. She would like to be able to change the settings of her devices when the situations and activities change. For example she wants her mobile phone, PDA and a laptop to be silent when she is at a lecture, but in the break between the lectures or at the lunch break she prefers them to be with sound again. Maria buys many devices which makes it difficult to control all of them at one point. She would like to have an application which can help her in managing her devices, as well as the security and privacy settings in general.

1.4 Assumptions

The design of the application in this project is based on some assumptions about the used technology and devices. These assumptions are listed below:

- The devices, which are owned by a user, are connected in a PN, and they can communicate with each other. The devices from a particular network can connect to devices from other networks, as well as external or public devices. The underlying technologies are not discussed in this project. It is assumed that they provide the needed functionality of the networks of devices.
- The user has a general user profile with personal information and preferences in the network, which is configured from a separate application. When the concept “user profile” is used in the conceptual and physical design of the statements based application, it is related mainly to user’s personal information and preferences. This is because most of the users understand the user profile in this way and it was considered that it would be easier for the users to separate settings of devices from the personal information and preferences. However, profile (or user profile) generally includes settings of devices, personal information and preferences.
- There are services which supply information to the statements application regarding which devices are included in a network, what possible settings the specific devices have, and what information the user profile in the system contains.
- The statements based application does not manage which devices are included in the PN. It just configures the settings of the devices it has been informed about.
- There is a *single sign on* for the network of devices, which means that the user does not need to log in for each device in the PN separately. In this way when the statements application apply new settings for a specific devices, the user does not need to authorize at the device.

1.5 Thesis overview

This thesis report documents the process of designing a statements based application for managing settings in different situations and activities.

There is a list of definitions, which describes different terms and how they are interpreted in the report. There is also a list of the used abbreviations. The definitions and the abbreviations are listed before the introduction.

The first three chapters introduce the literature study, needed to gather background information on related concepts and issues. Chapter 2 describes a literature study on profile management, which presents different concepts in relation to user profiles, security, privacy and sharing. Chapter 3 presents a literature study on ethical issues, related to information and communication technologies and the effect, which technologies can have on the users in terms of security, privacy and control. Chapter 4 presents a discussion on different methods in interaction design and creativity methods. Most of the presented design approaches and methods are used in this project. The rest are only included in order to demonstrate the possibilities the designers can choose from.

Chapters 5, 6, 7 and 8 are related to the actual design process of creating the statements based application. Chapter 5 gives an overview of the design phase of identifying user needs and establishing requirements. This includes what steps have been performed in this phase, planing of the interviews and a workshop for gathering the users' needs, as well as presenting the results from the user sessions. In Chapter 6 the phase of Conceptual design is introduced by presenting the low-fidelity paper-based prototypes of the application, planning of the user evaluation of the prototypes, as well as the results from the evaluation. Chapter 7 describes the Physical design of the application, more specifically the hi-fidelity electronic prototype of the application, the planning of the usability evaluation, and the results from the user testing and the user satisfaction questionnaires. Chapter 8 presents the final requirements specification for the design of the statements based application. The requirements specification has been developed from the first phase of the design process and updated in the following design phases. Conclusions and suggestions for future development of the application are discussed in Chapter 9.

The Appendix contains some extra materials for the different design phases, more specifically the project plan, planing the user sessions, drawings of the paper-based prototypes and screen shots of the Flash prototype, results of the interviews and the workshop, as well as the results of the evaluation sessions.

Profile Management

Profile management is an important aspect when designing and implementing applications and systems because it offers different opportunities for using the profile data, such as:

- improving the user experience when interacting with different applications, devices and systems;
- delivering services according to the user needs and interests.

Profiles can be very useful in different ways, but some privacy and security issues can occur when dealing with personal data. These issues need to be considered when designing profile managing applications and systems in order to keep the user's data secure and to maintain the user's trust.

The European Telecommunications Standards Institute (ETSI) has developed a set of guidelines for User Profile Management by considering different users' perspectives [ETSI'05]. Types of information which a profile should contain are suggested, along with ways for presenting the profiles to the users such as templates and wizards. Some of the concepts and guidelines for designing a profile management application are described in this chapter. The chapter also presents some other aspects and background of user profiles, as well as some research projects which can be relevant or of interest when designing a profile management application.

2.1 User profiles

“*User profile* is a set of user related information, preferences, rules and settings which affects the way in which a user experiences terminals, devices and services” [ETSI’05].

The profiles can be used for personalization of devices and services that gives possibilities for the user to receive services or set their devices according to their personal needs and requirements.

2.1.1 Types of profiles

ETSI defines the following categories of profiles [ETSI’05]:

- Base profile – Contains settings which are always active for the user (user’s name, birth date, etc.). It is usually a descriptive information about the user and could require higher security.
- Device and Service profiles – Contains information which is only associated with a certain device/service.
- Situation dependent profiles – Contains users preferences which depend on specific situations the users could be in or different activities they can do. The situation dependent profile defines the needed devices and services for a situation and the user preferences for these devices and services.
- Active/Inactive profiles – It is an alternative approach for categorizing profiles. If the profile is in use, it is active and if it is not currently used, it is inactive. Changing from active to inactive mode and reverse usually depends on changing of the situation. When a new situation occurs, a new situation dependent profile is activated and the previous profile – deactivated.

2.1.2 Conceptual structure of a user profile

A user profile can have a 3-level structure, where the information/preferences on the three levels can override each other [MAGNET D1.2.1’06]. The three levels are:

- User identity – It is the highest level and it contains the user’s static information, such as name, address, birth date, etc. The user can also define Aliases as cover IDs. The information for the Aliases can be false and the information which is not entered will be seen as N/A from the other users. The user should be allowed to have an empty identity (or without any information) so he/she can be completely anonymous.

- User roles – Each user has different social roles, which express his/her interests – for example: At university, At home, At work, On holiday, etc. Each role is associated with different profiles which contain the users preferences for devices and services for the specific role. The profiles can be organized in a hierarchy tree-structure of sub-profiles. The lower level of sub-profiles can have the preferences from the parent sub-profile/profile and some specific preferences. An example of a hierarchy tree-structure of role-based user profile is shown on Figure 2.1.

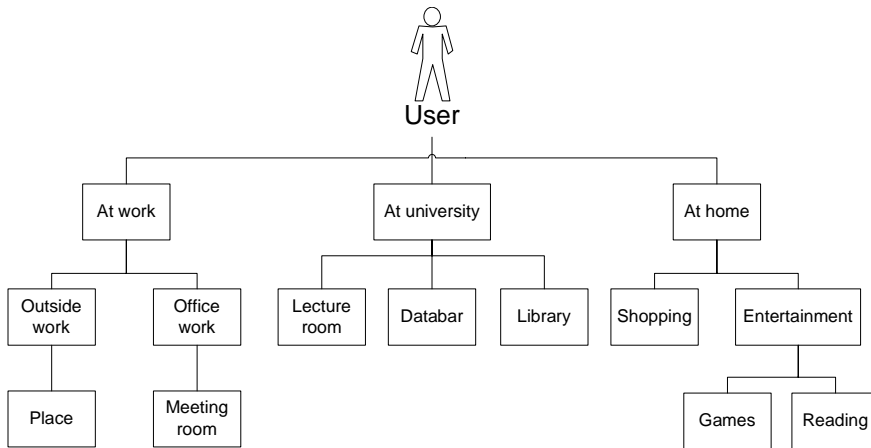


Figure 2.1: A hierarchy tree-structure of role-based user profile

- Presence status – This is the lowest level and it expresses what the user is doing at the current moment, for example – Away, At lecture, At lunch, In the library, etc.

2.1.3 User preferences

The users can specify different preferences which can be categorized in several groups [ETSI'05], [MAGNET D1.2.1'06]:

- Generic user preferences – preferences which are not connected to a specific context, device or service and can be applied for a number of services and devices.
- Context specific preferences – preferences which refer to a specific context. Activation of a specific user profile could be based on a specific context.

- Device/Service specific preferences – user specified preferences/parameters of a device or a service which personalize it, for example – the loudness of a phone ring, customized user interface for an application, etc.
- Privacy and Security preferences – preferences related to privacy and security issues. They could include what user’s information can be collected by the services, who can have access to user’s data, etc. [MAGNET D1.2.1’06] defines the user’s security preferences as – custom personal data filtering, user’s access to personal data and changing security policies.

2.1.4 User profile data

Profiles can contain different types of user information but the data can be generally categorized in the following groups [Hull’04]:

- Static – information which does not change very often such as user’s address book, user’s buddy list, list of classmates, favorite restaurants, favorite books, etc.
- Dynamic – information, which is associated mainly with user’s presence, user’s location and user’s device status and it changes very often.

2.1.5 Obtaining user profile data

Personalizing services and devices requires different types of information, which could be obtained by using explicit or implicit methods [ETSI’05], [Dumortier’05]:

- Explicit methods – The users are directly and actively involved in providing information by using fill-in profile, which is usually questionnaires and on-line forms. In this way, the users have overview and control over the collected information.
- Implicit methods – These methods are also called adaptive personalization. The data is collected by monitoring the user’s behaviour and the profiles are adapted according to the user requirements based on this information. The process could be transparent for the users and it will relieve them from manually adjusting their profiles.

It could be a good approach to combine both types of methods. The system can search for repeated user’s behaviour and patterns and explicitly ask the user for confirmation of the proposed assumptions. In this way, the user efforts for providing explicitly information will be reduced but the user will still have control over the profile updates.

2.1.6 3GPP Generic User Profile

3GPP Generic User Profile (GUP) is the collection of user related information which affects the way the user experiences services and which is shared by set of entities [3GPP GUP'05]. GUP is stored and managed in different entities such as the User Environment, the Home Environment, the Visited Network, etc. and may be accessed in a standardized way by different stakeholders, such as the user, the subscriber, the value-added service provider and the network operator. The GUP provides an architecture, data description and interface with mechanisms to create and manage the user related data in each entity and to make it easier to find all the user data as a whole in the home network environment. The 3GPP GUP consists of user profile components and an individual service may use a set of profile components.

[3GPP GUP'05] suggests several types of data which are included in GUP:

- Authorized and subscribed services information – This information usually consists of authorized services that the subscriber may subscribe to and services the subscriber actually has subscribed to.
- General user information – This information is not specific to individual services but it could be useful for any service. It could be user's name and address, preferences, the active Service Profile of the user, etc.
- Public Land Mobile Network (PLMN) specific user information – This information is not specific to individual services but could be useful for any service, such as addresses of the user (e.g. URLs), WAP parameters, General Packet Radio Service (GPRS) parameters, preferred access technologies (e.g. WLAN).
- Privacy control data of the user – It is specific to individual services (standardized or non-standardized) and it controls the privacy settings of a certain service.
- Service specific information of the user – It is specific to individual services (standardized or non-standardized). The data could be service customization data of the user, service authentication- and authorization data (for “single sign-on”) such as keys, certificates, passwords, etc.
- Terminal related data – It could be data for initial configuration, capabilities of the terminal currently in use (e.g. User Interface capabilities, communication capabilities, available services, etc.), backup data for recovery.
- Charging and billing related data – e.g. billing policy.

2.2 Context

The fast development of mobile and ubiquitous computing¹ and the moving from desktop to mobile environments present greater needs for using implicit information or context in the applications, instead of only using explicitly provided information from the users. The context can be used to adapt or change services depending on user's current situation. The applications which use context are called *context-aware* applications.

The definition given for context in [Dey'00] is:

“*Context* is any information that can be used to characterize the situation of an entity. An entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and application themselves.”

The context can be used for personalization and adaptation of services. There are different types of context. Some of the important ones for identifying a specific situation, pointed out in [Dey'00] are location, identity, time and activity. They can give answers for the questions: *where*, *who*, *when* and *what* and they can be used to obtain some other related information. For example, the entity's location can provide information about what other objects and people are around that entity and what activities are going on close to the entity.

[Schmidt'99] proposes a structure of the concept of context and specifies that context describes a situation and the environment, a device or a user is in. The context is categorized in two main groups: human factors related context and physical environment related context, as each of them contains three categories. For each context relevant features can be identified and their values determine the specific context. The context categories can be seen on Figure 2.2.

Context-awareness is defined in [Dey'00] as:

“A system is *context-aware* if it uses context to provide relevant information and/or services to the user, where relevancy depends on the users task.”

[Schmidt'99] proposes that context-awareness can give some benefits in ultra-mobile computing² such as adaptation to changes in the environment and improvement of the user interface. Adapting according to the environment is important because the ultra-mobile devices are used on the move and the environment changes very often. The context can be obtained explicitly (e.g.

¹Ubiquitous computing refers to embedding computers into everyday working and living environments in an invisible and unobtrusive way for the people. [Brey'05]

²“Ultra-mobile computing is characterized by devices that are operational and operated while on the move (e.g. PDAs, mobile phones, wearable computers)” [Schmidt'99]

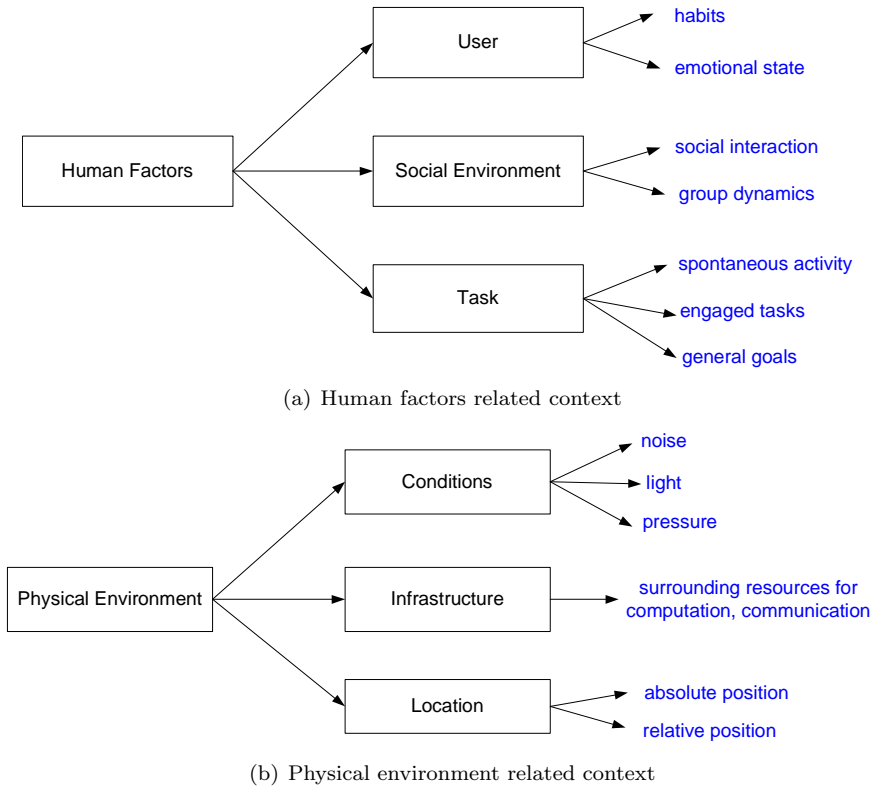


Figure 2.2: Context categories

specified from the user) or implicitly by monitoring the user. Improvement of the user interaction with the ultra-mobile devices is based on the idea that context information which can be obtained through awareness does not need to be provided by the user. Context information can be used for reducing the information delivered to the user and for supplementing the information provided by the user to the application.

The user profile contains preferences, settings and rules which are related to specific contexts. The user profile is not part of the context information, but it has to be applied together with the available context information to the specific context, the user is in, in order to find the best way to adapt the services and suit the user's needs [MAGNET D1.2.1'06]. If the service is not dependent on context information, the user profile alone can be used to personalize the services.

The moving user becomes dependent on context related to time and experience

[Panayiotou'05]. The experience is the activity which the user is currently experiencing, for example – a normal working day, vacation, etc. For a specific experience, the time will identify the user's interests for the specific activity for the given time period. Time-zones and experience preferences can be included in the user profile and they can enhance the personalization process and help in matching the user's interests with the local services. Another factor related to the user experience is the user's age. Based on the age group some default profiles can be created and offered to each new user in the personalization system.

2.3 Templates

ETSI suggests using templates and wizards to create and maintain profiles [ETSI'05]. A template can contain some initial rules, preferences and settings which will be helpful for the users, especially the first-time users, in setting their profiles.

There are two types of templates [ETSI'05]:

- Creation template – Changes to creation templates will not affect the rules and profiles, which have been previously created from them.
- Live template – Changes to live templates affect the rules and profiles, that are created from those templates.

Several things need to be considered when designing the templates:

- The default values in the initial templates should be chosen by considering the target user group, roles and situations.
- If the template should be a creation template or a live template.
- How changes to live templates will affect the profiles, previously created from them.
- What privacy issues should be included in the template.
- Which settings and preferences can be grouped together.
- How detailed the templates should be.
- Which items should have fixed values, or require input from the user.
- There should be offered options for the user to choose when possible.

There should be provided templates for creating different types of profiles, associated for example with different user's roles and situations.

2.4 Profile tool

A profile tool is needed for creating, viewing and modifying profiles [ETSI'05]. The user requirements of the profile tool depend on the tasks that need to be performed, user's preferences and abilities, the available terminal and the environment. It is suggested that a "Design for All" [ETSI'05] approach should be used when designing the tool in order to make the tool accessible for as many people as possible. This approach considers the user needs and requirements of different user groups.

Some guidelines for the design of the profile tool, described in [ETSI'05], are:

- It should be designed to minimize the user's memory load.
- The user should not be expected to enter information manually. The necessary data should be retrieved from other applications and used by the profile tool transparently for the user.
- The users should rather be asked to choose different alternatives from a menu than to type manually.
- The profile tool should be easy to use.
- Using templates and defaults for preferences in user profile will make the configuration of profiles easier.
- The users should be provided with examples in the right format when they need to enter information manually.
- Language support should be provided for the profile tool and if the user's own profile does not have a language preference, the user should be able to choose the preferred language when first using the tool.

2.5 Privacy

Privacy, in this report, refers to the ability of the users to control the flow of their personal information. Sometimes it is related to anonymity. Privacy can also be seen as an aspect of security. Thus, privacy and security issues are analyzed together in some situations.

There are a lot of privacy issues which need to be taken into consideration when designing user profiles because of the increasing role of personalizing services and devices and the importance of accepting these services [ETSI'05]. The following factors have strong influence on the security and privacy aspects of profile management:

- There is a large amount of information which is collected in order to achieve personalization. In many cases this information is very sensitive.
- The profile data is stored on remote databases and it is not controlled very well .
- The general users do not understand or do not think enough about privacy and security threats.
- Having security together with usability in one system is difficult to achieve. If there is a high security there will be different levels of authentication and security mechanisms and this will not give a high level of usability.

The users should know what information is collected and how it is used, as well as be warned if their information is used in an unapproved way, such as sharing with unauthorized parties.

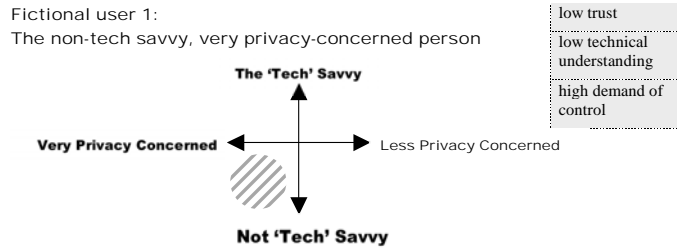
The templates should include privacy settings with initial defaults and options for the user to change them. The templates with different privacy options should be designed to meet the users requirements and can be associated with users' roles, devices, services, security levels, etc.

2.5.1 Types of users

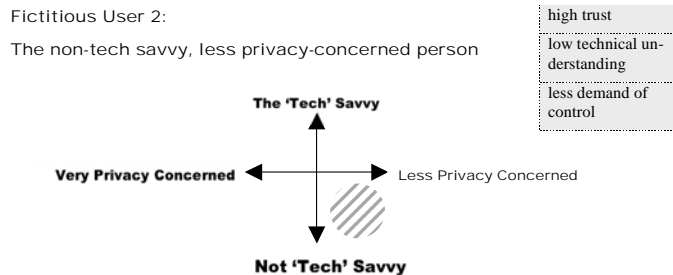
People have different opinions, attitudes and preferences regarding privacy issues. Four fictitious users, who represent theoretical and extreme positions with respect to privacy and technology, are defined in [MAGNET D1.2.1'06]. The parameters which have been used for assessment of different attitudes are Control, Privacy and sharing, Trust in Systems, Social Issues, Automatic Issues, PAN&PN-management, UI-playfulness and UI-feedback. The four types of user are presented on Figure 2.3.

2.5.2 Regulations for personal information

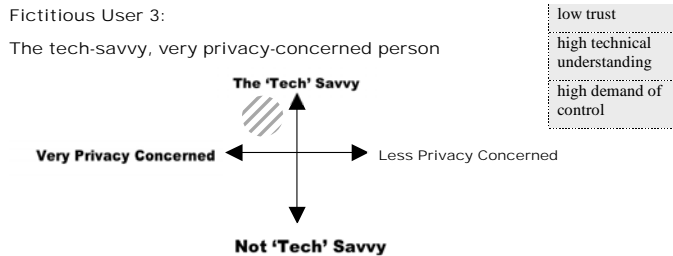
Users' privacy in relation to their personal information has great importance and processing of personal data is protected by different directives and rules. [EUParliament'95] and [Datatilsynet'00] describe the regulations for collecting personal information, what the information can be used for, how the information can be processed, etc. When designing a profile management application the laws for personal information need to be considered.



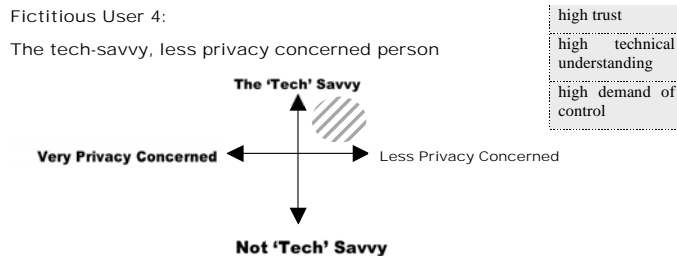
(a) Fictitious User 1



(b) Fictitious User 2



(c) Fictitious User 3



(d) Fictitious User 4

Figure 2.3: Types of users (taken from [MAGNET D1.2.1'06])

2.6 Security

Security is an important issue but users tend to be more interested in functionalities, graphical user interfaces and usability rather than in the security of the information, applications, services and devices [MAGNET D1.2.1'06]. There are different types of people who are concerned about security in different degrees. Nevertheless the systems have to ensure that there are default settings which provide security for the unconcerned users and support when specifying user's security preferences.

Some of the security elements which are required for the systems in order to provide high level security are:

- **Authorization** – It is required in order to control access to resources [MAGNET D4.4.1'06]. The mechanism for deciding who has permissions to access a certain resource is called access control. The profile data should only be accessed in authorized and secure way [ETSI'05]. The access to certain profile data can be granted to the public, to a group of people, to a single person or organization. The users may need mechanisms in order to exercise access control to their profiles. Some of the access mechanisms can be password and PIN control, smartcard access, biometric monitoring or combinations of them. Which method will be chosen depends on the context it is used in – for example complicated mechanisms should be avoided when there is no threat for the information. A disadvantage of using passwords and complicated procedures which require a heavy memory load from the user is that the users are willing to write down security information. This can easily lead to compromising security. This is why, other elements, such as smartcards and biometrics methods should be used when possible.
- **Authentication** – Access to profile data requires authentication of the user, organization, service or application which would like to access the profile data. Authentication is verifying the identity of the requester of data [MAGNET D4.4.1'06]. Usually authentication will be set during the initial profile creation but the authentication criteria should also be able to be managed afterwards, especially for the people who are responsible for managing other people's profiles.

Authentication settings can be defined in templates and can include for example – passwords expiration, limited number of typing wrong password for a certain period of time, etc.

There are different *authentication methods* specified in [ETSI'05] such as:

- User authentication which provides access privileges on a per user basis;
 - Client authentication which allows access from a specific IP address or terminal;
 - Session authentication which authenticates on a per-session basis;
 - Traditional line identification, as used for traditional basic telephony service.
- **Confidentiality and integrity** – Confidentiality ensures that the profile data is accessed only by the authorized people, services and applications and data integrity techniques ensure that the information is not modified during transmission [MAGNET D4.4.1'06].

The security part of the user profile can be divided in several groups, as specified in [MAGNET D1.2.1'06]:

- User Information – contains information related to the user such as name, user ID, address, interests, etc.
- Access Information – contains information about the access policy and security such as security service levels, preferred levels for service access, the user private keys, public keys, etc.
- Context – contains information about the circumstances under which the user uses PN applications or initiating the appropriate reactions.

2.7 Sharing

Users can personalize sharing of their profile data by blocking access or by filtering the information. [Hull'04] presents a framework, called Houdini framework, which enables context-aware and privacy-conscious user data sharing and is appropriate for mobile and ubiquitous computing. The framework includes self-provisioning of preferences and a rule-based policy infrastructure for managing these preferences. The users provide their preferences about what data to share and when to share it by web-based forms which actually expresses their privacy preferences about sharing. The users can also specify preferences about how to interpret context (what context to be used in specific situation). The provided information is translated to rules which can be interpreted by the rules engine that enables more efficient support of context-aware services.

2.8 Trust

Building and maintaining user's trust is very important in the fast development of the Web and mobile computing and should be considered when designing

systems. Websites use different mechanisms to build and maintain trust, like customer service, better handling of user data, text privacy policy, certification, etc. [Kolari'05].

The P3P framework uses certificate-based trust model. The P3P policy can establish trust by specifying its certifier which is a trusted authority. [Kolari'05] argues that this model is not efficient because the trust is connected very strongly to the presence of the certifier which is not used very much by the websites. Furthermore, even if the certifier is missing, an assumption is usually made that the presence of privacy policy is enough for building trust. This is why, [Kolari'05] suggests that website popularity and prior user experience of using the website should be considered in building trust in a website.

2.9 Identity Management

Identity management is a complex process that ensures secure creation, storage, exchange and update of digital identity [MAGNET D1.2.1'06]. It involves secure management and exchange of identity information, secure services provided to clients in a distributed network, etc.

The Liberty Alliance is a global organization working on defining open technology standards, privacy and business guidelines for federated identity management. Some of the relevant concepts of Liberty Alliance Project are presented below:

- Identity Federation – the act of establishing relationships between users or distinct service provider and identity provider accounts [Liberty ID-FF'04].
- Identity Provider – a service, which authenticates and asserts a user's or entity's identity [MAGNET D1.2.1'06].
- Circle of Trust – a federation of service providers and identity providers which have business relationships based on Liberty architecture and with whom the users can transact business in a secure and apparently seamless environment [Liberty CoT'05].
- Single sign-on – enables users to sign on once with a member of a federated group of identity and service providers (or the circle of trust from a provider's point of view) and to use different websites and services within the group without signing on for each one separately [Liberty ID-FF'04].

Maintaining a Circle of Trust and providing the users with single sign-on mechanisms will improve the user's experience when interacting with applications and devices. The Liberty Alliance's People Service provides a flexible and privacy considering framework for managing a social network – a user can track/manage

the people he/she knows so he/she can assign them different privileges to certain resources the user has [Liberty ID-WSF'05]. It will allow users to share information easier even across different service providers.

2.10 Rules

Rules are conditional phrases which express what action/actions should be taken under certain conditions. This concept can be used when creating a profile and it will require a rule editor in the profile tool [ETSI'05]. The rules consist of one or more conditions and one or more actions and can be used to define:

- profile activation criteria;
- filtering criteria;
- communication priority;
- privacy rules.

The user should be provided with a rule building tool to assist him/her in achieving the desired outcome of the rules because of the possible complexity of defining rules [ETSI'05]. There should be available pre-defined rules and rules templates. It will be preferable to provide the user with intuitive graphical user interface for entering the rules which will be internally translated to a rule definition language. On the other hand an administrator and more technically oriented users might prefer to enter the rules directly by using the rule definition language in a command line editor.

The rules can be active and inactive. Some rules will always be active and others will become active only when the situation dependent profile, they are associated with, is active. The user can specify exceptions to the rules. There are two principles: to specify what is allowed and then to define the exceptions, and to specify what should be denied and then to define the exceptions. The user should be able to choose the principle which they want to be applied. In case of conflicting rules the profile tool should provide the user with possible solutions.

2.11 Policies

Policies are usually a set of settings and rules which describe the behaviour of entities which can be used to specify privacy and security practices. Policies can include generic, service-specific and context-specific policies [MAGNET D1.2.1'06] and the user can specify different policies for different services.

2.11.1 Privacy policies

The Platform for Privacy Preferences (P3P): is a W3C framework for web privacy management [W3C P3P'06]. It gives possibilities to the web sites to express their privacy practices in a standard format which can be automatically retrieved by user agents. The user agents can be built in web browsers, for example as Java applets, and they allow the users to be informed about the web sites privacy practices. The P3P framework provides automating privacy policy verification process because it automatically compares the web site privacy policy with the user's preferences. In this way, the user does not need to read the privacy policy of each web site they visit. On the other hand, P3P do not provide mechanisms to ensure that the web sites act according to their policies or mechanisms for transferring data and securing personal data in transit or storage.

The P3P1.1 specification defines the syntax and semantics of P3P privacy policies. P3P policies consist of statements which are created by using the P3P vocabulary for expressing web sites privacy practices in a machine-readable XML format.

P3P framework enhancement: In order to promote P3P framework and to make existing privacy protection mechanisms more usable, [Kolari'05] proposes an enhancement of the P3P framework which provides better support for users. The enhancement includes using a more expressive policy language Rei (instead of APPEL and XRef) and improving the trust model. Rei gives possibilities for the users to specify their privacy preferences and also enables integration of existing web privacy mechanisms. The trust model is enhanced by including trust building mechanisms based on social recommendations. The users are provided with a web site evaluation ontology which allows them to give and exchange their opinions about web sites which are included in the specification of the privacy policies.

Privacy Policy Rule Authoring: [Karat'06] presents a research about how people in organizations can create high-quality policies which will be easily understood. Their goal is to create a technology which will enable people to have logical and verifiable connections between the policies they author and the decisions regarding accessing the data in the organizations. It is suggested that the users write the rules in natural language in a privacy policy workbench which are parsed and translated into machine-readable code. Two different tools for authoring privacy policy rules have been created and evaluated. The methods used in these tools are Natural Language with a Guide (NL with Guide) and Structured Entry from Element List (Structured List). NL with Guide allows users to write rules by using a guide for the rules as this guide identifies six possible elements in the rule. The second method allows users to choose elements

from the six lists of elements to create a privacy rule in the form of a sentence. The conclusion after evaluating these two options was, that by using these two methods, the users can create better quality privacy rules than by using control condition tool or Unguided Natural Language tool.

2.11.2 Security policies

Policy-based security is often used in systems where users, services and access rights change very frequently [Kagal'03]. In pervasive environments where there are many heterogeneous users, services and semi-automated entities it is difficult to ensure that all entities behave appropriate. More flexibility and automated security is required. By using policy based security it will be possible to control how different entities act without modifying their internal mechanisms.

Ethical Issues

The development and application of information and communication technologies (ICT) have a positive effect in assisting people in their everyday lives but it leads to some ethical issues concerning privacy, freedom, security, ownership, etc.

Ethics refers to standards of “right” and “wrong” and it usually describes what people should do [Velasquez’87]. Some ethical principles and standards are necessary in our information and digital world which may define what are the appropriate and responsible ways to use personal information and technologies. Ethics is not the same as laws but some laws can include ethical standards which the people should follow.

3.1 Ten commandments of computer ethics

The Computer Ethics Institute have created ten commandments of Computer Ethics with the intention to provide a set of standards to guide people in the ethical use of computers. These commandments were first presented in [Barquin’92].

1. Thou Shalt Not Use A Computer To Harm Other People.
2. Thou Shalt Not Interfere With Other Peoples Computer Work.
3. Thou Shalt Not Snoop Around In Other Peoples Computer Files.
4. Thou Shalt Not Use A Computer To Steal.

5. Thou Shalt Not Use A Computer To Bear False Witness.
6. Thou Shalt Not Copy Or Use Proprietary Software For Which You have Not Paid.
7. Thou Shalt Not Use Other Peoples Computer Resources Without Authorization Or Proper Compensation.
8. Thou Shalt Not Appropriate Other Peoples Intellectual Output.
9. Thou Shalt Think About The Social Consequences Of The Program You Are Writing Or The System You Are Designing.
10. Thou Shalt Always Use A Computer In Ways That Insure Consideration And Respect For Your Fellow Humans.

3.2 Autonomy and freedom

Some ethical questions appear around the Ambient Intelligence and if it enhances the people's autonomy and freedom or on the contrary – reduces them [Brey'05]. The vision of Ambient Intelligence is to provide an intelligent environment, which will respond to the people in intelligent ways. Thus, the people can be assisted in their everyday lives and the convenience, safety and security of the users should be increased. Ambient Intelligence should make the technologies easier to use by making the interactions more intuitive, efficient and secure. In order to fulfill its vision Ambient Intelligence needs to gather different information about users and situations. This is achieved by using profiling and context awareness which give possibilities to personalize and adapt to specific user's behaviour patterns (profiling) and to adapt to specific situations (context awareness). By using sensors for recording user's behaviour and the environment, along with making assumptions for users and situations, people's autonomy, freedom and privacy can be threatened. Another issue in this case is whether the users would be actually bothered that the technologies record their behaviour and make assumptions. It is possible that the users would prefer to receive personalized services, which would assist them in their everyday life, even though it would be seen as losing some autonomy, freedom and privacy.

Individual autonomy is connected to the ability to create one's own goals and values, to have the freedom to take one's own decision and to act based on these decisions [Brey'05]. Autonomy is related to freedom which can be categorized as negative and positive freedom. Both types of freedom are related to control as the positive freedom includes control over the environment and the negative freedom – control over one's thoughts and decisions. [Brey'05] states that Ambient Intelligence can help people gain control over the environment, as well as

have the potential of taking human control. The control can be taken away in several ways, such as:

- If the smart objects perform actions which do not fit to the user's needs and preferences;
- Even if the smart objects assume the user needs correctly, it could be considered that they take control by telling the user what to do;
- When the user profile or the knowledge base of the smart objects represents not only the user needs but also the interests of third parties is another type of loss of control.

Considering the discussion in [Brey'05] regarding control, it would be interesting to discuss to what extent the user needs to have control. Is it not enough to have overall control and being able to turn off the intelligence objects when they are not needed? Different people also have different perceptions of control. Some people would not need to control every detail in order to feel in control. This is why, as long as the user has the final decision or the power to stop or override the mechanisms of the smart objects any time, the people might be considered to have the overall control.

Another issue, discussed in [Brey'05], is that the smart objects appear to know more about the users needs and interests than the users themselves. The users can create profiles for different situations, but it will be difficult for them to predict their preferences for all future situations. It is difficult for the users to know what they want to do in every particular moment. This is why, the smart objects can be wrong about the users needs. This can lead to frustration, especially if the users cannot overtake the control. Using intelligent objects is also connected to trust in their judgements. If the device's assumptions are in conflict with the user's interests the user has to decide whether to rely on the technology.

3.3 Privacy

The issue of privacy attracts a lot of attention because many technologies, including Ambient Intelligence, have the potential to violate personal privacy [Brey'05]. Ambient Intelligence hides risks for privacy because of the sensitive personal information which is recorded and the ease with which it could be made available for other parties. It results from the facts that the smart objects contain, construct and use user profiles with users' unique preferences and behaviour patterns and that the smart objects are designed to be able to communicate with other devices. This on the other hand leads to possibilities for the personal information to move freely in the network of smart devices if some secure and safety mechanisms are not considered. A good privacy management

is required to avoid invasions of privacy when third parties access the personal information. The technology should provide mechanisms which will give possibilities for the user to choose if they authorize smart objects to record data or not, or if other agents can have access to the personal data or not. The users also have to be informed about the type of information which is collected and if there are any risks for violating the privacy.

3.4 Security

The development of the technologies leads to the necessity for formation of new global ethics according to [Bao'06], because of the many security threats, which exist in the informational world. This results in increasing the importance of information security. By using malicious software, such as viruses, worms and logical bombs some people acquire unauthorized access to information, which is supposed to be inaccessible, and steal private or international secrets. Network frauds and cheating in network trade are also a big concern.

People are becoming more and more anxious because of the loss of information and loss of control over the information systems, which turn into a big insecurity problem in the digital and information world [Bao'06].

Security supervision does not depend only on improvements of technologies and laws in the technological world but it is also a question of morality, considering collectives, security environment and normal social order. By including security supervision in the global ethics domain it will help in promoting the importance of security and the combination of ethical security supervision with technologies and laws. In this way, the technologies will be more ethical, work to standardize people's behaviour and guarantee social order and security.

Including the security in the global ethics is probably a good idea, but it will not necessary stop the creation of viruses and worms. This is why, security needs to be considered in designing technologies as one of the first priorities. Possible security threats should be investigated and addressed in the design. This is important because security can be the key for attracting users to use a specific technology.

3.5 Ethical issues in Interaction design

There are some ethical issues which arise in relation to the process of Interaction design, as presented in [Robertson'06]. It is possible to take different interaction design decisions, which can influence the human interaction in different ways. Some of the solutions enhance the capacity for users to make choices and to

impose those choices to the world and others reduce it. This leads to the consideration that a moral basis is needed for choosing between alternative design solutions which might be equivalent in terms of functionality and usability.

Designing an information and communication technology involves making different assumptions about the users' activities, which can result in building specific metaphors and models of these users' activities into the technology itself, organizational cultures and social identities of those who use it. When people are required to act according to the prescribed behaviour, associated with certain human activities, there can be some ethical issues if these assumptions for users' activities and options for action are better or worse compared to others. Depending on the choice of certain design decisions, the technology which is designed can be influenced and it could determine what a certain technology can or cannot do. Furthermore, the functionalities, the technology provides, can influence the behaviour of the people who use it. This is why, it is important to understand the users who might use the new technology. This is a main principle in the user-centered design. There are different methods and approaches to help the designers to understand the users and design good interactive products.

The principles which are defined in [Robertson'06] for judging different design solutions are:

- Avoid using technologies for enforcing social protocols.
- Choose solutions that enhance the possibilities for human agency instead of the ones that reduce them.

Ethical issues in Interaction design are also considered when carrying out evaluations with users [Preece'07]. The users need to be informed in the procedure for evaluation a design and how the gathered data and results from the evaluation would be used. They need to be also asked for permission to record and videotape the evaluation.

3.6 Concluding remarks

Ethical issues are important to be considered, when designing technologies, because they can show some possible problems of using the technologies and help in designing a better system/product. The ICT are created at the first place for assisting users and making their lives easier and better and this is why, the users' perspectives should be seen. This would involve investigating how the users would feel in control, when they would feel that their information is safe and that their privacy is not violated. However, some balance needs to be found between the technologies and the ethical issues. The technologies need to collect some data for the users' behaviour and make assumptions in order to provide

personalized and appropriate services depending on the situations. But they should make it in such a way that users are still in control and have their freedom, and without violating their privacy. The technologies should also make sure that the users' information is secure.

Design Methods

This chapter describes the process of interaction design, concepts and design methods and techniques, as well as creativity methods and tools, which can be applied in the different steps of the process of designing a profile management application. This chapter is based on literature sources. Most of the described concepts and methods are used in this project, but there are also some, which are only presented in order to show the different possible approaches and methods a designer can choose from. More specifically which exact design methods are used in the different steps of the design process and the reasons for choosing them are described when discussing the corresponding design step.

4.1 Interaction design

Interaction design is about creating user experiences which enhance the way people work, communicate and interact and it is defined in [Preece'07] as the following:

“Interaction design is designing interactive products to support the way people communicate and interact in their everyday and working lives.”

The key characteristics of the interaction design process, defined in [Preece'02], are:

- *Focus on users* – the process encourages involving the users in the design and provides opportunities for user evaluation and user feedback.

- *Specific usability and user experience goals* – these should be identified at the beginning of the project. They help the designers to choose between alternative designs.
- *Iteration* – it helps in refining the designs based on user feedback. The different activities are repeated in order to revise ideas through evaluation and to improve the design. The different iterations should lead to a more efficient design process of producing the right functionalities and looks.

The main objectives of designing an interactive system has to be specified and used to guide the design. They can be expressed by the so called usability goals and user experience goals. Usability and user experience are related to each other and sometimes it might be difficult to distinguish them clearly. Good user experience depends on the usability, on how a system/product looks and feels, and is related to how usable the system/product is [Preece'07]. There are also trade-offs between usability and user experience goals. The usability and user experience goals, should be specified in appropriate combination, depending on the users' needs and context of use. Usability and user experience, what they are affected by and how they can be measured and evaluated are described in the following subsections.

4.1.1 Usability

The Usability Professionals' Association [UPA'07] defines usability as:

“A measure of the degree to which a product can be used by specified users or groups to achieve specific goals of effectiveness, efficiency, and satisfaction in a specified context of use. ”

[Preece'07] relates usability to ensuring that the interactive systems/products are easy to learn and effective to use, which also involves optimizing the interactions between the users and the interactive systems/products in order to enable the people to perform their everyday activities. Usability goals are concerned with meeting specific usability criteria and they can be considered more objective, comparing to the user experience goals, because they are related to assessing how useful and productive a system is from its own perspective. [Preece'07] defines the usability as consisting of the following usability goals:

- Effective to use – how good the system performs what it is supposed to do;
- Efficient to use – how the system supports the users in carrying out their tasks;
- Safe to use – avoiding dangerous conditions and undesirable situations;
- Have good utility – if the system provides the right functionalities so the users can perform what they need and want to do;

- Easy to learn – how easy the system is to learn;
- Easy to remember – how easy the system is to remember to use after it is learned;

Usability is also expressed by design principles which are supposed to guide the designers, advise them to consider different aspects of their designs and help them improve the designs. The design principles usually include what the users should see and do when performing tasks with the interactive product [Preece'07]. Common design principles are visibility, feedback, constraints, consistency and affordance.

Another form of guidance is usability principles. Although some of the design and usability principles are similar, the design principles are intended to inform the design while the usability principles are used mostly in evaluation of prototypes and existing systems. The ten main *usability principles*, developed by Jakob Nielsen and presented in [Preece'02] are:

1. Visibility of system status – the user should be informed what is going on all the time;
2. Match between system and the real world – the words and phrases used should be familiar to the users;
3. User control and freedom – the users should be provided with possibilities to exit places where they unexpectedly have found themselves;
4. Consistency and standards – it should be avoided making the users wonder if different elements have one and the same meaning;
5. Help users recognize, diagnose and recover from errors – the error should be explained and solutions should be suggested;
6. Error prevention – the errors should be prevented at the first place when possible;
7. Recognition rather than recall – the options and elements should be visible;
8. Flexibility and efficiency of use – the experienced users should be given possibilities to perform the tasks quickly (e.g. shortcuts);
9. Aesthetic and minimalist design – not using irrelevant information which is rarely used;
10. Help and documentation – the provided information should be searched easily and the help should be followed easily.

Usability of a system/product can be assessed quantitatively and qualitatively. The quantitative methods are mainly related to measuring the user's performance on a certain task. Some of the basic quantitative measures are: time to complete a task, number of users who can perform a task fully, number of errors made by the users while performing a task, number of users, making a specific errors, time to learn a task, rating the user satisfaction or other aspects of design on a certain scale, etc. By analyzing the results from these measures, it should be possible to say to what extent a system is efficient, easy to use, easy to learn, etc. Quantitative measures are not always enough for assessing the usability, because the users can have different perceptions about how efficient and effective a system is, as well as the user satisfaction can be influenced by different factors. This is why, some qualitative measures should be also used for finding out what the users' reflections of using the system are and what the users' perceptions are in terms of usability goals. The qualitative methods can be related to patterns in user behaviour when interacting with the system and user opinions about the system.

Usability is an important part of the design process, but according to [Wright'06] the human-computer interaction (HCI) nowadays goes beyond the usability goals because of the increasing importance of the user experience in HCI. This can be explained with the tendency the changing of the idea of design in HCI in the process of developing the technologies and appearing of new and broader ideas about what it means to design an interactive system [Wright'06].

4.1.2 User experience

There are different understandings and explanations about user experience (UX). One of the more general definitions of UX is "Every aspect of the user's interaction with a product, service, or company that make up the user's perceptions of the whole." [UPA'07].

[Preece'07] presents the UX by defining a set of UX goals (both positive and negative), which relate to how a system feels to a user, more specifically how the users experience an interactive system/product from their perspectives. This is why, UX goals are considered to be more subjective, comparing to the usability goals. Some of the UX goals are:

- Satisfying;
- Enjoyable;
- Helpful;
- Motivating;
- Aesthetically pleasing.

UX is the emotional aspect of usability, which relates to taking into consideration the aspects and feelings of a user, when experiences an interactive system/product.

UX can also be defined as the overall user experience and satisfaction the user has when using a product or a system. Relating the UX to user satisfaction is similar to usability, but the source of satisfaction is different. The satisfaction, related to usability, can be achieved by eliminating the usability problems, whereas the UX is mainly about designing for pleasure [Roto'06-1].

Defining the UX very general, gives possibilities for interpreting it in different ways. This is why [Roto'06-1] states that a good definition for UX is needed, as well as definitions of methods for designing for and evaluating UX. In order to achieve that, it is necessary to find out what elements affect the UX, especially in mobile context, where there are different factors which influence the interaction. The goals of a successful product would be reached by identifying the building blocks of user experience [Roto'06-1]. These goals are related to providing the users with “wow, flow and show” [Nokia'05], where flow corresponds to right functionality and usability, wow – to pleasure, and show – to self esteem of owning the product or pride [Roto'06-1].

[Roto'06-1] differentiates experience and user experience by pointing out that user experience is a special case of experience, where a user uses the system, or he/she has the opportunity to control and manipulate the system. Situations when the users only observe and sense the system are referred to as experience. [Roto'06-1] also presents a model of the building blocks of UX (see Figure 4.1), by considering UX in a use case instead of the overall user experience. This is based on the idea that the overall user experience consists of smaller experiences. The user experience of an use case is based on “perception and emotional judgement of a specific part of a system after interacting with it” [Roto'06-1]. The perception of the system can be influenced by the user's state, context of use and system's interface and thus, the main building blocks of UX are defined as user, context and system.

The user component is related to the mental and physical states of the person who interacts with the system. The user's motivation, expectations, mental and physical resources affect the system perception, which in return influences the user experience and the user's state [Roto'06-2]. If a user is in bad mood, this can easily affect the user's perception of interacting with the system as bad UX. Another example can be if the users have low expectation, so they can easily perceive the interaction as good user experience. The system component includes all services, objects and products which are involved in the interaction. The context component defines the physical surroundings, social and temporal context, as well as task context.

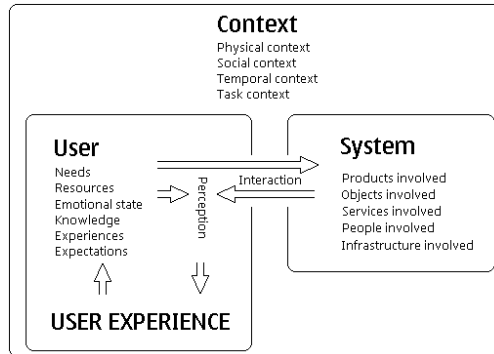


Figure 4.1: User experience building blocks (taken from [Roto'06-2])

When designing for mobile devices and technologies, the designers should understand the mobile context, which the devices or technologies are used in, because the mobile context can influence the user experience. Mobile technologies can be used in many different contexts, such as public transportation, shops, while walking on the street, in the park, at the university campus, while driving a car, etc. [Roto'06-1] defines the factors which affect the UX in these mobile contexts. The contextual factors are divided into physical context, social context, temporal context and task context. The physical context is related to body sense, such as temperature, rain, objects the user is in contact with, movement of these objects, as well as crowdedness and noise if they affect the usage of the system/product. The social context refers to the expectations other people have towards the user in a certain mobile context or how much the user wants to participate in social situations. [Roto'06-1] presents results from studies about the different behaviour of the users in different social contexts. In laboratory conditions, without social interactions, the users have been concentrated in the interaction with the system/product, while their attention is split and shifted to the environment when they are in the mobile context. The temporal context relates to the time a user can dedicate to the system. Results from studies show that the user's attention stays on a display of a mobile device less than 4 seconds, when in a mobile context. This can affect for example if the user would see the feedback which the system would give to the user. The task context refers to the role of a certain task in the main goal the user has. Sometimes a specific task is not enough to reach the user's main goal, but it is necessary on the way to reach it.

[Colbert'05] also discusses that the user performance in mobile context needs to be studied when designing personal and ubiquitous systems, as the main perfor-

mance parameter taken into consideration is user experience. UX is related in this article to “users’ perceptions of interaction that constitute quality of use” and considered as critical for the success of the ubiquitous systems. Some of the aspects of the context of use, mentioned in [Colbert’05], which can reduce the user experience are noise, multiple task performance, incomplete network coverage, time pressure, etc. An interesting result, described in the article, is that the users were adapting their behaviour to adverse “mobile” contexts. Instead of incurring bad user experience the users for example can cut the information short when the context is unacceptable, delay the communication until reaching a more suitable context, etc.

Culture is another factor, which is suggested to be considered when designing an interactive system/product in order to ensure usability, usefulness and appeal [Marcus’06]. It is presented that the cultural analysis can help in understanding and measuring the differences and similarities of user experience. The cultural context is becoming more important and the designers should consider the cultural differences of the target user group in order to achieve good user experience.

Designing for positive user experience is a very important goal in designing interactive products. This implies that it should be able to evaluate the user experience. If the user experience is negative or makes the user angry and disappointed, the reasons for the negative UX should be found out in order to improve the product. [Roto’06-1] states that the user experience is usually evaluated by user’s suggestive satisfaction after the user has performed some tasks with the evaluated product. Another approach is to evaluate the user’s feelings towards the system before and after interaction with it. In this case the initial user’s state would be directly addressed.

[Roto’06-1] states that the user experience should be evaluated through the user’s expectations, or analyzing if the system/product met the expectations the user had before interacting with it. An overview of the relation between user experience and expectations can be seen on Figure 4.2. The figure presents also that the user experience can be referred to as positive and negative instead of good and bad.

[Roto’06-1] proposes also that there are relations between the expectations about the effort of reaching the goal, the value of pleasure attached to this goal and the realized user experience. If the user expects higher effort to achieve the goal than the value of the pleasure, the user is not motivated to take an action, while if it is reversed the user would take the action.

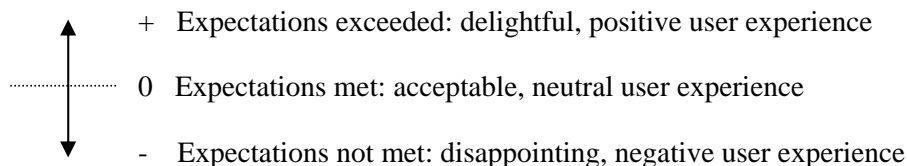


Figure 4.2: User experience in relation to users expectations. (taken from [Roto'06-1])

In other studies, described in [Arhippainen'05], it has been decided that the evaluation should focus on the user experience as a whole, instead of the usability. The evaluation has been concentrated on user's comments and the evaluators observations of the users' actions and interactions with the system, instead of quantitative measures. This shows another approach to evaluating the user experience.

Another important aspect of evaluation user experience is that the user should be provided with the “real usage context” [Kangas'05], which means that the users should be able to interact with the system, touch the buttons of a mobile phone (when designing for mobile device for example) and the users should be put in similar circumstances in which the interactive system/product is intended to be used. This is very important for designing for mobile devices and technologies because while “on the move” some new problems and aspects for considering can appear, different from the expected ones. This is due to the many changing factors in the mobile context.

To sum up, usability and user experience are very important for designing interactive products and they should be considered together in the design process. The factors which affect the usability and user experience of a specific system should be investigated and evaluations should be carried out in the context of use.

4.2 User-centered approach to interaction design

User-centered design focuses on the users, their tasks and their goals. It includes studying the users as well as involving the users in the development process. The users should be the driving force behind the development of the product in order to achieve a well-designed system which supports the users [Preece'02].

There are different degrees of user involvement, one of which is active user participation in the design process. Involving users actively in the design process can be accomplished by using *Participatory design*. This approach ensures that the users actually participate in the development together with the designers, so that the users can be considered as co-designers. Involving users actively in the design can be a difficult task. Some paper-based prototyping techniques have been developed which can lead to producing new and creative ideas. These participatory design techniques are described below:

- PICTIVE (Plastic Interface for Collaborative Technology Initiatives through Video Exploration) [Preece'02] – its purpose is to investigate screen and window layouts for a system by using video recording equipment, office items as post-it notes, pens, pencils, paper, etc., some design objects prepared by the designers as dialog boxes, menu bars and icons. Design is created in a shared design surface, by using the design components and creating new elements from the offices supplies. The video equipments records the creation of the design. Before the design sessions the users can be asked to create some scenarios about the usage of the system (or what they want the system to do for them), and the designers prepare some system elements which they think are relevant to the system.
- CARD (Collaborative Analysis of Requirements and Design) [Preece'02] – used for exploring work flow options by using playing cards with pictures of screen dumps and other relevant elements. The cards can represent users' goals and intentions as well as specific computer screens and tasks. The users can manipulate the cards to produce work flow scenarios and they can also create new cards during the design session if it is appropriate. CARD can be used to supplement PICTIVE because they have different focuses.
- Scenario construction framework [Schultz'07] – a participatory design and creativity framework that includes scenario construction through workshops by using different participatory design and creativity methods and techniques. Before the user workshop a landscape related to the problem is prepared, which includes only some elements for inspiring the users. This is the first story presented to the users and it is used as a prototype which will be developed further. The scenario landscape is a large paper which shows different situations and pictures of how the users think about the future. The users are provided with external image elements as pictures, words and short sentences which can be used in the process of constructing the scenarios. The results are narratives which can be used in forming use cases, mock-ups of low-fidelity prototypes, etc.

Participatory design has many advantages because the active user participation is beneficial for the designers in terms of applying the users' perspectives,

preferences and requirements in early stage of the design. This may lead to less changes after the evaluations. Participatory design also has some disadvantages, such as – the user’s thinking can be constrained by what they know and if the users are involved too much in the design, they might get bored and not too productive.

4.3 Lifecycle model of a design process – simple life cycle

Lifecycle model is a model which includes a set of activities and the relationships between them [Preece’07].

There are different lifecycle models developed for software engineering and HCI fields related to interaction design [Preece’07]. Some of the lifecycle models in software engineering are the waterfall lifecycle model and the spiral lifecycle model, while an example of HCI lifecycle model is the star lifecycle model. The waterfall lifecycle model is a linear model, in which each step needs to be completed in order to perform the next step. The different steps of the model are basically: Requirements Analysis, Design, Code, Test and Maintenance. One of the drawbacks of the waterfall model is that iteration and evaluations with users have not been built in the model. The spiral lifecycle model is based on risk analysis and prototyping, which are included in an iterative framework. This means that the ideas can be checked and evaluated. The iteration process is inspired by the need to identify and control the risks and not by the need for user involvement. The star lifecycle model does not present a specific order of the different activities, but it provides a central activity – evaluation. The design can move freely from one activity to another, but when an activity is completed its results need to be evaluated.

The lifecycle model for interaction design presented in [Preece’07] uses some ideas from the software engineering and HCI lifecycle models. It is named ‘A simple interaction design model’ and it shows the main four activities in interaction design: identifying needs and establishing requirements, developing alternative designs that meet those requirements, building interactive versions of the designs, so the users can interact with them, and evaluating them, and how they are related. The simple life cycle model is also related to the user-centered approach (see Section 4.2), because it is iterative and allows user involvement in the different activities throughout the process, especially the establishing requirements and evaluation activities. The simple life cycle model is shown on Figure 4.3.

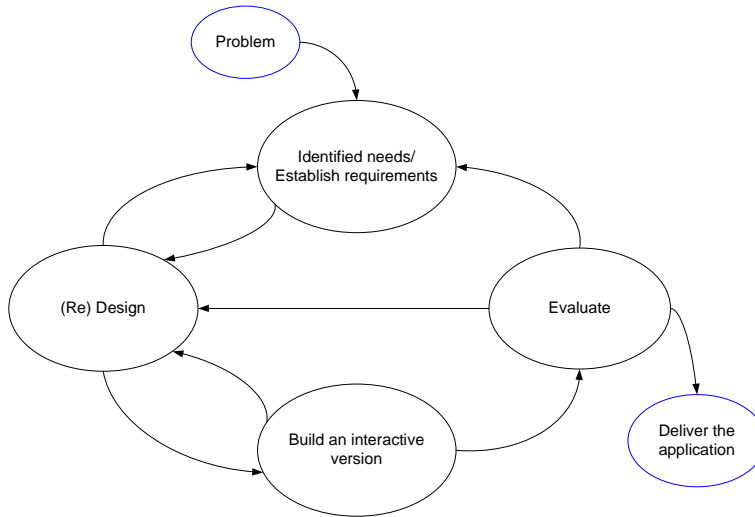


Figure 4.3: A simple life cycle model for interaction design (taken from [Preece'07])

There are two different types of design: conceptual and physical. Each of the designs requires an interactive prototype so that the users can evaluate the design effectively. Paper-based and cardboard prototypes (low-fidelity prototypes) are used in early stages in the development (usually for evaluation of conceptual design) and more advanced hi-fidelity prototypes are used when the design progresses (for evaluation of physical design). A modification of the simple lifecycle model by considering the different types of design and prototypes, which will be used in this project is presented on Figure 4.4.

The different activities in the detailed simple lifecycle model from Figure 4.4 are discussed in the following sections, based mainly on [Preece'07].

4.4 Identifying needs and establishing requirements

At the beginning of the design process there should be an understanding of who the users are, what their tasks and goals are, as well as the conditions under which the application/product which is designed will be used, the constraints, etc. This should lead to defining users' needs and requirements which are refined and supplement in the whole iterative interaction design process.

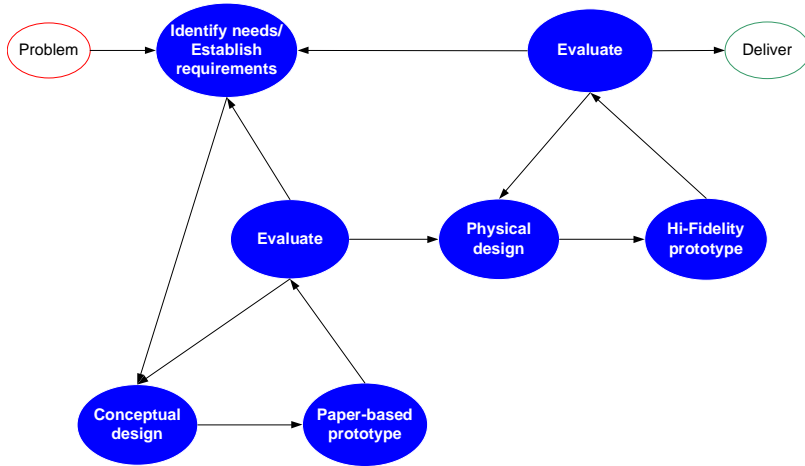


Figure 4.4: Overview of the design process based on the simple life cycle model

“A *requirement* is a statement about intended product that specifies what it should do or how it should perform.” [Preece’07]

One of the purpose of the activity of identifying needs and establishing requirements is to produce a requirements specification which contains as specific and clear as possible requirements. The activity itself is iterative and consists of several sub-activities which can be presented as shown on Figure 4.5. The main three sub-activities are sequential – data gathering, interpreting the data and formulating the requirements from the findings. They can influence each other in the iterative process. For example it might be needed to gather more data to clarify some ideas during the analysis. The requirements should also be revised and refined all the time, even in later stages of the interaction design process, to ensure that they are complete and well-defined. There are different types of requirements which can be extracted by different data-gathering and data-interpreting techniques.

4.4.1 Types of requirements

The requirements can be generally categorized as functional and non-functional ([Preece’07]).

- *Functional requirements* define what the system should do.
- *Non-functional requirements* specify the constraints on the system and its development. Some of the non-functional requirements which are used for this project are:

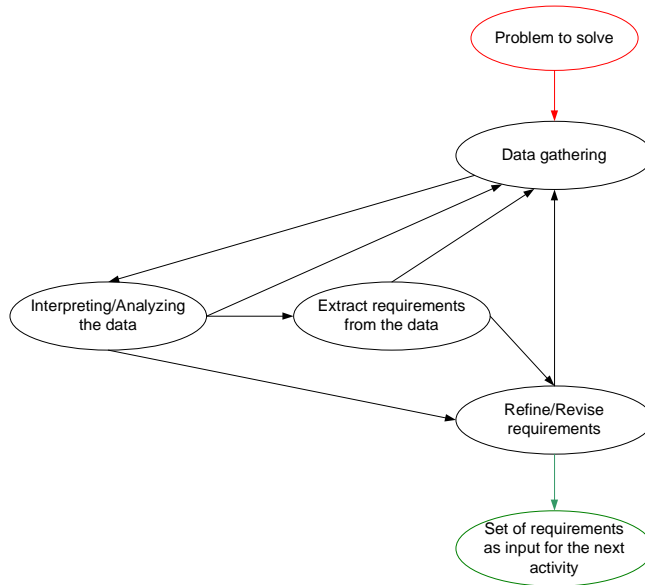


Figure 4.5: 'Identifying needs and establishing requirements'-activity

- Data requirements – related to type, size/amount, accuracy of the required data, how often it changes, how often it is updated, etc.
- Usability and user experience requirements – related to usability and user experience goals.
- Security requirements – consider the security issues of using the application/device (e.g. what type of access to the application is required, does it require password or other authorization mechanisms).
- Legislation and standard requirements – resulted from analyzing standards and legislations in connection to user profiles.
- User requirements – relate to the characteristics of the intended user group. Different types of users will have different requirements. For example, a novice user might require step-by-step instructions; a frequent user – short cuts for faster access; a casual user – clear instructions, series of menus. The preferences of a specific type of users are collected in a user profile and a device can have several user profiles. The user characteristics are already specified when defining the user domain. Thus the user requirements are not defined as requirements in the developed requirements specifications. However, the user domain characteristics are considered to belong to the requirements specification.

The requirements can be formulated in different ways, but they need to be clear and to state when they are considered fulfilled. One way of formating a requirement is by using a 'requirement shell' from the Volere Requirements Specification Template [Robertson&Robertson'06], which is a guide for writing requirements. The components of the 'shell' are shown on Figure 4.6. The Volere shell is used as a basis for formulating the requirements for the statements based profile management application, as it has been adapted for the needs of this project. Examples of the project requirements can be seen in Chapter 8.

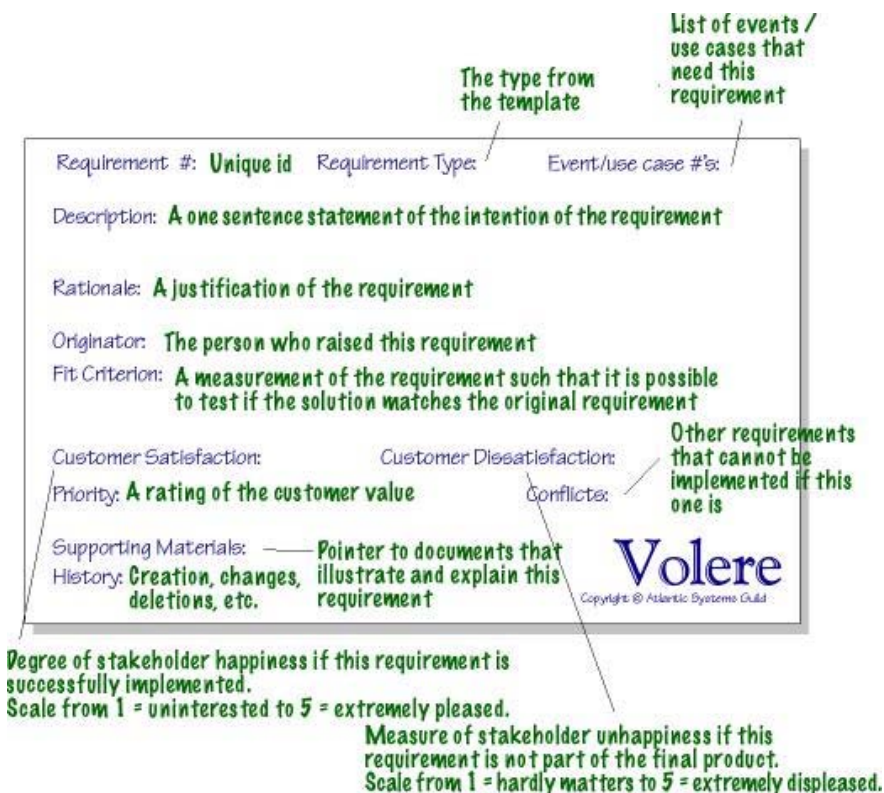


Figure 4.6: Volere requirements shell (taken from [Robertson&Robertson'06])

4.4.2 Data gathering techniques

Some basic techniques for gathering relevant information in the process of producing a set of requirements which can be combined, depending on the specific situations they will be used in, are listed further:

- Questionnaires – used for gathering demographic data and user opinions. They can have open and closed questions [Preece'07].
- Interviews – the main types of interviews are open-ended or unstructured, semi-structured and structured. The choice of type of interview depends on its purpose [Preece'07]. If the interview needs to find out what the users think about a new design idea, an unstructured interview is appropriate. The unstructured interview contain usually open questions and it is used to explore different opinions. The structured interview has predetermined questions and the questions are usually closed. It is used when the range of answers is known. The semi-structured interview have both open and closed questions. The evaluator usually has some questions for guidance, which also assures that certain areas are covered with the different users, but the evaluator asks the users extra questions in order to obtain more information in a certain area.
- Workshops – appropriate for data gathering with a group of users. Some of the advantages of making a workshop are that the users can inspire each other, so they can create some more innovative ideas.
- Observation – Observing the users in their every day tasks can help to get more accurate perspective of how they achieve different tasks.

4.4.3 Data interpretation and analysis

After the data gathering session, data interpretation has to be performed in order to start structuring and forming description of requirements. A template could be used to highlight the types of information which should be found and to guide the data interpretation process. There are different techniques which can be used to analyze the system from different aspects. Some of them, such as task descriptions, have a user-centered focus and can be used to understand users' goals and tasks.

4.4.4 Task descriptions

Task descriptions are used for describing existing tasks or envisioned tasks with a new product and may be produced during the data gathering session. The output can be used in next data gathering sessions. There are different types of task descriptions, which can be combined to capture different perspectives. The following task descriptions, excluding use cases and essential use cases, are used in this project:

- Scenarios – informal descriptions of users' activities or tasks in form of a story, which give possibilities to explore contexts, needs and requirements [Preece'07]. Scenarios are also described as a narrative written in a natural language, which focuses on the user, using the system and has a goal

to explore design decisions [Nielsen'04].

Scenarios can be used in different phases of the interaction design process and depending on the phase, they can be detailed in different levels. When identifying the user needs and establishing the requirements the scenarios can be used to describe existing tasks or potential uses of the designed application. Presenting scenarios as telling stories by using language which is understood by both users and designers makes it easy to involve the users in the design process, as well as creating common understanding between the users and designers. Users are often involved in the process of establishing requirements by creating scenarios, where they express their behaviour and activities in specific situations. The scenarios are important because they help understanding what people do and what their goals are, which is the basis for identifying different constraints and contexts, as well as the stakeholders and products, that are involved in the specific activity [Preece'07].

Scenarios can be also developed when creating the conceptual and physical design, where they are usually used to describe imaginary situations. They can be used as scripts for user evaluations of prototypes, as they define concrete tasks, which the users need to perform while interacting with the designed application [Preece'07].

[Jones'06] presents the elements which the scenarios should include: *setting*, *actors*, *goals or objectives* and *actions or events*. The *setting* introduce the user to the circumstances for the stories; the *actors* state who is participating in the story; the *goals or objectives* describe what the actors want to achieve; and the *actions or events* explain the different steps the actors do in order to achieve the goals.

- Use cases and essential use cases – focus on the user's goals, but emphasize on a user-system interaction, instead of the user's task itself [Preece'07]. A use case is associated with an actor and it presents the actor's goal in using the system by describing set of actions, some of which performed by the user and others performed by the system. The essential use cases on the other hand are a combination of scenarios and use cases as they try to avoid some of their disadvantages. An essential use case is narrative description which consists of three parts: a name that expresses the general user's intention, a stepped description of user actions and a stepped description of system responsibility.
- User stories [Cohn'04] – they describe functionality which can be valuable for the user of the system which is designed. An example of an user

story can be: “A user can post her resume to the website”. User stories are short and they can be written on story cards (small pieces of paper or cardboard). User stories are understandable for users and designers and they encourage participatory design. The users can be asked to write user stories to express their expectations of the functionality of the system. User story is similar to scenario but the main difference is that the scenarios are more detailed and they usually cover several user stories.

4.4.5 Personas

“A persona is a description of a fictitious user.” [Nielsen’04]

Each persona has its own characteristics and is described with specific details. Creating and using personas is used in interaction design in order to describe certain types of potential users of an application/system. According to [Grudin&Pruitt’03], creating personas makes the assumptions for the target user group more explicit. The authors state that the technique of using personas is a powerful and effective tool (if used appropriately), which can support and enhance the participatory design, as well as make the designers consider different social and political aspects of the design. It also provides enhancement of engagement and communication of data from different user research methods to the participants in the project.

Personas is a separate design method, but [Grudin&Pruitt’02] suggests that it should be combined with other usability methods in order to achieve better designed applications/systems. Personas are considered to be a foundation for building scenarios and data gathering. [Nielsen’04] also describes a way to integrate the methods for creating personas and scenarios in order to provide a process, which gives opportunities to broaden the understanding of the users and the situations of use and supports understanding of the user in relation to context, including surroundings, situations and needs.

Personas or Fictitious Users are used in this project in order to be aware of the different types of users. More specifically, the four fictitious users, defined in the MAGNET project, are used, whose characteristics are related to different concepts, such as privacy, experience in technology, control, etc. (see Section 2.5.1). Personas are also used for introducing the users in the context and as a basis for creating scenarios and user stories.

4.5 Conceptual Design

“A *Conceptual model* is a description of the proposed system in terms of a set of integrated ideas and concepts about what it should do,

behave and look like, that will be understandable by the users in the manner intended”. [Preece’02]

The conceptual model is derived from the user needs and requirements. The basis for creating it is the set of users tasks the product will support. The following points are important to be considered:

- The functions the product will perform – includes for example deciding what the system will do and what is left for the user;
- How the functions are related between each other – can include a certain order the functions need to be performed in, if the functions can be performed parallel, or they can be related by categorizing them in groups. The relationships between the tasks can lead to restrictions of the use of the product.
- What information needs to be available – relates to the data necessary to perform a certain task which should be described in the data requirements. This information has to be considered in order to make sure that it is available and the conceptual model uses it because that information is required to perform the task.

Scenarios and prototyping can be helpful in exploring new ideas and making design decisions during designing the conceptual model. Scenarios can be used to express imaginary situations which can help in developing the conceptual model or to check potential conceptual models. The prototyping, usually low-fidelity prototypes, is used to evaluate the conceptual models.

4.6 Physical Design

Physical design includes taking more specific and detailed decisions about the interface design, such as screen design, which icon to use, how to structure menus, etc. It is important to keep a balance between the different types of requirements, especially the balance between usability and user experience requirements and functional requirements, which are often in conflict. There is not a clear border between conceptual and physical design – some detailed issues can be discussed during the conceptual design, as well as some decisions, taken in the conceptual design should be revised in the physical design [Preece’07].

There are many guidelines, principles, rules and standards developed to guide the designers in developing usable products (design and usability principle have been described previously).

Some of the main elements which need to be considered when designing a GUI interface are windows, menus and icons [Preece’07]. It is also important how

each screen is designed and how the necessary tasks are split across the screens [Preece'02], or the screen design. The design issues which are important for the current project are described below:

Window design

In general windows are developed for computer applications to give possibilities for more information to be viewed and more tasks to be performed on the same screen [Preece'07]. Multiple windows can open from a certain screen with different types of information, as the user can easily switch between them. Using horizontal and vertical scrolling bars helps in presenting even more information in a certain window. However, multiple windows has some disadvantages – the user can have difficulties to find a certain window by switching between the different windows. A special kind of window, used in the GUIs, is the dialog box. It is commonly used for confirmations and error messages, as the user interaction is usually guided by providing some possible options.

Menu design

Menus are used in the interface in order to provide the users with recognition rather than recall, because users need to recognize the task from the presented options and do not need to remember the options. There are different types of menus to choose from when taking concrete decisions about an interface design. [Preece'07] categorizes the menus in flat lists, drop-down, pop-up, contextual and expanding menus, while [Leventhal '07] adds some more menu types as picture, pie menus and check-boxes (multiple selections). *Flat menus* are preferred when a small number of options need to be displayed at the same time and they can be useful for devices with small screens, such as PDAs and mobile phones. *Expanding menus* can be scrolling and cascading and they allow more options to be shown at one screen than the flat menus. *Contextual menus* are usually related to a specific item or icon and provide appropriate commands which are related to the context of the specific task, when the user clicks the item/icon and at the same time pressing the Control key. *Drop-down menus* are used commonly in order to present additional options to the user only when the user selects a title in the menu. The options are hidden when the user selects another interface element. *Pop-up menus* can appear when the user presses a certain element on the screen. Sometimes it can be difficult for the user to see that there is a menu, associated with the specific element. If the options of a menu are presented as icons, the menu is called *picture menu*. An alternative menu for a small number of options can be a *pie menu*, which is in the form of a circle, where the options are presented like pieces of pie. Menus which need to allow the users to select more than one option can be designed by using *check-boxes*.

Icon design

Icons appear in many interfaces and they are used for representing different types of functionalities, as well as desktop objects [Preece'07]. The icons are

considered to be easy to learn and use. An important aspect of the icon design is to make the meaning of the icons/images clear. An icon can be considered as a visual metaphor, which relates the specific image to a certain function at the interface. The good icon design provides the user with visual metaphors which can easily be understood and perceived in the right way, as well as related to the current situation by the users [Leventhal '07].

Screen design

Screen design has two aspects – how the task is split across a number of screens and how the individual screens are designed [Preece'02]. The first aspect can be approached by splitting the task into subtasks and specific actions and each task or subtask can have its own screen. However, it needs to be considered how simple and complicated tasks will be presented on the screens, because simple tasks might need to be combined on one screen, while complicated tasks might need to be presented in several screens, in order to keep a balance in presenting the information. The second aspect is related with the visual design of each screen. The visual design can be influenced by elements, such as use of colour, motion, grouping elements and the overall organization of the information. The design should assure that the user's attention is drawn to the important interface elements for a certain task. According to [Leventhal '07], good visual design can improve the usability of the designed application.

Gestalt laws

There are different guidelines which can be used for achieving good organization of the information on a screen. Some of the guidelines, which have been considered in this project, are the Gestalt laws. Gestalt laws are usually used to suggest how individual elements of an interface can be organized, so that better results are achieved in the visual design. The used Gestalt laws are:

- 'Law of Proximity' – Objects, which are closer to each other are perceived as forming a group [Borchers'96]. This is used to indicate that certain elements belong together.
- 'Law of Unity' – Objects that form closed shapes are also perceived as a group [Borchers'96]. This law is expressed in practice by using boxes and frames around some interface elements.
- 'Law of Equality' – Similar objects are also perceived as a group [Borchers'96]. The similarity of the objects can be achieved by characteristics, such as shape, colour, size, texture and orientation [Mullet'95].
- 'Law of Good Shape' – The perception tends to see objects as having perfect or simple shapes, because it makes it easier to remember [Borchers'96]. This law can be applied when designing buttons, which should have simple forms.

- ‘Law of Balance/Symmetry’ – The law is related to grouping based on the overall properties of the form instead of its separate parts [Mullet’95], or perceiving symmetrical objects as one whole structure. Furthermore, an object needs to be balanced and symmetrical in order to be perceived as complete [Chang’02]. Balance/Symmetry can be achieved when visual ‘weight’ is placed equally on each side of an axis.

Colours

Colour can be a very powerful tool, which can be used for drawing the users’ attention to certain interface elements, which are important for a certain task [Leventhal’07]. This is why, the choice of colours is important for attracting the users’ attention to the right elements, as well as for distinguishing interface elements from each other and from the background.

4.7 Prototyping

The users should be able to evaluate different designs of an interactive product. This can be achieved by prototyping or creating interactive versions of the designs (or designers’ ideas). Different types of prototypes can be used in different stages of the development. By creating different version of prototypes and by evaluating them in an iterative process, the final product is expected to be improved.

4.7.1 Low-fidelity prototypes

Low-fidelity prototypes are usually made by using paper and cardboard and they do not look very much like the final product. They are cheap, simple and easy to modify, so they can be used for explorations of alternative designs and ideas. Thus, the low-fidelity prototypes are used in the beginning of the development, especially during the conceptual design. [Preece’02] describes the following low-fidelity prototyping methods and techniques:

- Storyboarding – consists of series of sketches (screens for a GUI-based software system or scene sketches) which show how the user will perform a task using the device/application that is designed. Storyboarding can be used together with scenarios. In this way, the users are given possibilities to perform role-playing with the prototype while interacting with it by going through the scenario step by step.
- Sketching – when creating low-fidelity prototypes it is usually necessary to sketch different elements as icons, dialog boxes, symbols, etc. It is not necessary to create very advanced drawings, some elements can be presented by simple boxes, stick figures and stars, which can be used in a storyboard sketch.

- Prototyping with index cards – index cards are small pieces of cardboard and they can be used to prototype an interaction. Each card represents a screen or an element of a task. The users can use them to pretend that they are performing a certain task, while interacting with the cards.
- Wizard of Oz – interacting with a low-fidelity prototype can be achieved by using Wizard of Oz techniques, where the designer plays being a computer and shows the appropriate screen at the appropriate time, depending on the user's actions or saying what the actions are [Jones'06]. It is stated in [Preece'02] that Wizard of Oz approach assumes that there is a software-based prototype, and in [Leventhal '07] – that the operator, who actually runs the prototype and simulates output, depending on the user's actions, is unknown to the user. However, it is believed that the Wizard of Oz method can be applied with a paper based prototype, including cards, representing different screens of the designed application. When the user 'presses' something or thinks aloud what he/she does, the designer shows the appropriate screens. In this way, interaction can be achieved with the cheap and easy to make paper based prototypes.

4.7.2 Hi-fidelity prototypes

Hi-fidelity prototypes look more like the final product and are usually made from materials which are expected to be in the final product [Preece'02]. If a software system is designed, the hi-fidelity prototype should be electronic and developed by using a software tool. The hi-fidelity prototypes are used during the physical design. They are fully interactive and have the look and the feel of the final product but they are expensive and time-consuming to create.

4.8 Evaluation

Evaluation is a very important part of the design process because it helps designers to receive feedback about their products if they are usable and if they meet the users' needs and requirements. The definition for evaluation, given in [Preece'02] is:

“Evaluation is a process of systematically collecting data that informs what it is like for a particular user or group of users to use a product for a particular task in a certain type of environment.”

The user-centered design concentrates on understanding and taking into account the users' needs through the design process, as it was mentioned previously. This is why, the evaluation activity is performed at different stages of the design process.

4.8.1 Evaluation approaches

There are different evaluation approaches in interaction design and each approach has some methods and techniques associated with it. Some of the main approaches, described in [Preece'07], are *usability testing*, *field studies* and *analytical evaluation*. [Preece'02] and [Jones'06] also present the evaluation approach *informal evaluation*, which is referred to in the literature as “Quick and dirty”.

Field studies approach is characterized with performing the evaluation in natural settings with the goal to understand what people do in certain situations and how products are related to their activities. The *analytical evaluation* is related to two types of evaluation methods: inspections, which include heuristic evaluation and walkthroughs, and theoretically based models. The analytical evaluation is used to identify usability and other problems in the design. The important difference about the analytical evaluation is that the users do not need to be present, the evaluation is usually performed by designers and experts. The other two approaches are used in this project and they are described below:

- Informal evaluation – an informal way for designers to receive feedback from the users about their ideas and to confirm that their ideas and designs meet the users’ needs and requirements. This approach can be used in all stages of the design process because for a short period of time and without special equipment the designers can receive feedback, which will guide them in the right direction for creating an usable product. The techniques associated with the informal evaluation are: observing users, asking users, asking experts, etc.
- Usability testing – involves measuring typical users’ performance on prepared typical tasks, which the system is designed to perform, in a controlled environment. The users’ performance can be measured by noting number and kinds of errors that the users make and recording the time that it takes for the users to complete the task. While the users interact with the application/system, they are observed and the actions that they performed are logged. User satisfaction questionnaires and interviews are also used to find out the users’ opinions. The methods associated with usability testing are user testing, observing users and asking users, where the user testing has a major role. The obtained objective performance data and the user opinions, collected by questionnaires and interviews, are used to determine how usable the product is in terms of usability goals.

4.8.2 Evaluation methods and techniques

The evaluation methods, which can be associated with the evaluation approaches, as described below:

- Observing users – helps identifying user’ needs and evaluating prototypes. The observations can be recorded by using notes, video and audio. There are also some challenges for the evaluator how to observe without disturbing the users and how to analyze the data.

In controlled environments, when performing usability testing, it could be a problem that the observer does not know that the users are thinking and they can only guess from what they see. A way to solve this problem is to use a *think-aloud technique* which requires people to say loud what they think and what they try to do when interacting with a prototype [Preece’07]. Sometimes the user can become silent for a long period of time and the observer can remind him/her to say what he/she thinks. Another efficient way to inspire the participants to share their thoughts can be to have a group of two people that work together and discuss what they think and do.

Logging the user interaction with the system by taking notes can be a challenge, because the evaluator can miss something while writing what is happening. This problem can be overcome to some extent, especially in the situations when the designers/evaluators have an idea what they are looking for, before the observations occur, by using a coding sheet [Jones’06]. The coding sheet consists of several columns, where each column represents a specific event, the evaluators are watching for. The evaluator can write a tick in the relevant column and the time when a certain event occurs. In this way, the evaluator can log different events quickly and still can probably manage to also take some unstructured notes for not expected interactions and events.

- Asking users their opinion – a usual way to obtain feedback about a product from the users if it does what they want, if they like it, etc. The most used techniques to ask people are interview and questionnaire techniques. The interviews and the questionnaires can have closed and open questions and which type of questions is used depends on the situation when they are performed and on the evaluation goals. Regarding evaluating user interfaces there are some standard questionnaires, as one of the most used questionnaires is QUIS – Questionnaire for User Interaction Satisfaction, developed by the Human-Computer Interaction Lab at the University of Maryland [Jones’06].
- Asking experts their opinion – experts or combination of experts and users

can inspect the human-computer interface and predict problems which the users might have when interacting with it.

- User testing – the main part of usability testing, which involves measuring the performance of typical users doing typical tasks in a controlled environment (or laboratory conditions). The performance is measured by recording time to complete the task, number and type of errors per task, number of navigations to online help or manuals, number of users making a particular error, number of users completing a task successfully, etc. User testing is a form of experimentation which tests if the product is usable and the intended users can achieve the specific tasks. The results of user testing are used to improve the usability design. It is important for user testing to control the conditions, for example ensuring that the conditions are the same for each participant. This is why, the evaluation process has to be planned carefully. The DECIDE framework can be helpful in identifying the necessary steps.

4.8.3 DECIDE framework

The *DECIDE framework* is a framework to guide evaluation [Preece'07]. It provides a checklist to help planning the evaluation:

- *Determine* the *goals* the evaluation addresses;
- *Explore* the *questions* that need to be answered;
- *Choose* the *evaluation paradigm* and *techniques* which will be used to answer the questions;
- *Identify* the *practical issues* that must be addressed, such as choosing participants, deciding how they can be involved, choosing equipment which can be used, considering time constraints, etc. The practical issues for user testing are related to deciding on which tasks to test the users' performance, selecting typical users, preparing the testing conditions, and preparing a plan and schedule how to run the tests.
- *Decide* how to deal with *ethical issues*, such as people's privacy (or people's names should not be associated with the data collected about them and disclosed in reports unless they give permission for that). The participants in the evaluation should be informed about the aim of the tests and that their personal information will not be made public. It is a normal practice to ask the participants to read and sign an informed consent form with such information.
- *Evaluate*, interpret and present the *data*.

Another important point in the evaluation is to make a schedule for the evaluation study and to make a trial run (or a pilot study) of the planned evaluation. The pilot study can include checking the equipment and instructions, checking if the questions in the interviews and questionnaires are clear, checking that the experimental set up works properly, etc. It will help identifying problems in advance.

4.9 Creativity methods and techniques

Designing and developing of successful new products depend on the abilities to generate creative and innovative ideas. Different creative methods and techniques can be used in combination with interaction design methods in order to stimulate the creative thinking of designers and users.

Creativity is characterized with the abilities to think innovative (or out of the box), to consider different and unusual perspectives. Two main principles, which are recommended to be used in all stages of a creative process, are *divergent* and *convergent* thinking [Vidal'04]. Divergent thinking involves producing as many ideas and solutions as possible. After that, convergent thinking is applied to reduce the ideas and select the most promising ones. These two principles can be represented in a form of a diamond, which can be seen on Figure 4.7.

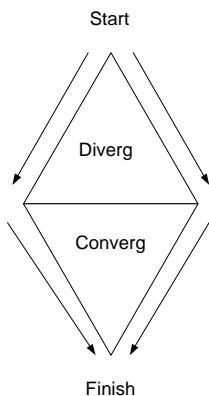


Figure 4.7: Illustration of diverging and converging processes

The *creative tools*, described in [Vidal'04] which can be used to support a creative process are:

- Brainstorming – used very successfully for producing many ideas and it encourages generating unconventional ideas. Critiques are not allowed

in brainstorm sessions and the participants can produce a large number of ideas and combinations of ideas freely. Brainstorming can be used in different situations where new creative ideas are required. It can take different forms: using post-it notes by the participants and placing them on a big piece of paper or the wall; the participants write their ideas on a big paper/papers, placed on the walls; group discussions, where the participants share ideas orally. A main characteristic of brainstorming is that the participants can see the ideas of the others and in this way, they can get inspired by each other and produce new ideas.

- Brainwriting – a form of non-oral brainstorming, where all rules of brainstorming are applied. The participants sit in a circle, write down their ideas for solving a specific problem and pass the papers to their neighbours, who brainstorm about the ideas on the paper for a short period of time and pass the paper further [Vidal'06]. This tool can lead to developing ideas from different perspectives and can be used for creating scenarios for example.
- Picture stimulation – used to provide ideas beyond those that can be obtained through brainstorming sessions. The participants look at set of selected pictures and relate the information gained from the pictures to the problem.
- Object stimulation – similar to picture stimulation but different objects are used instead of pictures. Sometimes words can be used, instead of pictures and objects, to associate with the problem.
- Mind mapping – used to structure complex situations through the problem solving process. Mind mapping is defined as a creative pattern of related ideas, thoughts, processes, objects, etc. Mind maps are usually used to structure the ideas after a brainstorming sessions as pictures, icons, colours and texts can be used to illustrate the ideas. The mind maps are constructed by drawing ideas from the center of the paper and moving in a radial and parallel way. An example of mind map is shown on Figure 4.8 and illustrates different concepts related to the process of mind mapping and its application.

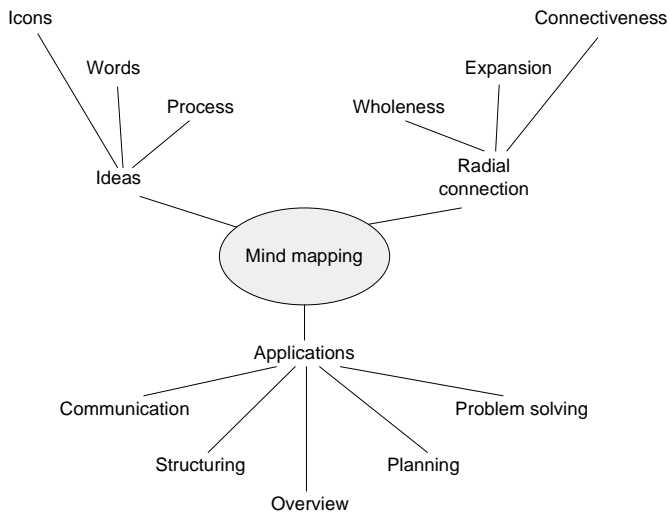


Figure 4.8: Mind Mapping (taken from [Vidal-Book'06])

Identifying User Needs and Establishing Requirements

The first step in the simple life cycle model, which has been decided to be used in this project, is identifying needs and establishing requirements. The process of identifying needs and establishing requirements for creating a statements based profile management application is shown on Figure 5.1, which includes only the first step from the iteration process, presented on Figure 4.3.

The data gathering techniques, which has been used to gather needs and requirements, are interviews and a workshop. First, the interviews have been made in order to collect some data about the users' general opinion about the concepts of PN and statements, as well as the possible ways of using the statements based application. After the interviews, initial drawings, expressing possible functionalities of the statements based profile management application, have been created. These drawings have been used in the workshop for an evaluation of the initial ideas. The workshop was also used for collecting more specific information for the use and functionalities of the application. This design phase has actually included a full iteration of the simple interaction design model, because there was gathering of information, creating some paper-based prototypes and making an informal evaluation on them.

The collected data from the interviews and the workshop as well as the initial drawings have been analyzed and used as input for creating the initial requirements specification. Some of the requirements have also been inspired by exist-

ing applications and designer's ideas and consideration.

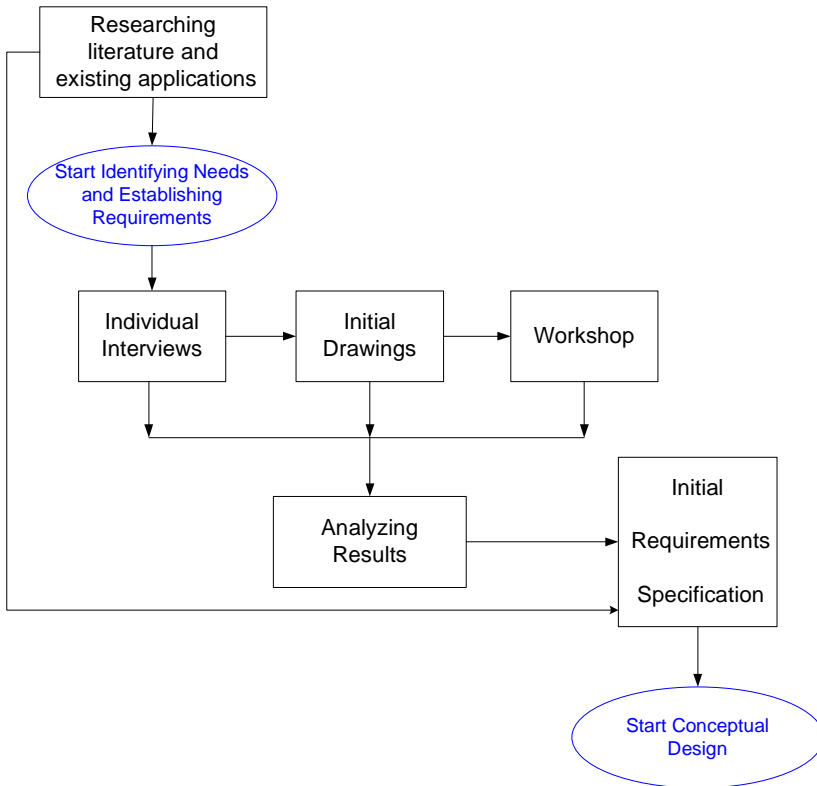


Figure 5.1: Process of identifying needs and establishing requirements

The planning structure of the interviews and the workshop has been inspired by the DECIDE framework (see Section 4.8.3) which is basically used for planning evaluations.

5.1 Interviews

The interviews were the first step of identifying user needs, which helped in obtaining initial information and user opinions about different concepts, related to this project. The planning process was based on the DECIDE framework elements. The implementation of the interviews and a summary of the results are presented further.

5.1.1 Planning and implementation of the interviews

Goals

The goals of the interviews were to identify the types of users (students) in terms of experience in technology and privacy concern; to find out the users' general opinions about the concepts of PN and statements; to find possible areas where the statements based application can be applied; and to find possible functionalities of the application which can enhance the student's work.

Questions

The questions which needed to be answered in the interviews are influenced by the determined goals of the interviews. The types of users are identified by using the helpful questions, specified when the four fictitious users (or personas) were created in 'MAGNET' (see Section 2.5.1). All questions which were prepared to guide the interview can be found in Appendix B.1.

Methods and techniques

The interview itself is a method for gathering data and it has been chosen in order to get information about different individual students. It has been decided to use semi-structured interviews with open end and with open and closed questions. As it was mentioned, a basic script with questions has been prepared for guiding the interview and to make sure that the main points are covered. The interviewer first used the prepared questions and when it was needed additional questions were asked in order to obtain more relevant information. The interviewer had the freedom to change the direction of the interview and to ask new questions depending on the user and his/her understanding of the specific problem. The order of the questions was organized in such a way that it was logical to go from general concepts (technology, privacy, control, trust, etc.) to more specific ones concerning the PN and statements. Because the concepts of PN and statements were new to the users, small presentations about them were given in the process of the interview before the questions related to each concept. The new information is not given at the beginning because the users should be lead slowly to the concepts and they need to warm up in order to better understand the concepts and to be creative. The closed questions in the interviews have been used to introduce the user into the topic and they were followed with open questions to obtain more information for the specific subject. The open end of the interviews gave possibilities for the users to discuss everything they thought was relevant and that they were inspired by in the process.

Practical issues

The practical issues, which have been considered, are related to users and equipment. The users who have been invited to participate in the interviews are students from different departments at DTU. By interviewing them it was possible to find different requirements for the application (because of the different needs

the students have). The interviewer had a paper with guiding questions, but the interviews have been recorded in order to achieve more fluency of the interview (not interrupted by stopping it to take notes). The necessary equipment was a microphone, a laptop and a recording computer application.

Ethical issues

Before each interview the interviewee was asked if he/she gives permission to record the interview. The users were also informed that their names will not be used in the report and that the recorded information will be used only for the purposes of this master project.

Analyzing and presenting the data

After all interviews were made, the recorded information was written down. The answers of the questions for each user were organized in different groups, as each group combines questions for a similar subject. How the questions are combined and what groups are created can be seen in Appendix B.1. The collected data from all users is presented as all information related to a certain subject is given at one place (not each interview information separately). By combining similar information from all users it was easier to analyze the data and it has led to finding more patterns in the different users' answers.

5.1.2 Experience in the process

The process of making the interview was an interesting experience. It was clear that the success of the interview and obtaining relevant information depend highly on the interviewer's skills of asking questions. The interviewer also needed to clearly present the new concepts and giving examples in the right way and at the right moment. In this way, the users would understand what was needed but would not be influenced by the designer's ideas. Some of the users could understand the questions and the concepts very fast, some needed more explanations and examples in order to answer the questions. It was difficult at moments to make the users imagine situations which they have not experienced, but when trying to relate the concepts to their everyday life, they could give very interesting answers. Some of the users had ideas about how the statements based application can assist them in their lives so they could give good examples and ideas very fast. In general, most of the users were active and as result, very relevant information was obtained. The first interview turned out to be a pilot study, because some difficulties and inconsistencies were found in the questions and in the order of the questions, which required adjusting the questions for the following interviews.

5.1.3 Results from the interviews

15 users have participated in the interviews. They were students in engineering with different technological background – some were students in Computer Technologies and Telecommunications and others in Biotechnology, Mechanical Engineering, etc. Full overview of the participants in the interviews is given in Appendix B.1.2. The raw results from the interviews of all users are presented in Appendix E. A summary of the results from the interviews with the important and interesting findings is presented further. The findings from all users are organized in groups by combining relevant questions from the interview.

Types of users

Inspired by the four fictitious users, created in ‘MAGNET’, the users from the interviews have been analyzed and classified in one of the defined user groups. Only three of these user types could be determined between the users participating in the interviews. The users were classified by evaluating the following parameters: Technical experience, Demand of control, Privacy concern, Level of trust, Social issues (attitude to strangers), Automatic actions, User Interface and System feedback. Interpretations of the fictitious users’ attitudes, defined in ‘MAGNET’, which suit the users from the interviews are presented in Table 5.1, Table 5.2 and Table 5.3. Only three types of users are given, because only three were identified when analyzing the results from the interviews. Some of the reasons why a Fictitious user 4 (technically experienced and not privacy concerned) has not been found among the students at DTU can be that the high experienced engineers are aware that something can go wrong with the systems and that the information they provide is not fully safe. They pay attention to what information they give and this is why, they are privacy concerned.

Most of the users (9 of them), who participated in the interviews, were identified as the third user type (Fictitious User 3), 5 users – as Fictitious User 1 and 1 user – as Fictitious User 2. Some of the users do not exactly fit in the description of one of the fictitious users, but they are classified to the closest one. A summary of the different parameters for each user, used for identifying the user types are shown in Appendix B.1.3. The fact that there were no users, who represented Fictitious User 4, and there was only one representative of Fictitious User 3 could have influence on the results, because of the lack of input from users who are not very privacy concerned.

The following conclusions about the different users’ attitudes to the parameters used for identifying the user types, which can be taken into consideration in the design process, are:

- Asking for confirmation for different actions should be optional and the user should be able to choose in which situations the system would ask for confirmation. The system should perform actions automatically mainly

Fictitious User 1: (see Figure 2.3a)	<i>Low/Medium Technical Experience</i> <i>Very privacy concerned</i> <i>High demand of control</i> <i>Low/Medium Trust</i>
Technical experience	Not too experienced user in using technologies
Demand of control	High demand of control. The user does not mind to confirm all actions in many cases.
Privacy concern	Very privacy concerned. The user does not want to give too much personal information.
Level of trust	The user trusts the systems only in some situations.
Social issues (Attitude to strangers)	The user does not like to be contacted by strangers, especially by e-mails and telephone calls.
Automatic actions	The user does not like the system to perform actions automatically, except when the tasks are simple and trivial.
User Interface	The UI should be practical and possibly good-looking and well-designed.
System feedback	The user would like to receive feedback almost always, especially in error and complicated situations.

Table 5.1: User type 1

for simple and trivial tasks, that the user does very often. By default it could be that the system asks before it performs an action and the user should be able to choose if the system should continue to ask or not (or performing actions automatically will be optional). The actions should not be too automatic, because the users would lose the control.

- Privacy issues should be addressed in the application. Only necessary personal information should be required for the specific purposes. Providing any extra personal information should be optional. The privacy policy and rules should be available, so the users would know how their information is used.
- The user's trust can be gained if the application performs what it is supposed to, gives notifications in the important situations or if it is trusted by other people.
- When a stranger contacts a user with some beneficial information for the user, the purpose of the contact should be stated, so the chance that the user answers is higher.

Fictitious User 2: (see Figure 2.3b)	<i>Low Technical Experience</i> <i>Less privacy concerned</i> <i>Less demand of control</i> <i>High Trust</i>
Technical experience	Not experienced user in using technologies
Demand of control	The user does not need to be in control, but wants to know sometimes what is happening with the system.
Privacy concern	The user is not very privacy concerned, only when the websites and the systems seem very untrustworthy.
Level of trust	High level of trust in the system.
Social issues (Attitude to strangers)	The user is a very social person. The user would like to be contacted by strangers.
Automatic actions	The user likes when the system perform actions automatically.
User Interface	The UI should be fancy, but without too many flashy things and too many colors.
System feedback	The user would like to receive feedback in general, but he/she wants to be able to choose if he/she wants to receive feedback. In this way, the user can skip feedback in situations when he/she knows what is happening.

Table 5.2: User type 2

- The UI should be practical, well-designed and working fast when a good performance is required, mainly when an application is used for studying or work. The UI can be ‘fancy’ when an application is used for fun and pleasure, but the fanciness should include good graphics, nice colors and not too many jumping, flashing and irritating elements. The optimal solution will be a trade-off or a good combination between a simple and fast working UI and a fancy UI.
- The system should be able to provide feedback, especially in error and complicated situations. Providing feedback should be optional, so the users can choose themselves for which tasks they want to receive feedback. The feedback can be provided by popping up ‘dialog boxes’, especially in error situations because the user would need to react in some way to continue his/her work; in a log file (for more experienced users); or in the status bar, so the user can see it but does not need to press anything.

When analyzing the answers from the different types of users for the concepts of PN and statements, there were not found significant differences between the

Fictitious User 3: (see Figure 2.3c)	<i>High Technical Experience</i> <i>Very privacy concerned</i> <i>High demand of control</i> <i>Low Trust</i>
Technical experience	High level of experience in using technologies
Demand of control	High demand of control, but the user does not need to confirm all actions the system does.
Privacy concern	Very privacy concerned. The user wants to have choice what information to give and wants to see the privacy policy.
Level of trust	Low trust in systems.
Social issues (Attitude to strangers)	The user does not like to be contacted by strangers. The user socializes difficult with people he/she does not know.
Automatic actions	Some actions can be automatic, but not all. The user would like to define which actions to be automatic.
User Interface	The UI should be simple and plain. It is more important to have good performance and to work fast than to be fancy.
System feedback	The system feedback should be provided for complicated tasks, not for simple ones.

Table 5.3: User type 3

different types users' opinions and attitudes. This is why, the results are summarized together for all users by extracting the common opinions and pointing out some interesting thoughts and solutions.

Management of Personal Network

Many users like the idea of centralized control of the PN. Most of the users would like to have possibilities to control their PN from each device, or at least from devices, such as computer, laptop, PDA, mobile phone. It might be difficult to control the whole PN from an "intelligent key" for example. Several users also mentioned that they would like to choose themselves where they want to manage the different devices from. Another issue which arose was related to the security of the PN. The users were concerned that security measures should be considered to avoid making all devices vulnerable if the controlling device is lost or stolen.

Most of the users would like to include around 5-10 devices in their PNs, so it is easy to manage them. These users did not expect that they would have more devices, which is most likely because of the fast development of the technologies.

2 of the users thought that the number of devices depends on the user's needs and if the user uses many devices very often, it should not be a problem to include all of them in the PN, especially if they can be controlled from a central device (e.g. PDA).

User's Personal Network

All users would like to include a computer (a desktop computer or/and a laptop) and a mobile phone in their PNs. 13 of the users would also add a PDA to their PNs, as some of the users would like the PDA and the mobile phone to be combined in one device. Other devices which the users would use in their PNs to help their studies are printer, scanner, projector, copy machine, USB-memory stick and iPOD. Some of the users would prefer to include home devices, such as TV, DVD recorder, washing machine, fridge, oven, stereo, lights, heaters, clock, etc. and a car in their PNs. More unusual devices which were mentioned are intelligent watch, intelligent key, interactive calendar and electronic library. The users would also like to have possibility to connect external devices to their PNs, for example printer at DTU, experimental equipment, etc. The external devices would be the ones that are not owned by the user, but the user uses for a certain period of time.

How do the users understand 'user profile'

The most common understandings for 'user profile' are:

- General description of the user, which contains user's personal information as name, age, address, e-mail address, telephone number, etc., user's habits and preferences.
- Set of settings which allows the user to personalize a device or an application.

Using statements

- The statements have been found useful for configuring settings in general, as well as for managing sharing and privacy settings, because settings of different devices can be activated from one place, instead of manually selecting the settings from each device. This makes configuring devices faster. Another issue which needs to be addressed so that the users would use the statements is the security of the system – the communication between the devices has to be secure with a proper encryption.
- The users would feel comfortable to use statements if the statements are easy to understand, use and configure and if the users can define them themselves. It would be nice to have well-defined schemes and profiles (or statements templates) with default values so the user can see an example of a statement, but it should also be possible to change the default statements

and define new ones. Some people would feel comfortable using statements if they can control them (or change them).

- The users would trust the devices in configuring the statements correctly and feel in control if they have defined the statements themselves and if they can see an overview of the settings of a particular statement. Many users would trust the statements based application and devices if they have tested the application first and they have seen that it works and that the settings are applied correctly. Trust to the application can also be gained if the application is recommended and trusted by others.

Situations/Activities in which the user would use statements

The statements are associated with different activities and situations, as well as different moods and status. The preferred statements with possible settings of the devices are given further. The different settings are optional and are a combination from the answers of different users. Some users prefer to have general statements for basic things – for example ‘At university/school’, ‘At home’, ‘Leisure time’, etc. while others would like to have statements for more specific activities, such as ‘At a lecture’, ‘Group work’, ‘Experiments’, etc. (or different statements for the activities they have at school). Both general and specific statements are described.

‘At university/school’ – All devices are in silent mode; the necessary papers are printed out; all messenger programs are off.

There should be a possibility to include special equipment (device or a piece of electronics), which the user needs for a specific project or course in the user’s PN.

‘At a lecture’ – All devices are in silent mode (the mobile phone can also be off); the mobile phone can receive calls from the user’s family in case something important happens; the voice recording machine starts recording the lecture; the laptop starts, logs on to the wireless network and connects to the DTU’s authorization website; if a specific course is chosen (or typed in) the slides for the specific lecture are downloaded to the laptop; the PDA shows the user’s notebook; if the user has prepared something for the course, it pops up on the laptop or the PDA; the laptop/the PDA has access to a printer so the user can print if he/she needs something for the lecture; if the user has not brought his/her computer there should be access from the user’s mobile phone/PDA to the computer so the user can take a file or a presentation from it. Not all users would like to download the slides for the lecture all the time, only when they decide.

The statement ‘Lecture’ can have parameters, for example which is the lecture, but according to the users one parameter will not be enough. It will also be necessary to know which number lecture it is for the year in order to find the

right slides. This, on the other hand, will require the users to select several things to activate the right set of settings and it will take longer time, so the users might not want to use sub-statements and parameters. The statement ‘Lecture’ can have sub-statements ‘Not listening’ if the user needs to go out of the lecture or gets distracted and ‘Not understanding’ when the user does not understand what the teacher is talking about. The settings for both sub-statements are the same – the voice recorder starts recording the lecture and the corresponding slides are marked so the user knows which slides he/she has to read more carefully (if all settings are the same, maybe only one statement will be required).

‘Project work’ – Sharing files with colleagues from a project, teachers and other students. The sharing folder can have different status and thus different access rights can be given. For example, if the status is ‘Working in progress’ only project members have access; when the status is ‘Delivered’, the teachers have access and when the status is ‘Graded’, group members and the rest of the students have access.

‘Giving presentation’ – The mobile phone is silent (or off); the projector is on and it has a direct access to the presentation file and other data which is needed for the presentation.

‘Experiments’ – The computer collects data from the experimental devices (which have been connected to the user’s PN); the computer or the PDA has access to a database to get the necessary materials (e.g. protocols which are guides for the experiments in the lab); the needed protocol is printed out; the task description is loaded on the screen (or printed); the mobile phone is silent; the necessary computer programs are started – e.g. Word, Excel, software for mathematical calculations, etc.

‘Semester starts’/‘School starts’ – When a new semester starts the user’s schedule is downloaded and this information is synchronized with all user’s devices; the information is updated regularly in all devices; there are also regular checks for news, e-mails, uploaded files in the working sharing folders and notifications if there is something new.

‘Meeting’ – The mobile phone is off; the agenda for the meeting pops up automatically on the laptop or PDA. If the meeting is with a supervisor and the supervisor mentions an article, the computer finds it for the user and prints it at the user’s printer at home.

Some other statements related to university or school are: *‘Group work’*, *‘Databar’*, *‘Library’*, *‘I am studying’*, *‘I am reading’*.

'At home' – Access from the home computer to a computer at the university; the computer logs on Internet, starts certain programs; the PDA synchronizes with the computer; the mobile phone has a normal sound settings; if the user has a central computer at home, which can be controlled from the mobile phone for instance, the heaters, lights, coffee machine, water warmers can be controlled from distance.

'I am sleeping' – The mobile phone is off (or silent) and only emergency calls can get through; Alarm clock is on; the fridge does not report any problems with food; the computer closes down or if the user has files for sharing, the computer is on and it uses the whole bandwidth for sharing; the temperature is set to for example 18 degrees; the lights are off; the water warmers are off (but they start working an hour before the user needs to get up); TV is off; Camera recording the front door is on; alarm system on; oven off.

'I am awake' – The mobile phone turns on; the computer checks for new e-mails;

'At work/At the office' – Mobile phone is in a silent mode; music player is off; the work computer is on; the coffee machine is on and it is set so the coffee is ready when the user arrives at work; the e-mail program and any other programs that the user uses for work are started.

Some sensors which can detect different states can be involved so some of the settings will be activated automatically. If the users stay in control and can change settings they would still feel in control.

'Watch a movie at home' – the computer at home is turned on; the movie program is automatically found, started and the image is displayed on the TV; the mobile phone or the PDA is used as a remote control.

The process should not be completely automated. There should be some security considerations so the neighbour will not be able to start the user's TV from a mobile phone.

Statements connected with the *'Mood'* – Specific music is played on the iPod or stereo (depending on the chosen mood); specific lights set-up is arranged.

'OFF' – All devices are turned off.

Some other possible statements are: *'Leisure time'*, *'In the gym'*, *'Cinema'*, *'Resting'*, *'At a party'*, *'Status Busy'*, *'Status Away'*, *'Status working'*, *'Now I have visitors'*, *'Away from home'*, *'Disconnect'*.

Possible settings of devices

The options for each device should be relevant settings for the particular device and some users think that all possible settings should be available for the user to choose from. It could be useful to have general settings (for example a high layer security scheme) which will apply to all devices, but there should be some rules to solve conflicts between the general settings and the settings of each device.

Mobile Phone – On, Off, Silent (if the user is at a lecture), Normal ring tone, Very loud (if the user is at a party), Vibrating, Different ring tones depending on who is calling.

Computer – On, Off, Connect to the Internet, Start e-mail program, Start Messenger program, Start Internet browser or other programs that the user needs, select settings of programs on the computer, Get slides for a lecture, Get last work/file on the project, Play specific music.

iPOD – On, Off, Different types of music depending on what the user is doing or the user's mood.

Fridge – Give sound notifications when the user is in the kitchen, communicate with the computer and send a list of the spoiled food and a shopping list (with the missing food).

TV – On, Off, Which channel to start.

Voice Recorder – Quality of sound, Volume level of recording.

Lights – The lights can be set depending on the certain atmosphere the user wants to create (e.g. night lights, party lights, reading lights), Turn on when the user comes home.

Managing statements

Formulating statements – The statements should be short (a word or a short phrase) and they should be formulated in a way so they suggest what the statement is about. They should also be easy to remember, but the users should be able to define the names themselves and to change the names of the predefined default statements.

Number of statements – The number of statements depends on the user's activities and how often a specific statement is used. Most of the users would use the statements for general and very often situations so they would need about 3-5 statements. On the other hand, if the user is in many different situations very often, there should not be a problem to use 10-20 statements. It is possible

to have some sub-statements but they should not be too many.

Activating/Switching between different statements – It should be possible to start the statements based application easily with for example a shortcut, a key combination, an icon, etc. When the statements based application is started there can be an icon in the taskbar which shows the active statement and when it is pressed, all statements are shown in a list from which the user can select another statement. The statements can also be presented in a drop-down menu in the taskbar or the toolbar on the top. Other ways are the statements to be shown in a menu (as the ‘Start’-menu for example), list (as the active courses in ‘Campus Net’) or buttons somewhere on the screen. If there is a small icon for the application in the right corner on the top or the button which shows the statements, the statements can be shown as small icons on the whole screen if a PDA is used. Statements can be activated by voice. Statements for simple tasks can be activated by using context aware services, but the user should be able to override the settings manually.

Configuring a statement – In the list/Drop-down menu or in the regular menu where the statements are, there should be an option ‘Create a new statement’ and it should also be possible to edit an existing statement by choosing ‘Edit statement’. The possible settings can be grouped by devices and some general settings (e.g. network and security settings). When a new statement is created/edited, the devices and the general groups settings are shown in a list, drop-down menu, regular menu, buttons, or tabs and when a device is selected, the possible settings for the device are given as check boxes, radio buttons or drop-down menus. The settings of each device can also be organized in groups, for example ‘Sound’, ‘Graphics’, etc. The statements, devices and settings of devices can be organized in a tree structure with possibilities to add devices and settings for the devices. The statement is on the top and when it is expanded, the devices are shown as branches. When each device is expanded, the settings of the device are shown on the third level. If a statement is only edited, the used devices and the active settings are shown, but each statement has a branch ‘Add a new device’ and each device – ‘Add a new setting’. The tree structure would be efficient if there are not too many devices. It is preferred to have some templates with default values which can be used when creating a new statement, instead of starting from scratch. There should be possibilities to see an overview of what a specific statement activates or what the settings of a particular device are. It should be possible to see common settings of all devices (by selecting for example ‘All common’ from the list with devices) so it will be easier to activate similar settings to several devices at once (for example all devices are silent). There could also be an option to see the settings of all devices at once (by selecting for example ‘All settings’) which on the other hand can produce a very long list and might not have too much usability. If there are contradictory settings, the application should prevent the user from making

mistakes. It could be that a user can not choose two settings to be active at the same time (for example 'ON' and 'OFF'). In this case, when one of the setting is chosen, the other will be disabled so the user cannot select it. The statements should be configured efficiently, without too many 'Click Next'-dialogs.

Social aspect of using statements – The statements would have a good effect on the users if they are practical and useful, help in configuring devices and make things faster. Using statements could help the users become more organized and improve their security (for example the system will automatically check if the doors at home are locked). Some users think that the statements will not have too much effect on their lives and others say that the statements will irritate them if they need to change the statements only for slightly different situations.

Avoiding irritation and intolerable experience when using statements – It should be possible to see an overview of the settings of a statement. The statements should be short and intuitive. Examples and tutorials should be available. It should be easy to work with the application and it should be trustworthy. It should be easy to find the statements and activate a new one. The statements should not pop-up all the time or be visible all the time. The default statements should be logical for new users to use and they should be able to be changed afterwards. Asking for confirmation and giving feedback should be optional and the users should be able to choose when they would like to receive notifications. It should be presented in some way which statement is active.

Sharing

Most of the users share information. Private information is only shared with people they know or with systems they trust. The users would never share information about their bank accounts, credit cards and passwords. There are some users that try to share as little as possible information and some that share a lot of information. The main sharing groups that the users have are 'Family', 'Friends' and 'Colleagues at work/at school'. The users would share pictures, music, home movies and maybe some more private information within the 'Family' sharing group; pictures, music, home movies, events information within the 'Friends' group; information related to the work/studies, files for reports, lecture notes, articles, results from experiments within the 'Colleagues at work/at school' group. The users would share the information by uploading it on ftp server, 'Campus Net', sending e-mails, sharing folders or by using a statement 'I want to share' with parameters [who to share with][what to share]. Checking if one of the user's friend have something new to share can be through a statement 'Check shared information'[name of a friend/group].

Enhancing student's work

The statements could enhance the student's work if they provide an assistance

in configuring the settings of devices. This could be achieved if the user knows what a statement does, notifies when there are contradictory settings, organize things and make them faster (so it saves time for the student which is very important). The statements could be helpful in exam periods when the students are stressed and can forget to do something important.

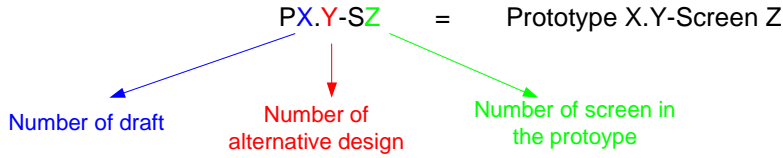
Additional functionalities and comments

- Two versions of the application can be provided – one for experienced and one for non-experienced users;
- The system should provide feedback in error situations;
- The statements can be valid for a certain period and in this way, they can be scheduled – the first statement can be active for 2 hours and after that the next statement is activated automatically;
- It should be possible to see which devices are being manipulated by a specific statement;
- The statements should be able to be activated by voice;
- The statements should be able to be activated automatically (by context awareness for example);
- There should be secure communication in the system;
- The system should give notifications if non-authorized activities occur on different devices, e.g. if somebody is trying to access the user’s computer;
- The system should give notifications when a device is out of battery;
- The system should check the status of devices automatically and give notification only if something is wrong.

5.2 Initial Drawings

By using the ideas from the interviews before the full analysis of the results, three alternative paper-based designs of the statements based application have been created. These designs are initial and they illustrate the first ideas about managing and configuring statements (see Appendix B.2). To be able to control the versions of paper-based prototypes, a specific notation is created for identifying which draft prototype and alternative design a certain drawing/figure represent. The used notation is shown on Figure 5.2.

The different alternative designs show different ways of activating statements, selecting devices and corresponding actions. The designs offer options of adding,



Example: P1.1-S2 = Paper prototype, draft 1, alternative design 1, screen 2

Figure 5.2: Notation for paper-based prototypes

editing and deleting statements, viewing what a statement activates, adding, editing and deleting devices and settings, viewing settings of a specific device, etc.

5.3 Workshop

The workshop was the second technique used for gathering the user needs and requirements. The planning process was based on the DECIDE framework elements. The implementation of the workshop, as well as the results are presented further.

5.3.1 Planning and implementation of the workshop

Goals

The goals of the workshop were to get additional information about the user needs when creating a PN, in which situations the users would use statements, how the statements are associated with specific devices and settings and how the statements can be presented and managed. Another goal in a slightly different direction was to evaluate the initial paper-based prototypes or drawings, created after the interviews.

Questions

The questions that need to be answered to reach the goals are included in the concrete tasks which were given to the users. The users should answer what devices they would include in their PNs, when they would use statements and how they would prefer to manage the statements, as well as the users should express their opinions about the shown alternative paper-based prototypes or sketches of the statements based application. The tasks and corresponding questions are described in detail in the plan for the workshop in Appendix B.3.1.

Methods and techniques

The workshop as a method was chosen for gathering additional information, because the users can get inspired by each other in the process and can produce more interesting and creative ideas. First, the users were presented with the main concepts which would be used in the workshop – PN, federation of PNs and statements. After that, the users were asked to do some tasks, in which different methods and techniques were used. Some of the main methods during the workshop were the creative methods – picture stimulation, brainstorming, mind mapping and brainwriting (see Section 4.9). A method from the Interaction design – creating personas or fictitious users – was used when creating scenarios for using statements (see Section 4.4.5). The users were also in the role of co-designers and through the participatory design they could create some screens about how the statements would be managed by drawing and using some elements prepared by the designer. The users also had available screen dumps of configuring general, privacy, security and sharing settings of existing applications. All of the methods are chosen with the consideration to inspire the users by showing them different elements and encourage them to add new elements and edit the existing ones in order to fit their needs and requirements. The evaluation of the initial drawings was informal (see Section 4.8.1) – there was a little discussion about the paper prototypes between the designer and the users, so the designer could receive feedback about the conceptual ideas. The initial drawings were shown to the users after the users created their alternative designs of the application in order not to be influenced by the designer’s ideas.

An overview of the tasks and the whole process of the workshop can be seen in the following short version of the workshop’s plan:

13:30 – 14:00: Welcoming and presenting what the workshop is about:

- Personal Network (PN) and Federation of PNs;
- Statements;
- Configuring settings by using statements.

14:00 – 14:20: Creating Personal Network

14:20 – 14:40: Brainstorming for different setting/options for devices

14:40 – 14:50: Break

14:50 – 15:10: Brainstorming for situations and activities for which statements can be used.

15:10 – 15:40: Associating situations/activities (respectively statements) with devices and their settings/options.

15:40 – 16:00: Creating some scenarios for situations and how to use the statements to configure devices in the different situations.

16:00 – 16:15: Cake break

16:15 – 16:45: Creating different ways (or screens) for managing the statements and the settings of the devices.

16:45 – 17:15: Evaluating alternative drawings for managing statements and settings of different devices.

17:15 – 17:30: Evaluation of the workshop

Practical issues

The practical issues which have been considered are related to users and equipment. The users who have been invited to participate in the workshop are students – 4 of the users are male, technically experienced, studying at DTU and one is a female, not too experienced in using technologies, student at CBS (Copenhagen Business School). 2 of the users have participated in the interviews, so they have had some understanding of the concepts in advance. The necessary equipment for the workshop was coloured and white papers and cardboard, pens, markers, scissors, recording equipment (a microphone and a laptop), camera for documenting the process. The set up of the workshop and some of the materials can be seen on Figure 5.3.



Figure 5.3: The set up of the workshop

Ethical issues

Before the workshop the users were asked if they allow recording and making pictures in the process of the workshop. The users were informed that their names will not be used in the report and that the recorded information and the pictures will be used only for the purposes of this master project.

Analyzing and presenting the data

All produced materials from the workshop have been documented by scanning or making pictures and writing down the results. The results are analyzed and presented by grouping them by tasks.

5.3.2 Experience in the process

The workshop was very effective in finding user needs and producing a lot and creative ideas, so it could be considered that the workshop was successful. The users were motivated and worked efficiently on the given tasks. They produced many ideas and different discussions. One of the reasons that the users were effective can be that they were inspired by the prepared materials and from each others ideas. Another reason can be that the users understood the main concepts of PN, federation of PN and statements, presented at the beginning of the workshop. The users could build up on top of these concepts. The users thought that the used methods and materials were interesting and that the workshop was planned well, but the workshop was a little long.

5.3.3 Results from the workshop

Descriptions of the tasks the users had during the workshop, as well as a summary of the corresponding results are presented in this subsection. All results of the workshop are shown visually and in written form when necessary in Appendix B.3.

Creating Personal Network through picture stimulation

The users were given pictures with different devices for inspiration in order to create their PNs, as well as they could also make pictures themselves. An overview of the process can be seen on Figure 5.4. The most preferred devices in the PN are a laptop, a mobile phone, a PDA, a desktop computer, a printer and iPOD. Some of the users would prefer to have the functionalities of several devices in one – for example a USB memory stick, iPOD, camera and GPS can be combined in a mobile phone. In this way, the number of devices in the network will be reduced. Some other devices which could be included in the PN are a scanner, a video camera, GPS, web camera, TV.

Brainwriting for options and functionalities of devices

The users were given different cards for each device, and were asked to write a setting or a functionality for the given device, after that the card was given to the neighbour who needed to write options too. Elements with different options (see Figure 5.5), prepared by the designer, and screen dumps from existing programs were available for inspiration.



Figure 5.4: Picture stimulation for creating Personal Network



Figure 5.5: Inspiring elements for producing options and functionalities of devices

Settings and functionalities of 8 devices (mobile phone, voice recorder, laptop, PDA, refrigerator, printer, watch, iPOD/MP3-player, TV and GPS) have been listed and they can be seen in Appendix B.3.4. Some conclusions drawn when analyzing the results are:

- Almost all devices have options ON/OFF and sound settings (silent, sound level, etc.);

- Mobile phone, laptop, PDA, GPS and iPOD should have access to the Internet;
- The devices should have power saving mode;
- The laptop and the PDA should be able to synchronize data;
- Some devices combine functionalities from other devices – for example a mobile phone has functions, such as memory stick, voice recorder, radio, scanning documents, GPS device; or a watch – alarm, count heart beat, count running speed/distance, mp3 player, radio, GPS, compass, temperature measurements;
- Security should be taken into consideration, especially for laptop and PDA;
- Some requirements, depending on the technologies, have been mentioned such as big battery life and big memory.

Situations and activities for which statements can be used

The users brainstormed about situations and activities for which statements can be used. The ideas were placed on white papers (see Figure 5.6) and after that mind-mapping was used to organize the ideas by grouping them. The resulted mind map can be seen on Figure 5.7.



Figure 5.6: Brainstorming for situations and activities

Associating activities with devices and their settings

The activities and the situations, which have been associated with the devices and their settings are chosen from the previous task (brainstorming for activities and situations): ‘Exam’, ‘At a lecture’, ‘Groupwork’, Leisure and Traveling

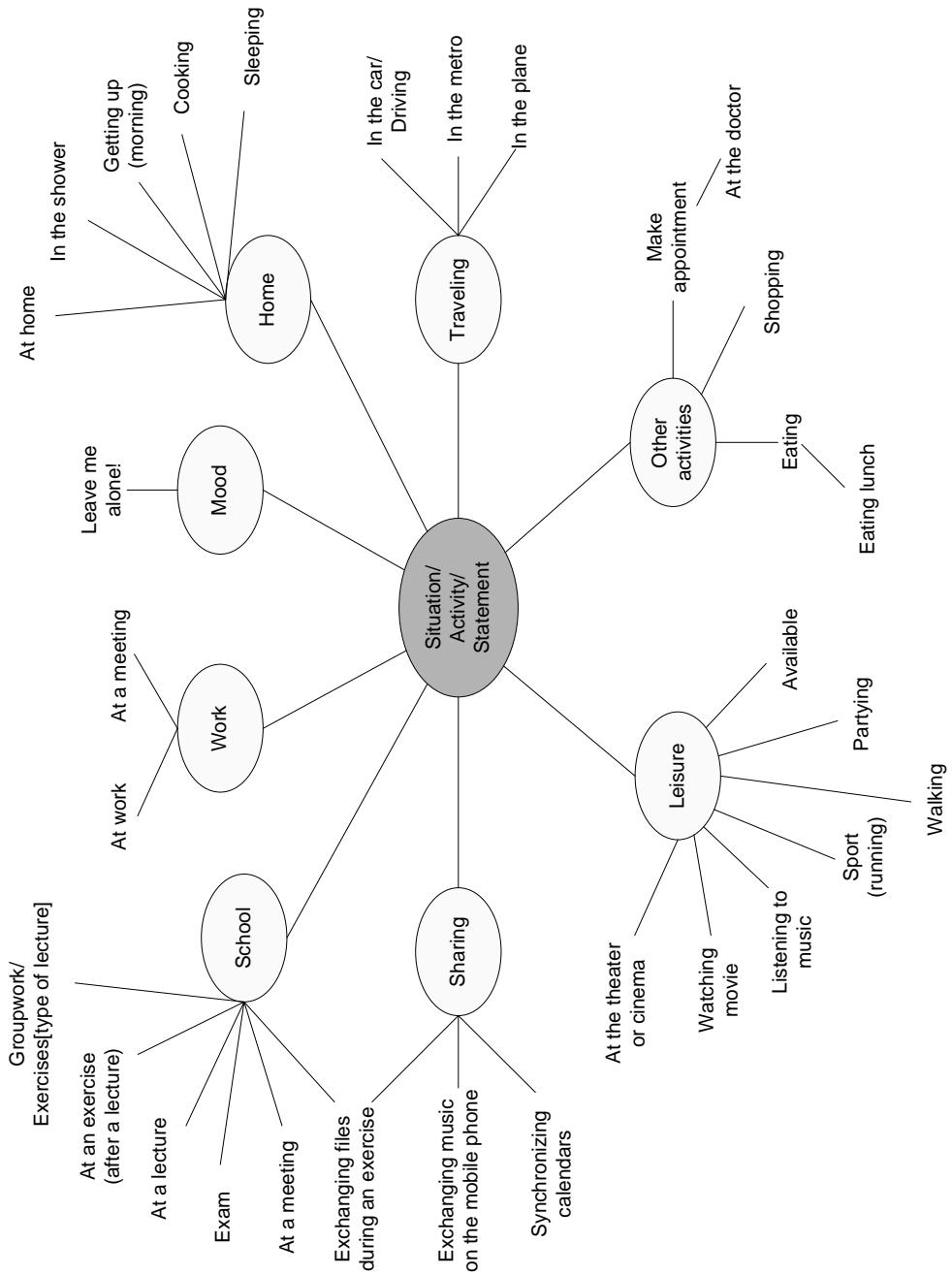


Figure 5.7: Mind map for situations and activities for which statements can be used

(by car, plane and public transport). Two of the activities which are considered very relevant for the scope of this project are given below and the rest can be seen in Appendix B.3.6.

At a lecture

- Phone – Silent ON, Vibration ON, Start voice recording of the lecture, Bluetooth ON, Pair with laptop, Transfer Voice;
- Laptop – Silent ON, Start the program used in the lecture, Connect to Wireless LAN (secure), Connect to PDA (secure), Start messenger with a status ‘Busy’, Bluetooth ON, Pair with Phone, Receive voice, Synchronize notes with PDA, Download notes and display them;
- PDA – Silent ON, Connect to Wireless LAN (secure), Connect to Laptop (secure), Synchronize notes with laptop, Auto-authorize on LAN and on laptop;
- Printer (at home) – Online;
- TV (at home) – Off;
- Bluetooth headset – Off.

Groupwork

- Phone – Silent ON, Vibration ON, Bluetooth ON, File sharing application ON;
- PDA – Silent ON, Stand by ON, Set status ‘Busy’ on MSN messenger;
- PC/Laptop – ON, Internet browser ON, MS Word ON, File sharing application ON, Connect to network (plus authorize - DTU authorization), Set status ‘Busy’ on MSN messenger, Suppress ‘new email’ pop-ups, Mute or lower volume, Find groupwork notes/assignments and ask to print;
- Printer – On;
- TV (at home) – Off;
- Bluetooth headset – Off;
- Surveillance webcam (at home) – On.

Brainwriting for creating scenarios by using a persona

A fictitious user (or a persona) (see Section 4.4.5) is created for this activity in order to provoke some ideas for creating scenarios for using statements.

The created persona is Peter. He is a student at DTU and he has four courses

this semester – Physics, Java Programming, Statistics and Data Security. For some of his courses he has homeworks and projects, and for others – only exams. Peter has lectures and group work for all of his courses. He has his devices in a PN and he uses it to manage his study process easier. Peter’s PN can connect to external devices in DTU and to PNs of his friends and teachers.

The users were asked to continue the story by including statements, using devices in a PN and connecting to other PNs. The scenarios were written on colorful cards as each scenario was started with a sentence/user story and the users needed to elaborate on that. The cards were going around the users and each of them continued the specific scenario they had at a time. The produced cards can be seen on Figure 5.8.



Figure 5.8: Cards for creating scenarios

The created scenarios are presented below:

- **Peter is studying at home**

He starts his laptop and the printer turns on and connects to the laptop. Furthermore the laptop connects to the internet and fetches the latest lecture slides.

The laptop displays a list of to-do items for Peter, ordered by increasing urgency. Peter dismisses some of the low-priority items and picks a high-priority item to work on.

The fridge prepares cold beer.

Peter’s messenger program starts up and sets status ‘At Home’.

- **Peter works in a group for his ‘Java Programming’ project**

Peter issues a ‘Groupwork’-statement.

Peter uses his PC to find and share info with the group.

Peter regularly closes the laptop to discuss with his group, then reopens it to find new info.

The statement activates sharing of the Java folder between him and his group.

- **Peter likes reading/studying in the bus**

His laptop synchronizes the lectures when they are available. The laptop displays the past lectures as soon as Peter opens it in the bus or train. The devices switch to silent mode while traveling.

His printer (at home) starts printing the slides for the lecture.

The computer connects to the mobile through bluetooth and the mobile connects to the Internet so Peter can get files from the home computer and synchronize his files.

- **Peter is giving a presentation for his Data Security Course**

He connects to the Internet via Wireless LAN and downloads his presentation. He starts the power-point slide show.

The mobile stops accepting calls and messages and goes into ‘remote control’-mode – Peter uses the mobile phone as a remote control to shift slides on his presentation.

- **Peter often takes breaks between his studies – e.g. for lunch or just doing something for fun**

He chooses statement ‘Break, relax’.

The laptop opens up his preferred newsgroups/channels.

His devices increase volume. He makes his location available to friends and he is able to localize them.

TV starts.

Designing different screens for managing statements

The users were asked to imagine how they would like the statements to be presented to them and how the statements would be managed. Each user has created an alternative design of the statements based application which can be seen in Appendix B.3.7. Some conclusions, drawn when analyzing the created designs, are:

- The defined statements can be presented in the left side of the screen, as links or as buttons. There is an option ‘Add new’ for creating a new statement at the same place (see Figure B.36 and Figure B.37).
- A statement can be triggered automatically by time, external sensor or calender. It should be possible to add a new trigger for a statement. When ‘Add trigger’ is selected the user should be able to choose the trigger rule (time: every day/week, 12:13; sensor: lights off, pc on, car near) (see Figure B.36).

- It should be possible to edit and delete a defined statement by choosing an icon ‘Edit’ and correspondingly an icon ‘Delete’, positioned next to the name of the statement (see Figure B.37).
- A statement can be chosen from a drop-down menu and there can be buttons for adding (‘Add’), editing (‘Edit’) and deleting (‘Delete’) a statement. When the button ‘Add’ is chosen, a new window is opened where the user can write the name of the statement. When ‘Edit’ is selected, a new window is opened with the list of the devices with possibilities to add, edit and delete a device. There are check-boxes in front of each device so it is possible to select more than one at a time. If one device is selected and ‘Edit device’ is pressed, the possible options for the device are shown in a new window. If more than one device are selected and ‘Edit device’ is chosen, only the common possible settings for the selected devices are shown. It should be possible to add, edit and delete a setting (see Figure B.40).
- A statement can be a combination of location and activity. This is why, it should be possible to choose a location and an activity from drop-down boxes at the same time. The different combinations of these two elements will result in different sets of settings. It should be possible to add a new activity and a new location. When the specific combination is chosen the settings can be edited by pressing the button ‘Edit this profile’. The settings can be grouped first by devices and then by specific functionality (e.g. power, silent, vibrate, etc.). The possible options for the functionalities are given in drop-down menus (e.g. the options for silent can be ON and OFF) (see Figure B.39).
- The statements can be managed as providing a menu in the left side of the screen with some of the possible actions that can be performed in the application – add a new statement, activate statement, delete statement, add new device. When ‘Add new statement’ is selected the user specifies the name and the settings of the devices. When ‘Activate statement’ or ‘Delete statement’ is chosen a list with the defined statements is shown with check-boxes in front of each statement and the user can choose which statement should be activated or deleted (see Figure B.38).

Evaluation of initial drawings

The evaluation of the initial drawings consisted of showing the alternative designs to the users and asking them for their opinion. The users said that the ideas presented on the screen sketches looked reasonable, but they could not give concrete comments because they did not go into the drawings in details.

Additional comments and ideas

- It should be considered how the external devices will be included in the PN. It could be that the devices are scanned with the mobile phone for example, so they could be recognized in the network. It could also be some kind of discovery service which finds specific devices by using some rules (e.g. all printers in building 341 at DTU).
- It could be nice if different statements can be downloaded with predefined default settings.
- There could be a discovery service for relevant statements (e.g. university related statements). When the statements, the user has subscribed to or the ones that are identified based on location for example, are found, they can be downloaded to the controlling device and integrated in the statements based profile managing application.
- It should be possible to see an overview if the devices work.
- A possible problem could be creating conflicts (or selecting contradictory settings) when choosing many options for the devices.
- Sharing should be included as a setting/functionality of a device, not as a separate statement.
- It should be possible to combine statements (e.g. 'Lecture' and 'Math'; 'Studying' and 'Home') in order to achieve more specific functionalities.
- It should be possible to activate statements automatically in some way (by using location, time context, etc.).

CHAPTER 6

Conceptual Design

This chapter presents the process of creating the conceptual design of the statements based profile management application and a low-fidelity prototype, which illustrates the design, as well as the evaluation of the conceptual design.

The identified needs and the established requirements at the first phase of the simple interaction design model and the research of literature and existing applications have been used as a basis for designing the conceptual model of the statements based profile management application. An overview of the process can be seen on Figure 6.1.

The different concepts and ideas about the functionalities of the application are presented by creating a low-fidelity paper-based prototype, which has been used in the evaluation of the conceptual design. After the evaluation sessions with the first four users and analyzing the results, some new screens, representing the new ideas, have been created. The new screens have been shown together with the main prototype in the evaluation with the last user in order to receive some feedback of new concepts. After that, the requirements specification has been updated by reflecting the necessary changes and improvements. The updated requirements specification has been used as a start in creating the hi-fidelity prototype.

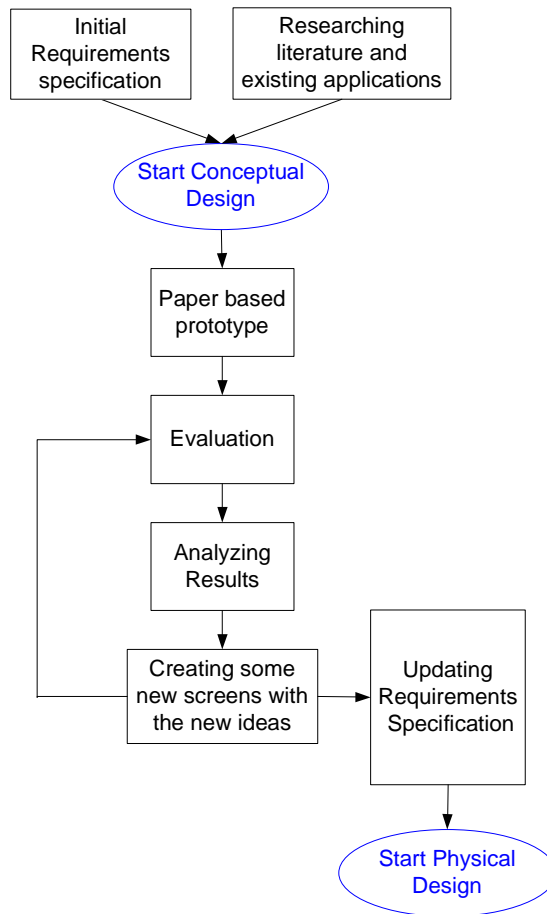


Figure 6.1: Process of conceptual design

6.1 Low-fidelity paper-based prototype

The design of the conceptual model is graphically presented by a paper-based prototype for a Nokia 770 mobile device. Different GUI screens are drawn on paper with a size of screen of the device Nokia 770 and stabilized with cardboard on the back, so it is easy to place them on and remove them from the screen of the PDA (see Figure 6.2).

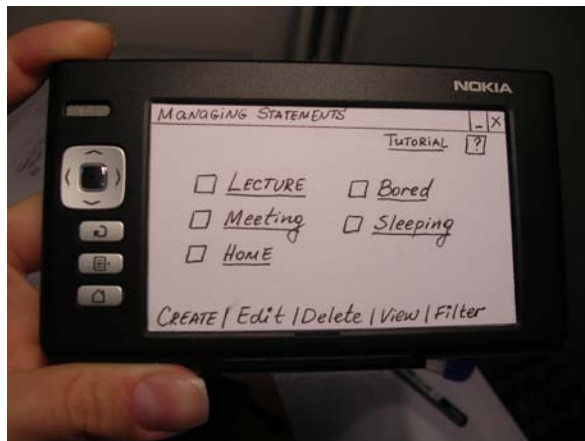


Figure 6.2: Paper-based prototype in use

The main functionalities of the application are to create, edit and delete statements. Configuring a statement is connected to choosing which devices should be set for the particular statement. Setting the devices is related to choosing particular settings of the devices. Considering the different actions which should be performed in order to configure a statement, the application can be seen as consisting of three layers – statements, devices and settings. These three layers and the main functionalities of the application are presented on Figure 6.3. The different elements of the figure represent the screens where the certain functionality is performed and the arrows show the navigation between the screens.

Examples of the concrete screens for the different layers, developed to illustrate the conceptual design, are shown on Figure 6.4, Figure 6.5 and Figure 6.6. All screens of the paper-based prototype are given in Appendix C.1. Figure 6.4 is the main screen of the application, which contains a list of statements, which the user can use. The actions, which can be performed on this screen, are activating a statement (by pressing the statement's name), creating a new statement (by pressing 'Create'), editing a statement (by checking the statement and pressing

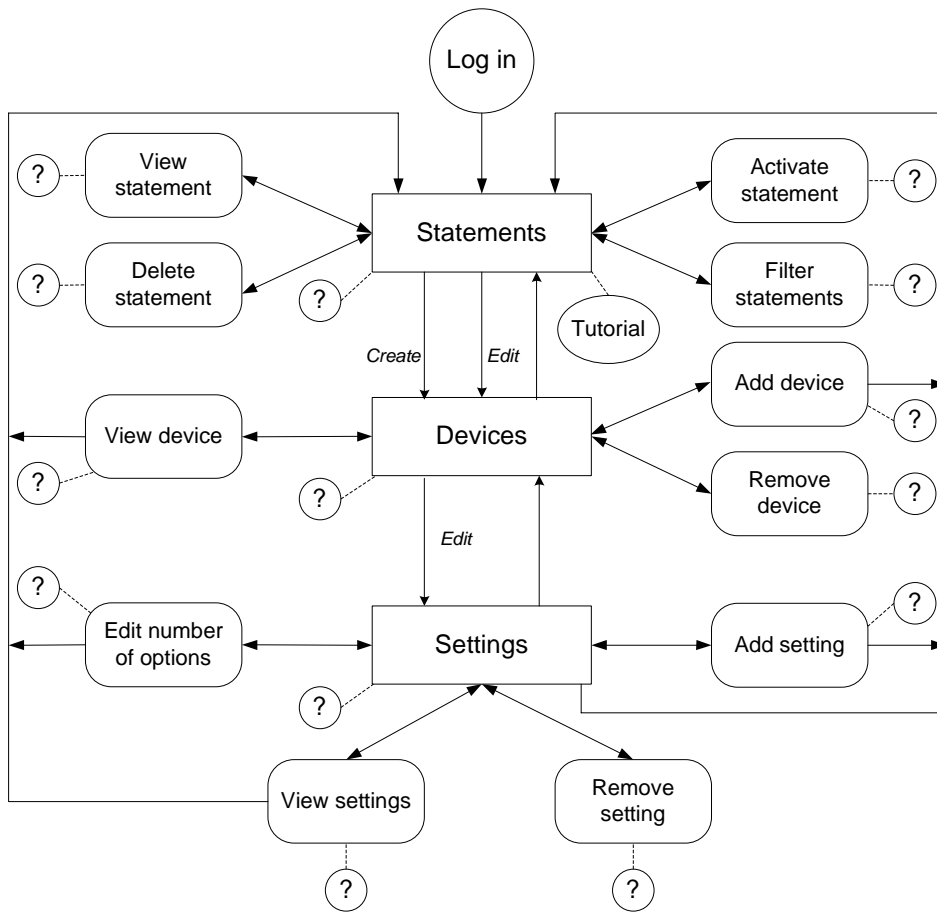


Figure 6.3: General concepts and navigation of the paper-based prototype

‘Edit’), deleting a statement (by checking the statement and pressing ‘Delete’), seeing what a statement does (by checking the statement and pressing ‘View’) and choosing which statements to be visible on this main screen (by pressing ‘Filter’). The user can also explore the tutorial with explanations how to use the application (by pressing ‘Tutorial’) and the help for the current screen (by pressing ‘?’).

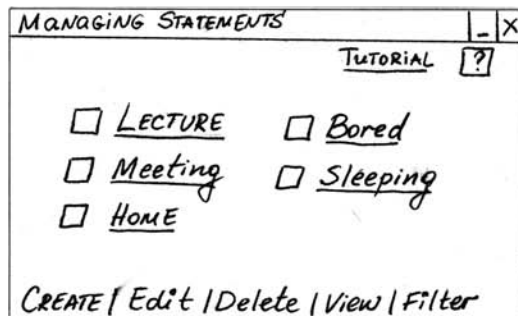


Figure 6.4: Main screen for managing statements (P2.1-S Main)

Figure 6.5 represents a screen containing the list of devices and the user profile which will be related to the statement. This screen can be reached when a new statements is created or when a statement is edited. At this screen the user can add devices from the PN to the statement (by pressing ‘Add’), edit the settings of the devices and user profile (by checking a device or the user profile and pressing ‘Edit’), remove devices from the statement (by checking the device and pressing ‘Remove’) and seeing what are the selected settings of a device (by checking the device and pressing ‘View’). The user can also see help for the current screen (by pressing ‘?’) and to go back to the previous screen with statements (by pressing ‘<<Statements’).

Figure 6.6 shows the screen for selecting settings for the mobile phone. There are default values for the settings because the screen is related to editing lecture. At this screen the user can add more settings to be set for the mobile phone (by pressing ‘Add’), remove settings (by checking the setting and pressing ‘Remove’), selecting/changing the values of a setting (by selecting a certain option from the drop-down menu of the setting), choose which options for a setting to be visible in the drop-down menu of the setting (by checking the setting and pressing ‘Edit’) and see the options for a setting (by checking the setting and pressing ‘View’). The user can also see help for the screen and go back to the previous screen with devices (by pressing ‘<<Devices’) and the main screen with statements (by pressing ‘Statements’).

CREATE STATEMENT			-	X
<Statements	use template	use existing statements		?
STATEMENT NAME: <input type="text"/>				
<input type="checkbox"/> USER PROFILE	<input type="checkbox"/> PDA			
<input type="checkbox"/> MOBILE PHONE	<input type="checkbox"/> All DEVICES			
<input type="checkbox"/> LAPTOP				
Add Edit Remove View				

Figure 6.5: Screen for choosing the devices when creating a new statement (P2.1-S1)

MOBILE PHONE'S SETTINGS FOR LECTURE			-	X
<Devices	STATEMENTS			?
<input type="checkbox"/> All				
<input type="checkbox"/> Power	ON	▼		
<input type="checkbox"/> Silent	ON	▼		
<input type="checkbox"/> Answering mode	NORMAL	▼		
	Save	Cancel		
Add Edit Remove View				

Figure 6.6: Screen for choosing the settings of a device (P2.1-S2.1)

6.2 Evaluation of paper-based prototype

In order to design a usable application, the conceptual design, presented by the paper-based prototype, has been evaluated by users.

6.2.1 Planning and implementation of the evaluation

The evaluation has been planned by using the DECIDE framework as guidelines (see Section 4.8.3) to make sure that good results are produced during the evaluation, which can be used in the subsequent phases of the design of the application.

Goals

The main goals of the evaluation were to check if the users understand the different concepts and design ideas for the application by going through the screens of the paper-based prototype; to find out if the users could navigate easily through the screens when performing a certain task; to check if the different types of information are organized logically for the user; to find out if something is missing and if something should be done better and how according to the user. Another goal of the evaluation process was to find out the users' point of view about security issues related to their PNs and what authorization mechanisms the users would prefer to use.

Questions

The questions, that needed to be answered in the evaluation process, are inspired by the defined goals. The first type of questions was some general questions for identifying the user type (as only the users who had not been participating in the interviews for gathering needs and requirements were asked these questions). The main group of questions was related to the tasks the users should perform by going through the screens of the paper prototype and some concrete questions when needed to find out if the users understand the concepts on the screens. The last type of questions was about the security issues. The concrete list of questions used in the evaluation process are included in the evaluation plan, which can be seen in Appendix C.2. The plan contained also a description of each task and the expected sequence of actions that the user should do in order to perform the tasks. In this way, it was easier to compare the expected actions with the actual actions the user did.

Evaluation approaches and techniques

The evaluation approach, which has been used, is "Usability testing" (see Section 4.8.1). Asking the user to perform tasks helped the evaluator to conclude if the user understands what should be done to perform a certain task. The evaluator could also see alternative ways of performing the task if the user did something which was not expected for the task at hand. It has not been mea-

sured how long it takes for the user to perform a certain task, how many mistakes the user makes, etc., because of the difficulties to interact with a paper-based prototype. The main evaluation techniques, which have been used, are observing users and asking users. Observing users is difficult when not knowing what the user thinks when interacting with the application. This is why, the technique “Think Aloud” is used to supplement the observation process. How the user would interact with the paper-based prototype of the application needed also to be planned. It was decided that the interaction would be performed by using the method “Wizard of OZ”, where the evaluator played the role of the computer and changed the screens depending on the user’s actions (or imaginary actions known to the evaluator when the user thought aloud).

Practical issues

The practical issues were related to the users who were invited to participate in the evaluation and the necessary materials and equipment to perform the evaluation. 5 users were invited to participate in the evaluation as there were representatives from the different user types (except Fictitious User 4, who turned out to be difficult to find). 4 of the users have been participating in the interviews for gathering needs and requirements and their user type was known which helped to select users from different user types. The necessary equipment was a paper with the evaluation plan, including the helpful questions and tasks, used also to make notes during the evaluation, a microphone, a laptop and a recording application in order to record the evaluation sessions, a device Nokia 770, used for placing the screens of the prototype on and the paper screens of the prototype.

Ethical issues

The users have been asked if they give permission for recording the evaluation. They have been also informed that the recorded information will be used only for the purposes of this master thesis and that their names will not be included in the report.

Analyzing and presenting the data

The information from each evaluation were written down as the answers of the users were grouped by the given tasks, following the evaluation plan (see Appendix E). The collected qualitative data has been analyzed and summarized. Comments and conclusions for the different functionalities (related to the given tasks) are presented in Section 6.2.3.

6.2.2 Experience in the process

The evaluation of a paper-based prototype can be a difficult task because of the imaginary interaction. Some users had difficulties to understand which of the elements of the screens can be clicked and which are just text or headings. It was

important not to give too much information to the user in order not to mislead him/her, but when the user could not determine what to do by himself/herself (because of the limited interaction) about something, the evaluator needed to give more explanations. In this way, the user could continue the task and the evaluator could get an opinion how the certain functionality should be given so the user understands it.

6.2.3 Results from the evaluation

The raw results from the evaluations are given in Appendix E as the summary of the results and the important findings are given below, grouped by the functionalities of the application.

User types

The users, invited to participate in the evaluations, are students at DTU. There were 5 users, who represented three of the fictitious user types. 1 user is Fictitious user 1, 1 user is Fictitious user 2 and 3 users are Fictitious user 3. It was difficult to find Fictitious user 4. The reasons for this are explained in Section 5.1.3).

4 of the users have been participating in the interviews so they knew some things about the PN and the statements based application, and one of the users heard about these concept just before the evaluation. There have not been found significant differences between the answers of the users who knew about the concept in advance and the user who did not know.

Log-in

Related screens from the prototype: S:Log-in (Figure C.2).

The Log-in functionality for the application is probably not necessary, because the users expect to be the only ones using the PDA and they would prefer to log in once when they start using the PDA. So the users prefer the single sign on concept. If the PDA can have several users, the log-in screen would be probably necessary. If a log-in screen is to be used the users understand what they should do to log in to the application.

Statements list – Main screen

Related screens from the prototype: S:Main (Figure 6.4).

There is a general understanding what the main screen shows and the different actions which can be performed at the screen. The first time a user starts the application he/she would see what the default statements do, check the tutorial or explore the application. The users like the idea of having default statements (maybe not too many) which will be shown the first time the user uses the application, as well as having a tutorial. There is missing an explanation what the user is supposed to do at the screen – e.g. a sentence ‘Choose a statement to manage’. It is not so clear how the check-boxes should be used and what would

happen when a statement is checked. This is why, another way of presenting the actions over the statements should be found. Some of the users would prefer to have the statements as buttons for activating and small icons for editing, deleting and viewing for each statement. In this way, the buttons for creating a statement and filtering statements can be placed separately, because they are not related to a specific statement.

View statement

Related screens from the prototype: S:4 (Figure C.11).

The users could understand that the View-functionality was for seeing what a specific statement consists of. Most of the users would prefer to have the view-functionality combined with the edit-functionality. In this way, the user can see an overview of the statement and at the same time can edit it. On the other hand one of the users stated that pure view-functionality is important, because the user might want to see only an overview of a statement. It is also possible to have both functionalities for view and edit separately, but when the user presses a setting on the View-screen, a check-box with the other choices for the setting can be shown. The users like the idea of presenting the devices as icons at the View screen. To make the different actions only one click away – the View can be a small icon/button next to each statement.

Activate statement

Related screens from the prototype: S:6 (Figure C.15) and S:Main" (Figure C.16).

The users could not see how a statement can be activated from the main screen. It was not very logical for them to activate the statement by pressing the name and to have check-boxes for the statements which are used for something else. The users would like to be able to activate a statement fast, with as few steps as possible. The statements can be presented as buttons and when a button is pressed the corresponding statement can be activated. In this way, the activation is performed with only one click. One of the users would even prefer to be able to activate the statements separately without opening the application. There can be a small icon on the task-bar for example and when it is pressed a list of the statements is opened. When one of the statements is selected, it is activated. It should also be possible to see which statement is active and to activate another statement from the application. Most of the users did not think that asking for confirmation when activating statements was necessary. If the activated statement changes its appearance by changing colour or shape, it is clearly distinguished which is the active statement at the moment.

Help and tutorial

Related screens from the prototype: S:7 (Figure C.12), S:8 (Figure C.13) and S:X (Figure C.14).

The users like that there is a tutorial, which is expected to contain a general

description of a statement and the application, as well as guidelines how to do different things in the application (how to create a statement, etc.).

It is also good to have help icon ('?') at each screen, so the user can always check what he/she can do at the certain screen. For the main screen it might not be necessary to have both 'Tutorial' and '?', because they will probably contain the same information – probably only 'Tutorial' is enough. The help can be organized as one whole system, as the help icons for each screen can be links to the corresponding page of the help system. It should also be decided if the help will be opened in a new window or at the same one. If the help system is opened in a separate window it will be possible to see the help while using the application.

Delete statement

Related screens from the prototype: S:3 (Figure C.7) and S:Main'(Figure C.8).

The users understand how statements can be deleted with the use of check-boxes and they would expect to be able to delete more than one statement. Some of the users would prefer to have a Delete-icon/button next to each statement, so they need to press once to delete a statement, even if it means that they cannot delete more than one statement at a time. The users wanted to be asked for confirmation when deleting statements because they might press 'Delete' by mistake and lose a statement, which they need. The option 'Don't ask me again for confirmation when deleting statements' would be used by some users if they delete statements very often. This is why, it is considered that it is fine to have this option.

Filter statements

Related screens from the prototype: S:5-1 (Figure C.9) and S:5-2(Figure C.10).

It was totally unclear what the option 'Filter' from the main screen was used for. Most of the users would prefer to have all their statements visible at the screen because they do not expect to have too many statements. Thus, they would not use the Filter-functionality. They would rather have a possibility to sort the statements in some way. When a button 'Sort' is pressed there can be shown a list of the statements as there is a 'Move up and down'-button which can be used to move the statements around. There can be also a 'Sort alphabetically'-button.

Create statement

Related screens from the prototype: S:1 (Figure 6.5).

It was clear what should be done to create a new statement (pressing the button 'Create'). It could be better if the button 'Create' was placed more separately from 'Edit', 'Delete' and 'View', which were related to a specific statement. Most of the users could see different ways for creating a new statement – from templates, from scratch or from existing statements. Some users were not sure what the templates contained. If the templates were similar to the existing

statements, it might not be necessary to have both. On the other hand, if it is possible to delete the default statements there should also be templates. There was a little confusion if the given devices at the Create statement-screen are already added to the statement or if they are all devices the user can choose from. It is not clear from the first site that they are default devices, as not all of them are required to be set and more devices can be added to the statement from the PN. A ‘Save’- or ‘Finish’-button, which would give possibilities to the user to save the statement before the settings of the devices are set, if the user cannot finish the statement at the certain moment is missing. The list of devices should include all devices from the PN according to some users (considering that they might not have too many devices) or the list should include the most used devices and a button ‘Other devices’, which would expand the list with devices in the PN.

Edit statement

Related screens from the prototype: S:2 (Figure C.5) and S:2’ (Figure C.6).

It was understood how a statement could be edited (by selecting the check-box of the statement and pressing ‘Edit’), but some users would prefer to have a small Edit-icon/button for each statement, so a certain statement can be selected for editing by one click. Most of the users would prefer to edit one statement at a time, because they want to take their time to configure the settings of the devices, so they do it right. If it is possible to edit only one statement at a time, it should be consistent with the other functions which means that it should be possible to delete also only one statement at a time. Some other users thought that editing more than one statement should not be a problem if it is clear which statement is edited at a time – the different statements can be given in different tabs for example.

View settings of device

Related screens from the prototype: S:2.6 (Figure C.39), S:2.7 (Figure C.40), S:2.7alt-1 (Figure C.41), S:2.7alt-2 (Figure C.42), S:2.8 (Figure C.43) and S:2.9 (Figure C.44).

According to several users ‘View’-functionality for seeing the settings of a device, without being able to edit them, is not necessary because the selected settings can be seen at the Edit device-screen or at the View statement screen for the certain statement. If there is ‘View’ for the devices and several devices are selected all settings for all selected devices should be shown.

User profile

Related screens from the prototype: S:1.5-1 (Figure C.22), S:1.5-2 (Figure C.23) and S:1.5-3 (Figure C.24).

Most of the users would like to be able to create a user profile for a specific situation, because they might need some specific personal information for the situation. If the user has a general profile in the PDA/system, when setting ‘User

profile' for the statement, it should be possible to select which information from the general profile will be used when applying the specific statement. If there is a relation between the general profile and the user profile for a statement, it should be clear if the general profile is overwritten when some new information is provided in the user profile for the statement. By default, the information in the user profile should be used only when the corresponding statement is applied. A button 'Update general profile' can be used when the new information should also be included in the general profile. One of the users could not really see how often the 'User profile' would be used, especially if there was a general user profile in the system or user profiles in the different devices. The functions Add/Edit/Delete/View for the user profile might not be necessary. The 'User profile' should be separated in some way from the devices.

Add device

Related screens from the prototype: S:1.8 (Figure C.27) and S:1' (Figure C.28). Some of the users would prefer to see all devices from the PN in the list of devices at the Create/Edit statement-screen, considering that they might not have too many devices. If a statement is edited and all devices from the PN are shown, the devices which are already added to the statement should be marked. One user preferred the list of devices to be empty when creating a statement from scratch and by the function 'Add' it should be possible to choose the devices for the statement. If the user would like to have default devices or settings he/she would use a template.

Remove device

Related screens from the prototype: S:1.9 (Figure C.29).

If there is an Add-function, it is appropriate to have Remove-function. The users were aware that the device was not deleted but only removed from the active list of devices and it could be included to the statement again by choosing 'Add'. It was understood how the check-boxes should be used to remove a device from the active list, but it was suggested to have a Remove-icon/button for each device, so there is not need for the check-boxes and a device can be removed by one click. It is appropriate to have a message asking for confirmation when removing a device together with the option 'Don't ask me again when removing devices'.

Edit settings of device

Related screens from the prototype: S:2.1 (Figure 6.6) and S:2.4 (Figure C.36).

The users could understand how to edit the settings of a device by using the check-boxes and pressing 'Edit'. Another way to edit settings of a device can be by pressing the button of the device (if check-boxes are not used and the devices are buttons) or just having a small Edit-icon/button next to each device (so it is consistent with the statements). So they would prefer to edit only one device at a time in order to make sure that the device is set right. Some users would

prefer to be able to edit common settings of devices by pressing a button ‘Common settings of device’ for example, not by selecting the devices and pressing ‘Edit’ because it is confusing. There could be also buttons ‘All devices ON’, ‘All devices OFF’, ‘All devices Silent’, etc. for the most used settings which might be common for all devices. Some other users think that it will be complicated and confusing to set common settings and they would not use this functionality. The devices have also different types of settings and even the similar settings might have different names.

Add setting of device

Related screens from the prototype: S:1.1.1 (Figure C.45), S:1.1'-1 (Figure C.46), S:1.1'-2 (Figure C.47) and S:1.1.2 (Figure C.48).

Most of the users would like not to have all possible settings visible at one screen, because the user might not use all of them, and that by using Add/Remove the user can choose which settings to be shown. When the button ‘Add’ is pressed it is expected either all possible settings of the certain device to be shown, including the ones that are already included to be set as they are marked in some way, or only the rest of the settings that are not included yet. When all extra settings are added for the device in the active list of settings and ‘Add’ is pressed, there can be an informative message that all possible settings are already in the active list. If the settings would have a ‘blank’-option or the setting would not be affected when activating the statement, all settings should be shown. If there should be a chosen option for the settings, only the settings which should be affected when activating the statement should be included in the list of settings (so the list should be empty when creating a statement from scratch).

Remove setting of device

Related screens from the prototype: S:1.1.4 (Figure C.50).

If it is possible to add more settings to be set for the devices, it is reasonable to be able also to remove them from the active list of settings. If the check-boxes are not used, there can be a Remove-icon/button next to each setting.

Edit number of options of a setting

Related screens from the prototype: S:1.1.3 (Figure C.49).

All users would expect that all possible options/choices for a setting are shown in the check-box (or in other form) for the setting, because they do not think that there would be so many options. If there are too many options, the most used ones should be on the top and at the end there should be a button ‘Find more options’. When ‘Find more options’ is pressed the list expands with the rest of the options for the setting. In this way, there should not be necessary to have the function ‘Edit’ for the options of the settings of the devices.

View options of a setting

Related screens from the prototype: S:2.1.1 (Figure C.51) and S:2.1.2 (Figure

C.52).

Most of the users do not think that the View-function for the options of the settings is necessary because the selected options for the settings can be seen in the Edit device-screen and an overview of all options for a setting can be seen in the drop-down menu for the setting.

General observations for all screens of the prototype

The used scheme for statements, devices and settings should be the same, so the user would understand easier what he/she needs to do and would not be confused. It is good to have a possibility to go back to the previous screen, as the link should be called '«Back'-button instead of '«Statements' or '«Devices', because the user might not know where he/she came from. Being able to access the main screen with the list of statements from every other screen might not be necessary, but if it is included the link should be called for example 'Home', instead of 'Statements'. It should be decided if all screens will be opened in the same window, or in different windows. If the help for example is opened as a separate window, it should not have a '«Back'-button. The screens should be probably opened in the same window because there is not too much space at the PDA to maintain many windows. There should not be a check-box saying 'All' or 'All devices', which is used to select all of the check-boxes at the screen, because it is confusing what would happen when the check-box is selected. It is better to have a link saying 'Select All'. There should be decided how the application handles a situation when a device, included in the statement which the user wants to activate, is out of order or is disconnected from the PN because of other reasons. The user would expect a feedback at activation time if something is wrong with a device, included at the statement and to ask for confirmation if the statement should be activated without the disconnected device. The headings/name of the different screens should indicate where the user is in the overall process – for example Statements/Create statement/Mobile phone.

Security issues when using PNs and statements

Most of the users would like to have high level of security within their PN and when communicating to other PNs. They did not want anybody to be able to connect to their network without permission. On the other hand, the single sign-on concept was preferred when connecting to the devices in a PN, which means that by authorizing only once when connecting to the PN, the user should be authorized to all devices in the PN. The users would like to remember only one password. When connecting to other PNs, the user would expect that he/she would need to be authenticated in some way by using a username and password or identity. The most preferred authorization methods are passwords. Some other methods which can be used are fingerprint scanning or another form of biometrics, digital signature, etc.

6.2.4 Paper-based prototype update

After analyzing the results from the evaluation session, some of the suggested changes and improvements to the screens of the prototype have been used to create new versions of the screens for the different levels of the application (statements, devices, settings). The new screens have been designed before the evaluation with the fifth user and they have been shown also for evaluation together with the main paper-based prototype. Figure 6.7 presents the main screen with the list of statements. The statements are buttons and when a button of a statement is pressed the statement is activated. There are small icons for editing, deleting and viewing a statement next to each statement. There are also buttons for creating a new statement, sorting the statements and tutorial. The help for the current screen is placed together with the icons for minimizing and closing the window.

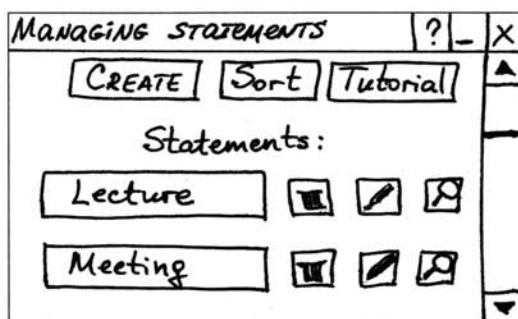


Figure 6.7: A new version of the main screen for managing statements (P3.1-S1)

Figure 6.8 shows the list of devices when creating a new statement. There are icons for editing and removing a device next to each device, and a separate button for adding a device to the statement from the PN. The user profile should be separated from the devices. Thus, a line between them is introduced. There is a possibility to save the statement at devices-level and also to go back to the previous page.

Figure 6.9 presents an overview of how the settings of a certain device (mobile phone) can be selected. The different options for each settings are given in a drop-down menu. There is a small icon for removing a setting next to it and a separate button for adding settings in the active list. The user can save the settings or go back to the previous screen without saving the changes.

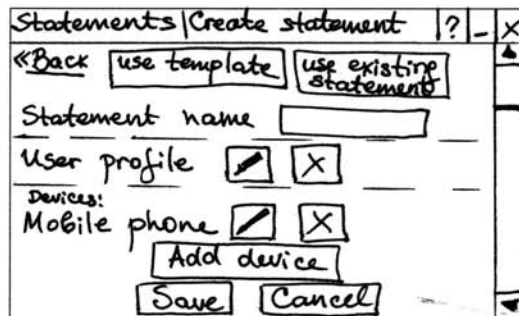


Figure 6.8: A new version of the screen for choosing the devices when creating a new statement (P3.1-S2)

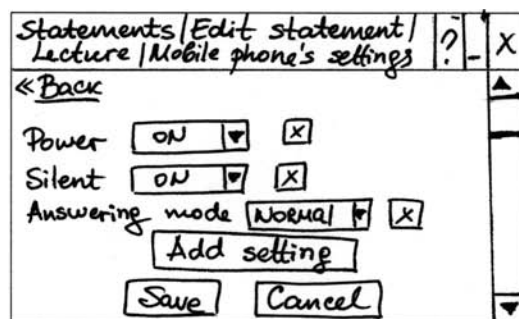


Figure 6.9: A new version of the screen for choosing the settings of a device (P3.1-S3)

Physical Design

This chapter describes the process of creating the physical design of the statements based profile management application; the development of an electronic prototype in Flash; different design decisions; and the preparation, and the evaluation of the electronic prototype.

The developed screens and the updated requirements specification in the Conceptual design phase, as well as the information from researching literature and existing applications, have been used as input for developing the physical design of the application. An overview of the process can be seen on Figure 7.1. In order to evaluate the physical design, an electronic prototype has been developed for a Nokia 770 mobile device. The selected prototyping tool is the computer program *Flash*, because of the great possibilities for combining graphics, animation and functionality, when developing an application. During the process of developing the prototype, some of the requirements have been changed, which resulted in updating the requirements specification on the fly with new or changed requirements. The electronic prototype is not fully functional, but it is developed in a way so the users can perform typical tasks with the application. When the prototype has been finalized for evaluation, a user testing has been prepared and carried out, as the users were asked to perform several tasks. The tasks have been based on some detailed scenarios, which have been created to represent the main functionalities of the application. After the test, the users have filled in a post-test questionnaire (or user satisfaction questionnaire), which reflects the user's perspective and opinion.

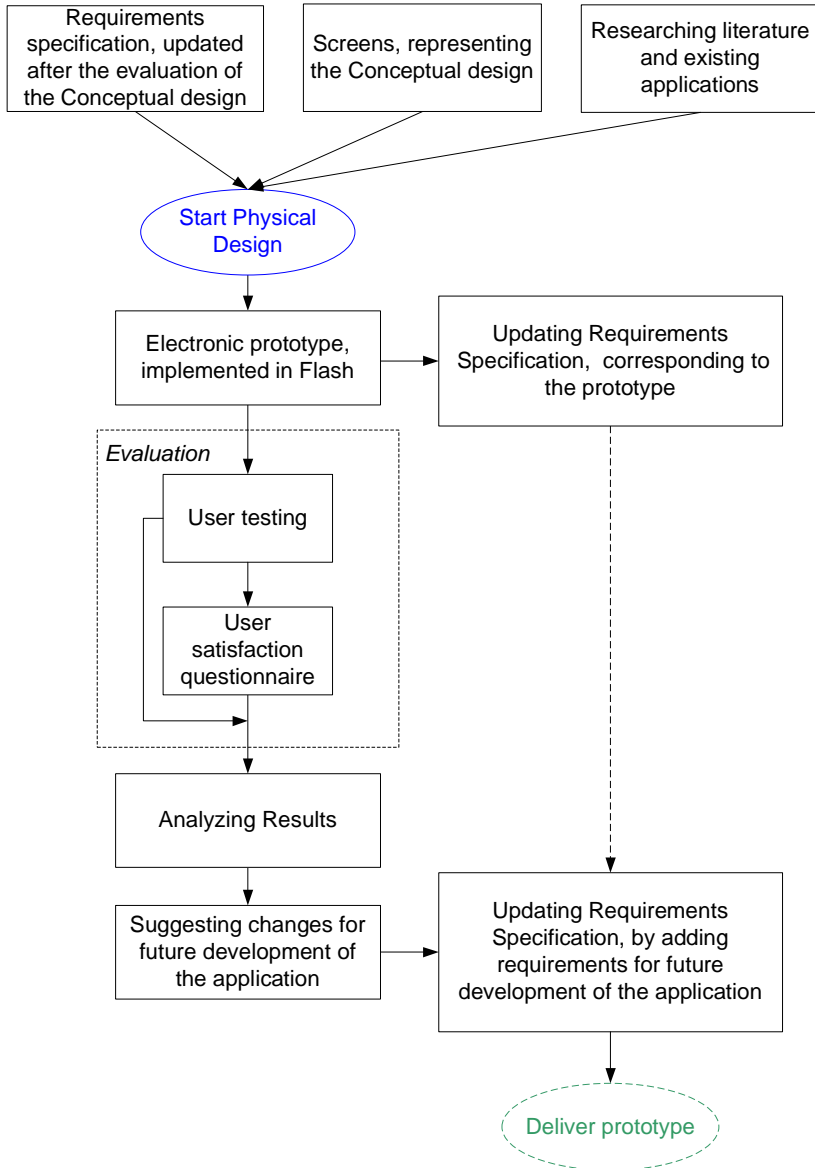


Figure 7.1: Process of Physical design

After the evaluations the results have been analyzed and summarized. Suggestions for changes in the prototype have been given by considering the direct results from the user testing and questionnaires, the indirect results, found from observing the users interaction with the prototype, and the designer's considerations. Some of the suggestions, as well as some designers ideas for improvement of the application, have been included in the requirements specification with status 'Future development' in order to be taken into consideration when developing future versions of the application.

7.1 Hi-fidelity Electronic Prototype

The design of the physical model is presented by a hi-fidelity prototype, developed in *Flash*. The prototype is electronic and it has been uploaded on the device Nokia 770 for the evaluations, so that the users could interact with the application on the mobile device. In this way, the users had a better idea how the final application would look and feel and the evaluation would give more realistic results. Using the prototype on the device can be seen on Figure 7.2.



Figure 7.2: Electronic prototype in use

7.1.1 Description of the prototype

The designed application has been described in the Conceptual design phase (Section 6.1) as consisting of three layers: statements, devices and settings. This structure is kept when creating the physical design, as the layer 'settings' is extended with 'user profile', which includes both personal information and security and privacy preferences. 'User profile' has not been included in the

‘settings’ layer when describing the low-fidelity prototype because there were alternative screens with and without the user profile. In other words, it was not sure that the ‘user profile’ should be included together with the settings.

The main functionalities, implemented in the prototype, are activating, creating, editing and deleting a statement, seeing an overview of a statement and sorting statements. When creating or editing a statement, the user can specify personal information and security and privacy preferences, which will be used when activating the statement; add a device to the statement from his/her Personal Network or search and add an external device; remove a device from the statement; add extra settings to a device and remove settings. Each screen is provided with a Help-button, which explains what different elements on the screen mean. The prototype has also a tutorial with explanations how different actions can be performed, implemented with small movie clips.

Screen shots, which show examples of different types of screens of the prototype are presented further. There are also descriptions of the possible actions the user can perform on a certain screen. All implemented screens of the prototype can be seen in Appendix D.1. The different screens of the electronic prototype have specific numbers in order to easily identify the version of the prototype and the screens. The used notation is similar to the notation, used for the paper-based prototypes (see Figure 5.2): ‘EX.Y-SZ’, where X is number of draft, Y is number of alternative design and Z is a number of screen.

When a certain screen of the application contains a lot of information, which cannot fit at the screen of the Nokia 770 mobile device, a scrollbar is used (see Figure 7.2). However, the scrollbar is not shown on the following screen shots, in order to enhance the overview of the given information.

Main screen

The main screen, or the screen which is opened when the application is started, is shown on Figure 7.3. This screen contains the list of the statements, which can be activated. The possible actions, performed on this screen are:

- Activate a statement – by pressing a button with the statement’s name. The colour of the button changes, which is an indication that the statement is active. If the button is pressed again, the statement is deactivated.
- Create a new statement – by pressing the button ‘Create’.
- Edit a statement – by pressing the Edit-icon (image of a pencil) for the statement, which is wished to be edited. There is an Edit-icon for each statement in the list.
- View a statement (or see an overview of the statement’s settings) – by

pressing the View-icon (image of an eye) for the statement, which settings are wished to be seen. There is a View-icon for each statement in the list.

- Delete a statement – by pressing the Delete-icon (image of a garbage bin) for the statement, which is wished to be deleted. There is a Delete-icon for each statement in the list.
- Sort statements – by pressing the button ‘Sort’.
- See tutorial – by pressing the button ‘Tutorial’.



Figure 7.3: Main screen – List of statements, where the statement ‘I am at a Lecture is active’ (E1.1-S Main)

Create a new statement

When a new statement is created, the user has three options – using a template as basis, using an existing statement as basis or ‘start from scratch’ (Figure 7.4).

If ‘Use template’ is selected a list of templates are shown (Figure 7.5). The user can choose one of them or choose option ‘None’ if he/she decides that none of the templates are suitable. Selecting ‘None’ is equivalent of ‘Start from scratch’. When using a template for creating a new statement, the new statements has default devices and default settings for the devices.

If ‘Use existing statement’ is selected a list of statements, which are already created, is shown (Figure 7.6). The list of existing statements should be equivalent of the list of statements at the main screen. There is also an option ‘None’ if the user decides not to use any of the existing statements, but to start from scratch. When using an existing statement to create a new statement, the new statement have the devices and the settings of the existing statement as basis.



Figure 7.4: Options for creating a statement, shown when the button 'Create' at the main screen is pressed (E1.1-S1)

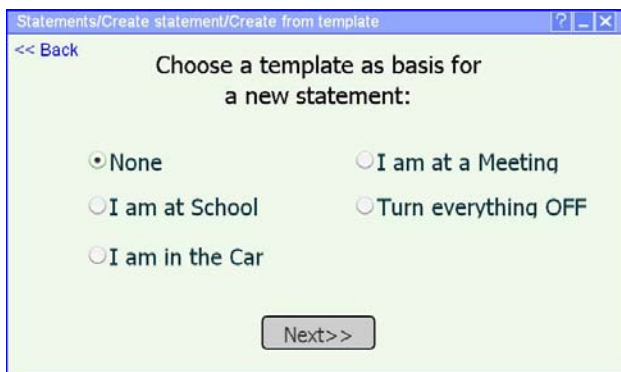


Figure 7.5: List of templates, shown when the create option 'Use template' is selected (E1.1-S1.1)

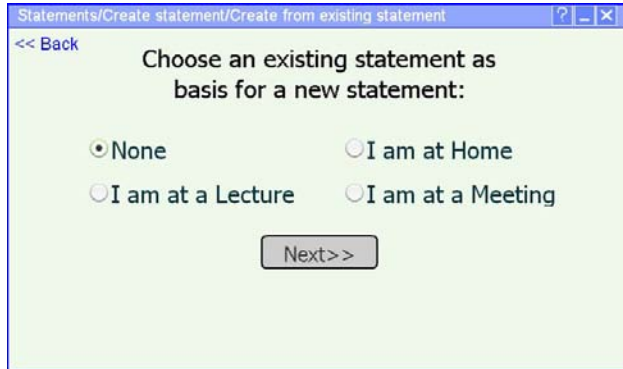


Figure 7.6: List of existing statement, shown when the create option ‘Use existing statement’ is selected (E1.1-S1.2)

If the create option ‘Start from scratch’ is used, only the most used devices, which are expected to be in the Personal Networks of many people (Mobile phone and PDA), are included to the statement. The devices have default settings ‘Off’.

List of devices for a statement

When a certain option for creating a statement is selected or a statement is being edited, a screen with list of devices and user profile, used for the statement, is shown (Figure 7.7). The actions that the user can perform are:

- Write/Edit the name of the statement;
- Configure the user profile – by pressing the Edit-icon (image of a pencil) for ‘User profile’.
- Configure a device – by pressing the Edit-icon (image of a pencil) for a specific device. There is an Edit-icon for each device.
- Remove a device from the statement – by pressing the Remove-icon (image of a ‘X’) for a specific device. There is a Remove-icon for each device. Only the present devices at this screen will be affected when the specific statement is activated. Removing a device is only putting the device from the active list of devices to the inactive list of devices. A removed device can be easily added again to the statement (by pressing ‘Add device’).
- Add a device to the statement – by pressing ‘Add device’.
- See help for the current screen – by pressing ‘?’.



Figure 7.7: List of devices and user profile for the statement, which is being created (E1.1-S2)

Adding devices to a statement

When a statement is created or edited the user can add devices to the statement. The user can add devices from his/her Personal Network and external devices (Figure 7.8). When the option ‘Add device from the PN’ is selected, the list of devices, which are in the user’s PN, excluding the devices that are already included in the statement, is shown (Figure 7.9).

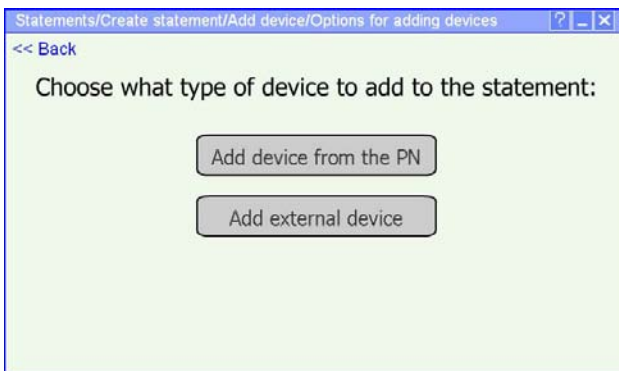


Figure 7.8: Options for adding devices to a statement, shown when the button ‘Add device’ is pressed (E1.1-S2.1)

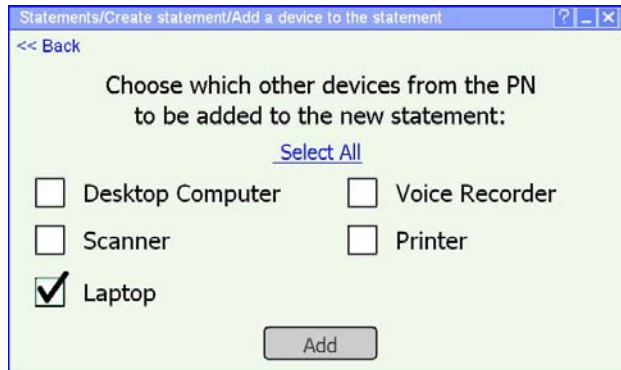


Figure 7.9: Adding device from a Personal Network (E1.1-S2.1.1)

When configuring a statement, the user can search for external/public device, which he/she would like to add to the statement. The screen for searching (Figure 7.10) is shown when the option 'Add external device' is selected. The search results are displayed in the same screen (Figure 7.11). When the specific device is found the user can add it to the active list of devices.

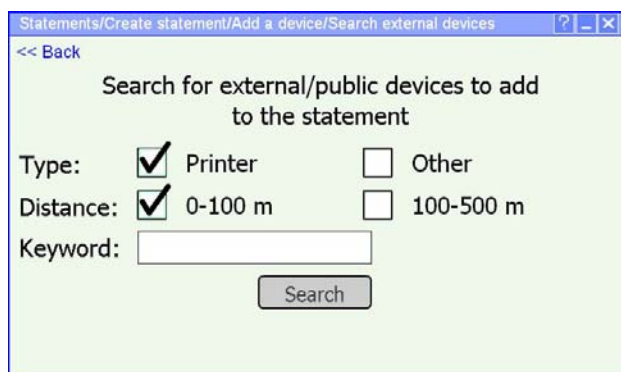


Figure 7.10: Searching for external devices to be added to a statement (E1.1-S2.1.2)

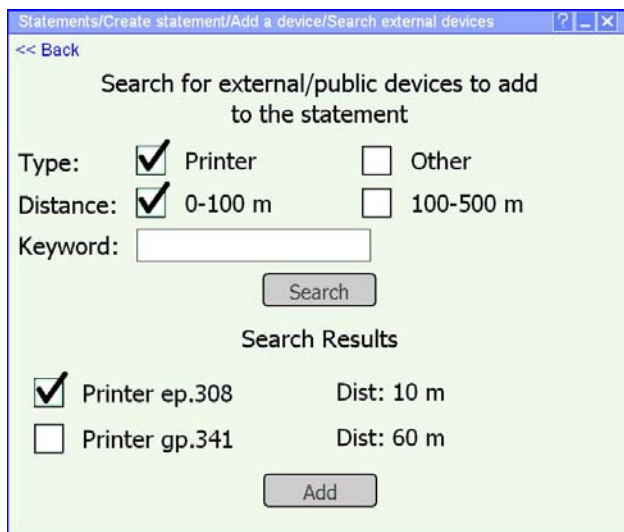


Figure 7.11: Search results with the found external devices, which can be added to statement (E1.1-S2.1.3)

Overview of a statement

The user can see an overview of which devices are affected with the specific statement, what their settings are and what user information and preferences would be used when activating the statement. The overview screen for the statement ‘I am at a Lecture’ is shown on Figure 7.12. The user has also a quick access to the Edit-screen for the statement by pressing the Edit-icon (image of a pencil), if some settings need to be changed.

Deleting a statement

When the user wants to delete a statement, he/she is asked for confirmation (Figure 7.13). There is also an option ‘Don’t ask me again for confirmation when deleting statements’, if the user knows what he/she is doing and does not want to confirm every time. If the user selects ‘Yes’, the statement is removed from the main screen and cannot be restored, only if the statement is created again. If the user selects ‘No’, the main screen is shown without deleting the statement. The same structure of confirmation message is also used when removing a device from the statement and removing a setting from a device. The difference between deleting a statement and removing a device/setting is that the device/setting can be easily restored by using ‘Add device’/‘Add setting’.

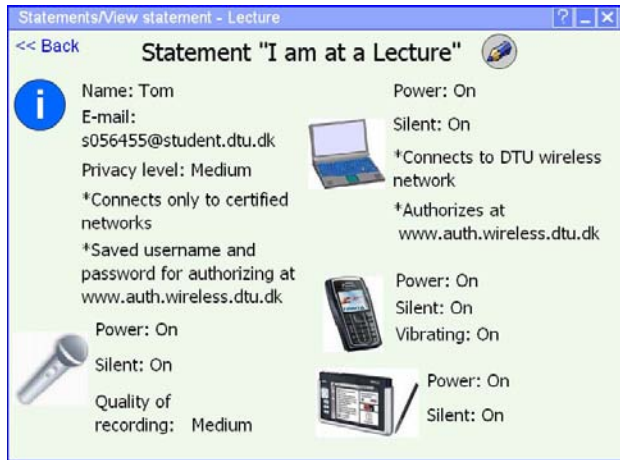


Figure 7.12: Overview of the settings for a statement (after pressing the View-icon for the specific statement) (E1.1-S3)

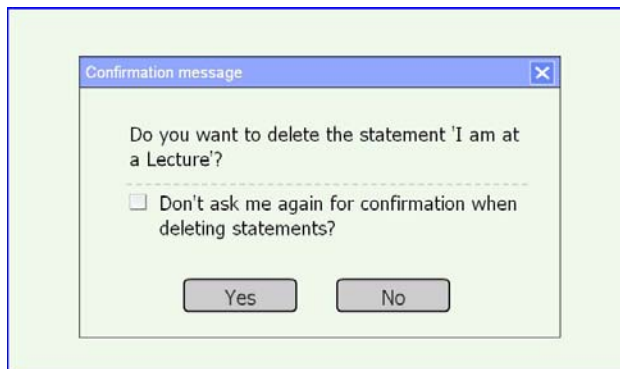


Figure 7.13: Confirmation message when the Delete-button for the statement 'I am at a Lecture' is pressed (E1.1-S4)

Sorting statements

The user can have different number of statements and if the statements are many, the user should be able to easily find the statement he/she would like to activate. This is why, a sorting function is included in the application. There are three options for sorting (Figure 7.14) – 'Sort by name', which sorts the statements alphabetically; 'Sort by most used', which sorts the statements as the ones that are used the most are at the top of the list; and 'Sort manually',

which gives possibility to the user to customize the order of statements by dragging and dropping them.

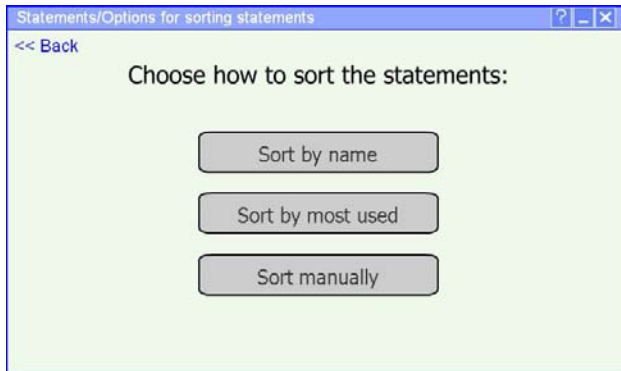


Figure 7.14: Options for sorting the statements, shown when the button ‘Sort’ is pressed (E1.1-S5)

Tutorial and Help

If the user does not know how to use the application, he/she can see demonstrations of different actions in the tutorial. When the button ‘Tutorial’ is pressed, an overview of the different Tutorial parts is shown (Figure 7.15).



Figure 7.15: Overview of the functionalities which are presented in the Tutorial, shown when the button ‘Tutorial’ is pressed (E1.1-S6)

It should be noted that the tutorial is not fully finished and it does not contain all possible functionalities. The user can also search for something specific in the tutorial. The results will be displayed in the same screen. The user can select a functionality, which he/she wants to see a demonstration of. When the tutorial part (for example ‘Activate a statement’) has been selected, a small movie clip (animation) is shown with a demonstration of what actions should be performed. Along with the demonstration, messages are displayed with explanations. If the movie clip contains more than one screen, the user has to press the link ‘*Click to proceed’ on order to continue the specific tutorial. As an example how a specific tutorial looks like, the first screen of the tutorial about ‘Activating a statement’ is shown on Figure 7.16.

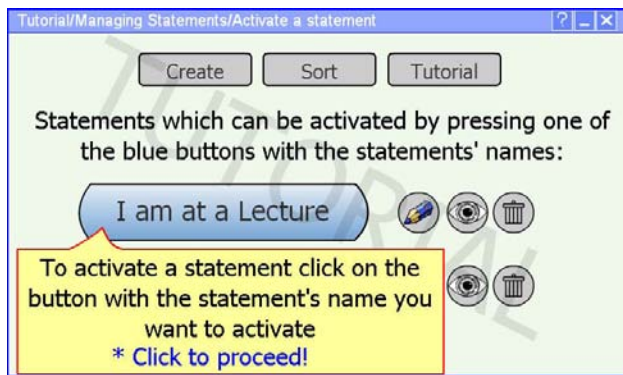


Figure 7.16: Tutorial for activating a statement (first part), shown when the link ‘Activate a statement’ at the main screen of the Tutorial is pressed (E1.1-S6.1)

When the user presses the link ‘*Click to proceed’ on the last screen of the specific tutorial, the user is asked if he/she wants to see the tutorial again (Figure 7.17). If the user presses ‘Yes’, the tutorial is repeated. Otherwise the overview of the tutorial is shown on Figure 7.15.

The user can also find help for each screen, excluding the pop-up messages, by pressing the Help-button (image of ‘?’) at the corresponding screen. An example how the Help-screen looks like is shown on Figure 7.18.

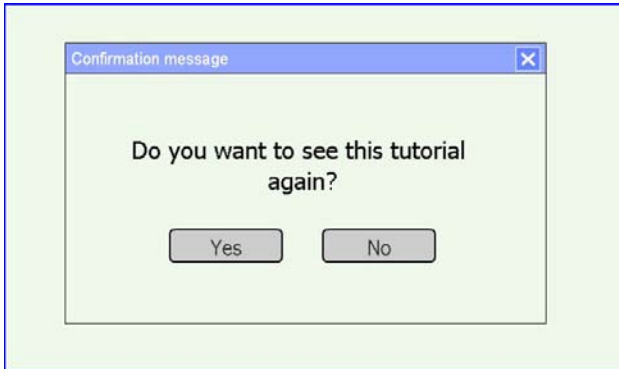


Figure 7.17: Confirmation message for repeating the tutorial for activating a statement, shown when the last ‘Click to proceed’ is pressed (E1.1-S6.2)

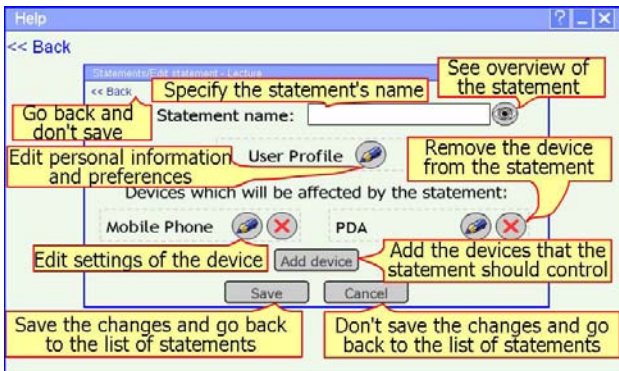


Figure 7.18: Help for the screen with devices and user profile for the statement ‘I am at a Lecture’ (shown when the ‘?’-icon is pressed at the Edit-screen for the statement) (E1.1-S7)

List of settings of a device

To configure a statement, the user has to select which devices would be included and also to choose the settings for these devices. Configuring the settings of a device can be performed by pressing the Edit-icon for the corresponding device, when a list of active settings for the device is shown. Active settings are the settings which will be affected when activating the statement. An example of the screen with active settings of ‘Mobile phone’ are shown on Figure 7.19 and of ‘Laptop’ – on Figure 7.20. The possible actions at this screen are:

- Select a value for a setting by selecting an option from a drop-down menu,

marking a check-box, etc;

- Add a setting which will be affected when activating the statement – by pressing ‘Add setting’;
- Remove a setting from the device – by pressing the Remove-icon (image of a ‘X’) for a specific setting. There is a Remove-icon for each setting. Only the present settings at this screen will be affected when the specific statement is activated. Removing a setting is only putting the setting from the active list of settings to the inactive list of settings. A removed setting can easily be added to the device again (by pressing ‘Add setting’).
- See help for the current screen – by pressing ‘?’.

To select which programs to be started on the laptop when activating the statement, the ‘+’ is pressed and a list with possible programs is shown (Figure 7.21).



Figure 7.19: List of active settings for Mobile phone, when creating a statement (E1.1-S2.2)

Adding settings to a device

If the user would like to choose a setting of a device, which is not present on the list with active settings, the user can add the wished setting by pressing the button ‘Add setting’. The shown screen contains extra settings for the specific device, as it does not contain the settings which are already included for the statement. An example for adding a setting to Mobile phone is shown on Figure 7.22.



Figure 7.20: List of active settings for Laptop, when creating a statement (E1.1-S2.3)



Figure 7.21: List of programs, which can be chosen when pressing the '+' at the Laptop-screen (E1.1-S2.3.1)

User profile

The user can choose what personal information and security and privacy preferences will be used in a specific situation (or when activating a statement) by selecting the Edit-icon for 'User profile' (Figure 7.23 and Figure 7.24). The user also has an option to use the 'general profile in the system', which is configured in advance. The idea of having 'User profile' for each statement is that the user has more control over the personal information and preferences if he/she needs some specific information to be available for certain situations.

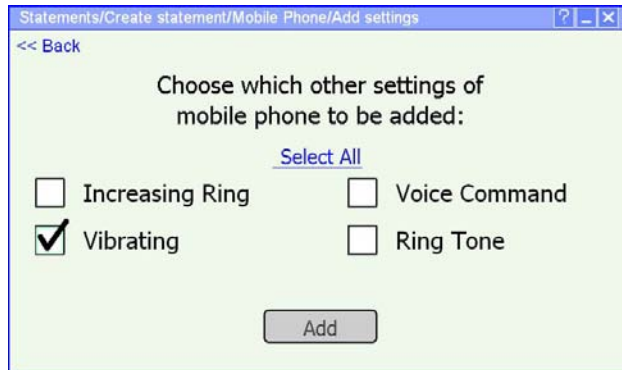


Figure 7.22: Adding a setting to a device, which will be affected by the statement (E1.1-S2.2.1)

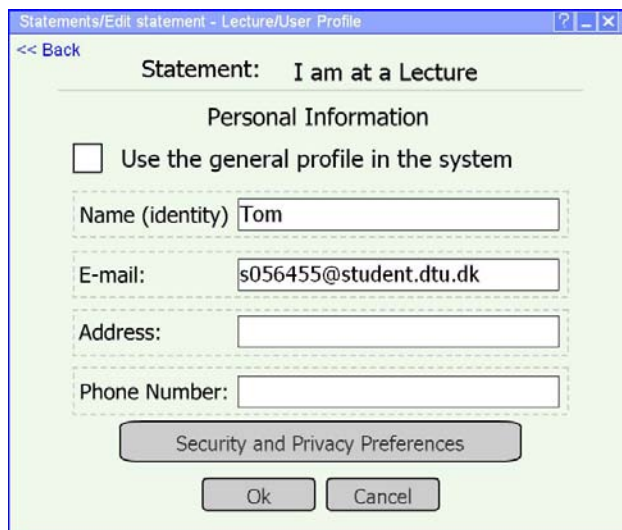


Figure 7.23: Possible User profile information, when editing the user profile for the statement 'I am at a Lecture' (E1.1-S8.1)

A general overview of the screen-structure and the navigation of the prototype, as well as the possible actions that the user can perform with the prototype are shown on Figure 7.25. A legend with explanation of what the different elements



Figure 7.24: Security and Privacy preferences, when editing the security and privacy preferences for the statement 'I am at a Lecture' (E1.1-S8.1.1)

of the diagram mean can be seen on Figure 7.26.

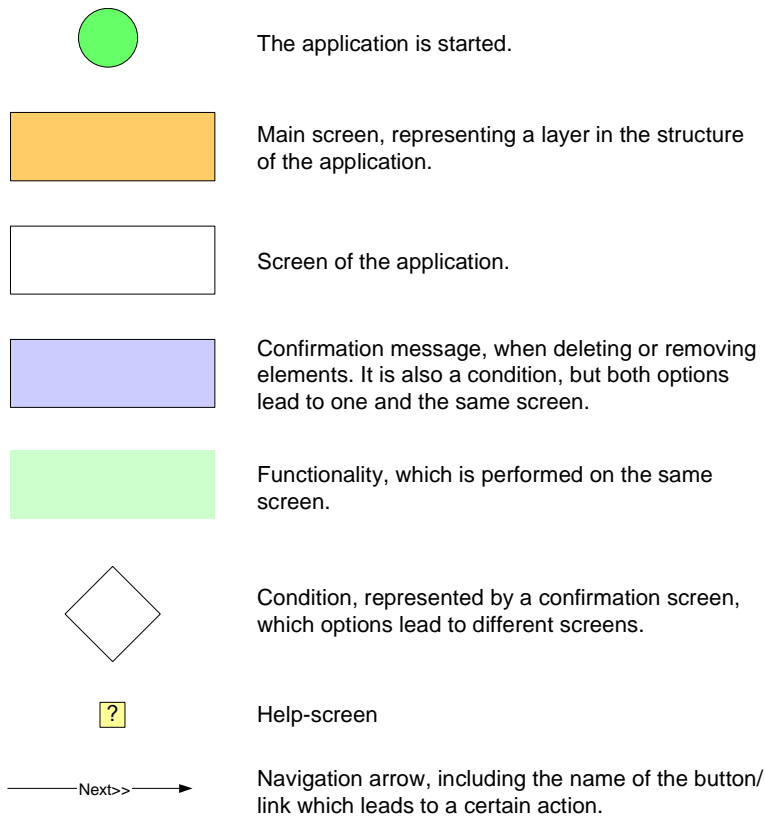


Figure 7.26: Legend for the diagram 'Overview of the different screens and possible actions in the Flash prototype' (Figure 7.25)

7.1.2 Design decisions

The design decisions are based on the fact that the application is being implemented for a mobile device, which has a small screen and that the interaction is performed by using a pen (or pen-based), as well as that the device is intended to be used on the move. Some of the decisions taken in the process of designing the prototype are described further:

Splitting the tasks across number of screens

There are simple and complicated tasks, which can be performed with the application. The simple tasks can be performed by going only to one screen (for example view and delete a statement), while the complicated tasks require to go through series of screens. The more complicated tasks (creating and editing a statement) have been organized in a way so that the user is shown first the screen with devices and user profile for the statement and then the user can configure the settings for each device and the user profile. The user can freely select which device to configure first and if he/she needs to add more devices, and is not restricted by a certain order of configuring the settings.

Structure of individual screens

Organizing the information and the different design elements on each screen of the application is very important and can be critical for understanding what the different elements represent. Some of the principles, used in the overall design of the individual screens, are inspired by the Gestalt laws (see Section 4.6) are given below:

- *Grouping screen elements*

The elements which belong together are grouped, so it is easier for the user to distinguish the different types of information. By following the ‘Law of Proximity’, some of the interface elements are grouped by placing them close to each other. An example of the ‘Law of Proximity’ is the possible options for a specific statement, which are also placed close to the button for the statement (see Figure 7.27).

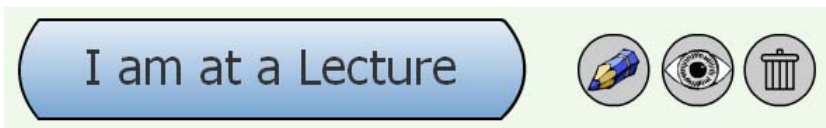


Figure 7.27: ‘Law of Proximity’

By using another Gestalt law ‘Law of Unity’, borders have been used around some other interface elements, in order to be perceived as a group.

En example of the ‘Law of Unity’ is shown on Figure 7.28.



Figure 7.28: ‘Law of Unity’

Following the ‘Law of Equality’ the buttons and the elements, which are placed in one row or column and should be perceived as a group, are designed to have the same size. Examples of this law are the icons, placed next to a statement (see Figure 7.27), and the buttons for options for creating a statement (see Figure 7.4).

Colour has also been used to help perceiving objects as a group. This is why, the buttons which need to be perceived as one group, have the same colour (see Figure 7.4).

- *Simple shape*
 ‘Law of Good Shape’ has been used when designing the different shapes in the interface. The used buttons in the interface have rectangular or close to rectangular and circle shapes, which are considered to be simple shapes. Some of the different buttons have been already shown on Figure 7.3.
- *Organization and visual structure*
 By following the ‘Law of Balance/Symmetry’ the overall structure of a screen is designed by trying to achieve equal visual weight, or to balance the different elements on the screen. More specifically, the different types of information is distributed equally around the vertical axis, going through the middle of the screen (see Figure 7.29).

Minimizing the user’s actions

In order to minimize the number of steps the user has to do to perform a certain task, the possible actions for a specific statement/device/setting are given as a set of icons for each entity (see Figure 7.3, Figure 7.7 and Figure 7.19). In this case, the specific functionality can be chosen with one click which relates to the usability goal efficiency, stated in Section 4.1.1. It also makes it more clear for the user what the possible actions for each element are. Furthermore, it distinguishes the common actions for each entity from the general functionalities, which are not related to a specific element (for example creating a new

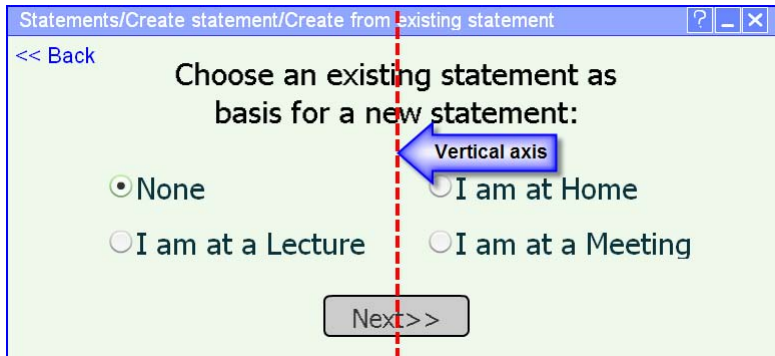


Figure 7.29: ‘Law of Balance/Symmetry’

statement, sorting statements, seeing tutorial).

Window design

Windows are a basic part of graphical interfaces and thus, it is important to decide what the window structure would be. For the statements based application it is decided that when a new screen is opened, it will be displayed in the same window, because the screen of the PDA is small and it would be difficult for the user to manipulate many windows and to find a specific one. In this case, the user is easily able to trace out consecutively the steps he/she has made by using the **<<Back**-button if it is necessary.

A specific kind of window – dialog box – is used for confirmation messages, because the dialog boxes are commonly used with this purpose in other interfaces and the users are familiar with them.

Menu design

The types of menus that are used in the prototype are horizontal flat menus, vertical flat menus and drop-down menus. Some of the horizontal ones are also picture menus. Calling a flat menu horizontal or vertical refers to the placement of the menu elements on the screen.

The horizontal menus are used for displaying general options (see Figure 7.30), which are not related to a specific statement, as well as to display the possible actions for a specific statement/device (see Figure 7.31).

The horizontal menu for the general options have been chosen because a small number of options need to be displayed and the screen is small. If the vertical menu was used for this purpose, it would make the screen even smaller. Presenting options as a horizontal menu on the right of a specific statement/device makes it easier to relate them to the statement/device. It is characteristic for



Figure 7.30: Horizontal menu for general options



(a) Options for a specific statement



(b) Options for a specific device

Figure 7.31: Horizontal picture menus

this horizontal menu that the options are given with icons, because it saves some space and makes the options more recognizable from each other. More about the icons is explained in the next subsection ‘Icon design’.

The vertical menus are used as sub-menus when a certain button is selected, for example from the general horizontal menu, in order to give more specific choices for the selected functionality (see Figure 7.32). The options in a vertical menu are the only ones presented on the screen, because in this way, the users can have a better overview of the possible choices and will not be distracted from other elements on the interface.

The drop-down menus are used for presenting the options for the settings (see Figure 7.33). The drop-down menus do not take too much space and can easily provide an overview of the choices for the setting. In order to be consistent in the design, even settings with only two options are given with drop-down menus.

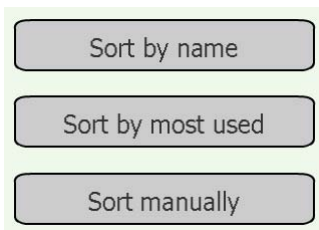


Figure 7.32: Vertical menu

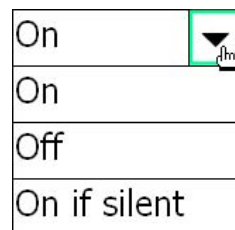


Figure 7.33: Drop-down menu

Icon design

It has been decided to use icons for the following situations: for presenting the devices in the overview of a statement (see Figure 7.34) and at the screens with the devices' settings (see Figure 7.35) and for choosing possible actions, which can be performed with a specific statement/device/setting (see Figure 7.31). The reasons to choose icons are that they are compact and do not take too much space, they are easy to learn and remember and they make the different options more distinguishable. The icons can also make the interface more appealing. However, it is a challenge to design good icons, because the used images need to be perceived in the right way and understood what they represent. The implemented prototype uses icons which are simple and easy recognizable on the small screen and which the users would be familiar with, such as icons which are commonly used in computer and mobile applications.

In order to give a hint to the users about what the functional icons are used for, a helpful text is displayed when the user hovers over the icon with a pen (see Figure 7.36). This helpful text is not present all the time because it would take a lot of space.



Figure 7.34: Icon, representing a device on the overview-screen

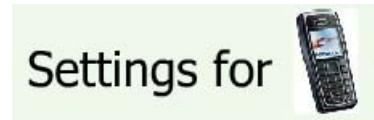


Figure 7.35: Icon, representing a device on the edit-screen for the device



Figure 7.36: Helpful text for the functional icons

Choice of interface elements

Other elements which have been included in the design of the interface are presented below:

- *Check-boxes (multiple selections)* are used to give the user a possibility to select more than one option at a time. They are used when adding devices to a statement, giving criteria for searching for external devices

and adding settings to a device. In these situations the user can save time if he/she needs to add several devices or settings, and the search would be better if several criteria are selected. Example of check-boxes can be seen on Figure 7.37.

- *Radio buttons* give the user the possibility to select only one option and they are used when selecting a template or a existing statement as basis for creating a new statement. An example of radio buttons is shown on Figure 7.38 .
- *Scroll bar* is chosen to be displayed for longer screens instead of clicking ‘Next’ to see the rest of the information on another screen. The scroll-bar can be seen on Figure 7.2. In this case the user can have a better overview of which information belongs together. Otherwise the user might get lost in the many ‘next’ screens and might get confused.

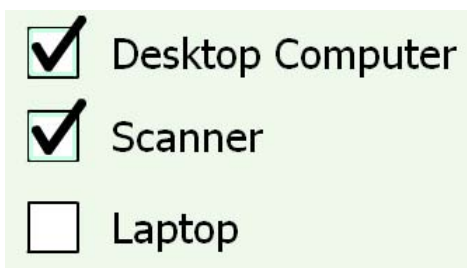


Figure 7.37: Check-boxes

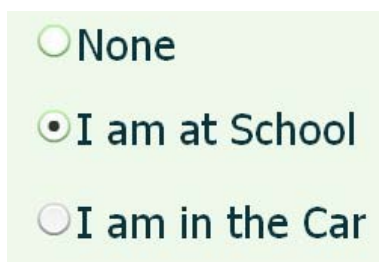


Figure 7.38: Radio buttons

Colours

The overall colour scheme is selected to be blue-light green, because it creates a more neutral atmosphere and is not disturbing and annoying, looked from the designer’s perspective. Colours on the main screen are also used to attract the user’s attention to the main functionality – activating statements by presenting the statements as big blue buttons. When a statement is activated, the colour is changed to more powerful one – which should attract more attention, so the user can easily see which statement is active. The colours on the main screen can be seen on Figure 7.3.

7.2 Scenarios

In order to specify some typical tasks/functionalities which students can perform by using the statements based application, some specific scenarios have been developed. The scenarios are detailed and include the actions for performing a certain task. This is why, they have been used as a basis for defining the typical

tasks for the user testing and the corresponding expected steps to perform the tasks.

7.2.1 Scenario 1: Activating a statement

Actor: Maria, a 25-year-old student in Biotechnologies at DTU, non-experienced user in computer technologies

Maria has a new application on her PDA – Nokia 770, which would help her to manage the settings of her devices in her Personal Network by using statements for identifying different activities, situations and mood. When she starts the application for the first time, a set of default statements are shown on the first screen. Maria is at the cafe in the university. She has a lecture in one hour and wants to find out how she can apply the default statement ‘I am at a Lecture’ before she enters class. She does not want to waste time of exploring the application and this is why, she selects ‘Tutorial’ with the idea that she can find quickly an explanation how to activate a statement. The tutorial is opened in the same window by displaying different options. She reads through the options and finds the one she needs – ‘How to activate a statement’. When she presses the option a small movie starts with demonstrations of what she needs to do in order to perform the necessary task. She liked that after each demonstration, a text with explanation is shown and that she can decide when to go further in the tutorial for activating a statement. Seeing the tutorial is enough for Maria and she presses ‘No’ when she is asked if she wants to see this tutorial again. The system returns Maria to the main screen of the Tutorial, where she can choose ‘<<Back’ and go to the main screen of the application with the list of default statements. Now she knows how to activate a statement. Before she enters the lecture-room, she presses the button ‘I am at a Lecture’, which changes colour, so Maria is sure that the statement is active and the necessary settings are applied.

7.2.2 Scenario 2: Seeing an overview of the devices and settings of a statement

Actor: Tom, a 20-year-old student in Computer Science at DTU, experienced user in computer technologies

Tom has just installed a new application on his PDA – Nokia 770, which would help him to manage the settings of his devices in his Personal Network. When he sees the default statements, he wants to check what devices and their settings are associated with the statements. He decides to check the settings of the statement ‘I am at a Lecture’ first and looks around the statement to find how he can do that. He likes to explore new applications in general and this is why, he presses the icon ‘eye’, which is closed to the statement and might be related to

seeing an overview of the statement. When he pressed the ‘eye’ he saw a little text ‘View’, shown under the icon, which confirmed that he was in the right place. He guessed first that the icon ‘eye’ is probably used for this function because ‘eye’ can be associated of seeing or looking into something. Now Tom can see which devices are affected by the statement ‘I am at a Lecture’ and what their settings are, as well as what personal information and security and privacy settings are preferred when the statement is activated.

7.2.3 Scenario 3: Creating a new statement

Actor: Tom, a 20-year-old student in Computer Science at DTU, experienced user in computer technologies

Tom is at home and he is exploring his statements based application. Tom participates in many groupwork sessions for his courses at the university and he thinks that it might be useful to use a statement to set the devices in his PN for these sessions. He can see that there is not a default statement, which can be directly used for the situations when he has groupwork. He can decide to edit one of the default statements or create a new one. He prefers to create a new statement. He can easily see the ‘Create’-button, which he presses. The options for creating a new statement are displayed. He decides to ‘use template’, because he would only need to adjust the settings if there is a proper template for his needs. The template ‘I am at a Meeting’ sounds close enough for him, so he selects it and presses the ‘Next’-button. He changes the name of the statement to ‘I am at Groupwork’ in the new screen, which is shown. The devices which need to be set for this statement are his mobile phone, his PDA, his laptop and an external printer at the university, which is close to the rooms where he usually has groupwork. The laptop and the external printer are not included in the chosen template. This is why, he includes them by pressing ‘Add device’. The laptop is selected from the list of devices in the PN (by pressing ‘Add device from the PN’). In order to add the external printer, Tom needs to search for it first. He selects ‘Add external device’ and writes some search criteria for the printer. When he presses ‘Search’ some printers’ names are displayed, and he chooses which one to add to the statement. If none of the printers was suitable, he could repeat the search. After he has all needed devices for the statements, he selects the ‘Edit’-button for each one in order to specify the concrete settings. He wants also to specify which e-mail is preferred to be used when the statement is activated. This is why, he selects the ‘Edit’-button for user profile and writes the specific e-mail. He looks through the security and privacy settings, but the default ones are appropriate and he leaves them how they are. When he is finished with configuring the devices and the user profile, he presses ‘Save’ and the new statement is displayed in the list of statements.

7.2.4 Scenario 4: Editing the settings of a statement and adding a device to a statement

Actor: Nina, a 27-year-old student in Telecommunication at DTU, experienced user in computer technologies

Nina has an application on her PDA, which assists her in configuring the devices in her PN and user profile. She has a statement for the situations when she is at a Lecture. She has just included a voice recorder to her PN and she wants to use it during lectures. This is why, she wants to include the new device to the statement 'I am at a Lecture', so she can set the appropriate settings. In order to do that she needs to edit the statement by pressing the 'Edit'-button. Then she uses 'Add device' and selects the option 'Add device from the PN'. All devices, included in the PN, excluding the ones that are already included in the statement, are displayed. Nina finds the voice recorder, mark its check-box and presses 'Add'. Then she sets the settings by pressing the 'Edit'-button for the Voice recorder. After she is finished, she saves the changes by pressing 'Save'.

7.2.5 Scenario 5: Deleting a statement

Actor: Brian, a 22-year-old student in Telecommunication at DTU, experienced user in computer technologies

Brian has a default setting 'I am driving', which he is not going to use, at least in the near future, because he does not have a driving license. Thus, he decides to delete it in order to reduce the number of statements. He presses the 'Delete'-button or the icon 'recycle bin' and then selects 'Yes' when he is asked for confirmation. The statement 'I am driving' disappears from the list with statements.

7.2.6 Scenario 6: Sorting statements

Actor: Maria, a 25-year-old student in Biotechnologies at DTU, non-experienced user in computer technologies

Maria likes using statements for configuring her devices in her PN and user profile. She has made 12 statements, which she uses in different situations. Maria is going to a lecture and before entering the lecture-room she wants to find the statement 'I am at a Lecture' easy and quickly, because she is in a hurry. Sometimes it is difficult to find the statement she needs if she just scrolls the list. This is why, she sorts the statements by pressing the button 'Sort' and because she uses this statement very often, she selects the option 'Sort by most used'. In this way, the statement 'I am at the Lecture' shows between the first statements.

7.3 Evaluation of the hi-fidelity prototype

After the electronic prototype has been developed, it has been tested in order to evaluate how usable it is, and more precisely to identify problem areas, which need to be taken into consideration in further developing of the design.

7.3.1 Planning and implementation of the evaluation

In order to achieve good results, the evaluation has to be planned carefully. This is why, the ‘DECIDE’ framework (see Section 4.8.3) has been used to guide the evaluation. The different elements of the framework, as well as the the implementation of the evaluation are described below:

Goals

The main goal of the hi-fidelity prototype evaluation was to identify the usability and user experience problems in the interface, which included finding out if the users could understand how to use the application and if they could easily navigate through the different screens in order to perform the tasks; if the users understood the different concepts used in the design and how they perceived the used elements in the interface. Another goal was to find out if something was missing in the interface and how the problem areas could be improved, according to the users’ opinions.

Questions

Three groups of questions, which needed to be answered in the evaluation process, were identified. All guiding questions used in the evaluation process can be found in Appendix D.2. The first group of questions aimed to identify the user types, by categorizing each user as one of the four fictitious users. The second group of questions was improvised open questions, which were asked in the process of performing the tasks in order to clarify the user’s opinion when commenting certain part of the interface. These questions were asked after the user had performed a certain task, in order not to disturb the user’s performance. The last group of questions was a part of the user satisfaction questionnaire. They were asked after the test. These questions aimed to find out how the users evaluated the design, considering usability and user experience areas, as well as to find out the users’ opinions for particular design solutions and elements. The questions from the questionnaire are presented in Section 7.3.3.

Evaluation approaches and techniques

The chosen evaluation approach was “Usability testing” (see Section 4.8.1), where the users’ performance was measured on typical tasks. The evaluation methods, which are associated with this approach and are used in the evaluation, are user testing, observing users and asking users through interviews and questionnaires (see Figure 4.8.2). The user testing is selected as a main evalu-

ation method, because this is an evaluation of an electronic prototype and user testing is very appropriate for evaluating hi-fidelity electronic prototypes, which are very close to the real application which is developed. By observing the user interaction with the system and measuring the user performance, the results of the evaluation are more realistic, which leads to identifying more usability and user experience problems and improving of the design. The user testing is supplemented by a structured interview for identifying the user types before the test and an unstructured interview for clarifying the users' opinions when commenting the interface during performing the tasks, observing the users when interacting with the prototype during performing the tasks and user satisfaction questionnaire, performed after the test.

The questions for the structured interview for identifying the user types were prepared in advance, because the criteria for categorizing the users were defined, while the questions asked during the performing of the tasks were improvised and depended on the comments the user have when interacting with the prototype. Observing the users was enhanced, by using the method 'Think Aloud' while the users were performing the tasks. In this way, the evaluator could more clearly understand why the users perform certain actions and what makes them confused and/or annoyed.

The user satisfaction questionnaire was used to find out the users' opinions about the interface after performing the test. It contained semantic differential rating scales (see Table 7.1), open and closed questions. The rating scales were used, because the users would make judgements about different things – for example how easy to use or how pleasing the interface is – which is important for the usability and user experience.

Difficult to use						Easy to use
Inefficient						Efficient
Difficult to learn						Easy to learn
Unhelpful						Helpful
Inconsistent						Consistent
Not secure						Secure
Outdated						Modern
Annoying						Pleasing
Bad User Experience						Good User Experience

Table 7.1: Semantic differential rating scales

Practical issues

When doing an evaluation, many practical issues have to be considered in order to achieve relevant results, which would help in improving the design. The practical issues which have been identified in advance, before performing the evaluation, are described below:

- **Designing typical tasks**

In order to test the intended functionalities of the prototype and to find out how usable the prototype is, it is very important what tasks are selected to test the users' performance. The tasks, which were given to the users to perform during the evaluation, are typical tasks for the target user group and are associated with activities, the users are familiar with. The users were also guided into the context of the situation by giving them general background information. In this way, the users would feel more comfortable in performing the tasks. The background information and the tasks, developed for the evaluation, are described further.

Background Information

Imagine that you, as a student, have a Personal Network, which consists of the following devices: a PDA Nokia 770, a mobile phone, a laptop, a desktop computer, a printer, a voice recorder and a scanner. You always carry with you your PDA Nokia 770. The settings of the devices and your user profile for different situations, activities and emotional states can be managed by associating sets of settings of devices and user information with "statements", where a statement can be for example "*I am at a Lecture*", "*I am happy*", etc. The "Statements based profile management application" is a software program which runs on your PDA Nokia 770 and it can help you in managing the statements you need in order to configure the settings of your devices easily and quickly. You are using the "Statements based profile management application" for the first time.

Tasks for the user testing

1. You don't know what would happen when the statement "*I am at a Lecture*" is selected. How would you check what the statement "*I am at a Lecture*" does?
2. You are going to a lecture and before you enter the lecture room you would like to apply the statement "*I am at a Lecture*". Can you show how you would do that?
3. You need a statement which would assist you when you work on a student project with a group. What would you do? For the statement you need to set your user profile, your mobile phone, laptop and PDA

as well as a public printer at the university. The settings for the devices are given in the following table (Table 7.2).

Devices	Settings
Mobile Phone	On; Silent; Set on vibration; The settings for mobile phone which are not necessary should be removed from the statement.
PDA	On; Silent;
Laptop	On; Silent; Connects to the DTU wireless network; Makes sure that you can use Internet; Internet Explorer and the necessary programs for the groupwork are loaded.
Public printer at the university	Prints only at one side as portrait.

Table 7.2: Settings of devices for a statement, used when working in a group.

4. A new semester starts and you need some different settings when you are at lectures. This is why, you would like to change the settings of statement “*I am at a Lecture*”. Can you show me how you would do that?
5. You don’t need the statements that you have created for the groupwork any more. Can you show what would you do?
6. If you have many statements how would you find the one you need?

A list of expected actions, necessary to perform each task and success criteria, which were used to identify if the user completed the task successfully, were defined. Some of the actions could be performed in a different order than specified. The actions necessary to complete the tasks and the success criteria can be seen in Appendix D.2. This document has been used by the evaluator to easily track the users actions and to quickly identify if the user makes an error or just perform the task differently than expected.

During the tests, quantitative performance measures have been obtained, by recording the following types of data:

- Time to complete a task

- Number and type of errors per task
- Number of users making a particular error
- Number of users completing a task successfully

A coding (or a helpful) sheet for taking notes (see Section 4.8.2) has been used by the evaluator in order to easily log when an user asks for help, presses help-button or tutorial-button, makes an error, is confused or annoyed, has completed the task successfully and the time to complete the task. The coding sheet is presented with Table D.3 in Appendix D.

- **Selecting typical users**

Identifying if the prototype is usable for the target user group requires that the tests are performed with different representatives from the target group. This is why, the selected users for the evaluation are students with different level of technical experience and privacy concern, or the users represent different types of fictitious users (see Section 2.3), excluding only Fictitious User 4, which was difficult to find in order to participate in the evaluation. It was decided to make 10 evaluations, because it would be possible to make some relevant quantitative analyzes of the results. Almost all of the users (8) have participated in the activities for gathering user needs and establishing requirements (interview or/and workshop), as 4 of them have also participated in the evaluation of the conceptual design. There were also 2 new users who participated for the first time in activities, related to this project. The advantage that 8 users have participated in previous activities and evaluations has been that they have heard about the concepts of Personal Network and Statements, so they could concentrate on the interaction with the prototype and performing the tasks, instead of using their energy and attention to first understand the concepts.

- **Preparing the testing conditions**

The test has been performed in a studying office/room. The evaluator was present in the room for evaluation in order to assist the users when necessary, to observe their actions and to take notes. The necessary equipment was papers with the scripts for the users, the helpful materials for taking notes and comparing the users' actions with the expected ones; a microphone, laptop and recording application in order to record the evaluation sessions; a device Nokia 770, where the application for the prototype has been run.

- **Planning the test procedure**

A plan and guiding questions for the evaluation were prepared in advance (see Appendix D.2). The equipment was set up and tested to make sure

that it worked correctly before each user session. The users were introduced to what the evaluation was about and what the procedure was. The users who had not been participating in previous activities and evaluations, were interviewed to identify which user types they were. After that, the user was given a script with background information and six tasks. While performing the tasks, the user was asked to say aloud what he/she thought, while the evaluator observed and took notes to document important things of the user's performance. After the test, the users were given a questionnaire to fill in. The evaluation session for each user took approximately 50-60 minutes.

Ethical issues

The users have been asked if they allow to record the evaluation session. They have been informed that their activities would be logged and that the collected information would be included in the project report and in this way, it would be made public. On the other hand the users have been assured that their names would be kept confidential and they would not be included in the report. The users have also been informed that they can stop the evaluation at any time if they feel uncomfortable with the procedure. An official consent form has not been prepared, because it has not been considered to be necessary.

Analyzing and presenting the data

The recorded evaluations were transcribed. The users' comments and the notes from the evaluator's observations for the different users have been grouped by tasks. The answers of the users for the different questions have been grouped by specific question. Grouping the users' opinions and answers for a specific task/question would make the analyzing of the results easier, because relevant information for a specific topic is presented together.

The collected data from the evaluation can be divided in two main types – qualitative and quantitative data. The qualitative data has been produced from think-aloud protocols and observations, the audio transcripts and evaluator's notes, as well as from the open questions in the post-test questionnaire, while the quantitative data has resulted from measuring the users' performance, errors, etc., as well as the questionnaire rating scales and closed questions. The qualitative data has been analyzed by looking for incidents and patterns of behaviour in the users' comments, actions and answers. Incidents can be cases when the user cannot find something in order to perform a certain task and they can inform the designer about the possible problem areas. Patterns or similarities in the users' actions or comments can also be used to inform about common user behaviour or problems. The quantitative data, on the other hand, has been analyzed by using simple descriptive measures from statistics. Furthermore, the data has been presented graphically with diagrams, which helps to visualize the results of the measurements or the answers of a certain closed question.

The used descriptive measures from statistics are *arithmetic mean*¹(usually just called the mean) and *standard deviation*².

7.3.2 Experience in the process

Performing the tests and the whole evaluation process of the electronic prototype has been an interesting process for both the evaluator and the users. The interaction with the prototype has been a better experience for the users than the interaction with the paper-based prototype because the users could perform a whole task from the beginning to the end by themselves, as well as they have had more freedom to explore the prototype. A disadvantage of the electronic prototype has been that it has not been fully developed, which means that not everything worked if the users tried to explore things out of the tasks. Despite this disadvantage, all necessary elements to perform the tasks have been implemented. Because of the possibilities of direct interaction with the prototype, the users could get an idea of how the application would look and feel. Most of the users seemed to be interested to see how the application was developed and enjoyed interacting with the prototype. They were enthusiastic and wanted to share their opinions and comments in order to inform and improve the design.

7.3.3 Results from the evaluation

This section presents a summary of the results, obtained from the evaluation sessions, as the results from all users are grouped by task or by question. All full results from the evaluations are given in Appendix E.

Overview of the users

The users, who took part in the evaluation of the hi-fidelity prototype, are representatives of the target user group students with different level of experience in technologies and level of privacy concern. The users represent only the first three types Fictitious users – 4 of the users are Fictitious User 1, 1 – Fictitious user 2 and 5 – Fictitious user 3. It was not possible to find Fictitious User 4, most likely because of the same reasons, which have been stated when identifying user needs and evaluating the Conceptual design (see Section 5.1.3). The

¹The mean is defined as $\bar{x} = \frac{\sum_{i=1}^n x_i}{n}$, where n is the number of observations and x_i is the i -th observation. [Johnson'05]

²The standard deviation is defined as $SD = \sqrt{\frac{\sum_{i=1}^n (x_i - \bar{x})^2}{n - 1}}$, where \bar{x} is the mean. [Johnson'05]

overview of the users can be seen in Table 7.3. The level of experience is given as separate information (even if it is indirectly included in the description of the certain Fictitious user) because the most differences which have been noticed are between experienced and non-experienced users.

User	Fictitious User Type	Level of experience in technologies
1	Fictitious User 1	Medium
2	Fictitious User 3	High
3	Fictitious User 1	Medium
4	Fictitious User 1	Low
5	Fictitious User 3	High
6	Fictitious User 3	High
7	Fictitious User 2	Low
8	Fictitious User 3	High
9	Fictitious User 1	Low
10	Fictitious User 3	High

Table 7.3: Users, participated in the evaluation of the physical design

Performing the tasks

The user testing has been carried out by asking the users to perform 6 typical tasks. The evaluator observed and took notes of the users' interaction with the prototype and the users' behaviour. The summary of the observation results for all users, which are used for measuring the users' performance, are shown in Table 7.4. The table contains the number of users who have been observed to be in a certain situation (asking for help, be confused, etc), the number of users, who completed a certain task, as well as the mean value for the time to perform a certain task.

In general, most of the tasks could be completed successfully by all users. An overview of how many users have completed a certain task can be seen on Figure 7.39. The most problems, identified from the observations, were while performing Task 1 (seeing an overview of a statement) and Task 3 (creating a statement). This has been concluded because some users have asked for help, have made errors, have been confused or annoyed. The task, which has the most users who asked for help (3), were annoyed (4) and were confused (7), is task 3. It is important to point out that the different users have been confused for example by different things – such as not being able to find the 'Ok' and 'Can-

Task #	Press Help/Tutorial	Ask for help	Make error	The user finds something annoying	The user is confused	Completing the task	Mean Time [min]
1	3		3	2	4	8	< 1
2	1	1			1	10	< 1
3		3		4	7	10	10.1
4						10	< 1
5						10	< 1
6						9	< 1

Table 7.4: Summary of results from the observation process

cel' buttons first or the 'Vibrating'-setting for Mobile phone, not understanding why the necessary settings for a device should be removed, not understanding why the 'user profile' is needed for each statement, etc. This can be understandable, because Task 3 (creating a statement) contains many elements and requires different actions (more than the other tasks). The problem areas are discussed when commenting the performance of each task.



Figure 7.39: Overview of successful completion of the tasks

In order to compare the users' performance of the tasks, the time for performing a certain task has been measured. Most of the tasks (excluding only Task 3) were performed very quickly, less than one minute per task, because the tasks were short and simple. If the users could performed these tasks, it took them less than one minute per task. This is why, it would be more relevant to com-

pare the users' performance when performing Task 3. The time for each user is given on the diagram on Figure 7.40. The diagram also shows that the mean value of the time, needed to perform the task is 10.1 minutes. The standard deviation has been calculated, because the standard deviation is an indication of how widely spread the different time values are, or how close the values are to the mean value. The standard deviation is 3.38, which is a high number and leads to the conclusion that the time values are not too close to the mean value. In general, the time needed for the different users to perform Task 3 is quite different.

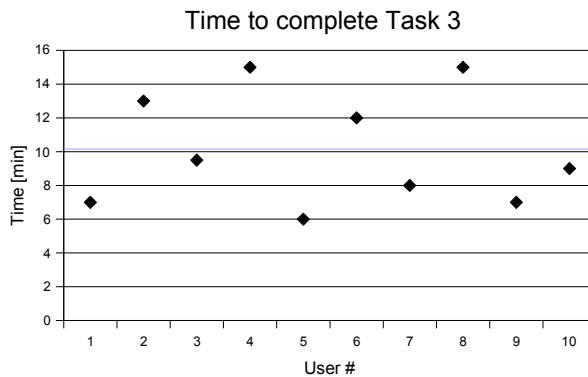


Figure 7.40: Time to complete Task 3 – all users

It is interesting to see the performance of the experienced and non-experienced users separately. Most of the non-experienced users could perform the task for between 7 and 10 minutes, as the mean value is 9.3 (see Figure 7.41). One of the non-experienced users needed 15 minutes to perform the task, which needs to be investigated further to find the reasons for that. The experienced users performed the task for between 9 and 13 minutes, as the mean value is 11 (see Figure 7.42). One of the experienced users used more time – 15 minutes to perform the task, while another needed only 6 minutes. This is rather unexpected result.

The reasons that the experienced users in general performed the tasks for longer period can be that they explored the application more and looked through the different possibilities more thorough, while the non-experienced users did only the necessary thing to perform the task. Some of the experienced users also criticized different elements and said what was good during the process. Only one of the non-experienced users, needed longer time to complete the task because he/she needed more time to figure out what to do, and only one of the experienced users performed the task very quickly. This means that the user's

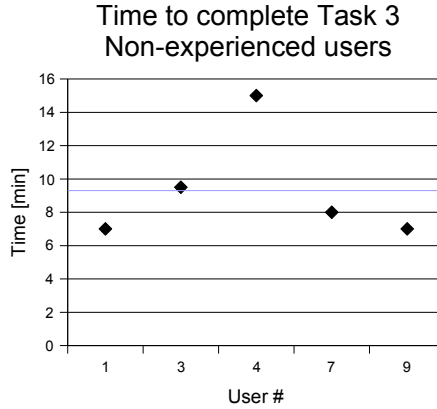


Figure 7.41: Time to complete Task 3 – Non-experienced Users

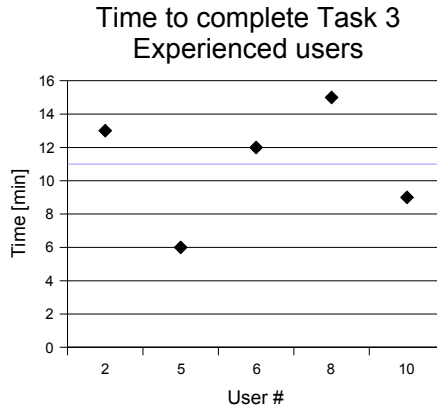


Figure 7.42: Time to complete Task 3 – Experienced Users

performance depends not only on the user's technical experience, but also on personal characteristics and how the user perceives different elements.

Only two types of errors were made while performing the tasks – both in relation to Task 1 (seeing an overview for a statement). The first error was that the user pressed the statement-button instead of the View-icon to perform the task, and it was made by two users. The second error was that the user pressed the Edit-icon for the statement to perform the task. It was considered as an error, even though the user could see the settings but with more actions and

not as a whole overview, because it differed from the defined success criteria for the task. The second error was also made by only one user. Both errors can be related to the different expectations that the users have when interacting with the interface. Not having too many errors while the users performed the tasks and almost fully completing of the tasks leads to the conclusion that the users' performance was very good and that the interface is suitable for performing tasks, similar to the tested ones.

Some specific observations and comments for each task are given below:

- *General* – Some of the users preferred to see the tutorial first before performing the tasks, because they used the application for the first time, while others tried out and explored the options in order to perform the tasks. Some of the users read the headings and the leading text of the screens and got an idea what was shown on the screen, while others thought that some of the texts were too long, so they just interpreted the content of the screens themselves. In general, it was important for the users what settings and options were used for the devices. They were asking what a specific setting was used for and if it was possible to have this setting. This is why, the selected settings for the devices are the ones that the user knows and normally uses. If there are settings that the user does not understand, he/she should have access to quick help to see what a certain setting does. Some of the users thought that specific features were not needed, until it was explained how it was intended to work. It shows that if the information is presented in the right way to the users, they might find the certain feature useful. One of the main differences, observed between experienced and non-experienced users was that the more experienced users had more requirements and expectations about the application. They also had many suggestions for extra features and alternatives.
- *Task 1* – Most of the users can perceive the image of an 'eye' with seeing an overview of a statement. Some of the users were not sure at the beginning which button/icon to use, so they just explored the View-icon, which they guessed could be used for seeing the overview or they pressed the 'Tutorial'. After the View-screen was shown they were sure that they were at the right place. Even the users, that made an error first, when performing this task, could find the right button afterwards themselves and perform the task successfully. Only two of the users could not associate the 'eye' with the intended functionality and could not solve the task. These users were first confused that what they tried did not succeed and then annoyed. One of them was experienced and the other one – non-experienced user. This is why, it is difficult to evaluate if the icons are better recognized by experienced or non-experienced users. Most likely, it depends on the

personal perception of images. Most of the users found that using an ‘eye’ for the View-icon was logical and understandable enough.

- *Task 2* – All users could perform this task and thought that it was logical and clear to activate a statement, by pressing the button for the certain statement, because the statement-buttons were big and attracted the attention. Some of the users could not understand what happened when they pressed the button, so they were a little confused. They expected something more to happen than changing the colour of the button. They were missing some more confirmation that the specific statement was activated or a text on the screen which always show which the active statement was. Some other users were satisfied with the changing of the colour as notification that something was happening.
- *Task 3* – The users could easily find how they could create a new statement. They could understand what the button ‘Create’ was supposed to do. Most of them could also understand the different options for creating a statement. Some of them preferred to use templates and others – to start from scratch. Nobody of the users used the option ‘Use existing statement’, probably because there were not created too many statements. One of the users could not even understand why this option was necessary. Most of the users could understand the used icons for editing (‘pencil’) and removing (‘X’), but one user could not find how to remove settings from a device. The ‘X’-icon was absolutely unclear for this user. The same user though that it was difficult to understand that ‘pencil’ was used for editing, but he tried it and managed to change the settings. All users could understand how to add a device to the statement, while it was difficult to realize that not all settings of a device were included in the list of setting of a device – so it was a little difficult for some of them to see the ‘Add setting’-button. But after looking around and wondering how to add a setting, they could find the ‘Add setting’-button. It was not clear for some users that only the settings, affected by the statements were included in the edit-screen for the device. Some of the users were not sure what certain settings were used for, for example ‘Answering mode’ and ‘Forwarding calls’ (for Mobile phone), ‘Use only certified networks’ (for Security and Privacy preferences). Another interesting observation was identified in relation to the user profile. Most of the users could not understand why it was necessary to have an user profile for each statement and some of them could not understand what ‘user profile’ meant. They would expect that they had already set their profile. This was why, most of them selected the option ‘use the general profile in the system’. After a short explanation from the evaluator, about the purpose of the user profile in a specific statement was, most of these users agreed that they had not thought about that and it was a good idea.

- *Task 4* – All users could understand that the icon ‘pencil’ was used for editing, even if one of them was not too sure at the beginning and another one did not think that ‘pencil’ was an appropriate choice. The similar structure of creating and editing a statement helped the users to understand easier the Edit-screen for the statement and the possible actions that they could do.
- *Task 5* – All users could understand that the icon ‘recycle bin’ was used for deleting. Almost all of them liked that there was a confirmation message. One of the experienced users was planning to use the option ‘Don’t ask me again’, but changed his/her mind when realized that the deleted statement could not be recovered. Only one decided to choose the option ‘Don’t ask me again’, because he/she knew what he/she was doing (experienced user).
- *Task 6* – Most of the users would use the sort functionality in order to find the statement, they need. Some users would also scroll through the statements if they were not too many (one of the users expected that he would have probably only 5 statements, even if it could be possible to have a lot more). Some users could not understand what happened when the sort option ‘Sort manually’ was selected or what they needed to do to sort them manually, while it was very natural for others to drag the statements in the wished order.

Users’ suggestions for improving the design

During the evaluation, some users have suggested alternative solutions for different aspects of the application. The suggestions have been summarized and presented in Table D.4, Table D.5, Table D.6 and Table D.7, which can be found in Appendix D.4. The suggestions are grouped by area or functionality where it should be applied. It should be noted that these suggestions are described as the users have presented them and some of them might be contradictory or alternatives for the same thing. Some of these suggestions are considered for future development of the prototype.

Post-test questionnaire

The results from the post-test (or user satisfaction) questionnaire are presented mainly graphically in order to get a better overview of the users’ answers. The questions from the questionnaire are given before presenting the corresponding results, so it is easier to the reader to identify what the results describe. Some conclusions from the analysis of the results are also presented when discussing specific results.

Question 1. Rate the design by using the scales below. For each pair of adjectives, put a cross at the point between them that reflects how they describe the design according to you.

The summary of the results from rating different aspects of the design are given in Table 7.5, where the number of users who have chosen a certain rating options is presented. The table also contains the mean values and the standard deviation for each rating, which are used in analyzing of the results.

	Options						Mean value	Standard deviation
	1	2	3	4	5			
Difficult to use	0	0	2	3	5	Easy to use	4.3	0.82
Inefficient	0	1	0	6	3	Efficient	4.1	0.88
Difficult to learn	0	0	0	2	8	Easy to learn	4.8	0.42
Unhelpful	0	2	1	2	5	Helpful	4.0	1.25
Inconsistent	0	1	0	2	7	Consistent	4.5	0.97
Not secure	1	1	0	4	4	Secure	3.9	1.37
Outdated	0	0	3	4	3	Modern	4.0	0.82
Annoying	0	0	2	5	3	Pleasing	4.1	0.74
Bad User Experience	0	0	0	6	4	Good User Experience	4.4	0.52

Table 7.5: Summary of results from rating of the design

In general, by taking into consideration the mean values of the ratings (see Figure 7.43), most of the design aspect have been evaluated quite high – around 4 and even more. Because the mean values are not enough to make conclusions about the collected data, the standard deviations have been calculated. They can show how the different ratings are distributed around the mean value. Most of the evaluated items (except ‘Helpful’ and ‘Secure’) have standard deviations less than one ($SD < 1$) which means that the users have similar opinions about a specific aspect. In this way, it is easy to conclude if a particular aspect is evaluated as good or bad. If the users’ evaluations are very different, there can be difficulties to design/redesign the application in a way so all users are satisfied with it. In order to investigate the users’ answers a little more, each rating has also been analyzed separately. Descriptions about how the different evaluated aspects (adjectives) should be understood and how they have been explained to the user are given when discussing the results for each pair of adjectives.

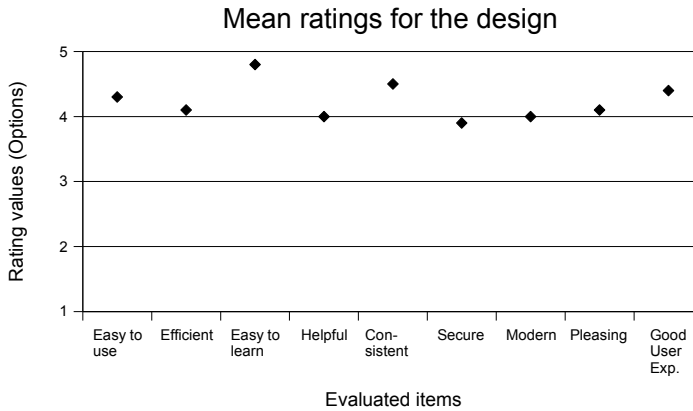


Figure 7.43: Mean ratings for different aspect of the design

Perceiving the design as ‘easy to use’ means that the user can easily understand what to do in order to perform the necessary tasks. Most of the users have rated the design in the right side of the scale (options 4 and 5), which leads to the conclusion that the design is in generally perceived as easy to use (see Figure 7.44). The lowest ratings are only in the middle (option 3) and they have been given by one experienced and one non-experienced user. One of the reasons that a non-experienced user has voted that the design is equally easy and difficult to use can be that the user has had a different perception of the used concepts and elements in the interface. The rating of the experienced user in the middle of the scale can probably be explained with the knowledge about different systems and the ideas for alternative designing of the interface that an experienced user most likely has.

Perceiving the design as ‘efficient’ means that the system supports the user in performing the tasks, so the user can quickly perform the tasks with minimum actions. Most of the users have perceived the design as ‘efficient’, which is showed by rating at the right side of the scale (options 4 and 5), but there is one user who has been more critical and rated the design closer to ‘inefficient’ (option 2) (see Figure 7.45). This user is an experienced users, who could most likely imagine another way of designing the system in order to make it more efficient.

Evaluating the design as ‘easy to learn’ shows that the user can easily and quickly learn how to use the application. 80 % of the users have rated the design with the highest value (option 5) (see Figure 7.46), which together with the

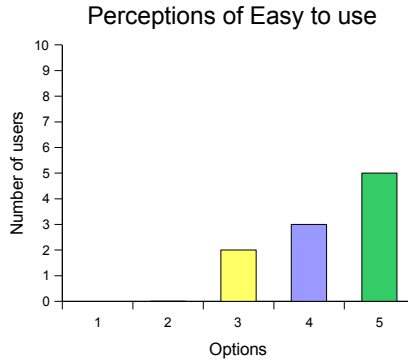


Figure 7.44: A graphical representation of the design according to whether it is perceived as ‘easy to use’ or ‘difficult to use’

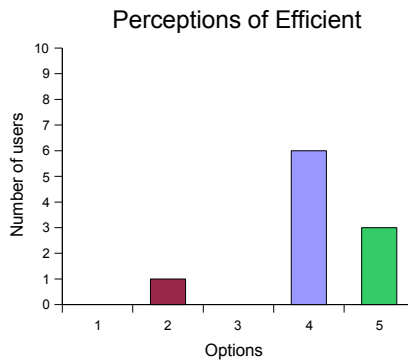


Figure 7.45: A graphical representation of the design according to whether it is perceived as ‘efficient’ or ‘inefficient’

mean value 4.8 and the standard deviation 0.42 lead to the conclusion that the prototype (respectively the application) is considered easy to learn.

‘Helpful’ is related to the design of the interface and not to how helpful the application is for the users. If the interface is ‘helpful’ it would mean that it provides the logical structure, necessary and meaningful information, in form of organizing the information, names of buttons, icons, headings, messages, etc., in order to help the user in solving the tasks. Even though more than 50% of the users have rated the design with options 4 and 5 and that the mean value is 4.0, the standard deviation is more than 1 ($SD = 1.25$), which means that the

users are not consistent in their opinions. It is not clear from these results if the application is helpful. Most specifically there are also users who consider the design not so helpful (see Figure 7.47). This leads to the conclusion that there are some problems, related to providing help and organizing the information, and that changes need to be made to provide more helpful interface in the future versions of the application.

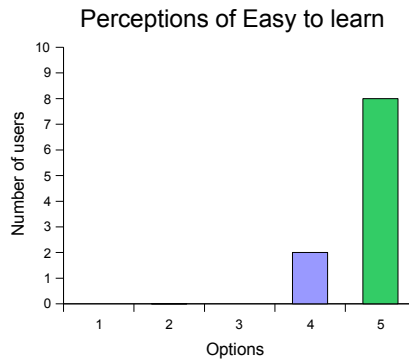


Figure 7.46: A graphical representation of the design according to whether it is perceived as ‘easy to learn’ or ‘difficult to learn’

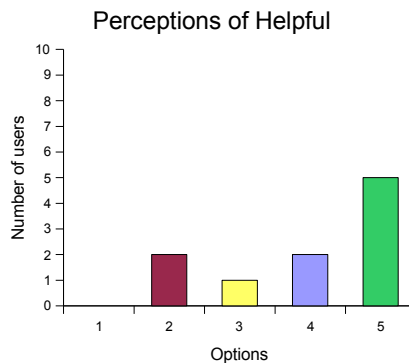


Figure 7.47: A graphical representation of the design according to whether it is perceived as ‘helpful’ or ‘unhelpful’

‘Consistent’ is related to using similar organization and layout of the information, as well as synonymous elements which are used with the same purpose

through the screens. Most of the users have evaluated the design with the highest rating (option 5) as being consistent (see Figure 7.48). Only one user has rated the design closer to ‘inconsistent’, but he has commented that the design is consistent, but it should have been made differently according to the user’s perspective. This is why, it could be concluded that the design is consistent and if changes need to be made related to other aspects, it has to be taken into consideration keeping the consistency of the design.

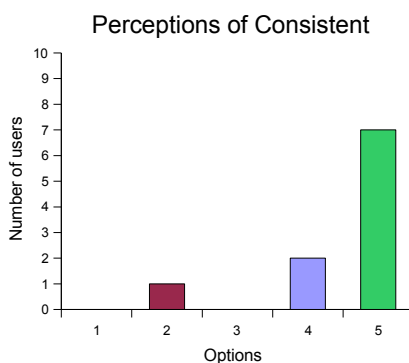


Figure 7.48: A graphical representation of the design according to whether it is perceived as ‘consistent’ or ‘inconsistent’

Rating the design as ‘Secure’, means that the user feels secure when using the application, more specifically that the security considerations, security options and protection mechanisms (for passwords for example) in the interface are good and enough. Even though, most of the ratings of the ‘security’ aspect are in the right side of the scale (option 4 and 5), there are some ratings in the opposite side (options 1 and 2) (see Figure 7.49). Considering a mean rating value of 3.9 and the standard deviation of 1.37, it leads to the conclusion that more security aspects/settings need to be taken into consideration in order to make the users feel secure.

Rating the design as ‘modern’ is related to evaluating if the interface look and feel up-to-date or if it contains modern elements and interaction. Most of the users have rated the design as ‘modern’ by evaluating with options 4 and 5, but there are also users who have not been certain if the design is ‘modern’ so they have chosen the middle of the scale (option 3) (see Figure 7.50). This brings up the need to research further the modern tendencies of designing mobile applications and to try to apply new elements to the design or to organize the information in a new way. The changes should be applied only if it fits with the

functionality and only if it will enhance the usability and user experience of the application.

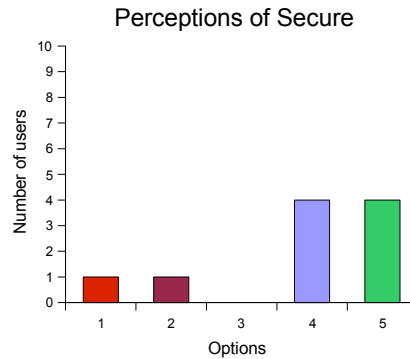


Figure 7.49: A graphical representation of the design according to whether it is perceived as 'secure' or 'not secure'

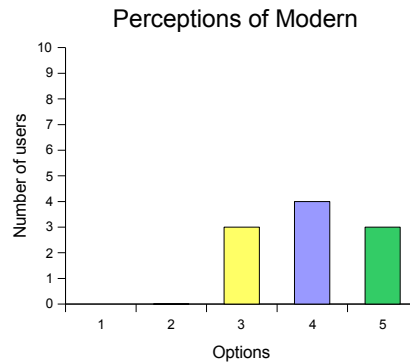


Figure 7.50: A graphical representation of the design according to whether it is perceived as 'modern' or 'outdated'

‘Pleasing’ design is associated with an interface which is nice and attractive, the one the user would like to use and which does not annoy him/her. The rating of this aspect is similar to the rating of ‘modern’ – most of the user perceived the design as ‘pleasing’, but there are some that rated it in the middle of the scale (see Figure 7.51). This would require further consideration how the interface can be made more pleasing, so that the users would use the application with pleasures.

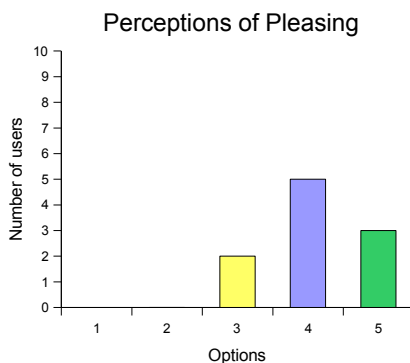


Figure 7.51: A graphical representation of the design according to whether it is perceived as ‘pleasing’ or ‘annoying’

Another important aspect of the design is the overall user experience. The users have been asked to evaluate if the application (prototype) provides good or bad user experience for them. ‘Good user experience’ is associated with the positive feelings that the interaction with the application creates for the user in the overall process of working with the application. All of the ratings lie in the right part of the scale (options 4 and 5) (see Figure 7.52), which means that all of the users have had a good or almost good user experience during the interaction with the application. In this case, the goal should be to keep the good user experience and to try to improve it when making changes for future development.

2. Do you think that your expectations about managing settings of devices at your PN are met?

Meeting the expectations of the users about the developed application is very important and it could be used for evaluating the overall user experience. Almost all of the users thought that their expectations were met, and only one user expected more than the prototype offered. This leads to the conclusion that the



Figure 7.52: A graphical representation of the design according to whether it is perceived as 'good user experience' or 'bad user experience', when interacting with it

prototype of the application addresses the intended functionalities. The results of this answers of the question are shown graphically on Figure 7.53.

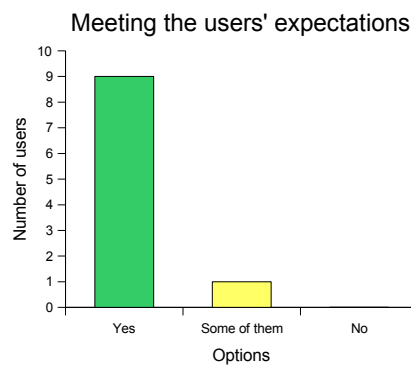


Figure 7.53: Results from Question 2

Question 3. What are the good things about the application interface?

The results from this questions are summarized by combining similar answers, grouping the answers by the related areas and presenting also how many users have mentioned the same good thing about the application.

General

- The interface is consistent. (3 users)
- The application is intuitive and explicit. This is why, it is easy to understand how to use it. (5 users)
- The interface is user friendly. (1 user)
- The used colours are nice. (3 users)
- It looks nice. (2 users)
- It is usable. Besides some minor details, the overall design is understandable and easy, which gives a possibility for the user to perform the needed tasks and to have a good user experience. (1 user)
- It is good to use a scroll bar instead of jumping to a next screen when there is more information. (2 user)
- It is good to have the statement name for the screens for devices and settings, and user profile. (1 user)
- The text on the screens is big enough and readable, because usually the text at mobile devices is small. (1 user)
- There is a border around the elements which belong together (text and icons for a device/a setting). In this way, it is clear which button/icon to press for a certain device/setting. (1 user)

User profile

- It is good to provide user information and security and privacy preferences (or to set the user profile) for a statement. (3 users)
- Having an option to use the general profile in the system when setting the 'User profile' for a statement. (4 users)

Security and privacy preferences

- The changing text explaining what a certain privacy level is, when a certain privacy level is chosen from the drop-down menu, at the 'Security and privacy preferences'-screen. (3 users)
- The option 'Log network activities' is good. (1 user)

Icons

- It is good that there are two different types of icons for deleting a statement and removing a device/setting. (1 user)

- The icons have helpful text which is shown when the pen touches the icon. In this way, the text does not block the other elements on the screen. The helpful text is also good because it confirms where the user is. (2 user)
- It is good that icons are used in the interface, because they are easy to understand and there is not too much text. (6 users)

Asking for confirmation

- It is good asking for confirmation when deleting a statement and removing a device. (1 user)
- It is nice to have the options ‘Don’t ask me again’ when the system asks for confirmation, because some users do not like the pop-ups. In this way, the application is more flexible and the user can decide if he/she wants the confirmation or not. (2 user)

External devices and searching for external devices

- Separating the devices in the PN from external/public devices when adding a device to a statement. (1 user)
- It is good to have a ‘keyword’ for the searching of an external device, because if the name of the server is given, all printers connected to the server can be given. (1 user)
- There is an option to configure printers at DTU. (1 user)

Settings

- It is easy to add a setting to a device. (1 user)
- The settings for the devices are logical. (1 user)

Tutorial and Help

- The Tutorial and the Help are innovative and nice. The small movie-clips for the Tutorial, which show how specific actions can be performed, are very helpful. (6 users)

Functionalities

- It is good that there is sorting functionality, which gives possibility to the user to configure his interface. (2 user)
- It is good to have an option to see an overview of the devices and settings included in a statement. (2 user)
- It is easy to create a new statement. (2 users)

Question 4. What are the bad things about the application interface?

General

- The user has to confirm the choices of settings by pressing the button ‘Ok’ (how it works in Windows applications). This is one of the main differences between Windows and Mac applications. The settings should be saved at the time they are selected/pressed as it is in Mac applications, because it is faster. It is also difficult to see the ‘Ok’ and ‘Cancel’ buttons at the bottom of the windows if there is a lot of information. (1 user)
- Not separating between actions and settings. Connecting to a wireless network and starting a program are actions according to the user and they should not be included in the statements. One of the reasons is that it takes time to connect or to start a program, while the other settings can be applied when they are selected. (1 user)
- The alignment of the buttons. The buttons should be positioned symmetrically – for example the buttons ‘Ok’, ‘Cancel’ and ‘Add setting’ (for screen for a device) can be placed in one column or in one row so they are symmetric. (1 user)
- The scroll-bar should be reset to start from the top every time a new screen is displayed. (2 users)
- Using scroll-bar. The screens have to be changed in some way without using a scroll bar. (1 user)
- Most of the heading texts are too long. (1 user)
- The <<back - button should go back to the previous screen where the user comes from (not a logical going back to the previous level). (1 user)

Activating a statement

- It is not clear which statement is active if only the colour of the button changes when it is pressed. (1 user)
- Activation of statements should be able to be performed from independent place, from a small icon in the task bar for example. When the icon is pressed the list with statements should be shown, and the user can choose which one to be activated. One would not use the full application every time he wants to activate a statement. (1 user)
- It is possible to activate only one statement at a time. One of the users would prefer to be able to combine minimum two statement at once. (1 user)

- The colours of the buttons for the statements are not nice. (1 user)

Creating a statement

- The option ‘Use existing statement’ for creating a new statement is not clear. (1 user)
- When creating a statement from scratch, there should not be given default devices – the screen should be empty and the user can add himself/herself the devices he/she needs. (1 user)

Icons

- Some of the icons are not very good and clear, or at least some of them for one of the users. (3 users)
- The icons should not have text that appear when a mouse/pen is scrolled over. (2 user)

Tutorial and help

- The icon ‘question mark’ for help was too small so the user could not see it. There should be a button saying ‘Help’ for each page. (2 users)
- The help-screen has too much information, so the user cannot find what he/she needs. (1 user)
- The pop-up window, asking if the user would like to see the tutorial he has just seen again. The user should exit the certain part of tutorial after the movie clip is finished. If the user wants to see it again, he/she can select the corresponding link again. (1 user)

Security and privacy preferences

- The ‘Security and Privacy preferences’ are not accessible enough. There are two levels from ‘User profile’, because editing the security and privacy preferences is from the Edit-screen for user profile, and only one level from the devices. This is why, ‘Security and Privacy preferences’ should be the same level as user profile. (1 user)
- The username and password about authorization at a wireless network should not be under user profile, but in the settings for laptop, when a certain wireless network is selected in ‘Connect to wireless network’. (1 user)

Sorting statements

- Sorting manually is not necessary, because if there are many statements, it would not be practical to drag and drop them. (1 user)

Laptop settings

- When programs are chosen from ‘Start program’ at the Edit-screen for Laptop, they are not displayed in the list with the other settings. (2 users)

Searching external devices

- When searching for an external device, the search results are shown at the same screen. (1 user)

Question 5. Was it easy to understand what you need to do in order to set your devices and user profile?

90 % of the users could understand how to set the devices and the user profile in all cases and 10 % of the users – only in some cases (see Figure 7.54). These answers confirm that one of the main functionalities of the application is presented in an understandable way for the users, which means that the 3 level-structure of the application (statements-devices and user profile-settings) works well.

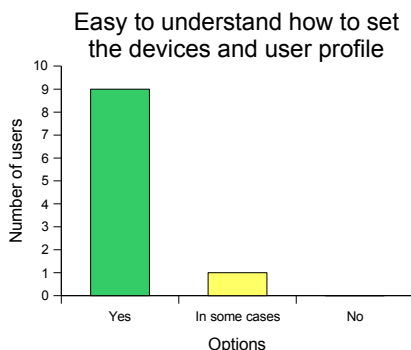


Figure 7.54: Results from Question 5

Question 6. What is missing at the interfaces?

General

- Lack of configurability – having more possibilities to configure the application and select different settings; The user expects something more from a device/application, something which amazes him with creativity and functionality, for example possibility to activate two statements at a time. (1 user)

- Text, written under the icons, to explain what they are used for. (1 user)
- An option to have a log-in screen for the application. (1 user)

Activating a statement

- A message or a mark ('check') to show which is the active statement. (3 users)
- Confirmation/feedback that a statement is activated. (4 users)
- Asking for confirmation when activating a statement. (1 user)

Sorting statements

- Sorting by feature or specific settings of a specific device. (1 user)
- Hint for sorting manually. (1 user)

Help and feedback

- A small icon with a question mark for help next to different settings, options, buttons, etc. so the user can check what they mean. (6 users)
- A hint what a 'certified network' at the 'Privacy and security preferences'-screen is. (1 user)
- Feedback that a statement is deleted. (1 user)

Settings

- Options to download updates or plug-ins for new features and settings for the devices. A device can automatically say to the application to update the settings if there is something new. (1 user)
- When selecting which program to start for the laptop, the selected programs are not displayed in the active list with settings for the statement. (1 user)
- Quick access to the statements for activation (icon at the task-bar). (1 user)
- There can be an option to choose general preferences if security and privacy preferences are made a separate section. (1 user)
- Lack of possibilities to set common functionalities of devices; The user would like to have an option to make all devices silent or to turn all of them off. (1 user)
- Lack of security settings. The user would prefer to have more choices about cryptography and protocols. (1 user)

- It is missing where to forward the calls for the 'Forward calls'-setting of the Mobile phone. (1 user)

Question 7. Would you use the application?

The overview of the results are shown on Figure 7.55. Most of the users (80 %) would like to use the application and one finds the application useful in some situations, which is an indication that the idea to be able to control many devices from one application is found useful. The results can also mean that the application was easy to use for the users, because if the users can not understand how to use the application and cannot perform the tasks, they might get angry and annoyed and it might take them longer time to set the devices from one application than from each device. This might lead to lack of wishing to use the application in general, even if they like the main idea. There is also one user who is convinced that the application would not be useful for him.

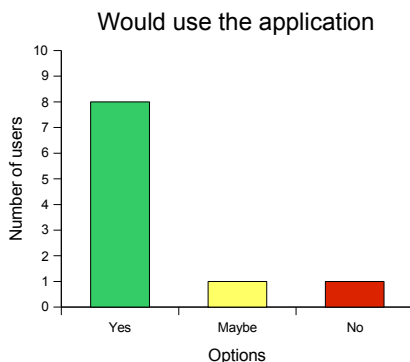


Figure 7.55: Results from Question 7

Question 8. Do you think that the application would help you in your study process somehow?

The results are presented graphically on Figure 7.56. Half of the users do not think that the application would help them in the study process, mostly because they do not have many devices, which they use at the university. The opinion of the ones who think that the application would help them in the studying (30 %) is that the application would save time if it assists the students in configuring different devices. There are also some users who are not sure if the application would help them or not. If the application does not help the study process of the students, it might not be a clear indication that the students would not use the application. But in order to attract more students as users, additional

research should be done to find out what the application should include in order to benefit the students in their study process.

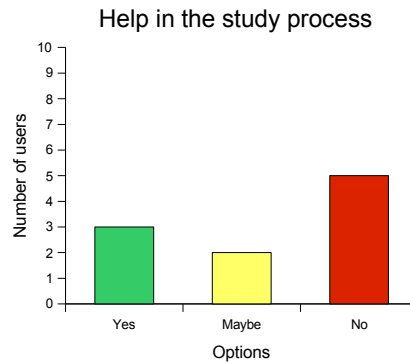


Figure 7.56: Results from Question 8

Question 9. Do you understand what the icons are used for?

Most of the users (80 %) perceived the used icons in the intended way, while one user could understand only some of the icons, which means that in general, the used metaphors in the form of icons are good and intuitive. The results of the question can be seen on Figure 7.57.

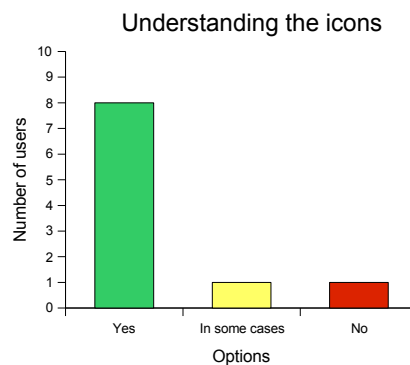


Figure 7.57: Results from Question 9

Question 10. Would you prefer icons than using text?

Most of the users (70 %) (see Figure 7.58) would prefer icons to be used in the interface than only buttons with text, because they think that the icons do not take too much space and the users can easily and quickly identify the purpose of the buttons. Some of these users would like the icons to be given with text under or above the icons, which gives a hint what the specific icons refer to. Considering that most of the users prefer icons than text and that most of them understood the used icons in the interface of the prototype, it can be concluded that the icons with the used images in the application must be kept. The only change can be that some text is added for each icon, for example 'Edit' for the icons with image 'pencil', etc.

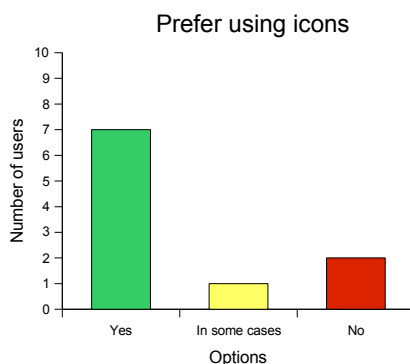


Figure 7.58: Results from Question 10

Question 11. Does it make sense to have helpful text for the icons when the pen hops over the icon, even though it does not work exactly as at the computer and it might be shown when the action is performed?

The results are graphically presented on Figure 7.59. Half of the users liked that there was some helpful text, shown when they pressed a certain icon, because it gave them confirmation that they were at the right place and because most of the icons were very intuitive; they did not need to see the message all the time. Even though half of the users have been positive about the text showing when an icon is pressed, there are some users who do not think that it is a good idea and some who have not been sure what is better. This is why, if the settings of the stylist (the pen) used for the PDA cannot be adjusted, so the text is shown before the action is performed, it might be needed to consider another way of giving a hint what the icons mean. A possible solution has been suggested in the previous question – writing text above or under each icon.

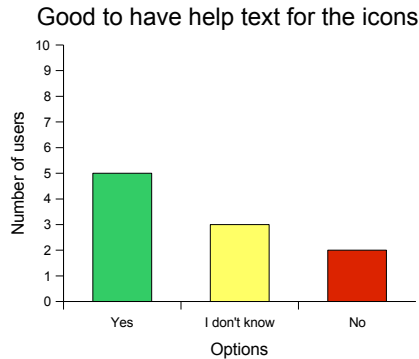


Figure 7.59: Results from Question 11

Question 12. Are the names of headings, buttons, text-messages clear and meaningful?

60 % of the users could understand the used names for the different elements in the interface, while 40 % thought that only some of the names were clear and meaningful (see Figure 7.60). This can be interpreted as most of the names of headings buttons and text-messages have served their purpose of guiding and giving hints to the users what the different elements are and what the possible functionalities are. This is why, only the problematic names should be identified and changed, while keeping the rest intact.

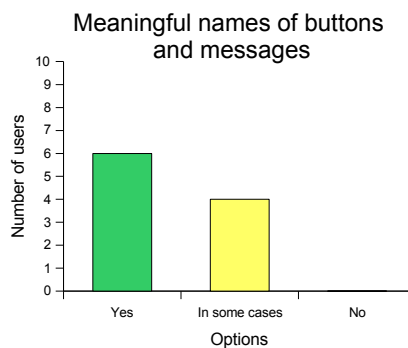


Figure 7.60: Results from Question 12

Question 13. What do you think about the font and the font size of the characters – is it easy to read the characters at the screen?

All of the users thought that it was easy to read the characters (the text) on the screens (see Figure 7.61), which means that no changes are necessary in the font or the font size of the text.

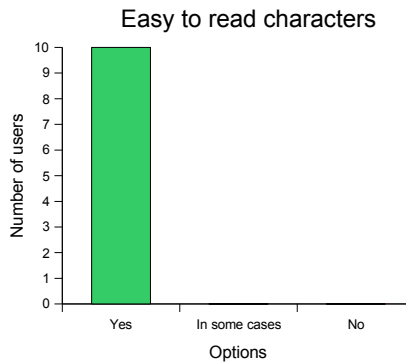


Figure 7.61: Results from Question 13

Question 14. Do you prefer the screens to have a scroll bar instead of “click-next-screen” solution?

Almost all users (90 %) preferred to see all related information at one screen, even if this required using a scroll-bar (see Figure 7.62). Thus, the users can have a better overview which elements and information belong together. This leads to the conclusion that the decision to use a scroll-bar is good and the scroll-bar should be kept for the next prototypes which will be developed.

Question 15. Do you like the colour scheme?

All users liked the used colours and their combination in the interface (see Figure 7.63), which means that the colour scheme should be kept in future prototypes.

Question 16. Would you prefer to use the single sign-on concept (or logging in once at the mobile device), instead of having a log-in screen for the application?

All users preferred to log-in only once at the mobile device (PDA) or the single sign-on concept instead of having separate log-in screen for each application at the PDA, including the statements based profile management application. The

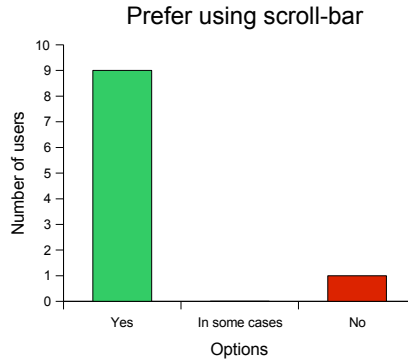


Figure 7.62: Results from Question 14

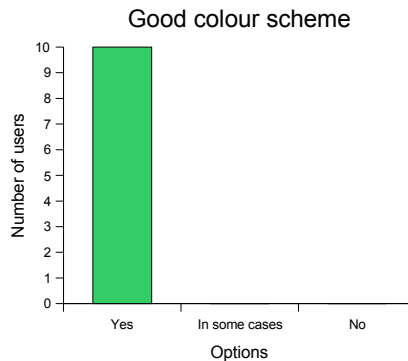


Figure 7.63: Results from Question 15

results can be seen on Figure 7.64. This confirms that log-in screen for the application is not necessary if there is a log-in screen for the PDA. In case the user's PDA is not protected with password, an optional log-in screen can be developed for the designed application.

Question 17. Do you have some other comments about the design or the functionalities of the prototype?

The additional comments at the end of the usability evaluation are presented below. The comments are presented as they have been said by the users in order the reader to get an idea of the users' final thoughts and discussions about the prototype. The final comments can be used when designing the next versions

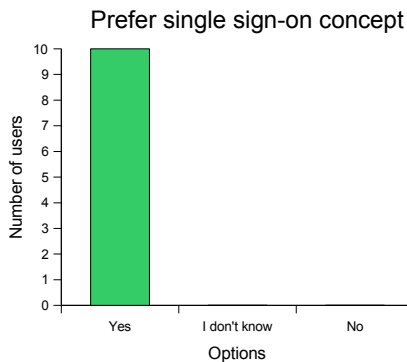


Figure 7.64: Results from Question 16

of the prototypes of the application.

General

- The interface is intuitive.
- The interface uses common structure and elements that are used in other applications for mobile devices and computers. This is helping in understanding and using the application, because the users would be familiar with the used elements.
- The interface looks fine overall.
- The user expected first a more complicated application, because mobile devices are usually complicated, but it was actually easy to use.
- If the application is used couple times, it will be simple to use it. It is good for the application to be simple, but the user needs more confirmations.
- The application would be useful for the people that have many devices and participate in different activities.
- The user finds the application very easy to use because he knows what a Personal Network is. If he did not know what a PN is, it won't be probably so easy, but still easy to use the application.
- The user enjoyed working with the prototype and seeing the movie-clip for the Tutorial. She thought it was very nice and fun experience.
- There were some things that the user could not understand at first but she figured out by trying and exploring. The user did not need to look for help because she prefers to explore things.

- The interface is not modern if the user needs to press ‘Ok’-button all the time to confirm. He thinks that Apple has a modern approach and that is what he finds pleasing and attractive.
- The application was not perfect but it was good.
- It was clear that the main functionality of the application was activating statements by pressing the buttons.

Security issues

- The user would feel secure even if he/she does not have a log-in screen for the application. The user prefers to log in once when he/she uses the device (single sign-on).
- When the user selects a statement, he/she would like the devices that are included in the statement to log in automatically without prompting the user for password – he/she likes the single sign-on concept.
- The user needs to be sure that the passwords he/she saves in the application are secure even if he/she loses the device or the device is stolen.
- It is difficult to evaluate if the PN and the application are secure. The user would like to know how the different connections in the PN are made in order to feel fully secure. Regarding the user’s personal information, he/she would feel secure, but he/she would not like the information to be displayed publicly.

Tutorial and Help

- The tutorial looks fine.
- One of the users did not notice the Help-buttons (‘?’) for each screen, because he/she did not expect that there was help for each screen.
- The icon ‘?’ for help and the ‘Tutorial’-button can flash when the user uses the application for the first time, so it attracts the attention.
- ‘*Click to proceed’, used in the Tutorial should be named ‘Next’ for example to be consistent with the whole design.
- The Help-screen is OK, but it can be too much information for some users.

User profile

- The user understood what ‘User profile’ meant and if he/she did not, he/she would check what it was behind it. The name ‘User profile’ is a proper technical term.

- The user was presented the idea of having a user profile for each statement. The user thought that the idea was good, and that he/she did not think in this way. The user was not sure that he/she would use it often because he/she was not used to fill in his/her user profile very often.

Icons

- Using an icon 'X' for removing a device and a button 'Add device' is not very similar approach.
- Some of the icons might be difficult to understand from users that are not too good in using computers. The 'recycle bin' would be understood, but the 'pencil' should be changed with a 'paper and a pencil'-icon.
- It is fine to have two different icons for deleting a statement and for removing a device/setting. The icon 'X' is understandable and it is fine to be used for removing a device or a setting from a statement.

Settings

- It makes sense to have only the settings that would be affected on the screen for a device.
- The user would feel that he/she has more freedom if there are more settings.

Navigation

- It might be nice to have a button which leads directly to the main page, called for example 'Statements'.
- It is good to have a quick access to the View-screen from the Edit-screen and vice versa.

7.3.4 Ethical issues related to the technology

When dealing with technologies some ethical issues about privacy, security and freedom come forth. Thus, the users have been observed and different discussions and comments about privacy, security and freedom have been logged. While performing the tasks and interacting with the prototype some of the users were concerned how the application manages their privacy and security. They liked that they can select different security and privacy settings for different situations, but some of the more experienced users wanted to see more extended security and privacy settings in order to feel secure. Most of the users did not feel that their privacy is threatened, because they could choose what information to include in the user profile and to set the privacy level. The fact, that the users are aware of issues about privacy and security, requires that the

application provides good security and privacy mechanisms so the users can feel secure. Changing the settings of the devices automatically only by selecting one button was not found very practical for the users who did not think that they would use the application in general. It can be related to the idea that they might lose control. This is why, they would prefer to set the devices separately. There was also a discussion about how the user would have more freedom. For the experienced users it seemed that if there is a variety of settings for configuring the interface itself and the different devices and user profile the users would feel more free, because they can select between many settings and configure the application how it would suit them best. On the other hand, the non-experienced users would feel that they have more freedom when the application is easy to use and understandable, which is the opposite of having many settings. In this case, a compromise can be made as keeping the interface simple but giving options for the experienced users to customize the interface and add more settings. The only element which intends to monitor the user's behaviour, at least in the implemented prototype, is detecting which statements are used more often in order to sort them when the sorting option 'Sort by most used' is selected. It did not seem to bother and be a problem for the users. If the future prototypes include some context aware services, which would automatically trigger some statements, the users should be asked if they would feel that they lose control and if their privacy is threatened in this situation.

7.3.5 Suggestions for changes for future development of the application

Based on the observations of the users performing tasks during the user testing, the users' suggestions and the results from the user testing and user satisfaction questionnaire, as well as the designer's considerations, some suggestions for changes and general recommendations about the application are defined. The suggestions are described as giving the area, which they refer to, explanation and the reason for suggesting a change.

Area	Suggestion	Reason
General	The icons are supplemented with label (text) written under them, which explains what they do.	The user can easier find out what the icon represent.
General	The headings of the screens with settings of the devices should be renamed to 'Affected settings' by also giving the image of the specific device.	It is more likely that the user reads the heading if it is short.
General	There should be a notification if a certain device from the PN or an external device from a statement is disconnected from the network by any reason and this device should disappear from the list.	The user can have better control over the non-available devices and would be able to take some other actions.
General	It should be possible to select more than one statement and in this way, make different combinations of statements.	The user have more possibilities and freedom for using the statements.
Activating a statement	The statements which is active should be by default on the top of the list of statements.	The user can easily find the active statement.
Activating a statement	The active statements should be marked with a 'check' in front of the name of the statement.	The user can easily identify which statement is active.
Activating a statement	There should always be one statement which is active at a moment.	The user won't be confused what happens when all statements are deactivated.
Activating a statement	There should be a general statement, including all devices from the PN with default setting, which is used when the specific statements are deactivated.	The user can easily see an overview of the current default settings in the same way as of a specific statement.

Table 7.6: Suggestions for changes and recommendations for future development of the application – Part 1

Area	Suggestion	Reason
Activating a statement	If applying a statement would take some time, a progress bar should be shown to inform about the progress. The statement button can be used as progress bar.	The user can easier follow the progress of activating the statement and get a feedback when it is done.
Activating a statement	There should be a shortcut for activating statements. For example from a small icon at the task bar the list of statements can be shown and the user can activate one.	The user can more quickly activate a statement when a new situation occurs.
Templates	The user should be able to see an overview of the devices and settings for a template before he/she chooses it.	The user can choose the template which suits his/her needs best.
Templates	The option 'None' for the templates should be removed.	It might be confused that it is related to a template.
Using Existing statements for creating a new	The option 'None' for the existing statements when creating a new statement should be removed.	It might be confused that it is related to an existing statement.
Settings of devices	It should be possible to configure common settings of devices.	The user can quickly select settings for several devices at once.
Laptop settings	There should be a search function for searching wireless networks, not only selecting from defined ones.	The user might want to connect to new wireless networks.
Laptop settings	The specific option 'Authorize at auth.wireless.dtu.dk' should be replaced with 'Automatic authorization'.	In this case the option can be used in general for every wireless networks.

Table 7.7: Suggestions for changes and recommendations for future development of the application – Part 2

Area	Suggestion	Reason
Laptop settings	When the programs, which would be started when activating a statement, are selected, they should be shown on the screen with settings.	In this case the user have an overview of all affected settings.
Searching public devices	The option 'Find the nearest device' should be added as a search criteria.	This is in case the user does not know how far a certain device can be.
Security and Privacy Preferences	There should be a section/button 'Authorization' at the screen for 'Security and privacy preferences', where the needed information for authorization for different networks should be provided.	The authorization information is grouped in this way in one section.
Security and Privacy Preferences	The access to 'Security and privacy preferences' should be at the same level as 'User profile', or accessed from the screen with devices and user profile.	The user can quickly access these preferences, without dependence of the user information.
Deleting a statement	The user should always be asked for confirmation when deleting a statement (or the option 'Don't ask me again' should not be present).	The user is prevented by making a mistake, which cannot be recovered.
Sorting statements	The statements should be sorted by the most used ones by default, with exception that the active statement is at the top.	The user can easier find the statements he/she uses the most.
Sorting statements	There should be an option to save the sorting order when the statements are sorted manually.	The user can sort in the wished order many times.

Table 7.8: Suggestions for changes and recommendations for future development of the application – Part 3

Area	Suggestion	Reason
Tutorial	The ‘*Click to proceed’ at the last screen of the movie-clip for a certain tutorial (functionality) should be renamed to ‘*Click to finish’.	The user would be aware that this is the last screen.
Tutorial	The user should not be asked if he/she wants to see the tutorial again for the certain, functionality if he/she has just seen, but just return to the main page of the tutorial.	The user would not be annoyed by pop-ups. It is easy to select the tutorial from the main menu again.
Tutorial	The user should be able to see/read the whole tutorial from the beginning to the end.	This is in case the user does not know what to look for.
Tutorial	The tutorial can be divided in chapters, for example ‘Introduction’, ‘Statements’, ‘Devices’, ‘Settings’.	The user can have a better overview of the different parts of the tutorial.
Help	The help can be organized in a way, so when the ‘?’-icon is pressed a message ‘Please click on an element at the screen in order to see additional information’ is displayed. When an element is clicked, a yellow remark/bubble is shown for the corresponding element.	The user can see help only for the elements he/she is interested in one at a time.

Table 7.9: Suggestions for changes and recommendations for future development of the application – Part 4

Final Requirements Specification

This chapter describes the requirements specification of the statements based profile management application. The requirements specification contains the requirements which are implemented in the prototype; requirements which have not been implemented because of the restrictions of developing only a prototype, but which are considered important for understanding how the application works; as well as requirements, which are recommended to be used when future prototypes of the application are developed.

Each requirement is formulated by using the Volere requirements shell as a basis (see Section 4.4). However changes have been introduced in the shell in order to adapt it to the needs of this project. Some of the components have not been used and this is why, they were deleted from the shell (for example ‘Customer Satisfaction’, ‘Customer Dissatisfaction’, ‘Priority’, ‘Conflicts’, ‘Supporting Materials’). The component ‘Event/use case #s’ has been replaced with the more general ‘Reference #’. ‘Reference’ points to screens of prototypes, or documents which inspired the requirements or show the them implemented. Two new components have also been added to the shell – ‘Phase’ and ‘Status’. ‘Phase’ is used to indicate in which phase of the design process a certain requirement is created, while ‘Status’ shows what status the requirement has in the specific phase. These two components have been introduced in order to follow the development of the requirements in the different phases. The different values for the status are:

- The status of the requirements is '*New*', when they are created in the mentioned phase.
- If the requirement is still valid at the next phase, the status is changed to '*Active*'.
- If the requirement is changed at the next phase, and used in the new version, the status is '*Changed/Active*'.
- If the requirement is changed two times in the following phases after the creation, the status is '*Changed²/Active*'.
- Status '*Deleted*' is given when it is decided that the requirement is not needed.
- The requirements which are recommended to be taken into consideration in the future developing of the application have status '*Future Development*'.

Each requirements has a unique id, which consists of a letter/letters giving a hint about the type of the requirement and a number. The unique id has been used from the beginning of the design process, thus it can be used to follow the development of a requirement, which has been created in the previous versions of the requirements specification (see Appendix E). The requirements are not necessary presented in a consequent order. This is because the requirements for future development are given at the end of each section for a specific type of requirements, and the deleted requirements are presented in the last section '*Deleted requirements*'.

8.1 Functional requirements

This section presents the requirements, which define what the designed application should do.

Requirement #: **F1** *Reference #:* P1.3-S1 (Figure B.12), E1.1-S2 (Figure 7.7)

Description: The application should be able to configure settings of more than one device.

Rationale: The application should control a PN and a PN usually consists of different number of devices.

Originator (Source): Designer

Fit Criterion: There should be more than one device available to set for each statement in the screen design.

History: Created 25.04.2007 *Status:* Active

Phase: Identifying Needs and Establishing Requirements

Requirement #: **F2** *Reference #:* P1.2-S1 (Figure B.8), E1.1-S Main (Figure 7.3)

Description: The application should give possibilities to the user to Create, Edit and Delete statements, as well as to View what a specific statement is doing.

Rationale: The user can be in different situations which change with the time, so the user should also be able to perform different actions to the statements.

Originator (Source): Designer

Fit Criterion: There should be buttons/icons with functions 'Create', 'Edit', 'Delete' and 'View' for the statements in the screen design.

History: Created 25.04.2007 *Status:* Active

Phase: Identifying Needs and Establishing Requirements

Requirement #: **F7** *Reference #:* P1.1-S2 (Figure B.4),
E1.1-S2 (Figure 7.7)

Description: The list of devices when creating/editing a statement should not include all devices from the PN. The list of devices when editing a statement should include only the devices that are affected when applying the statement. When creating a statement from scratch the list of devices should include some default devices, such as PDA and mobile phone. The mentioned devices are shown only if they are present in the PN.

Rationale: The users might have too many devices in their PN. The mentioned default devices when creating a statement from scratch are chosen, because they are the most used devices by the users.

Originator (Source): Designer

Fit Criterion: There should be buttons to 'Add' and 'Remove' devices from the active list of devices. Default devices should also be shown when creating a statement.

History: Created 07.05.2007 *Status:* Changed²/Active
Phase: Identifying Needs and Establishing Requirements

Requirement #: **F8** *Reference #:* P3.1-S1 (Figure 6.7),
E1.1-S Main (Figure 7.3)

Description: It should be possible to delete and edit only one statement at a time.

Rationale: In this way the users would not be confused which statement they are editing or deleting.

Originator (Source): Designer

Fit Criterion: There should be Edit- and Delete-icons for each statement in the screen design and because of this there should be no possibilities to edit and delete several statements.

History: Created 05.06.2007 *Status:* Active
Phase: Conceptual Design

Requirement #: **F9** *Reference #:* P3.1-S1 (Figure 6.7), E1.1-S5
(Figure 7.14)

Description: There should be a sorting function for the statements. The statements can be sorted alphabetically, by how often they are used or ordered by the users.

Rationale: The users would easier find the statements they need.

Originator (Source): Users

Fit Criterion: There should be a button 'Sort' in the screen design.

History: Created 05.06.2007

Status: Active

Phase: Conceptual Design

Requirement #: **F10** *Reference #:* P3.1-S1 (Figure 6.7),
E1.1-S Main (Figure 7.3)

Description: All possible statements should be shown at the main screen of the application, as it is expected that the user does not have too many statements – probably around 10-20.

Rationale: The users can have an overview of their statements. It is expected that the users need all statements which are created. If they do not need them, they would probably delete them.

Originator (Source): Users

Fit Criterion: All statements should be shown at the main screen. There should not be a button for managing the number of statements shown at the main screen.

History: Created 05.06.2007

Status: Active

Phase: Conceptual Design

Requirement #: **F12** *Reference #:* P3.1-S2 (Figure 6.8), E1.1-S8.1 (Figure 7.23)

Description: It should be possible to set a user profile when creating a statement, as the information from this user profile will be used when a statement is applied. The user profile should include personal information, as well as security and privacy preferences.

Rationale: The users can specify which personal information or security and privacy preferences to be used for the concrete situation.

Originator (Source): Designer

Fit Criterion: There should be an element 'User profile' at the Create/Edit statement screen.

History: Created 05.06.2007

Status: Changed/Active

Phase: Conceptual Design

Requirement #: **F13** *Reference #:* P3.1-S2 (Figure 6.8), E1.1-S2 (Figure 7.7)

Description: It should be possible to edit the settings of only one device at a time and to remove only one device from the active list of devices at a time.

Rationale: In this way the users would not be confused which device they are editing or deleting.

Originator (Source): Designer

Fit Criterion: There should be Edit- and Remove-icons for each device in the screen design and not possibilities to edit and remove several devices.

History: Created 05.06.2007

Status: Active

Phase: Conceptual Design

Requirement #: **F14** *Reference #:* P3.1-S3 (Figure 6.9), E1.1-S2.2
(Figure 7.19)

Description: The list of settings, when selecting to edit a device, should include only the settings of the device, which will be affected, when activating the specific statement.

Rationale: There might be many settings for a device, many of which the user does not use.

Originator (Source): Designer

Fit Criterion: There should be buttons for adding and removing settings from the active list of settings for the specific device.

History: Created 05.06.2007

Status: Changed/Active

Phase: Conceptual Design

Requirement #: **F15** *Reference #:* P3.1-S3 (Figure 6.9), E1.1-S2.2
(Figure 7.19)

Description: All options/choices for a setting of a device should be given when the user selects the specific setting, as the most used ones can be shown on the top of the list. At the end of the list there can be a button 'More options' which expands the list with the rest of the options.

Rationale: The user should have an overview of all options for a setting. With the button 'More options' the list of options is expected not to be too long.

Originator (Source): Designer

Fit Criterion: All options should be accessible when selecting a setting of a device. There should be a button 'More options' where the options are selected from.

History: Created 05.06.2007

Status: Active

Phase: Conceptual Design

Requirement #: **F16**

Reference #: E1.1-S2.1.2 (Figure 7.11)

Description: The application should give possibilities to the user to search for external/public devices, which he/she can add to a statement; to edit their settings (or at least the settings which would be allowed to be edited); and to remove external devices from the statement.

Rationale: The user might need to use some external devices in some situations/statements.

Originator (Source): Designer

Fit Criterion: There should be buttons/icons with functions 'Add', 'Edit' and 'Remove' for the external devices, as well as 'Search' in the screen design.

History: Created 15.08.2007

Status: New

Phase: Physical Design

Requirement #: **F17**

Reference #: E1.1-S1 (Figure 7.4)

Description: The user should be able to create a new statement by using an existing statement as basis.

Rationale: The user can create a statement easier if the new statement uses similar devices and settings as one of the existing statements.

Originator (Source): Designer

Fit Criterion: There should be an option for creating a new statement by using an existing statement in the screen design.

History: Created 15.08.2007

Status: New

Phase: Physical Design

Requirement #: **F18**

Reference #: E1.1-S8.1 (Figure 7.23)

Description: The user should be able to select an option to use the general profile in the system, when configuring the user profile for the statement.

Rationale: The user might not need to use specific information for a statement, so he/she does not need to fill in the information, which already exists in the general user profile in the system.

Originator (Source): Designer

Fit Criterion: There should be an option (given with a check-box for example) to use the general user profile in the system in the screen design.

History: Created 15.08.2007

Status: New

Phase: Physical Design

Requirement #: **F6**

Reference #: P1.2-S3 (Figure B.10), P1.2-S4
(Figure B.11)

Description: It should be possible to select common settings for all devices/chosen devices.

Rationale: It will be easier and faster to configure the common settings for several devices at once when similar behaviour is needed for several devices.

Originator (Source): Users

Fit Criterion: There should be buttons/icons/entries in a list for selecting common settings of all devices and for chosen devices as for the last one there should be a possibility to choose several devices at the same time.

History: Created 25.04.2007

Status: Future Development

Phase: Identifying Needs and Establishing Requirements

Requirement #: **F19**

Reference #: N/A

Description: The user should be able to select only some information from the general user profile in the system, when configuring the user profile for a statement.

Rationale: The user might only need some specific information from the general profile to be used for the concrete situation, and he/she does not need to type the information if it already exists in the general user profile.

Originator (Source): Designer

Fit Criterion: There should be a drop-down menu for the different types of information in the 'User profile' for a statement, which contains the corresponding information from the general user profile.

History: Created 15.08.2007

Status: Future Development

Phase: Physical Design

8.2 Data requirements

This section presents the requirements related to the data, the designed application needs to have access to.

Requirement #: **D1**

Reference #: N/A

Description: The application will need direct access to the settings of each device.

Rationale: It is required because the settings are applied in the device when a statement is activated.

Originator (Source): Designer

Fit Criterion: When a new statement is activated with different settings, the corresponding settings in the devices themselves should change and match the settings defined in the statement.

History: Created 25.04.2007

Status: Active

Phase: Identifying Needs and Establishing Requirements

Requirement #: **D2**

Reference #: N/A

Description: If the user has a general user profile in the PDA (or in the PN), the information from there should be available to the application if the user selects the option to use the general profile in the system.

Rationale: So the general user profile information can be used when the specific statement is activated.

Originator (Source): Designer

Fit Criterion: The user profile information is included in the overview of the statement.

History: Created 05.06.2007

Status: Changed/Active

Phase: Conceptual Design

Requirement #: **D3**

Reference #: P2.1-S1.8 (Figure C.27), E1.1-S2.1.1 (Figure 7.9)

Description: The application should have access to the devices which are in a PN.

Rationale: Managing the PN should not be in the statements based profile management application. The application should be regularly updated with information about which devices are included in the PN.

Originator (Source): Designer

Fit Criterion: When the user wants to add a device to a statement, all devices from the PN should be shown, so the user can choose from them.

History: Created 05.06.2007

Status: Active

Phase: Conceptual Design

Requirement #: **D4** *Reference #:* P2.1-S1.1.1 (Figure C.45), E1.1-S2.2.1 (Figure 7.22)

Description: The application should have access to the possible settings of the devices in a PN.

Rationale: The settings for the devices with all their options/choices should be available so the user can set them.

Originator (Source): Designer

Fit Criterion: When the user wants to add a setting to a device, the settings of the device, which are not already added to the device, should be shown, so the user can choose from them.

History: Created 05.06.2007

Status: Active

Phase: Conceptual Design

8.3 User experience and usability requirements

The user experience and usability requirements, which are described in this section, are related to the usability and UX goals.

Requirement #: **US2** *Reference #:* P1.1-S1 (Figure B.3), E1.1-S Main (Figure 7.3)

Description: There should not be too many levels of statements/sub-statements (maybe only one-level or at most two-level statements).

Rationale: It would take longer time to activate a statement if there are many levels of sub-statements.

Originator (Source): Users

Fit Criterion: The application should allow creation of statements at one or two levels only.

History: Created 25.04.2007

Status: Active

Phase: Identifying Needs and Establishing Requirements

Requirement #: **US3** *Reference #:* Templates (Section 2.3)

Description: There should be templates with default values available for creating new statements

Rationale: It will be easier to create a statement if the user uses a basic form/template. The default values will give an idea of what the possible combinations of settings are. If some of them suit the user, there is no need to make a lot of changes.

Originator (Source): Designer

Fit Criterion: There should be ready default statements with default settings when the user starts using the application.

History: Created 25.04.2007 *Status:* Active

Phase: Identifying Needs and Establishing Requirements

Requirement #: **US4** *Reference #:* Jakob Nielsen's usability principles (Section 4.1.1)

Description: The application should be able to ask for confirmation from the user before performing an action, but the user should be able to choose for which actions he/she wants to give confirmations. More specific the user should be asked for confirmation when deleting a statement, removing a device and removing a setting of a device.

Rationale: The user would be able to control the actions and some mistakes can be prevented. Asking for confirmation being optional gives more choice to the user and he/she can skip giving confirmations for simple and trivial tasks. It would also avoid irritation from too many prompts from the system.

Originator (Source): Users

Fit Criterion: There should be a window/'dialog'-box which asks the user if he/she would like the specific action to be performed. There should be options to give permission for the action or cancel it. There should also be an option to say that the application should not ask for conformation next time the same action is performed.

History: Created 07.05.2007 *Status:* Changed/Active

Phase: Identifying Needs and Establishing Requirements

Requirement #: **US5** *Reference #:* Jakob Nielsen's usability principles
(Section 4.1.1)

Description: The application should notify the user and provide feedback in critical, important and error situations. Feedback when simple actions are performed successfully should be optional. More specific: there should be given feedback at activation time when a device is disconnected from the PN and the user wants to activate a statement which includes this device; there should be provided feedback when the user closes the window of the application before saving a statement when creating/editing a statement that the statement is not saved and it should ask the user if he/she wants to save before exiting the application.

Rationale: The user would know what is happening with the system in important and error situations, so he/she can react in an appropriate way. It would also avoid irritation if the user knows why the system does not work.

Originator (Source): Users

Fit Criterion: There should be a message/'dialog'-box with feedback (information about the situation). If there is a blocking problem, the user should react in some way to continue working with the application (for example selecting 'Ok'). There should also be an option to say that the application should not give feedback next time the same situation occurs.

History: Created 07.05.2007

Status: Changed/Active

Phase: Identifying Needs and Establishing Requirements

Requirement #: **US10**

Reference #: N/A

Description: The user should not be asked for confirmation when activating a statement. But, when the statement is activated, it should be clear that the statement has been applied, by for example giving feedback in form of a message and/or colour change.

Rationale: The activation should be fast and the users should be sure of which the active statement is.

Originator (Source): Users

Fit Criterion: When a statement is being activated, a message asking for confirmation should not be shown. After the statement is applied, a feedback message should appear and/or the colour of the statement should change telling the user that the activation has been successful.

History: Created 05.06.2007

Status: Changed/Active

Phase: Conceptual Design

Requirement #: **US11**

Reference #: P3.1-S2 (Figure 6.8), E1.1-S2.2
(Figure 7.19)

Description: There should be possibility to go to the previous screen from a certain screen.

Rationale: The user can navigate through the application.

Originator (Source): Designer

Fit Criterion: There is a '«Back'-button at the screens.

History: Created 05.06.2007

Status: Active

Phase: Conceptual Design

Requirement #: **US12**

Reference #: N/A

Description: The screens of the application should open in the same window/browser.

Rationale: There is not too much space at PDA's screen to handle many windows.

Originator (Source): Designer

Fit Criterion: A new window shouldn't be opened when a new action is performed.

History: Created 05.06.2007

Status: Changed/Active

Phase: Conceptual Design

Requirement #: **US13**

Reference #: User experience (Section 4.1.2)

Description: The application should be designed for good user experience.

Rationale: So the users would feel comfortable and would like to use the application.

Originator (Source): Designer

Fit Criterion: The results from user testing and user satisfaction questionnaire should point to that the users have good user experience.

History: Created 15.08.2007

Status: New

Phase: Physical Design

Requirement #: **US14** *Reference #:* Usability goals (Section 4.1.1)

Description: The application should be easy to learn.

Rationale: So when the users use the application several times, they can perform the tasks easier.

Originator (Source): Designer

Fit Criterion: The users can perform the tasks faster after they have used the application for some time.

History: Created 15.08.2007

Status: New

Phase: Physical Design

Requirement #: **US15** *Reference #:* Usability goals (Section 4.1.1)

Description: The application should be efficient.

Rationale: So the users can perform the tasks quickly with minimum actions.

Originator (Source): Designer

Fit Criterion: The time a user needs to perform a task within the application should be reasonable.

History: Created 15.08.2007

Status: New

Phase: Physical Design

Requirement #: **US16**

Reference #: UX goals (Section 4.1.2)

Description: The application should be satisfying, enjoyable, motivating and pleasing.

Rationale: The users should have good emotions when using the application, so they would like to use it again.

Originator (Source): Designer

Fit Criterion: The results from user testing and user satisfaction questionnaire should point to that the users have perceived the application as satisfying, enjoyable, motivating and pleasing.

History: Created 15.08.2007

Status: New

Phase: Physical Design

Requirement #: **US17**

Reference #: N/A

Description: The tutorial should open in a new window.

Rationale: It could be useful to have the tutorial in a separate window, so the user can look at the help and at the same time use the application.

Originator (Source): Designer

Fit Criterion: A new window is opened when the Tutorial is selected.

History: Created 15.08.2007

Status: Future Development

Phase: Physical Design

8.4 Security requirements

The security requirements in this section deal with the security issues of using the designed application.

Requirement #: **S1** *Reference #:* Identity Management (Section 2.9)

Description: There should be Single sign-on within the user's PN (the user signs on only once and have access to all his/her devices). Single sign-on is also used when logging-in to the PDA, so there is no need for a log-in functionality for the application.

Rationale: If the devices are owned by the user and they are included into the user's PN, it means that these devices are trusted by the user and by signing on once it will be faster to start using the devices and the applications on them.

Originator (Source): Designer

Fit Criterion: Authorization when using the application should be required only when starting the application.

History: Created 07.05.2007 *Status:* Changed²/Active
Phase: Identifying Needs and Establishing Requirements

Requirement #: **S3** *Reference #:* N/A

Description: The level of security when an external device is added to a statement, which involves connecting the external device to the user's PN, should be high. The system should recognize which device is external all the time.

Rationale: The external devices can contain threats for the PNs and this is why the application should have special security rules for them.

Originator (Source): Designer

Fit Criterion: There should be options for setting the security rules for the external devices.

History: Created 07.05.2007 *Status:* Future Development
Phase: Identifying Needs and Establishing Requirements

Requirement #: **S4**

Reference #: N/A

Description: The application should prompt the user when he/she needs to be authenticated to a system/network the user would like to use (which is included in the statement).

Rationale: The user will not need to authenticate himself/herself separately to the network and than to use the statement. The authentication will be integrated into the application.

Originator (Source): Designer

Fit Criterion: It should be considered in the screen design how the user would authenticate himself/herself.

History: Created 07.05.2007

Status: Active

Phase: Identifying Needs and Establishing Requirements

Requirement #: **S5**

Reference #: N/A

Description: Security measures should be taken when a device is lost/stolen and the application is tried to be used to access the other devices.

Rationale: The devices in the user's PN should not be vulnerable if one of them is lost.

Originator (Source): Designer

Fit Criterion: It should not be possible to access other devices from the PNs.

History: Created 07.05.2007

Status: Active

Phase: Identifying Needs and Establishing Requirements

Requirement #: **S6**

Reference #: N/A

Description: The communication between the devices in a PN should be secure.

Rationale: So the users would feel comfortable to use the application and the whole system

Originator (Source): Designer

Fit Criterion: There should be security protocols with high encryption in the PN.

History: Created 07.05.2007

Status: Active

Phase: Identifying Needs and Establishing Requirements

8.5 Legislation and standard requirements

This section presents the requirements resulted from analyzing standards and legislations in connection to user profiles.

Requirement #: **P1**

Reference #: Privacy policies (Section 2.11.1)

Description: The application should provide a privacy policy to the user, so the user knows how the provided personal information is used.

Rationale: The user would trust the system more if the privacy rules are stated.

Originator (Source): Users

Fit Criterion: There should be a link to the privacy policy.

History: Created 07.05.2007

Status: Future Development

Phase: Identifying Needs and Establishing Requirements

Requirement #: **P2** *Reference #:* Regulations for personal information
(Section 2.5.2)

Description: The required personal information should not be mis-
used and should follow the legislations about private information.

Rationale: The user would trust the system more.

Originator (Source): Designer

Fit Criterion: The users should be informed how their personal in-
formation is intended to be used and they are asked for permission.

History: Created 07.05.2007 *Status:* Active

Phase: Identifying Needs and Establishing Requirements

8.6 Deleted Requirements

This section shows the requirements, which are deleted from the requirements specification. It is considered that they are not needed any more because of changes, which have occurred during the design process.

Requirement #: **F5**

Reference #: N/A

Description: The application should give possibilities to the user to Add/Edit/Delete external/public devices to his/her PN

Rationale: The user might need to use external or public devices, which are not owned by the user and they should be connected to the user's PN only temporary. That is why there should be difference between including user's devices in the PN and external devices.

Originator (Source): Users

Fit Criterion: There should be buttons/icons with functions 'Add', 'Edit', 'Delete' for the external devices in the screen design.

History: 25.04.2007

Status: Deleted

Phase: Identifying Needs and Establishing Requirements

Reason for deleting: It has been assumed that if devices need to be added to the PNs, it would be performed from another application. The designed application provides only the functionality of adding external devices to the statement (see Requirement F16).

Requirement #: **F11**

Reference #: P3.1-S2 (Figure 6.8)

Description: There should be a possibility to save a statement, when it is created, before it is finalized (or before the settings of the devices are set). If there are no settings selected for the devices, the statements should be marked as not finished.

Rationale: The user should be able to continue configuring a statement.

Originator (Source): Users

Fit Criterion: There should be a button 'Save' at the Create statement-screen (or the list of devices and user profile for a statement).

History: Created 05.06.2007

Status: Deleted

Phase: Conceptual Design

Reason for deleting: The devices cannot have blank settings.

Requirement #: **US1**

Reference #: P1.1-S5 (Figure B.7)

Description: There should not be given too many settings/options for each device.

Rationale: It could be difficult and confusing to browse between the settings if they are too many and the user might lose interest of using the application.

Originator (Source): Users

Fit Criterion: The number of settings/options for each device should be less than a specific number (defined in the process of design).

History: 25.04.2007

Status: Deleted

Phase: Identifying Needs and Establishing Requirements

Reason for deleting: It has been decided that all options will be given for a specific setting of a device. In relation to that only the settings, which are affected will be included, the requirement sounds undefined.

Requirement #: **S2**

Reference #: N/A

Description: The application should require from the user to authorize the actions of including devices in the PN.

Rationale: The users should have control over which device is included in his/her PN.

Originator (Source): Designer

Fit Criterion: The user should be prompt when a new device is about to be included in the PN.

History: 07.05.2007

Status: Deleted

Phase: Identifying Needs and Establishing Requirements

Reason for deleting: Including devices to PNs is not performed from the designed application.

Conclusions

9.1 Summary

This thesis report documents the process of developing a new concept for profile management and the design of an application for managing different settings, including security, privacy and sharing settings. The application is based on using statements for configuring settings, when the users perform different activities. The design process of the application has focused on user centered design in order to take into consideration the users' perspectives for the designed application, as well as applying different interaction design and creativity methods.

Involving the users in the design process was an interesting and challenging process. It required a lot of planning and preparation for the users' sessions in order to motivate the users and to inspire them to produce creative ideas, as well as to give opportunities to the users to interact with the prototypes in appropriate test conditions. Furthermore, it was also a pleasure and a good experience to work with the target user groups because they provided a lot of input for the new concepts and new ideas for the design of the application. By involving the users in the data gathering process and the evaluations of the prototypes, the application should be some steps closer to the users' needs and requirements.

Some of the difficulties in the design process were related to choosing the "right" functionalities for the application by considering the users' needs and requirements, selecting the relevant ideas from the users' comments and suggestions, as well as designing for good user experience for both technically experienced

and non-experienced users.

9.2 Results

The results, produced in this project, are divided in four categories – the first category is related to the concept of statements and the design of the statements based application; the second category includes the users' opinions about the statements concept in general; the results from the third category are related to the evaluations of low-fidelity and hi-fidelity prototypes, and the last one includes ethical and social issues, which have arisen in the design process.

9.2.1 Statements based application design

The main result, produced in this master project, is the hi-fidelity prototype of the designed application, representing the concept of using statements for managing settings. The prototype is implemented for a mobile device and it presents the main functionalities which the statements based profile management application should have. The application gives possibilities to control different devices, connected in a network, from one place. The statements are related to different situations, activities and emotional states. After defining the settings for a particular case, the user can easily and quickly switch the settings of the devices when a need for this occurs. The application also gives options to control security and privacy settings and the use of personal information in the different situations, activities and emotional states. Statements based application is designed to assist the users in their everyday activities and to make the communication between people easier. Easy communication can be achieved by facilitating connection to other people's devices. There are also opportunities to easily find and use public devices.

Using statements based interface for managing settings in different situations and activities is considered good because the statements can help the users imagine the specific situation or activity. The statements usually are meaningful to the users and can give a hint when the particular statement should be used.

9.2.2 General user opinions about statements

The statements have been found to be useful for configuring settings of devices, as well as for managing privacy and security settings, because settings of different devices can be activated from one place instead of manually selecting the settings from each device. This also makes the configuring of devices faster. An important issue for some of the users is the security of the system – the communication between the devices has to be secure, in order for them to use

the statements based application.

The users stated that they would feel comfortable to use statements if the statements are easy to understand, easy to use and configure, and also if the users can define them themselves. Being able to define their own statements also makes the users feel in control and trust the devices when configuring the statements correctly, together with being able to see an overview of the settings of a particular statement. Trust to the application is additionally gained if the users try out the application and it shows that it works correctly, as well as if it is recommended and trusted by others.

The situations and activities in which users would like to use statements are related to school or university, work, home, traveling, and leisure. The users stated that they would also use the statements in relation to different moods. The number of statements depends on the number of activities the users often perform or the situations the users are often in. Most of the users thought that they would need statements only for the general situations, so they would probably need around 5 statements. The users probably did not take in consideration that in the future they might need to control many devices, and probably manage different and many situations and activities. However, after presenting some possibilities for using statements in activities that the users perform nowadays, the users began to imagine how the statements based application can be used in the future.

9.2.3 Results from the evaluations of the low-fidelity and hi-fidelity prototypes

The development of low-fidelity prototypes and a hi-fidelity prototype, as well as carrying out user evaluations gave possibilities to refine the concepts and the design ideas about the main functionalities of the application and the GUIs for presenting these functionalities. The iterative design process has helped in selecting the important functionalities and features that the application for managing settings of devices, personal information and preferences should have.

The objective results of the users' performance, as well as the subjective results from the user satisfaction questionnaires and interviews, show that the developed electronic prototype of the application is in general easy to use, easy to learn and provides mostly good user experience. Nevertheless, there are some features which need to be improved particularly in order to satisfy the experienced users who would like to have more security and privacy settings and options for customizing the application itself.

Perceiving the application as easy to use is related to the abilities of the users to understand the different interface elements and how the interaction is organized,

which is based on the users' previous experiences and knowledge. The users, experienced in using different technologies and applications, could easily figure out how to perform a certain task even if they needed to explore the application or try out different things. The non-experienced users could also manage to perform almost all of the tasks, which leads to the conclusion that they could perceive the interface elements in the intended way.

The main difference between experienced and non-experienced users was that the more experienced users had more requirements and expectations about the application. They also had suggestions for extra features and alternatives.

Some of the results from the evaluations are subjective and depend on the users' perspectives. Thus, it is possible to obtain different results when testing the prototypes with other users under other conditions. However, the electronic prototype gives an idea about how the statements based application can look and feel and it can be used as a basis for further development of the statements-concept and the application for managing statements.

9.2.4 Ethical and social issues

Ethical issues when using information and communication technologies are usually related to privacy, security, control and freedom. Most of the users were privacy and security concerned and they were interested in how the application would deal with these issues. Some of the users were satisfied with the provided security and privacy settings, while others (usually the experienced ones) required more security settings to the application.

Freedom is not the same for experienced and non-experienced users. For the experienced users freedom can be achieved by having more choices and options for configuring the settings of the devices and user profile, as well as customizing the application. On the other hand, the non-experienced users feel free when the application is easy to use and understand. Being easy to use is related to simple interface, which is in contradiction with having many settings and choices.

Another important issue is related to control and performing automatic actions by the application. Some of the users prefer some actions to happen automatically but they still want to be and feel in control. This can be a challenge to achieve – it would require that the application and the technology have gained the users' trust. There were suggestions for automatically triggering some statements by using context-aware services for location and time, which would make changing of statements easier.

The users have different opinions about the effect the statements based application would have in their lives and their study process. Some believed that the

effect would be good if the statements are practical and useful, help in configuring devices and make things faster. There were also some opinions that using statements would not have too much effect on the users, as well as some users thought that changing statements for slightly differences in the situations would irritate them.

9.3 Future work

This project has been about the design process of creating a statements based application. There are many issues which need to be considered as well as ideas which need to be refined.

More research is required in order to identify the most common situations the users are in, activities, the users perform and emotional states the users experience, in order to provide appropriate templates and default settings.

It would be interesting to investigate how context-aware services can be included in the statements based application. Some statements or settings can be triggered automatically, which can improve the user experience. It should be studied if the users would feel that their privacy and security are threatened and if they would feel in control, if statements are activated automatically from the system.

Some issues which can be considered in future developments of the application are the possibility of selecting more than one statement and in this way to be able to make different combinations of the statements; configuring common settings of devices, which would make it easier and faster to select all devices or the selected devices to be silent for example.

The statements based application should be further developed in order to make the profile management in a network of devices easier for the users, to ensure that the users' information is secure and to provide better assistance to the users in a future with a lot of devices and technologies.

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APPENDIX A

Project time plan

APPENDIX B

Identifying User Needs and Establishing Requirements

This appendix presents additional materials from the design phase Identifying user needs and establishing requirements. More specifically materials related to the planning for the individual interviews, identifying the types of the users participated in the interviews; the initial paper prototypes or drawings of the statements based application, as well as the planning of the workshop and the results from it.

B.1 Individual interviews

The questions used as a guide for the interviews and an overview of the users, who participated in the interviews are presented in this section and a scheme for identifying the user types. The raw results from all interviews are given in Appendix E.

B.1.1 Structure and helpful questions for the interview

Interview for identifying user needs and trying to find what the requirements could be about a statements based profile management application

Age

Gender

Occupation

1. (*Technology*) Do you feel comfortable to use different types of technologies computers, PDAs, mobile phones? (Do you consider yourself experienced in using computers, mobile devices?)
2. (*Technology*) When you buy a new device or install a new program do you check the default settings and apply new ones?
3. (*Technology*) How often do you check and change the settings of your devices and applications?
4. (*Control*) Do you want to be in control in general when interacting with a system? (Do you need to know what is happening with the system all the time? Do you need to confirm all the steps the system takes or you have some trust in the system?)
5. (*Control*) In which situations do you prefer to be in control?
6. (*Privacy and sharing*) What is your attitude to privacy? Are you privacy concerned?
7. (*Privacy and sharing*) Are you interested to know who has access to your data?
8. (*Trust in systems*) Do you have trust in systems in general? (Do you trust that the system is reliable, stable and it works correctly?)
9. (*Trust in systems*) Do you trust that the information stored in the system will not be used by any other person or authority?
10. (*Social issues*)
 - (a) What is your attitude to strangers? (Is a stranger seen as a threat or opportunity?)
 - (b) Do you like to be contacted by strangers?
11. (*Automatic issues*) Do you like when the system performs some actions automatically, without asking for confirmation?

12. (*UI-playfulness*) Should the interface be playful? Should it be fancy or plain?
13. (*UI-feedback*)
 - (a) Do you prefer the system to provide feedback about what has been done or what has failed?
 - (b) What do you think about 'dialogue'-boxes with system feedback?

⇒ **Presenting the MAGNET's concepts of PN and federation of PNs.**

14. (*PAN&PN-management*)
 - (a) Should the devices in the PN be controlled from one place or from each device? (Should the management of PN be centralized or embedded in each device?)
 - (b) How many devices would be optimal to be in the user's PN?
15. (*Students PN*)
 - (a) What devices do you usually use related to your education and work?
 - (b) Which devices would you include in your PN, imagining that it is possible for all devices?
16. How do you understand user profile (profile)?

⇒ **Presenting the concept of statements based profile management application.**

(Users' point of view about using statements for managing privacy and sharing settings)

17. Do you think that statements could be useful for configuring sharing and privacy settings?
18. Do you think you would feel comfortable to use statements?
19. Would you trust the device that by choosing a statement, the settings will be performed correctly?

20. Would you feel that you are in control when using statements?
21. In which situations would you prefer to use statements? (When would you prefer the device to configure your devices?)
22. What statements would you use? (Examples)

(Managing statements)

23. What devices should a specific statement be able to control/set? (What should the statement include?) (By giving an example from the mentioned statements)
24. What options in the settings for a particular device should be available?
25. How should the statements be formulated so it will be easy for you to understand and use?
26. How many statements would be optimal for you to use? (How many would you like to deal with?)
27. How would you switch between statements? (How would you prefer to choose the new statement you want to apply?)
28. Where should the statements be presented in the main application so they'll be easy to find and use? (How will the statements be presented in GUI?)
29. How would be easier for you to change settings of a particular statement? (How to map the statement with the particular settings?)
30. *(Social aspect)* Do you think using statements will have a social effect on you? (Would they affect your life?)
31. *(Statements and avoiding irritation and intolerable user experience)* How should the statements be made and introduced to the user so the configurations are easy to make, understand and use? (How to avoid irritation of using the statements?)

(Student's roles)

32. How many different roles do you have considering the different types of activities you need to do?
33. Describe some activities you do in your student life (in your student role).
34. What preferences for your devices do you have for each activity? (What settings in the user profiles for the different activities do you have?)

35. (*Sharing*)
- What do you think about the concepts of sharing and privacy?
 - Do you share information?
 - What types of information would you share?
 - Is there any information you wouldn't share? (Which types of information do you want to keep private?)
36. (*Sharing in different groups of people*)
- What are the different types of groups you would like to share with?
 - What would you share within the different groups?
 - How would you share information within the different groups?
37. (*Student life*) Do you think that your student work can be enhanced by providing configurations and settings assistance?
38. What functionalities of the statements based profile management application will support you as a student and will enhance your work?

B.1.2 Users overview

Women: 5

Men: 10

- User 1: A female Phd student in Telecommunications, DTU, age – 25, nationality – Bulgarian, Fictitious User 1.
- User 2: A female Phd student in Electronics and communication (Acoustics), DTU, age – 25, nationality – Belgian, Fictitious User 1.
- User 3: A female student in Environmental engineering, DTU, age – 31, nationality – Romanian, Fictitious User 2.
- User 4: A male student in Mechanical Engineering (Wind energy), DTU, age – 25, nationality – Bulgarian, Fictitious User 3.
- User 5: A male student in Informatics, DTU, age – 23, nationality – Danish, Fictitious User 3.
- User 6: A male Phd student in Electronics and communication (Acoustics), DTU, age – 24, nationality – French, Fictitious User 3.
- User 7: A male student in Computer Engineering, DTU, age – 25, nationality – Polish, Fictitious User 3.

- User 8: A female student in Biotechnologies, DTU, age – 24, nationality – Polish, Fictitious User 1.
- User 9: A male student in Mechanical Engineering (Wind energy), DTU, age – 24, nationality – Bulgarian, Fictitious User 1.
- User 10: A female student in Software Engineering, DTU, age – 23, nationality – Danish, Fictitious User 3.
- User 11: A male user in Telecommunications, DTU, age – 25, nationality – Polish, Fictitious User 3.
- User 12: A male Phd student in Cellular and molecular biology, DTU, age – 25, nationality – Turkish, Fictitious User 1.
- User 13: A male student in Telecommunications, DTU, age – 40, nationality – Somali, Fictitious User 3.
- User 14: A male student in Telecommunication, DTU, age – 24, nationality – Danish, Fictitious User 3.
- User 15: A male student in Electro Engineering, DTU, age – 22, nationality – Danish, Fictitious User 3.

B.1.3 Identifying the user type of the users

By using the information from the previous questions, each user has been identified as representative of one of the 4 Fictitious user types defined in MAGNET. An overview of the users and the different parameters used for identifying the user type can be seen on Figure D.41 and Figure B.2.

	Close to Fict U.1	Fict U.1	Fict U.2	Close to Fict U.3	Fict U.3	Fict U.3	(Fict U.3)	Fict U.4	Fict U.1
	User 1	User 2	User 3	User 4	User 5	User 6	User 7	User 8	User 9
Experience (Low, Medium, High)	Medium	Medium	Low	High	High	High	High	Low	Medium
Control demand (Low, Medium, High)	Medium she wants to confirm actions only sometimes	High, confirming all actions	High Medium	High, but not conf. all steps	Medium, he wants to know how to set up things but not necessary to know how they work	High, he wants to be able to change settings	High, but no need to confirm everything	High, she would confirm all actions	High
Privacy concern (Low, Medium, High)	High	High	Low; only when the websites are very non-trustworthy	Medium, esp. when his game acc. is involved	High	Medium	High	High	High
Trust (Low, Medium, High)	High	Medium; she does not trust system, in general, but she trusts her iPad for	High	Medium. He trusts the system for simple operations	Medium	Medium, he does not trust systems completely	Low	High	Medium he trusts mobile phones, but not computers
Social issues - strangers (Yes, No, Sometimes)	Sometimes, depending on the situation	Sometimes, depending on the situation	Yes	No	Sometimes, depending on the situation	Sometimes, depending on the situation	No	No	No
Automatic actions (Always, Sometimes, Never)	Sometimes, when the automatic actions are authorized by her	Never - she does not like automatic actions	Always she likes the system to perform act autom.	Sometimes for simple operations	Sometimes for simple tasks	Sometimes for actions he does very often	Sometimes	Sometimes only for some things	Sometimes for simple actions
UI (plain, practical, fancy, combination)	Practical	Practical	fancy but without too many colours and flashing things	fancy but useful, good practical desktop, no flash, more	nice interface with nice graphics	nice and practical, no flashy things	simple or a good combination	well-being and practical (no flash, and confusing)	well-designed
Feedback (Always, Sometimes, Never)	Sometimes, only for error situations	Always	Sometimes. She would like to know if she wants feedback	Sometimes in error situations and more in case of complicated situations	Sometimes in error situations	feedback in a log file	Sometimes for complicated tasks	sometimes only in error situations	sometimes for complex tasks

Figure B.1: Identifying the user type of the first 9 users

	close to Fict. U3 User 10	Fict. U.3 User 11	close to Fict. U 1 User 12	Fict. U.3 User 13	Fict. U.3 User 14	Fict. U. 3. User 15
Experience	High	High	Low	High	High	High
Control demand	High, she would change things if she needs to	High, but he does not want to receive messages all the time, only in error ^{situation} what is happening	High - he wants to be in control, but does not know what is happening	High	High, he wants the system to do only what he has told it to	High, but he does not need to know what is happening on a low level
Privacy concern	High	very high	High	Medium	High	High
Trust	High	Low	High	Low. He knows that something can always go wrong	Medium - he trusts systems, but what they should do	Low - he does not trust systems by default
Social issues	-#	Sometimes depending on the situation	No	Sometimes depending on the situation	Sometimes, when he subscribes to social lists	Sometimes, dep. on the sit
Automatic actions	Sometimes, she wants to have an option to turn off aut. actions	he prefers the system to ask for confirmation, but he wants an option to choose if he wants conf.	Sometimes. No automatic actions for operations which can not be reversed	The system asks by default for conf. and the user can disable this option	Sometimes	Sometimes. There should be limit how much the system should ask
UI	fancy and functional	simple and working fast	plain	as simple as possible	fancy only if it does not increase performance	functional and fast for everyday use, but of course, for pleasure
Feedback	Sometimes if something is important	Feedback in the status bar and log file	Always	Always	Sometimes only in error situations	Sometimes in critical situations and errors

Figure B.2: Identifying the user type of the last 6 users

B.2 Initial paper based prototypes

This section presents three alternative paper-based prototypes for managing statements, developed in order to be evaluated by the participants in the workshop.

B.2.1 Alternative Design 1

P1.1-S1 (Figure B.3) indicates how the list of statements and an option for adding a new statement can be shown by selecting an icon from the status bar which contains the active statement. The statements are grouped and when using left click of the mouse the sub-statements are shown and the user can activate the wanted statement. With a right click on a statement, the options for editing, deleting and viewing settings are shown.

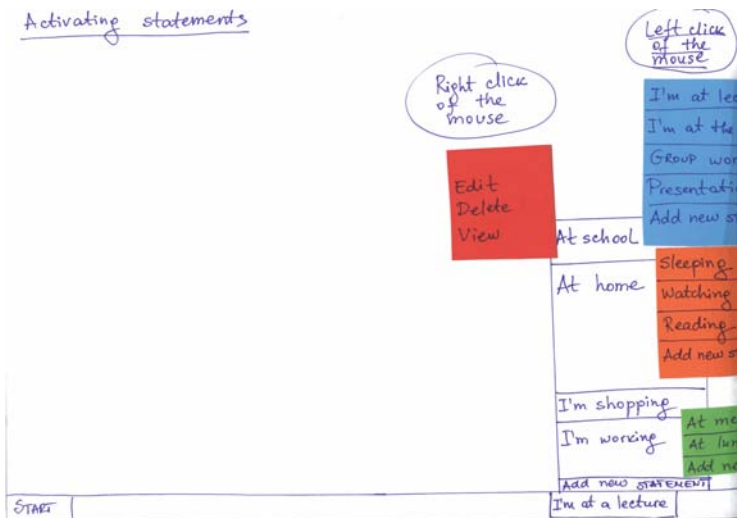


Figure B.3: Alternative Design 1 – Activating statements (P1.1-S1)

P1.1-S2 (Figure B.4) presents how a new statement can be created or an existing one edited. First the statement name is given in a text box and then the devices which should be associated with the statement are selected. If more than one devices are selected, only the common settings can be seen by choosing ‘Configure common settings’. Editing a device’s settings is by using ‘Edit (device’s) settings’. Other actions which can be performed over the devices are adding, deleting devices and viewing settings of devices.

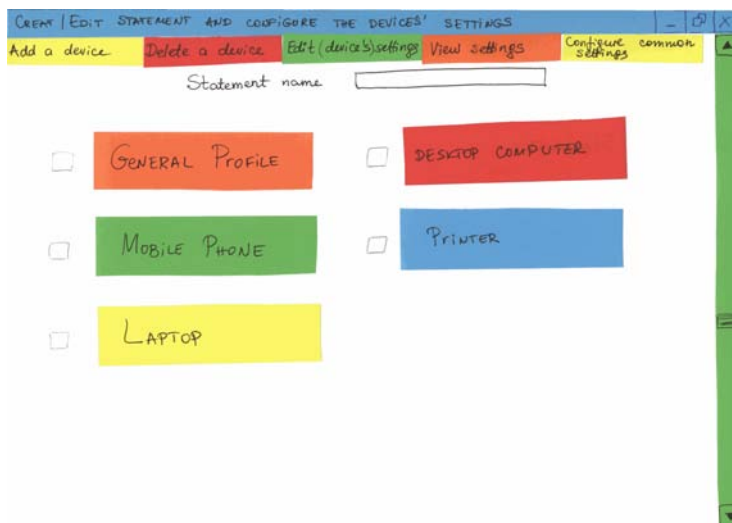


Figure B.4: Alternative Design 1 – Create statements (P1.1-S2)

P1.1-S3 (Figure B.5) shows the possible settings for 'General profile' which are organized in some groups (e.g. Identity, Status shown to others). The possibilities are to add, edit and delete settings and viewing the selected settings for the 'General profile'. P1.1-S3 is opened when 'General profile' is selected from P1.1-S2.

P1.1-S4 (Figure B.6) shows the possible settings of a mobile phone. The screen is opened when 'Mobile phone' is selected from P1.1-S2.

P1.1-S5 (Figure B.7) shows the possible settings of a laptop. The screen is opened when 'Laptop' is selected from P1.1-S2.

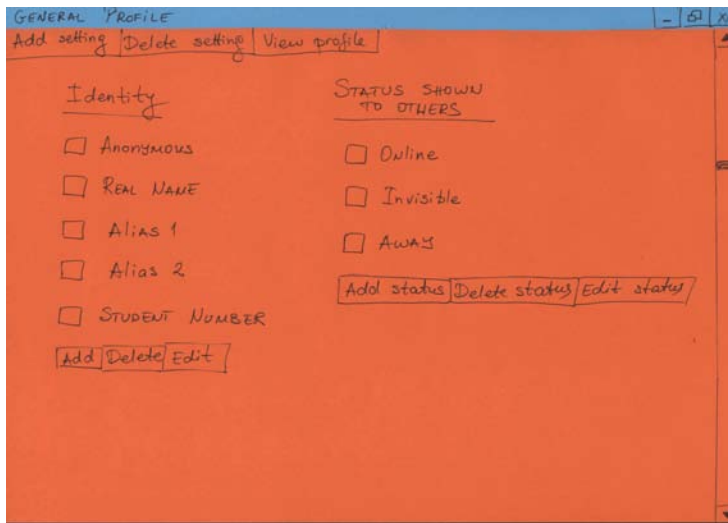


Figure B.5: Alternative Design 1 – General Profile (P1.1-S3)

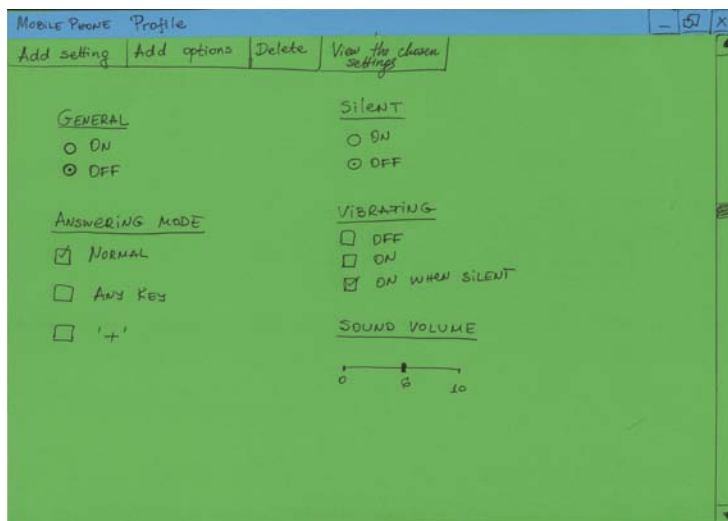


Figure B.6: Alternative Design 1 – Mobile Phone Profile (P1.1-S4)

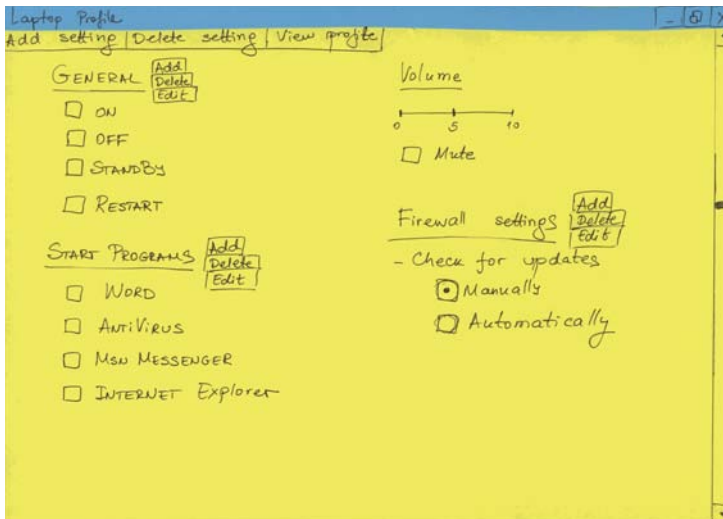


Figure B.7: Alternative Design 1 – Laptop Profile (P1.1-S5)

B.2.2 Alternative Design 2

P1.2-S1 (Figure B.8) indicates that when a small icon in the taskbar to the right is activated, the defined statements and an option for adding a new statement are presented as buttons. There are options for editing, deleting and viewing the settings of a statement, shown as small icons next to each statement.

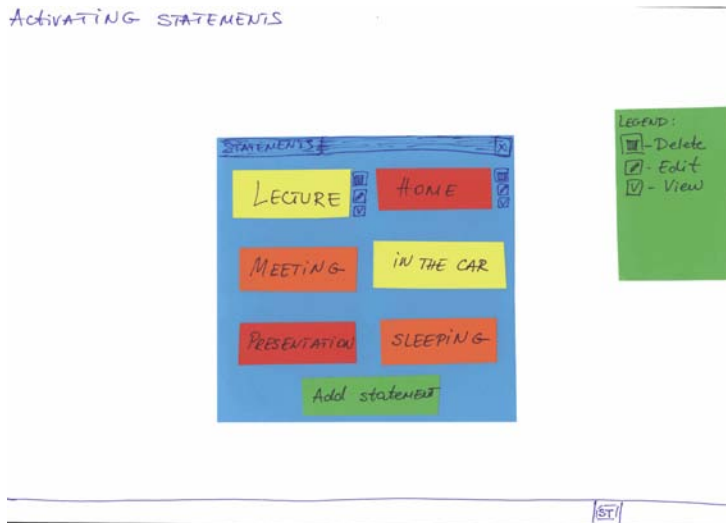


Figure B.8: Alternative Design 2 – Activating statements (P1.2-S1)

P1.2-S2 (Figure B.9) would be opened when a new statement is created or an existing one is edited. First the name of the statement is given and then the device are chosen from a drop-down menu. It is also possible to select all devices in order to only show the common settings of all devices; common settings of selected devices; and to add a device from the drop-down menu. When a device is chosen and ‘Edit’ is pressed the possible settings for the device are shown.

P1.2-S3 (Figure B.10) shows how the common settings of all devices can be presented, by choosing ‘All’ in the drop-down menu in P1.2-S2.

P1.2-S4 (Figure B.11) shows how the common settings of two selected devices can be presented, by choosing ‘Common settings’ in the drop-down menu and selecting the two devices (mobile phone and laptop) in P1.2-S2.

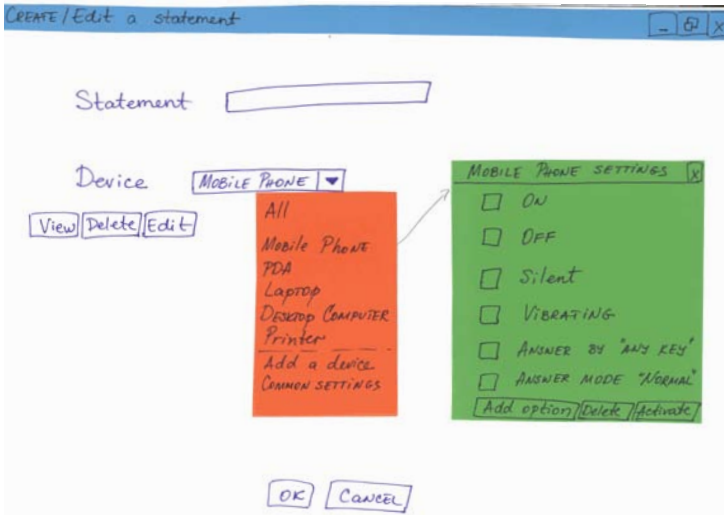


Figure B.9: Alternative Design 2 – Create statements (P1.2-S2)

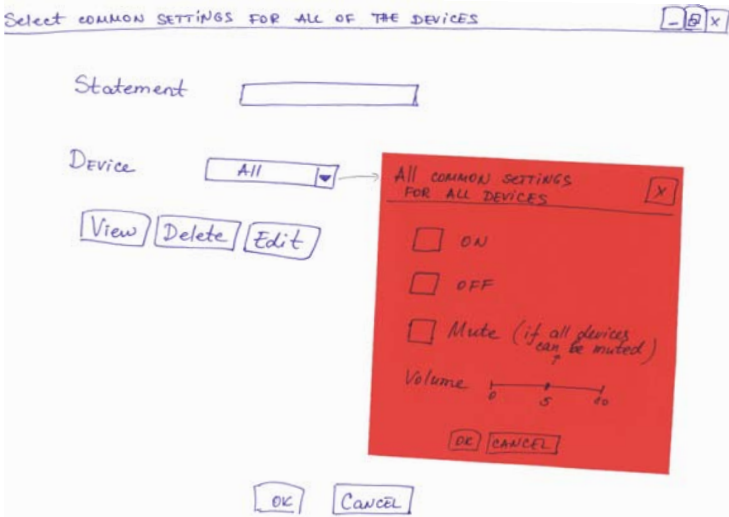


Figure B.10: Alternative Design 2 – Common settings for all devices (P1.2-S3)

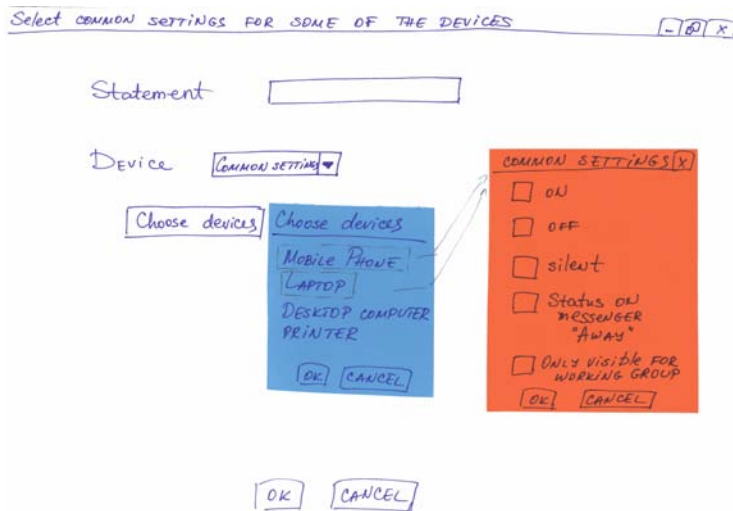


Figure B.11: Alternative Design 2 – Common settings for some devices (P1.2-S4)

B.2.3 Alternative Design 3

P1.3-S1 (Figure B.12) indicates how a statement can be created, where the devices and the settings are organized in a tree structure. When a device is chosen, the possible settings are shown under the device. It is possible to select all devices and see their common settings, several devices and see their common settings, to add, edit and delete a device, to add and delete a statement.

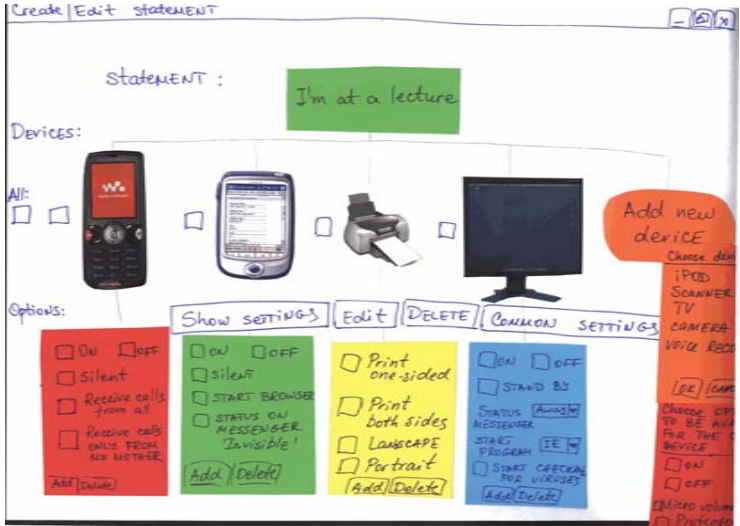


Figure B.12: Alternative Design 3 – Creating statements (P1.3-S1)

B.3 Participatory design workshop

The plan for guiding the workshop for identifying user needs and evaluation of initial drawings, as well as the results from the different workshop activities are given in this section.

B.3.1 Workshop Plan

13:30 - 14:00: Welcome the participants. Present what the workshops is about. Inform the users that the information collected at the workshop won't be used for any other purposes than the project and that the users' names won't be used. Ask the users if they give their permission to make pictures and record them. Invite the users to get coffee/tea/juice and biscuits. The users present themselves.

Presenting the concepts related to the thesis:

- Personal Network (PN) and Federation of PNs (show a picture with a person and set of devices which are in his/her PN – Figure B.13 and a picture illustrating communication between two PNs – Figure B.14);

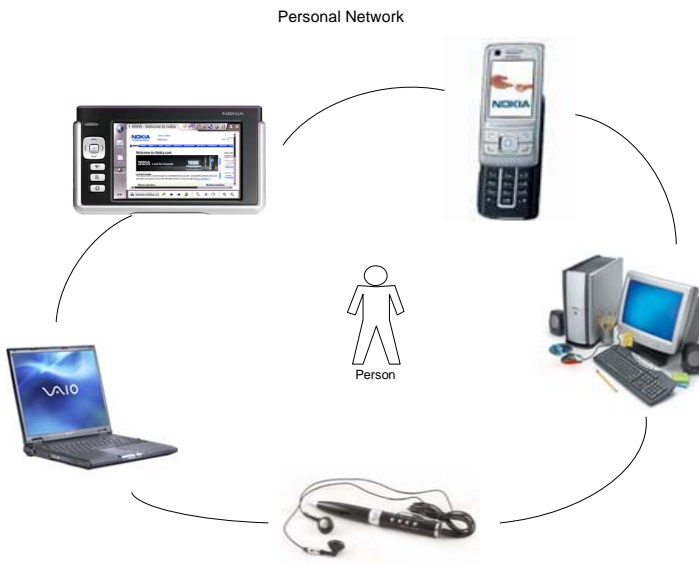


Figure B.13: Personal Network

- Statements and how they are related to the settings of the devices in PN (show picture with a statement and settings for devices – Figure B.15 and Figure B.16); What is a statement? – it is a sentence, short phrase or a

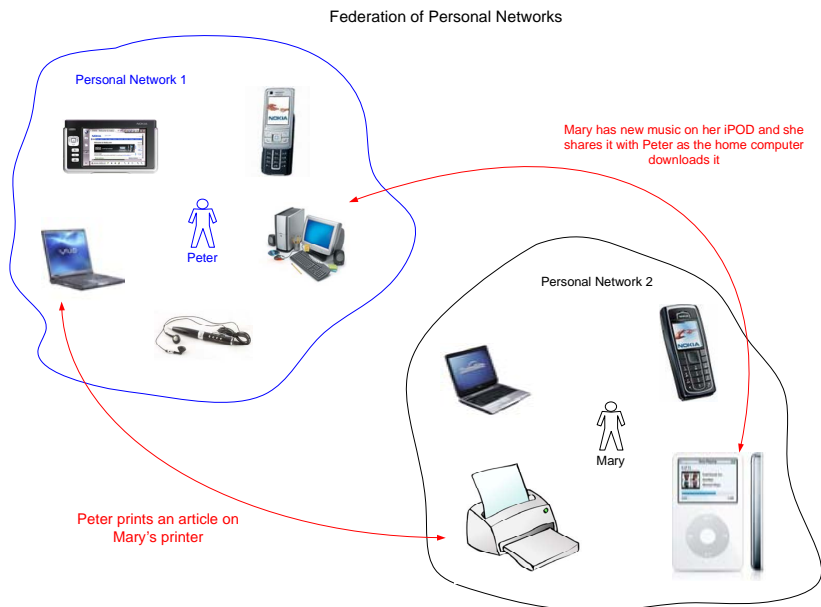


Figure B.14: Federation of Personal Networks

word which expresses what activity the user does or want to do (e.g. I'm at a lecture, I'm sleeping, Shopping, I want to share, etc.).

- Give an example by presenting a scenario for using the statements for configuring settings of more than one device in their PN:

Scenario – Mary prints from her computer at home to a DTU's printer

Mary is making interviews for her project. She prepares helpful questions for the interview on her home computer. She doesn't have a printer and she needs to use a printer at DTU to print the questions for each person she interviews. She has a statements based profile application for managing her devices in her PN and for communicating to other PNs. She has a scheduled interview for 15:00 o'clock in building 341 at DTU.

She chooses a statement "I want to Print" which has three parameters [what to be printed], [where to be printed] and [when to be printed]. She chooses the file which needs to be printed, the building where she has the interview, as the system finds out automatically which printer should be used, and she chooses the time when the file should be printed (when she

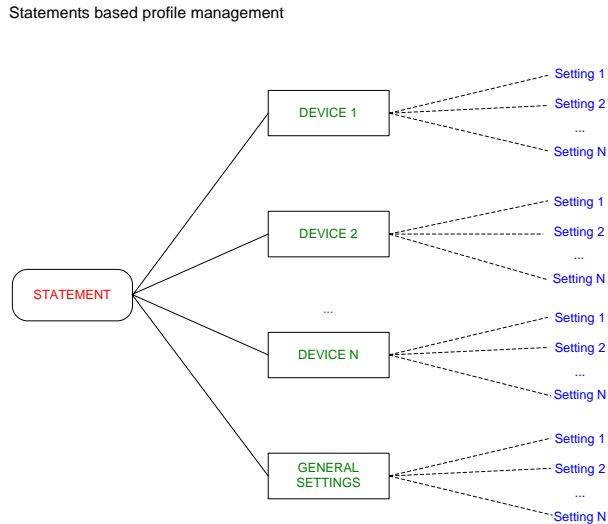


Figure B.15: The concept of a statement

will be close to the printer).

The system gives a notification which printer is chosen and confirmation for the name of the file and the time. If Mary prefers another printer she can manually select the printer's name.

If there is a queue for the printer the system can estimate when to start printing in order to print on time. If there will be a delay for the printing, Mary will receive a message for notification of the delay.

When Mary chooses a printer in DTU, her identity, visible to the system, is her student number. The system checks Mary's identity with the student database in DTU and authenticates her. So Mary doesn't need to type in passwords. At 14:50 Mary's paper with questions is printed out and waits to be picked up.

Nowadays the scenario for the same situation in most cases will be:

- Create the file at your home computer.
- Start FTP-client.
- Upload the file on your student ftp: ftp.student.dtu.dk.
- Go to a databar in DTU – log-in in a DTU's computer (because most of the time it is difficult to configure your laptop to print on DTU's printers).

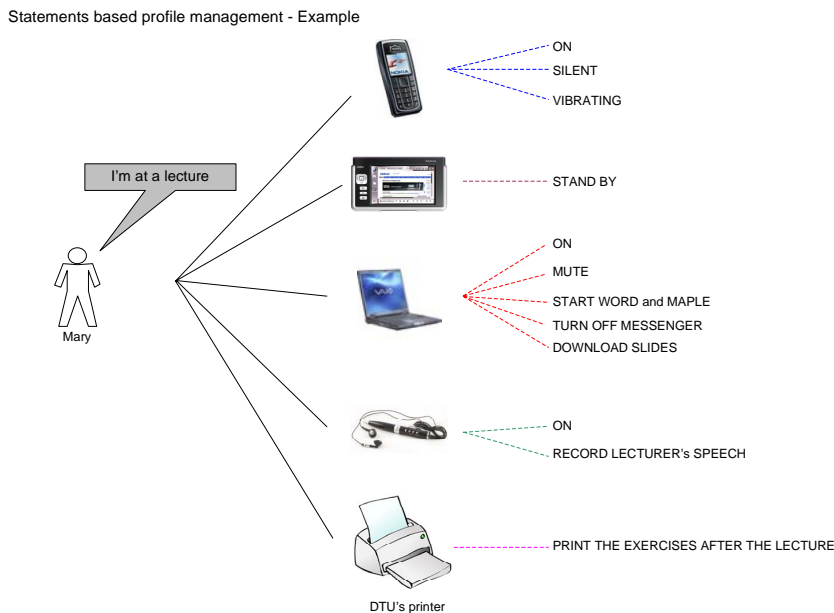


Figure B.16: Example of a statement

- Wait if other people are printing and there is a queue for the printer.
- Print.

14:00 – 14:20: Picture stimulation for creating Personal Network - the users create their PN by using pictures of different devices and by creating new elements for devices if they need something which is missing. The users should try to think primarily about devices that will enhance their student work and help them in their studies. The pictures and the new elements are attached to a piece of paper.

14:20 – 14:40: Brainstorming for different setting/options for the devices, which should be available when the users want to configure the devices. Cards for the different devices are prepared. The card contains the name of the device and the users write down some settings/options based on the functionalities the device has (or what the device can do). Each participant is given a card at the beginning. When he writes something the card is given to the neighbour clockwise who adds more settings on the card. The participants are provided with some screen shots with settings from several computer applications for inspiration.

14:40 – 14:50: Break

14:50 – 15:10: Brainstorming for situations and activities for which statements can be used. The users should try to think primarily about situations related to their student activities, student jobs, studying in different ways. For each situation a statement is needed - the statement can be formulated. The statements can also contain parameters.

Grouping them by using Mind mapping.

Brainstorming for statements about sharing and privacy as sharing is not only considered sharing of files and documents, but also showing status on messenger programs for example, sharing information between the devices in PN (for example when the battery of one device is low the needed information from this device is shared/transferred to another device), etc.

15:10 – 15:40: Associating situations/activities (respectively statements) with devices and their settings/options. The users are asked to select a situation/activity and choose which devices should be associated with the situation and respectively the statement and what settings for each device should be chosen. The users can choose the devices and options from the available pictures and elements as well as they can create new elements for devices and options. The users can be asked to say which devices and settings are needed for the sharing statements (if any) and what the devices should do.

15:40 – 16:00: Brainwriting for creating some scenarios for situations and how to use the statements to configure devices in the different situations. A fictitious user a student is created by the designer. The created persona is presented to the users. The users are given cards with a beginning of a story/situation. When a user has written something the card is passed to the neighbour clockwise.

16:00 – 16:15: Cake break

16:15 – 16:45: Creating different ways (or screens) for managing the statements and the settings of the devices. Some discussion about how the statements can be managed can be started. After that the users can be asked to create some screens about the profile management application by drawing, choosing different elements and creating new elements. How the users imagine to activate and create statements, how different devices and options should be presented.

16:45 – 17:15: Evaluating alternative drawings for managing statements and settings of different devices. The users are asked to say what they think about the drawings and the different elements. Which of the designs they prefer or which of the elements.

17:15 – 17:30: Asking for evaluation of the workshop from the participants.

What do they think about this way of working?

Thanking them for participating.

Finishing the cake :-)

B.3.2 Overview of the users, who participated in the workshop

- User 1 – A male student in Computer Engineering, DTU, age – 25, nationality – Polish, Fictitious User 3 (the same user as User 7 from the individual interviews for gathering needs).
- User 2 – A male master student in Telecommunications, DTU, nationality – Danish, high technical experience and privacy concerned, Fictitious User 3.
- User 3 – A female student, Copenhagen Business School, nationality – Bulgarian, low technical experience and privacy concerned, Fictitious User 1.
- User 4 – A male master student in Telecommunications, DTU, nationality – Danish, high technical experience and privacy concerned, Fictitious User 3.
- User 5 – A male student in Electro Engineering, DTU, age – 22, nationality – Danish, Fictitious User 3 (the same user as User 15 from the individual interviews for gathering needs).

B.3.3 Picture stimulation for creating Personal Network



Figure B.17: User 1's PN



Figure B.18: User 2's PN



Figure B.19: User 3's PN



Figure B.20: User 4's PN



Figure B.21: User 5's PN

B.3.4 Brainwriting for options and functionalities of devices

There were screen dumps of existing programs for configuring different types of setting available for the users in order to provide inspiration for the possible options and functionalities. Some of the screens, which are presenting the different types of screens that has been used, are shown on Figure B.22, Figure B.23, Figure B.24, Figure B.25 and Figure B.26. After the screen dumps different options and functionalities are given for several devices.

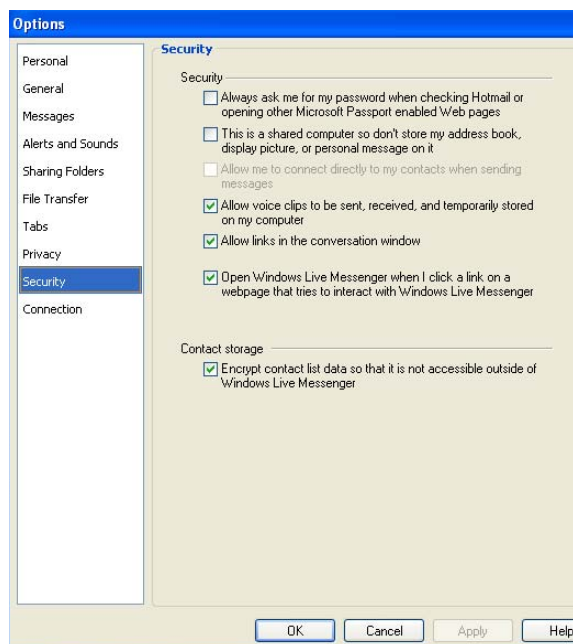


Figure B.22: Configuring security settings in MSN Messenger

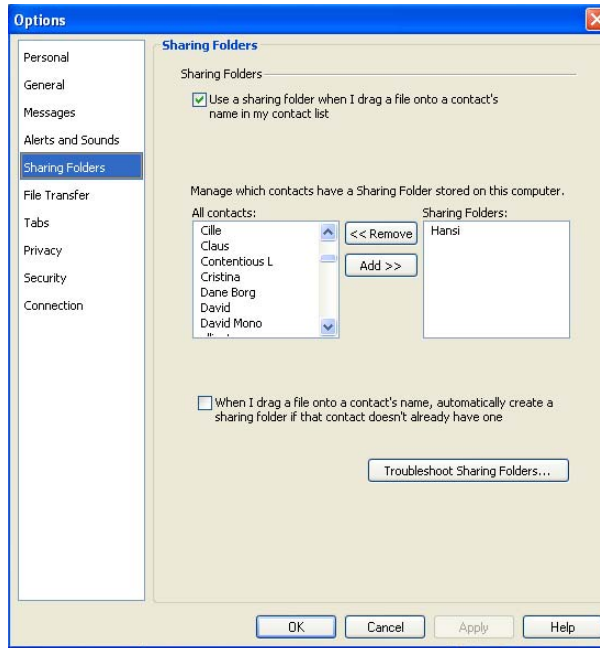


Figure B.23: Configuring sharing settings in MSN Messenger

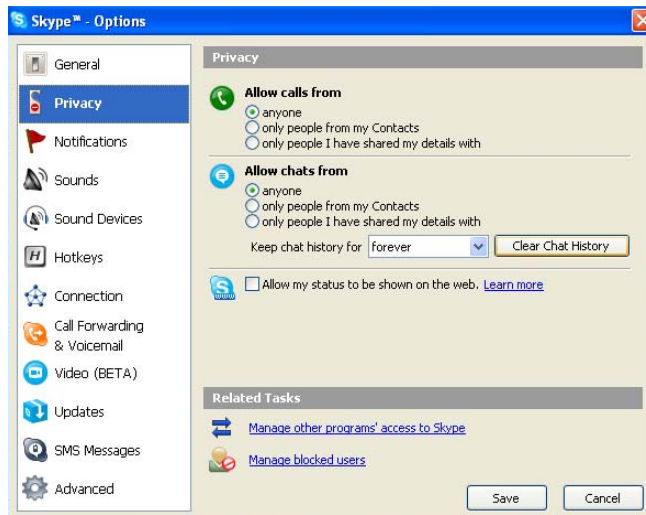


Figure B.24: Configuring privacy settings in Skype

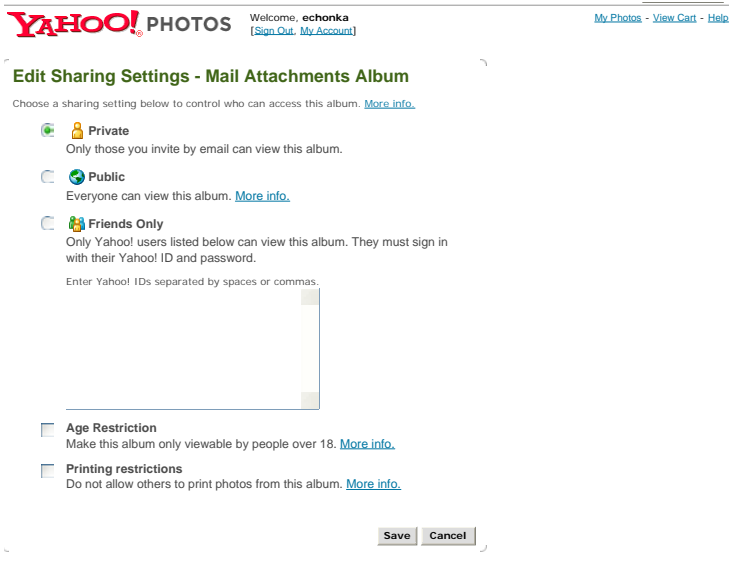


Figure B.25: Configuring privacy settings in Yahoo Photos



Figure B.26: Configuring security settings in Internet Explorer

Mobile Phone:

- On/Off;
- Soundless/vibrating;
- Change ring tone;
- Camera;
- mp3;
- Memory stick;
- Voice recorder;
- Find surrounding devices;
- GPS device;
- Radio;
- Organizer/Alarm;
- Fast Internet access;
- Watching movies;
- Scan documents;
- Download music.

Voice Recorder:

- Record voice;
- Play voice;
- Long battery life;
- On;
- Off;
- Good indexing of recorded voice (“search function”);
- Big memory;
- Easy transfer of voice files;
- Recording settings depending on environment (sound volume, background noise, etc.).

Laptop:

- On/Off;
- Silent;
- Standby;
- Power saving;
- Play music;
- Enable sharing folder;
- Log on as other user;
- Remote connection;
- Synchronize data;
- Organizer;
- Camera;
- Fast start-up-time;
- Wireless Internet;
- Good security.

PDA:

- Read e-mail;
- Surfing the Internet;
- On/Off;
- Sleep/Standby;
- Play music;
- Online/Offline;
- Lock keys/touchscreen;
- Security – lock other devices;
- Organizer/Alarm;
- Synchronize data;
- Power saving;

- Scanning of print materials.

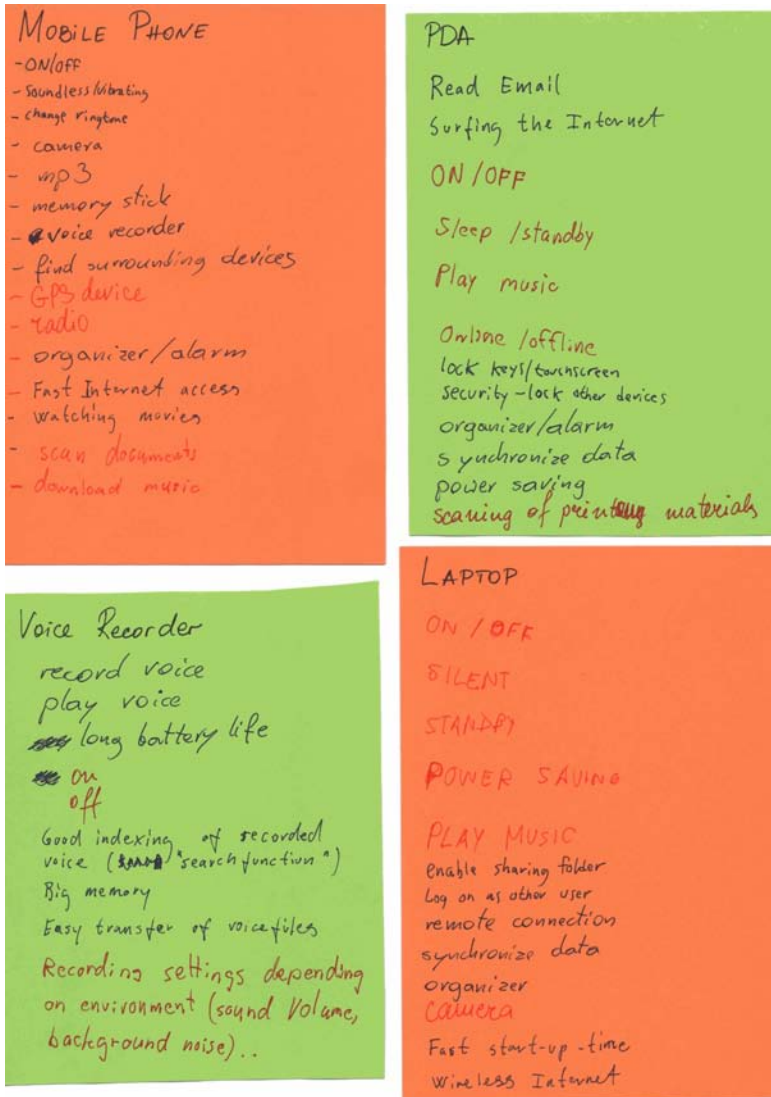


Figure B.27: Devices Options 1

Fridge:

- Cool food;

- Check what food is missing and maybe write a sms or e-mail to whoever does the shopping;
- Suggest recipes based on ingredients;
- The fridge is really huge so it can point you to where various food is (“cheese: 3rd drawer”);
- Set temperature;
- Self cleaning;
- Check whether food is out of due (rotten).

Printer:

- On/Off;
- Print;
- Print images directly from USB-sticks, memory cards, etc.;
- Small screen on the printer which allows you to see the image before you print;
- Check paper and toner/ink status;
- Scan/fax images;
- Allow remote connections.

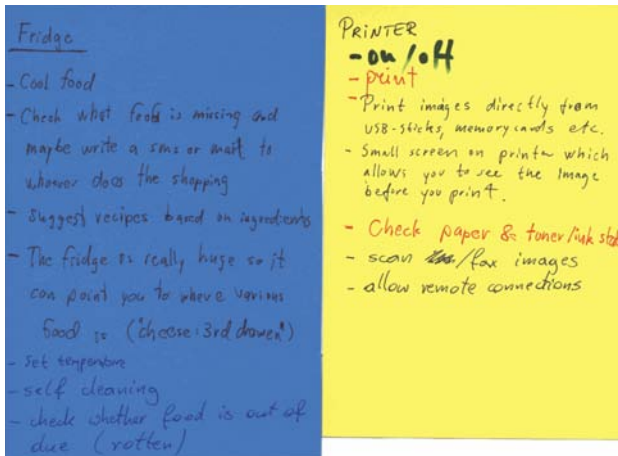


Figure B.28: Devices Options 2

Watch:

- Alarm/Organizer;
- Count heartbeat;
- Count running speed/distance;
- Radio;
- Find other devices;
- mp3 player;
- GPS;
- Compass;
- Temperature measurements;
- Show the time!!!

iPOD/MP3-player:

- Upload data to specific location (data = music, pictures, etc.);
- Watch pictures/movies;
- Calendar/Organizer;
- Contact book;
- Voice recorder;
- Download from the Internet;
- On/Off.

TV:

- Read e-mail;
- Watch TV;
- On/Off;
- Surf Internet;
- Record programs;
- Play music;
- Set sound level;
- Set channel;

- Silent mode;
- Play DVDs;
- Download movies.

GPS:

- Record voice;
- Taking pictures;
- Downloading route plan while you are driving;
- (info) radio;
- Voice control;
- Calculate route length;
- Portable;
- On/Off;
- Download list of different locations depending on the user's location.

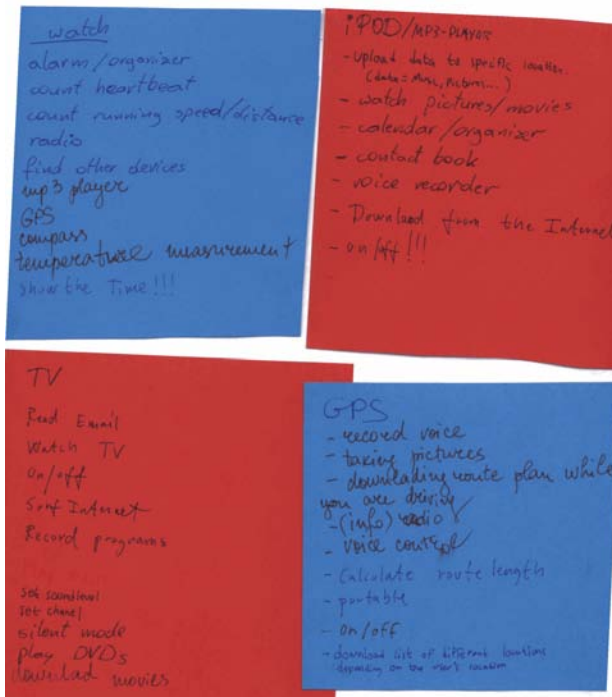
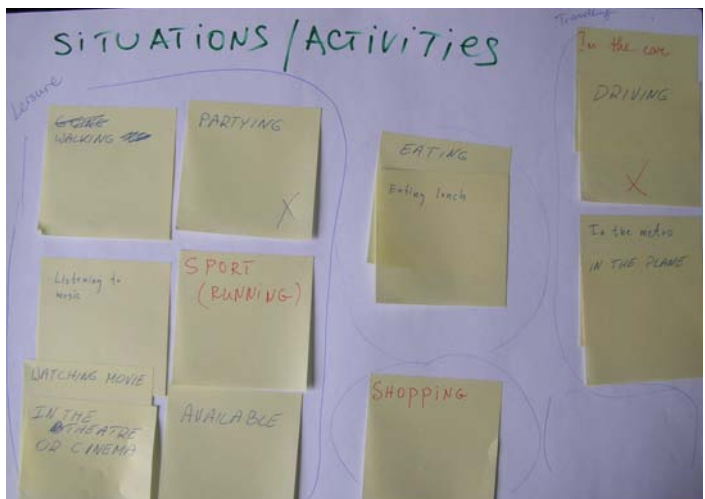
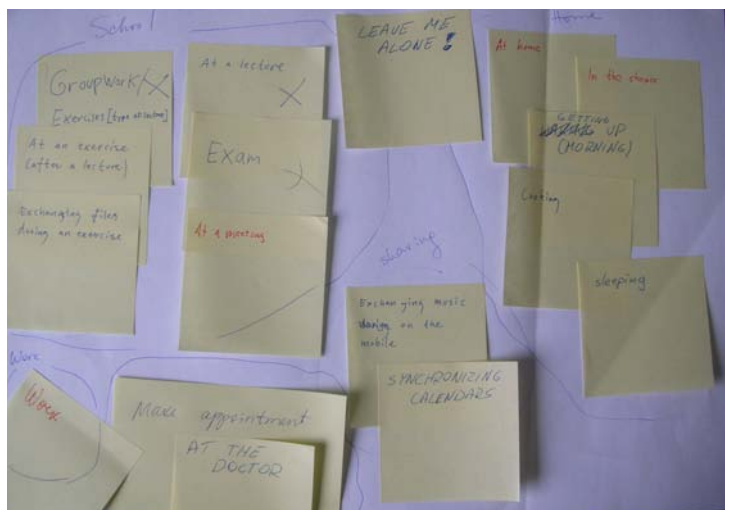


Figure B.29: Devices Options 3

B.3.5 Brainstorming for situations and activities for which statements can be used



(a)



(b)

Figure B.30: Brainstorming for situations and activities

B.3.6 Associating activities/situations with devices and their settings

The results are given as showing the original result as well as writing down what the scanned paper contains so it is more clear for the reader.

Exam

- Mobile Phone – Off (or silent and receiving voice mails);
- PDA – Off (after it has done the settings);
- Laptop – Wireless LAN disabled at DTU (enabled at CBS), Start relevant program for the given exam, Disable alarms and any automatic actions, Start timer count down application;
- Home Computer – Set messenger program to ‘At Exam’, block calls and inform your status, welcome in pleasant way and do not irritate (after the exam);
- Fridge – Prepare cold beer (after the exam).

Statement: Exam

Device:	Mobile phone	PDA	Laptop	home computer	FRIDGE
Settings	OFF	OFF (after it has done the settings)	Wireless LAN disabled Start relevant program for the given exam	set messenger program to 'at exam' status block calls and inform your status	
	ON (silent) receive voice mail		DISABLE ALARMS AND ANY AUTOMATIC ACTIONS On (CBS) Start timer count down application	WELCOME IN PLEASANT WAY AND DO NOT IRRITATE!	PREPARE COLD BEER

Figure B.31: Associating ‘Exam’ with devices and settings

At a lecture

- Phone – Silent ON, Vibration ON, Start voice recording of the lecture, Bluetooth ON, Pair with laptop, Transfer Voice;

- Laptop – Silent ON, Start the program used in the lecture, Connect to Wireless LAN (secure), Connect to PDA (secure), Start messenger with a status 'Busy', Bluetooth ON, Pair with Phone, Receive voice, Synchronize notes with PDA, Download notes and display them;
- PDA – Silent ON, Connect to Wireless LAN (secure), Connect to Laptop (secure), Synchronize notes with laptop, Auto-authorize on LAN and on laptop;
- Printer (at home) – Online;
- TV (at home) – Off;
- Bluetooth headset – Off.

At a lecture:

Phone	Laptop	PDA	Printer (at home)	TV (at home)	Bluetooth headset
<ul style="list-style-type: none"> • Silent ON • Vibrator ON • Start voice-recording (at the lecture) • Bluetooth on • Pair with laptop • Transfer voice 	<ul style="list-style-type: none"> • Silent ON • Start the program used in the lecture • Connect to wireless LAN (secure) • Connect to PDA (secure) • Start messenger with status 'Busy' • Bluetooth on • pair with phone • Receive voice • Synchronize notes with PDA • DOWNLOAD 	<ul style="list-style-type: none"> • Silent ON • Connect to wireless LAN (secure) • Connect to laptop (secure) • Synchronize notes with laptop • Auto-authorize on LAN and on laptop 	<ul style="list-style-type: none"> • off • online 	<ul style="list-style-type: none"> • off 	<ul style="list-style-type: none"> • Off

Figure B.32: Associating 'Lecture' with devices and settings

Groupwork

- Phone – Silent ON, Vibration ON, Bluetooth ON, File sharing application ON;
- PDA – Silent ON, Stand by ON, Set status 'Busy' on MSN messenger;

- PC/Laptop – ON, Internet browser ON, MS Word ON, File sharing application ON, Connect to network (plus authorize - DTU authorization), Set status 'Busy' on MSN messenger, Suppress 'new email' pop-ups, Mute or lower volume, Find groupwork notes/assignments and ask to print;
- Printer – On;
- TV (at home) – Off;
- Bluetooth headset – Off;
- Surveillance webcam (at home) – On.

Statement: Groupwork

Phone	PDA	PC /Laptop	TV	Printer	Surveillance Web
<ul style="list-style-type: none"> - Silent ON - Vibrate ON - Bluetooth ON - File sharing application ON 	<ul style="list-style-type: none"> - Standby ON - Silent ON - Set busy on MSN 	<ul style="list-style-type: none"> - On - Internet browser ON - Word ON - File sharing application ON - Connect to network (+authorize) (DTU AUTH) - Set busy on MSN - Suppress "new email" popups - Mute or lower volume - Find groupwork notes/assignments and ask to print 	- Off	- ON	Off ON

Figure B.33: Associating 'Groupwork' with devices and settings

Leisure

- General settings:
 - Alarm and ring volume should be high and increasing;
 - Additional password control on all used devices.
- PC – Allow chats from anyone (when in available state), Run antivirus program (when not in available state), Synchronize with other devices;
- Phone – Allowed callers are ALL;
- PC and Phone – Status 'Away' (Not when in available state), Voice commands are OFF.

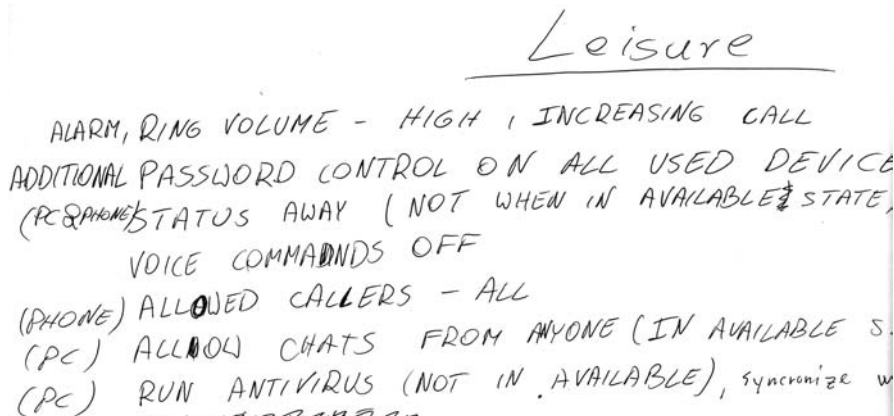


Figure B.34: Associating 'Leisure' with devices and settings

Traveling – Car(Driving)

- Phone – On, Vibration Off;
- Hands free – On, Volume control;
- Computer – Check for updates, Synchronize with other devices, Start virus scan (stationery computer);
- GPS – On, Downloading maps, Connect to information service, Check for updates;
- Printer – Stand by;
- Scanner – Stand by;
- MP3 player – On, Play;
- Fridge – send list of products to buy.

Traveling – Plane

- Phone – Off, forward calls;
- Hands free – Off;
- Computer – On, Play movie;
- GPS – On (if it works);
- Printer – Stand by;

- Scanner – Stand by;
- MP3 player – On, Play;
- Fridge – Send list of products to buy.

Traveling – Public Transport

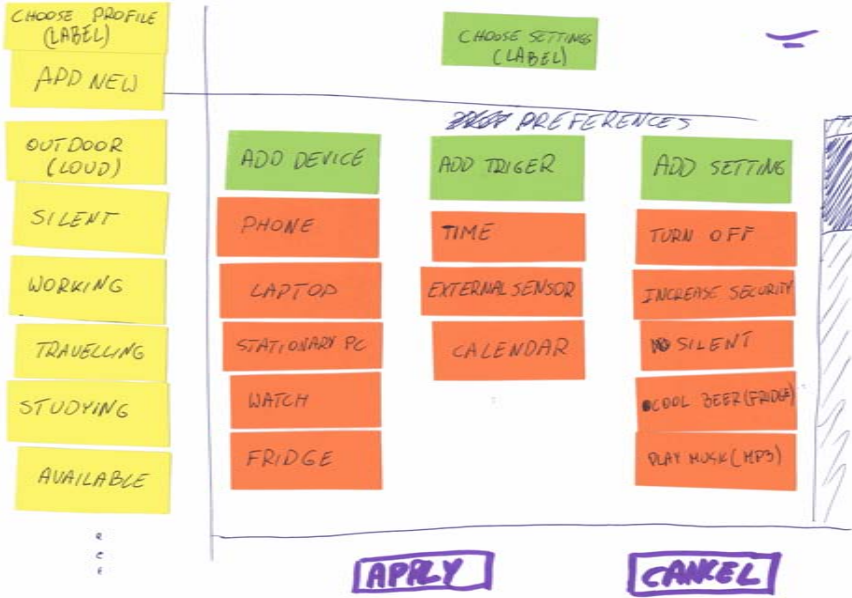
- Phone – Increasing ring (or Silent);
- Hands free – On;
- Computer – Search for wireless Internet in the vicinity (or off);
- GPS – Off;
- Printer – Stand by;
- Scanner – Stand by;
- MP3 player – On, Play;
- Fridge – Send list of products to buy.

Travelling

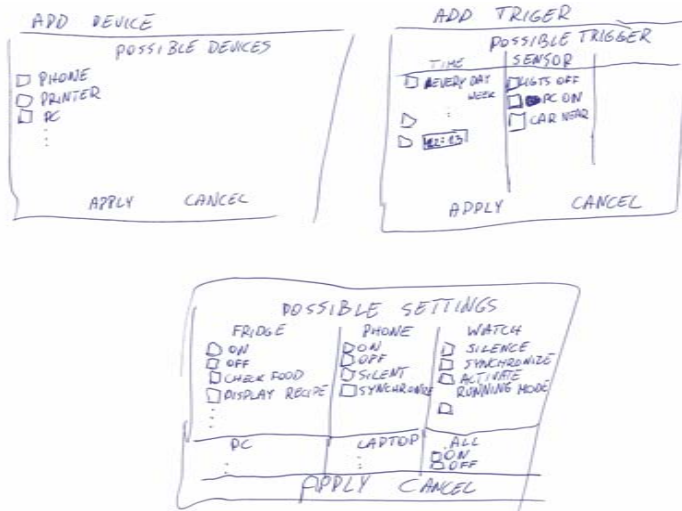
	car (driving)	plane	public transport
phone	- silent on - vibration off	- off - forward calls	- silent - increasing ring
computer	check for down updates (wifi) - update the system - start virus scanning - synchronize with devices	- off - play music	- off
GPS	on, download up maps, connect to information service check for updates	- off - on (if it works)	- off
hands free	- on - volume control	- off	- off - on
printer	stand by	stand by	stand by
scanner	stand by	stand by	stand by
mp3 player	on play	on play	on play
FRIDGE	need list of products to buy		

Figure B.35: Associating 'Traveling' with devices and settings

B.3.7 Designing different screens for managing statements



(a) Main screen



(b) Additional screens

Figure B.36: User 1 Design

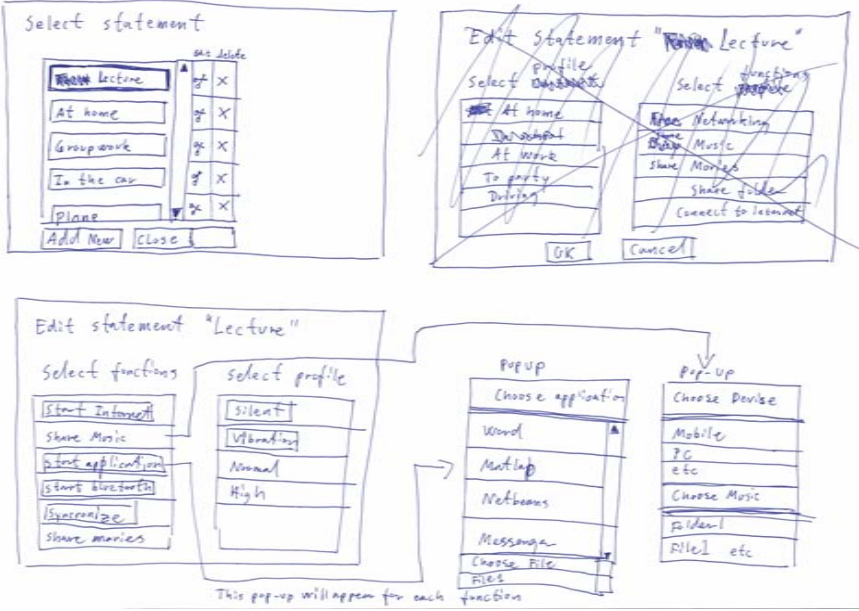


Figure B.37: User 2 Design

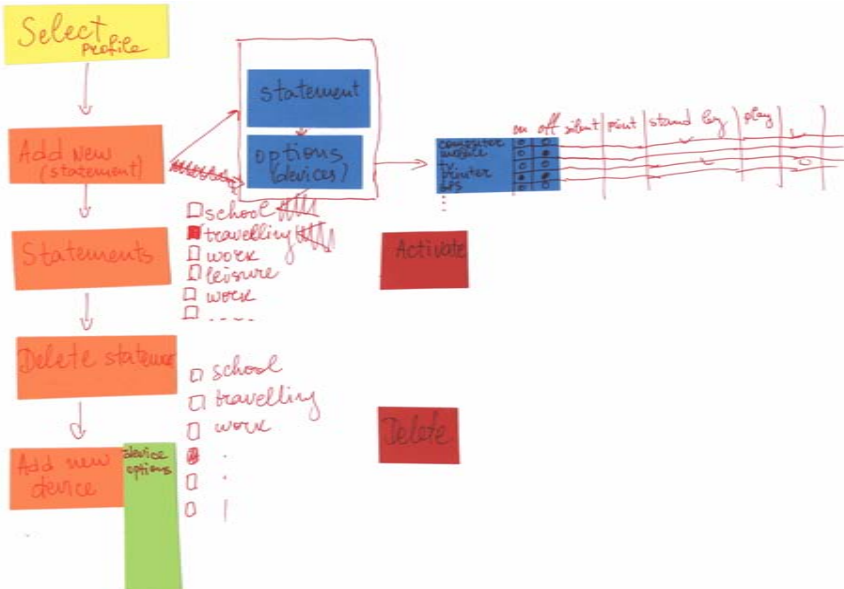


Figure B.38: User 3 Design

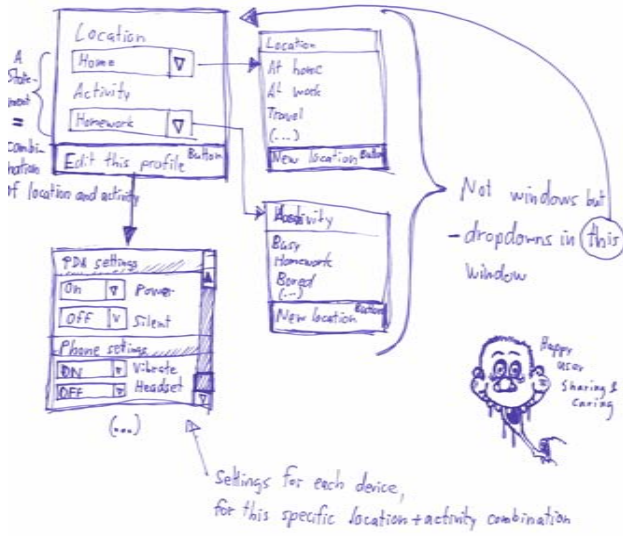


Figure B.39: User 4 Design

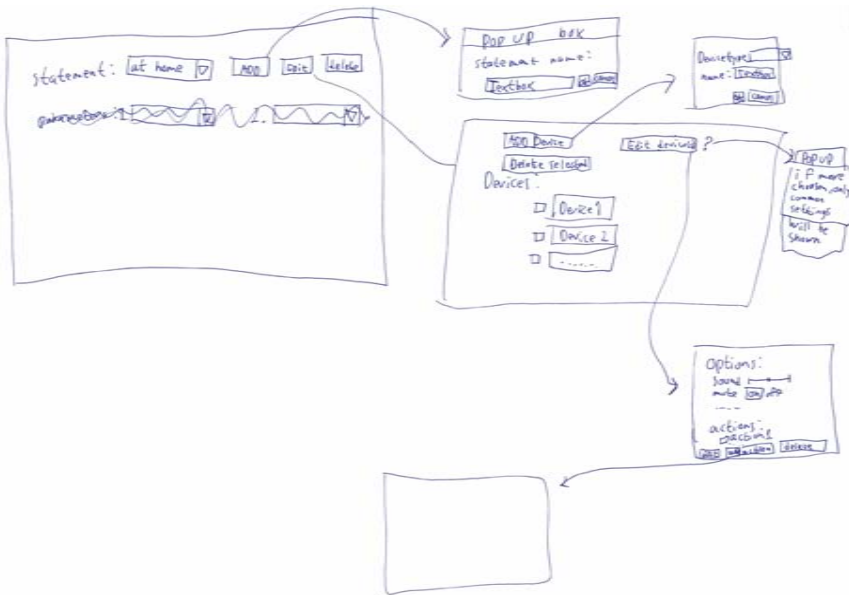


Figure B.40: User 5 Design

Conceptual design

This appendix presents the different screens of the low-fidelity prototype, plan and guiding questions for the evaluation, and an overview of the users, who participated in the evaluation. The raw results from the user testing and the post-test questionnaires are given in Appendix E.

C.1 Paper based prototype

This section presents different screens which are the conceptual model of the designed application and some diagrams which give some ideas of how the different screens are connected. This is the second paper based prototype which have only one version as a whole, but some of the screens have some alternative versions. The prototype is P2.1 as each screen number/id will be given further. The screen number/id corresponds to the screen numbers/ids given in the evaluation plan for the tasks and in the results from the evaluation. The captions of the figures contain information about the title of the specific screen and what actions need to be performed in order the screen to be shown.

C.1.1 Screens of the prototype

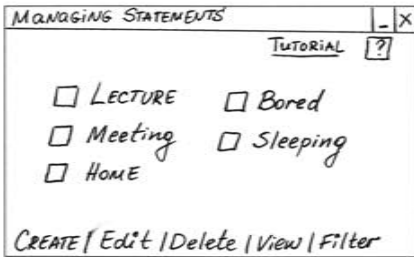


Figure C.1: Main screen – ‘Log in’ is pressed and the user is authenticated at the log-in screen. (S:Main)

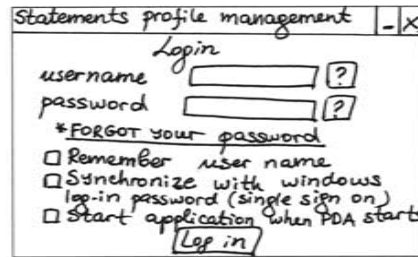


Figure C.2: Log in-screen – The application is started. (S:Log-in)

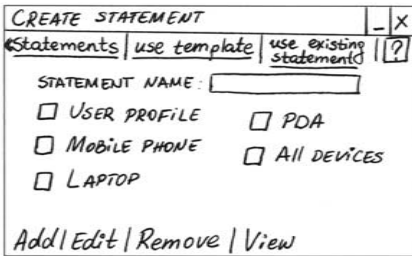


Figure C.3: Create statement-screen – ‘Create’ is pressed at the Main screen.(S:1)

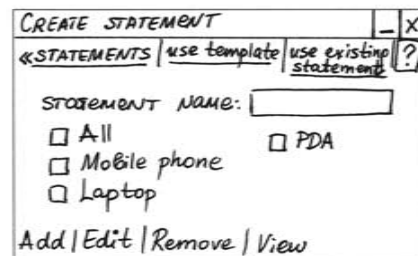


Figure C.4: Create statement alternative-screen – Similar to the Create statement-screen, but ‘All’ placed at the top and without ‘User profile’.(S:1-alt)

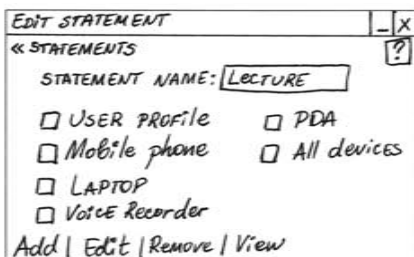


Figure C.5: Edit statement-screen – The check-box for the statement ‘Lecture’ is selected and ‘Edit’ is pressed at the Main screen.(S:2)

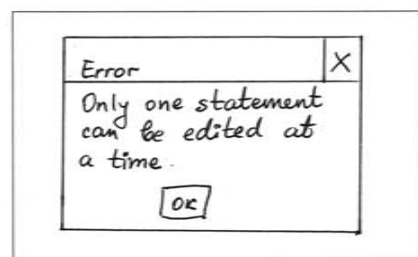


Figure C.6: Edit statement-screen’ – Two statements are selected and ‘Edit’ is pressed at the main screen.(S:2’)

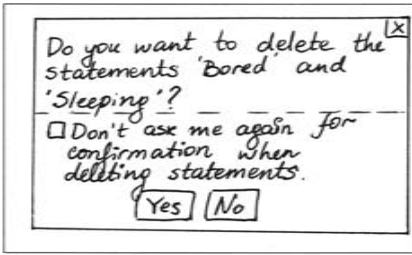


Figure C.7: Delete statement-screen – The check-boxes for the statements ‘Bored’ and ‘Sleeping’ are selected and ‘Delete’ is pressed at the Main screen.(S:3)

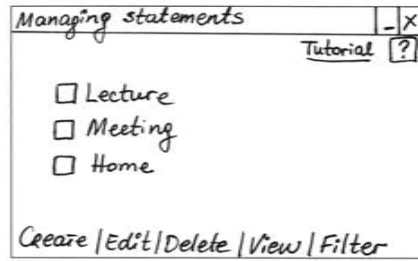


Figure C.8: Main-screen’ – Result main screen after deleting the statements ‘Bored’ and ‘Sleeping’.(S:Main’)

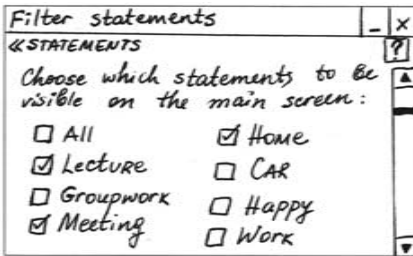


Figure C.9: Filter-screen 1 – ‘Filter’ is pressed at the main screen.(S:5-1)



Figure C.10: Filter-screen 2 – The scroll-bar in Filter-screen 1 is moved down to see the rest of the screen.(S:5-2)

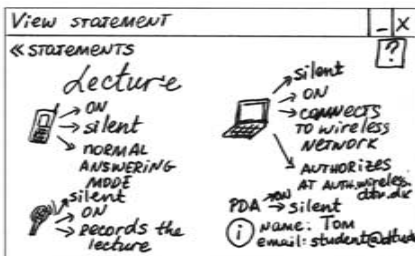


Figure C.11: View-screen – The statement ‘Lecture’ is selected and ‘View’ is pressed at the main screen.(S:4)

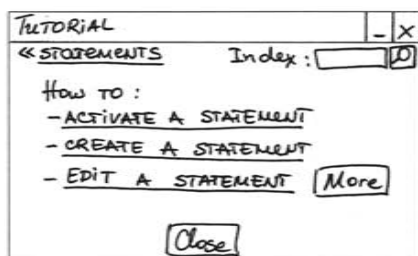


Figure C.12: Tutorial-screen – ‘Tutorial’ is pressed at the main screen.(S:7)

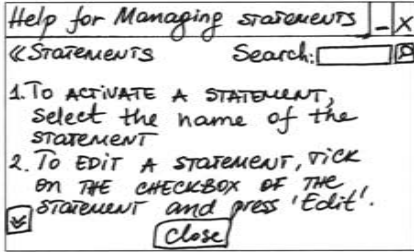


Figure C.13: Help-screen - '?' is pressed at the main screen.(S:8)

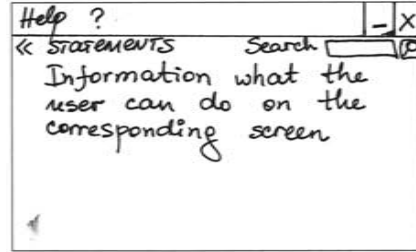


Figure C.14: General Help-screen - '?' is pressed at a certain screen.(S:X)

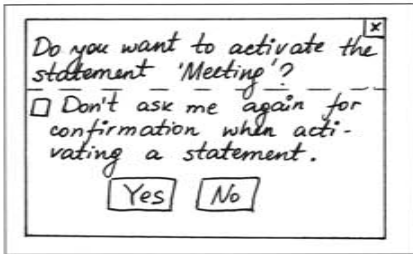


Figure C.15: Statement activation-screen - The name of the statement 'Meeting' (which is an activation link) is pressed at the main screen.(S:6)

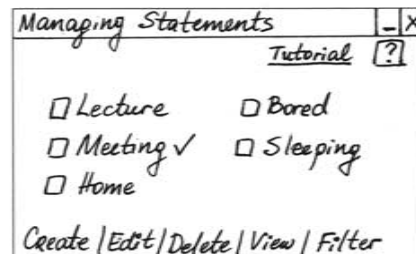


Figure C.16: Main-screen" - Main screen after activating 'Meeting' and pressing 'Yes' at the Statement activation-screen.(S:Main")

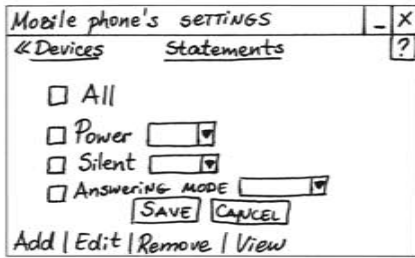


Figure C.17: Mobile phone-screen – The check-box for ‘Mobile phone’ is selected and ‘Edit’ is pressed at the Create statement-screen.(S:1.1)

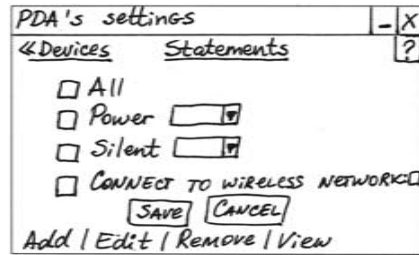


Figure C.18: PDA-screen – The check-box for ‘PDA’ is selected and ‘Edit’ is pressed at the Create statement-screen.(S:1.3)

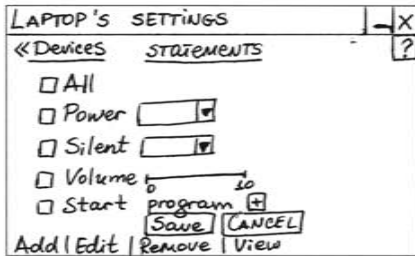


Figure C.19: Laptop-screen 1 – The check-box for ‘Laptop’ is selected and ‘Edit’ is pressed at the Create statement-screen.(S:1.2-1)

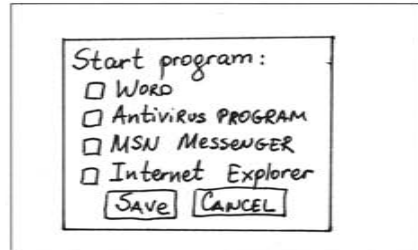


Figure C.20: Laptop-screen 2 – ‘+’ for ‘Start program’ at the Laptop-screen is pressed/expanded.(S:1.2-2)

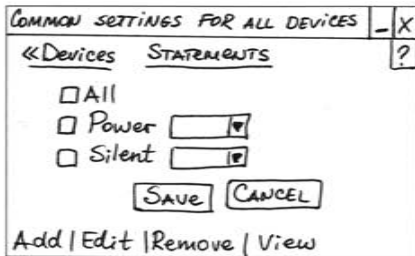


Figure C.21: Common settings for all devices-screen – The check-box for ‘All devices’ is selected and ‘Edit’ is pressed at the Create/Edit statement-screen.(S:1.4)

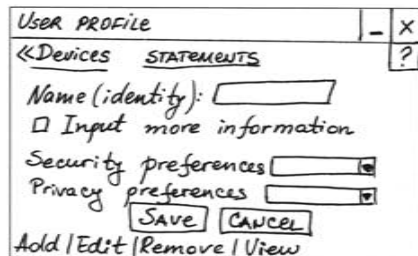


Figure C.22: User profile-screen 1 – The check-box for ‘User profile’ is selected and ‘Edit’ is pressed at the Create statement-screen.(S:1.5-1)

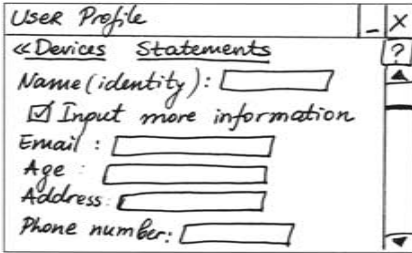


Figure C.23: User profile-screen 2 – The check-box for ‘Input more information’ is selected at the User profile-screen 1.(S:1.5-2)

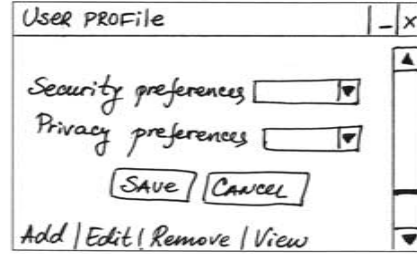


Figure C.24: User profile-screen 3 – The scroll-bar in the User profile-screen 2 is moved down to see the rest of the information.(S:1.5-3)

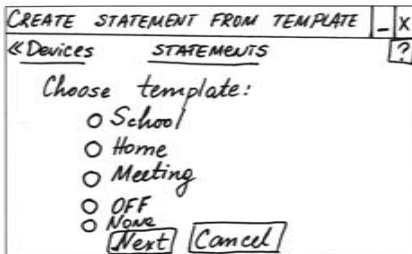


Figure C.25: Create statement from template-screen – ‘Use template’ is selected at the Create statement-screen.(S:1.6)

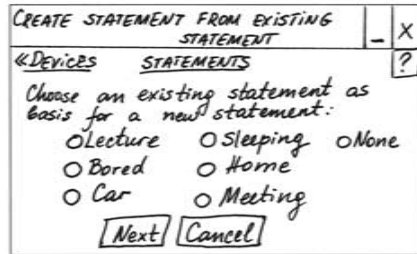


Figure C.26: Create statement from existing statement-screen – ‘Use existing statement’ is selected at the Create statement-screen.(S:1.7)

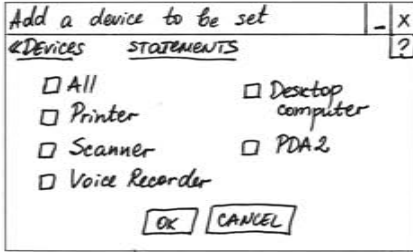


Figure C.27: Add device-screen – ‘Add’ is selected at the Create statement-screen.(S:1.8)

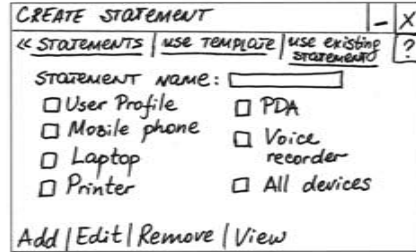


Figure C.28: Create statement-screen’ – Create statement-screen after the check-boxes of ‘Printer’ and ‘Voice recorder’ are selected and ‘Ok’ is pressed at Add device-screen.(S:1’)

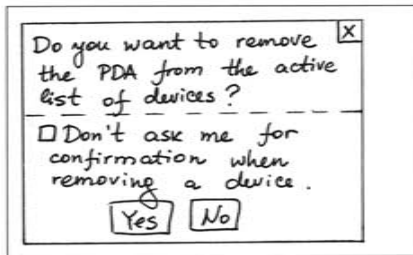


Figure C.29: Remove device-screen – The check-box for ‘PDA’ is selected and ‘Remove’ is pressed at the Create statement-screen.(S:1.9)

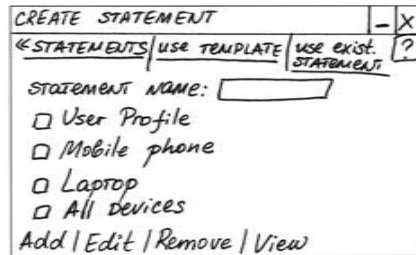


Figure C.30: Create statement-screen” – Create statement-screen after ‘Ok’ is pressed at Remove device-screen for removing the PDA.(S:1”)

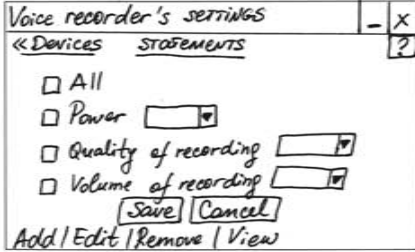


Figure C.31: Voice recorder-screen – The check-box for ‘Voice recorder’ is selected and ‘Edit’ is pressed at the Create statement-screen’.(S:1.10)

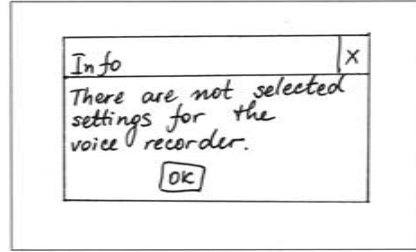


Figure C.32: View statement-screen – The check-box for ‘Voice recorder’ is selected and ‘View’ is pressed at the Create statement-screen’, as there are no selected settings for the voice recorder in advance.(S:1.11)

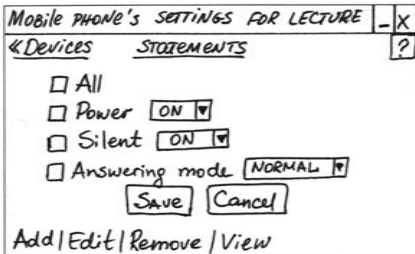


Figure C.33: Mobile phone-screen’ – The check-box for ‘Mobile phone’ is selected and ‘Edit’ is pressed at the Edit statement-screen.(S:2.1)

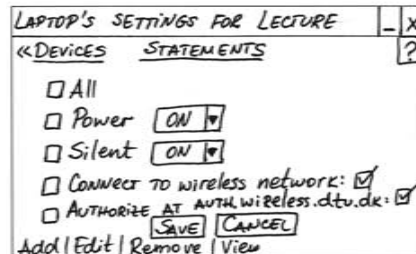


Figure C.34: Laptop-screen’ – The check-box for ‘Laptop’ is selected and ‘Edit’ is pressed at the Edit statement-screen.(S:2.2)

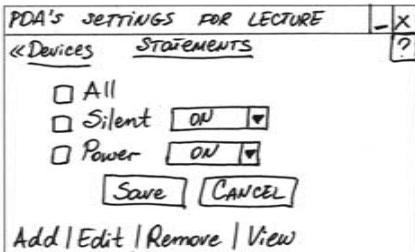


Figure C.35: PDA-screen’ – The check-box for ‘PDA’ is selected and ‘Edit’ is pressed at the Edit statement-screen.(S:2.3)

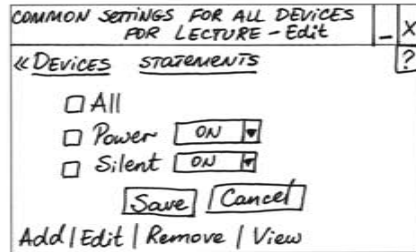


Figure C.36: Common settings for all devices-screen’ – The check-box for ‘All devices’ is selected and ‘Edit’ is pressed at the Edit statement-screen.(S:2.4)

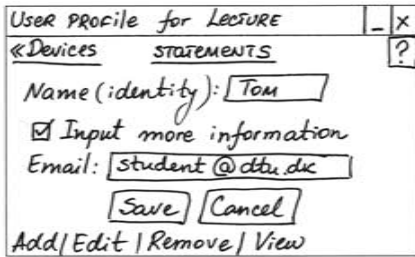


Figure C.37: User profile-screen' – The check-box for 'User profile' is selected and 'Edit' is pressed at the Edit statement-screen.(S:2.5)

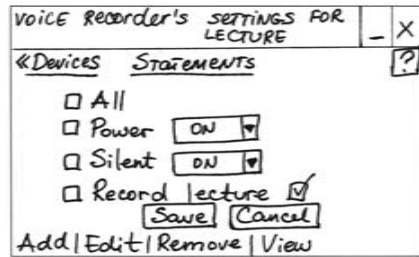


Figure C.38: Voice recorder-screen' – The check-box for 'Voice recorder' is selected and 'Edit' is pressed at the Edit statement-screen.(S:2.10)

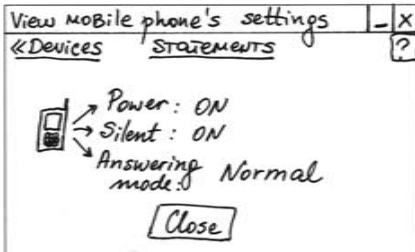


Figure C.39: View device-screen' – The check-box for 'Mobile phone' is selected and 'View' is pressed at the Edit statement-screen.(S:2.6)

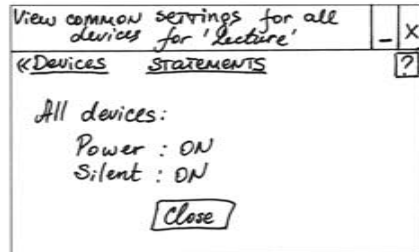


Figure C.40: View device-screen" – The check-box for 'All devices' is selected and 'View' is pressed at the Edit statement-screen.(S:2.7)

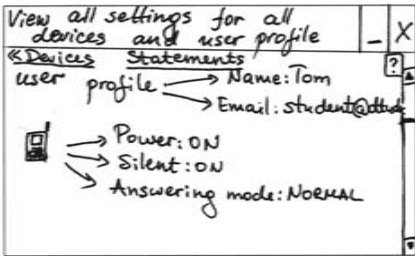


Figure C.41: View device-screen" alternative 1 – The check-boxes for 'All devices' and 'User profile' are selected and 'View' is pressed at the Edit statement-screen. (S:2.7alt-1)

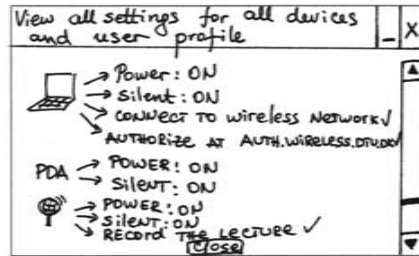


Figure C.42: View device-screen" alternative 2 – The scroll-bar in View device-screen" alternative 1 is moved down to see the rest of the information.(S:2.7alt-2)

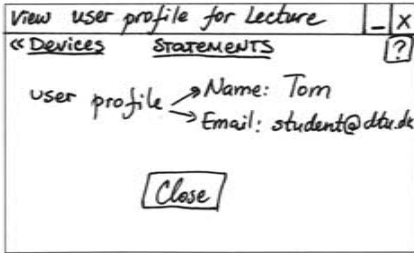


Figure C.43: View user profile-screen – The check-box for ‘User profile’ is selected and ‘View’ is pressed at the Edit statement-screen.(S:2.8)

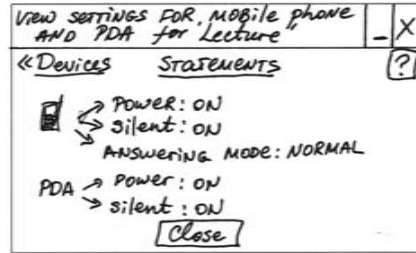


Figure C.44: View device-screen” – The check-boxes of ‘Mobile phone’ and ‘PDA’ are selected and ‘View’ is pressed at the Edit statement-screen.(S:2.9)

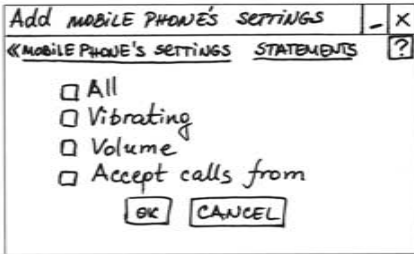


Figure C.45: Add settings to a device-screen – ‘Add’ is pressed at the Mobile phone-screen to add settings for the mobile phone.(S:1.1.1)

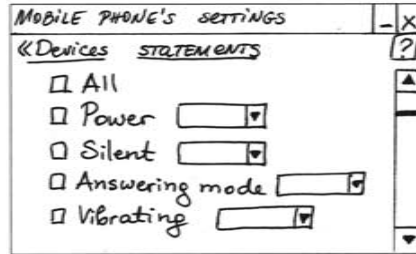


Figure C.46: Mobile phone-screen’ 1 – Result after the check-box for ‘All’ is selected and ‘Ok’ is pressed at Add settings to a device-screen.(S:1.1’-1)

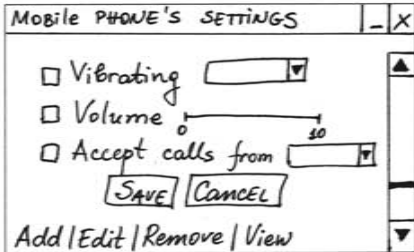


Figure C.47: Mobile phone-screen’ 2 – The scroll-bar in Mobile phone-screen’ 1 is moved down to see the rest of the settings.(S:1.1’-2)

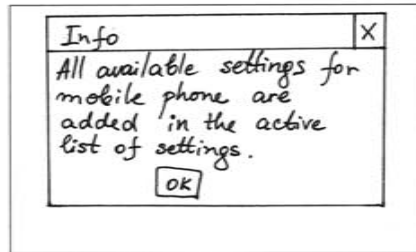


Figure C.48: Add settings to a device-screen’ – ‘Add’ is pressed at the Mobile phone-screen after all possible settings are added to the active list of devices.(S:1.1.2)

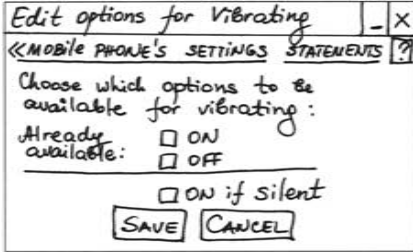


Figure C.49: Edit options for a setting – The check-box for ‘Vibrating’ is selected and ‘Edit’ is pressed at Mobile phone-screen’ 1 and 2.(S:1.1.3)

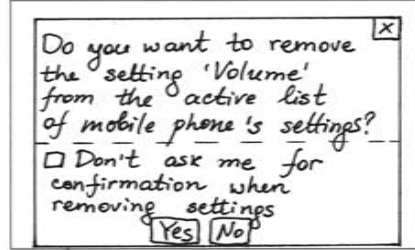


Figure C.50: Remove settings of a device-screen – The check-box for ‘Volume’ is selected and ‘Remove’ is pressed at Mobile phone-screen’ 1 and 2.(S:1.1.4)

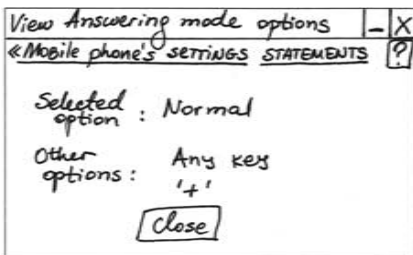


Figure C.51: View options for a setting – The check-box for ‘Answering mode’ is selected and ‘View’ is pressed at Edit device-screen’ .(S:2.1.1)

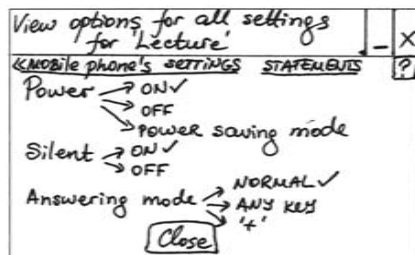


Figure C.52: View options for all settings – The check-box for ‘All’ is selected and ‘View’ is pressed at Edit device-screen’.(S:2.1.2)

C.1.2 Diagrams about how the screens are connected

The diagrams are used to illustrate the connections between the screens and to be easier to find the needed screen. The screens have been made with different colour back so it is easy to orientate which level a certain screen belongs. The colours are given at each diagram. The Create statement and Edit statement screen are given separately in order to show the differences when creating a statement and when editing one (the main difference is that when editing a statement, the devices have default setting).

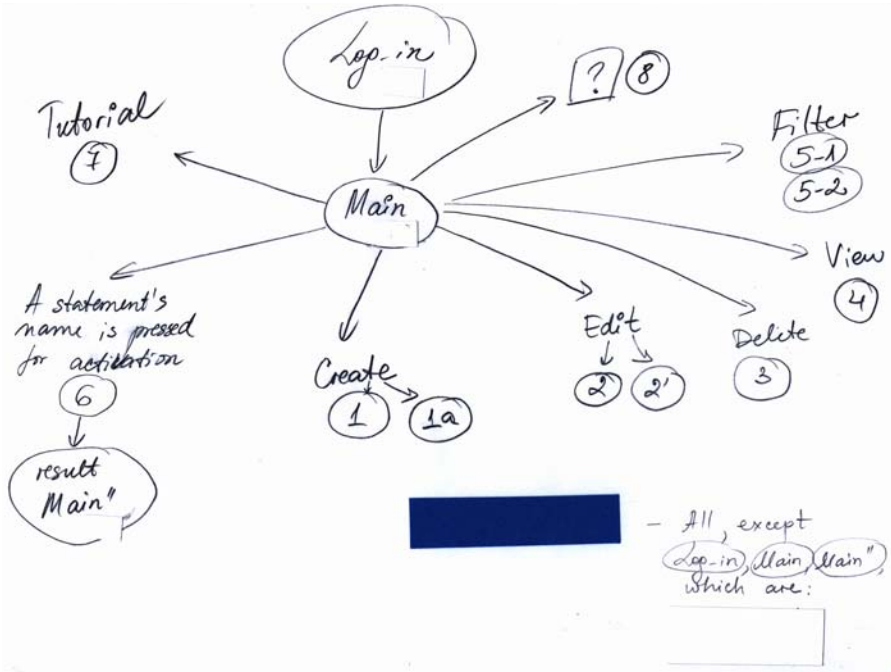


Figure C.53: Diagram for the screens connected to the main screen

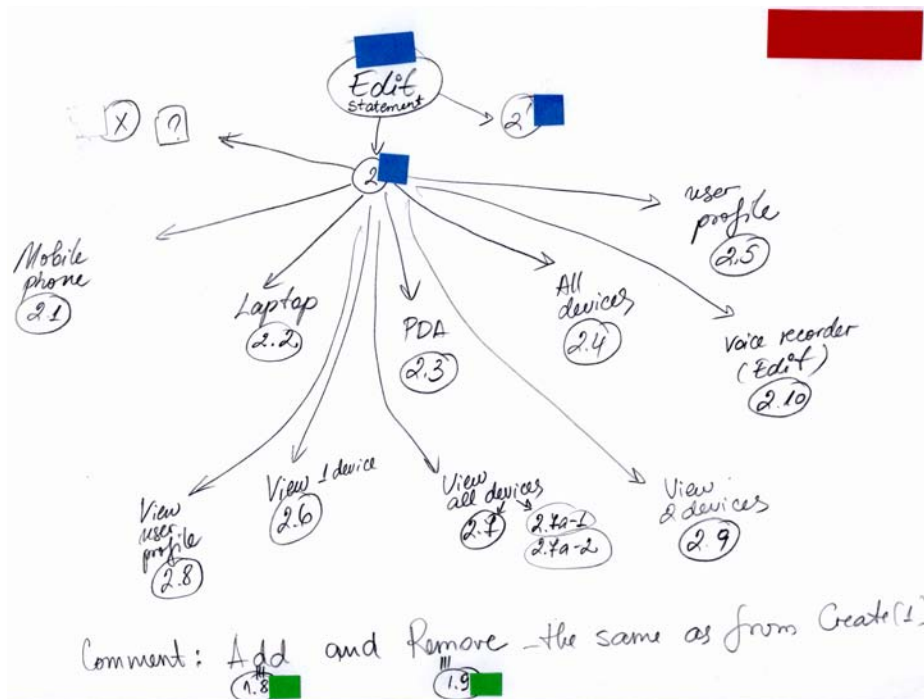


Figure C.54: Diagram for the screens connected to the edit statement screen (devices-level)

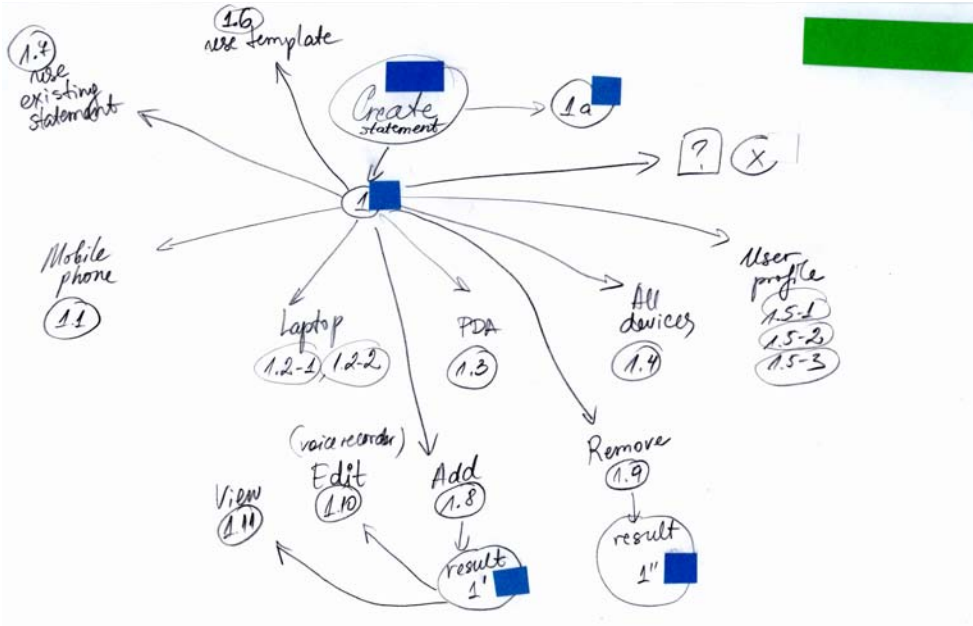


Figure C.55: Diagram for the screens connected to the create statement screen (devices-level)



Figure C.56: Diagram for the screens connected to the mobile device screen (settings-level)

C.2 Plan and guiding questions for the evaluation of the conceptual design

This section presents the structure of the evaluation and the questions which are used to guide the evaluation process. The conceptual design evaluation process includes identifying the user type, presenting the concepts of PN and statements, giving tasks to the user and asking them additional questions in order to find out if they understand the prototype and how it could be made better, as well as some questions about security issues.

Evaluation plan

Introduction to the overall evaluation process and asking the user if he/she gives permission for recording and taking pictures during the evaluation session.

Interview for identifying the user's type

Age

Gender

Occupation

1. (*Technology*) Do you feel comfortable to use different types of technologies computers, PDAs, mobile phones? (Do you consider yourself experienced in using computers, mobile devices?)
2. (*Technology*) When you buy a new device or install a new program do you check the default settings and apply new ones?
3. (*Control*) Do you want to be in control in general when interacting with a system? (Do you need to know what is happening with the system all the time? Do you need to confirm all the steps the system takes or you have some trust in the system?)
4. (*Privacy and sharing*) What is your attitude to privacy? Are you privacy concerned?
5. (*Privacy and sharing*) Are you interested to know who has access to your data?
6. (*Trust in systems*) Do you have trust in systems in general? (Do you trust that the system is reliable, stable and it works correctly?)
7. (*Social issues*) What is your attitude to strangers? (Do you like to be contacted by strangers?)

8. (*Automatic issues*) Do you like when the system performs some actions automatically, without asking for confirmation?
9. (*UI-playfulness*) Should the interface be playful? Should it be fancy or plain?
10. (*UI-feedback*) Do you prefer the system to provide feedback about what has been done or what has failed? In which situations?

Introduction to the concepts of PN and statements

Evaluation of the paper based prototype

- Explaining how the evaluation process will be performed to the users. The user will be presented some screens made of paper. The user will be asked to do some simple tasks by using the paper based prototype (representing the system) and imagining a certain situation and how the system can be used in this situation.
- The user is also asked to think aloud or to say what he/she thinks so the evaluator will be able to follow the different steps and actions the user performs to solve the task.
- The paper based prototype consists of individual screens, drawn on paper, which are dependent on each other – the sequence depends on certain action or imagining performing the action (or a certain screen will be presented to the user after the user does a particular action). Each screen is placed on top of the screen of a Nokia 770 device, when it is needed. This relates to the “Wizard of Oz” prototyping method.

Tasks given to the user and corresponding questions

The sequence of actions is described by referring to screen number/id or screen-card number/id, which corresponds to the number/id of the screens of the paper-based prototype, presented in Section C.1.

1. First impressions of the application (Log-in screen and main screen)

This is the first time you see the application. What are your first impressions?

What would you do first to start using the application?

What would you do first at the main screen of the application?

Sequence of actions required to perform the task:

The application is started by pressing on a short-cut of the application on the task-bar. The username and password are entered in the log-in screen which is opened after starting the application. The button log-in is pressed.

The user can perform some actions on the main screen.

Additional questions:

C.2 Plan and guiding questions for the evaluation of the conceptual design

Log-in Screen: Is something missing on the Log-in screen?

Would you like to have a log-in screen for the application?

Are the given choices on the Log-in screen reasonable - would you select them at certain circumstances? When would you need and use these options?

What would you expect to happen when '?'-s close to username and password fields are pressed at the log-in screen?

Main screen: Is something missing on the main screen?

2. View statement

You don't know what would happen when the statement 'Lecture' is selected. How would you check what the statement Lecture does?

Sequence of actions required to perform the task:

Tick on the check-box of 'Lecture' and press the button 'View' at the main screen. The result of the action is shown on screen-card 4.

Additional questions:

What do you expect to happen when '<< statements' is selected at the view-screen (or screen 4 from the prototype)?

What do you expect to happen when '?' is selected at the view-screen (or screen 4 from the prototype)?

3. Activate a statement

You would like to apply the statement 'Meeting'. Can you show how you would do that?

Sequence of actions required to perform the task:

Press the name of the statement 'Meeting' at the main screen. A message asking for confirmation will be shown (screen 6 from the prototype). The user should select 'Yes' to activate the statement. After the activation of Meeting, the main screen is shown by putting a mark at the activated statement (screen Main" from the prototype).

Additional questions:

Do you understand how a statement can be activated? Is it confusing?

Do you understand that you have to click on the statement's name and not select the check-box?

How would you prefer to activate a statement? Would it be better if the user has to select the check-box and press a button Activate (as the other functions are represented by buttons)?

4. Look for help

You do not know much about the program and what you can do with it. What would you do?

How would you find out what you can do on the particular screen?

Sequence of actions required to perform the task: The 'Tutorial' (screen 7 from the prototype) is selected for the first question and '?' (screen 8 from the prototype) is selected for the second question.

Additional questions:

What would you expect to happen when 'Tutorial' and '?' are selected?

Do you understand that the '?' gives help for the current screen?

5. Delete a statement

You don't need the statements 'Bored' and 'Sleeping' any more. Can you show what you would do?

Sequence of actions required to perform the task:

The check-boxes for 'Bored' and 'Sleeping' are selected and 'Delete' is pressed at the main screen (screen Main from the prototype). A message asking for confirmation will be shown (screen 3 from the prototype). The user should select 'Yes' to delete the statements. As a result the main screen is shown without the statements 'Bored' and 'Sleeping' (screen Main' from the prototype).

Additional questions:

Would you like to be asked for confirmation?

Would you use the given option to refuse confirmation at any situations? If yes - in which situations?

6. Filter statements

What would you expect to happen if 'Filter' is pressed?

You want to change which statements to be visible at the main screen. How would you do that?

Sequence of actions required to perform the task:

'Filter' is pressed at the main screen (screen Main from the prototype). The screen 5-1 from the prototype is shown. When the scroll-bar is used screen 5-2 from the prototype is shown.

Additional questions:

Is it logical to use the name 'Filter' for this functionality?

7. Create a statement (general)

You need a statement which does not exist in the application. What would you do?

Sequence of actions required to perform the task:

'Create' is pressed at the main screen (screen Main from the prototype). Screen 1 from the prototype is shown.

Additional questions:

Are there different ways to create a new statement? What are they?

Which one would you prefer to use?

8. User profile

Should the user profile be presented together with the devices?

Does it make sense for you to give some personal information which can be used in the certain situation when the statement is used?

Look at screens 1.5-1, 1.5-2, 1.5-3 and give your opinion.

C.2 Plan and guiding questions for the evaluation of the conceptual design

9. Create a statement from an existing statement

You need a statement which would assist you when you work on a project with a group. The settings of the statement would probably be close to the settings you have for the statement Lecture. How would you create this statement?

Sequence of actions required to perform the task:

'Use existing statement' is pressed at screen 1 from the prototype. As a result screen 1.7 from the prototype is shown.

Additional questions:

Do you think having the possibility to create a statement from existing statement is useful?

10. Edit two statements

What would you expect to happen if two statements are selected and Edit is pressed at screen Main from the prototype?

Sequence of actions required to perform the task:

The check-boxes for 2 statements are selected and Edit is pressed. The error message at screen 2' from the prototype is shown.

Additional questions:

Do you find it logical to edit one statement at a time?

11. Edit a statement

You would like to change the settings of statement Lecture. Can you show me how you would do that?

Sequence of actions required to perform the task:

The check-box for Lecture is selected and Edit is pressed at screen Main from the prototype. As a result screen 2 from the prototype is shown.

12. View settings of devices for 'Lecture'

You are not sure what different settings for the devices in the statement 'Lecture' are and it would be nice if you know that so you would know what you want to change. What would you do?

Sequence of actions required to perform the task:

Each device can be selected separately and then 'View' is pressed at screen 2. Screen 2.6 shows settings for the Mobile phone. Screen 2.8 shows settings for user profile.

Additional questions:

What would you expect to happen when Mobile phone and PDA are selected and 'View' is pressed? (How would you see the settings for Mobile phone and PDA?)

What would you expect to happen when '<<Devices' is pressed?

Does it make sense to call it '<<Devices' if it also includes 'User profile'?

13. View settings for all devices

What would you expect to happen when ‘All devices’ and ‘user profile’ are selected and ‘View’ is pressed?

Would you prefer only the common settings to be shown for the chosen devices (screen 2.7) or all settings for user profile and all devices (screen 2.7a)?

14. Add a device to a statement

You would like to configure some settings for your printer when the statement ‘Lecture’ is selected (the printer is not in the active list of devices for ‘Lecture’).

What would you do?

Sequence of actions required to perform the task:

‘Add’ is pressed at screen 2 from the prototype. Screen 1.8 is shown. The check-box for the ‘Printer’ is selected and ‘Ok’ is pressed at screen 1.8. As a result screen 1’ is shown with a small correction of the heading (it should be Edit instead of Create in the heading).

15. Edit settings of Mobile phone

If you want to apply changes to the Mobile phone what would you do?

Sequence of actions required to perform the task:

The check-box for ‘Mobile phone’ is selected and ‘Edit’ is pressed at screen 2 or the name of the Mobile phone is pressed. As a result screen 2.1 is shown.

16. Add settings for Mobile phone

You would like to activate some more settings which are not given in the list at screen 2.1. What would you do?

How would you include all extra settings to the active list of settings for the mobile phone so you can set them?

Sequence of actions required to perform the task:

‘Add’ is pressed in Screen 2.1. As a result screen 1.1.1 is shown. The check-box for ‘All’ is selected and ‘Ok’ is pressed at screen 1.1.1. The result is shown at screen 1.1’-1 and 1.1’-2.

Additional questions:

Do you like that the active list of settings only contains some settings? Do you like that it is possible to include more settings?

What would you expect to happen when you press ‘Add’ again (after all available settings are included)? → *Sequence of actions:* Screen 1.1.2 is shown when ‘Add’ is pressed at screen 2.1?

17. Edit options for a setting (Vibrating)

The given options for the setting Vibrating for the Mobile phone (on, off) don’t contain an option which you would prefer to use. Would you look for more options and where?

Sequence of actions required to perform the task:

The check-box for ‘Vibrating’ is selected and ‘Edit’ is pressed at the screen 1.1’-

C.2 Plan and guiding questions for the evaluation of the conceptual design

1. As a result screen 1.1.3 is shown.

Additional questions:

Do you understand what screen 1.1.3 shows?

Is it logical to include options to settings by using button 'Edit'?

18. View options for all settings of Mobile phone

You would like to have an overview of the mobile phone's settings. What would you do?

Sequence of actions required to perform the task:

The check-box for 'All' is selected and 'View' is pressed at screen 2.1. As a result screen 2.1.2 is shown.

Additional questions:

Does it make sense to view all possible options for the settings, as the chosen option is marked?

19. Edit several devices at a time

You would like to select settings for all devices at one time. What would you do?

Sequence of actions required to perform the task:

The check-box for 'All devices' is selected and 'Edit' is pressed at screen 2. As a result screen 2.4 is shown with the common settings of all devices for Lecture.

Additional questions:

Is the screen showing what you expected?

Do you like the idea that by selecting several devices or all of them, the common settings for them are shown?

Is it clear that by pressing 'Edit' the common settings will be shown?

20. Remove a device

You don't need to have your PDA in the active list with devices any more. What would you do?

Sequence of actions required to perform the task:

The check-box for PDA is selected and Remove is pressed at screen 2. A message asking for confirmation is shown screen 1.9.

Additional questions:

What would you expect to happen when you press 'Yes'?

Do you understand that the device is not deleted from the system, but moved to the inactive list and you can include the device again by choosing the 'Add' function?

21. Common (general) questions for all screens

Do you think that something is missing at the screens - any type of information, navigation buttons or something else?

Are the used names for headings and buttons meaningful and intuitive (or can you imagine what the different elements at the screens are used for from their

names)?

What was good in the screens?

What was bad and confusing?

User's point of view about some security issues when using PN and statements

22. What security requirements would you have to your PN and when communicating to other PNs?

23. What levels of security would you like to have within your PN, when your PN communicates with other PNs and when your PN communicates with external devices?

24. What do you think about single sign-on concept? Would you use it?

25. What methods of authorization would you prefer when logging in the statements application/PN, and when your PN communicates with other PNs?

C.3 Overview of the users, who participated in the evaluation

- User 1 – A male student in Informatics, DTU, age – 23, nationality – Danish, Fictitious User 3 (the same user as User 5 from the individual interviews for gathering needs).

- User 2 – A female master student in Computer Science, DTU, age – 26, nationality – Danish, Fictitious User 3 (the user has not participated in the interviews or the workshop for gathering needs).

Technology: She feels comfortable to use different types of technologies. When she buys a new device or installs a new program she checks what the default settings are.

Control: She wants to be in control when interacting with systems. She wants to know how the things work.

Privacy and sharing: She is privacy concerned. She does not give too much personal information to websites for example. She would give personal information only to websites, she trusts and she is aware that her information could be misused. She wants to know who has access to her personal data, but she does not look for the information. She rarely checks the privacy policies, only if the websites are untrustworthy.

Trust in systems: She generally trusts systems, the ones that are on the market and do not have too many bugs. She would trust Windows or Word for example. She trusts a system until she sees that it does not work. She trusts the systems because she needs to use them, but on the other hand she is aware that the systems can fail.

(Social issues): She does not like to be contacted by strangers in general,

especially via e-mails and phone calls.

Automatic issues: She is sometimes annoyed when the system does things automatically (for example changing words from small to capital letters in Word). The system should ask for confirmations when it concerns deleting and any other unrecoverable actions. She likes having the Recycle Bin and storing the deleted files there, but she thinks that it is annoying to ask for confirmation before sending the files to the Recycle Bin.

UI-playfulness: She would like the UI to be a little fancy but not too much. She is a MAC user (Apple).

UI-feedback: She would like the system to give feedback when something fails, but it does not need to be in a dialog-box (the dialog-boxes can be annoying). The feedback can be given as some text somewhere on the screen or in the status bar, or by changing colours.

- User 3 – A female student in Environmental engineering, DTU, age – 31, nationality – Romanian, Fictitious User 2 (the same user as User 3 from the individual interviews for gathering needs).
- User 4 – A female Phd student in Telecommunications, DTU, age – 25, nationality – Bulgarian, Fictitious User 1 (the same user as User 1 from the individual interviews for gathering needs).
- User 5 – A male student in Electro Engineering, DTU, age – 22, nationality – Danish, Fictitious User 3 (the same user as User 15 from the individual interviews for gathering needs).

C.3.1 Identifying the user type of the user, who participated for the first time in user sessions

User #	Experience	Control demand	Privacy concern	Trust	Social issues (strangers)	Automatic actions	UI	Feedback
User 2 Fictitious User 3	High	High	High	Medium	No	Sometimes, mainly for simple actions	a little fancy but not too much	Sometimes, mostly in error situations.

Figure C.57: Identifying the user type of User 2

APPENDIX D

Physical design

This appendix presents the different screens of the hi-fidelity prototype, plan and guiding questions for the evaluation, an overview of the users, participated in the evaluation, as well as users' suggestions for changing and improving the prototype. The raw results from the user testing and the post-test questionnaires are given in Appendix E.

D.1 Electronic Flash prototype

This section presents screen shots from the electronic prototype of the statements based profile management application. When a certain screen of the application contains a lot of information, which cannot fit at the screen of the mobile device Nokia 770, a scrollbar is used. The scrollbar is not shown on the following screen shots, so the reader can have a better overview of the given information.

The screen shots are examples of different functionalities of the prototype, as well as they present the design decisions in the implementation of the prototype.

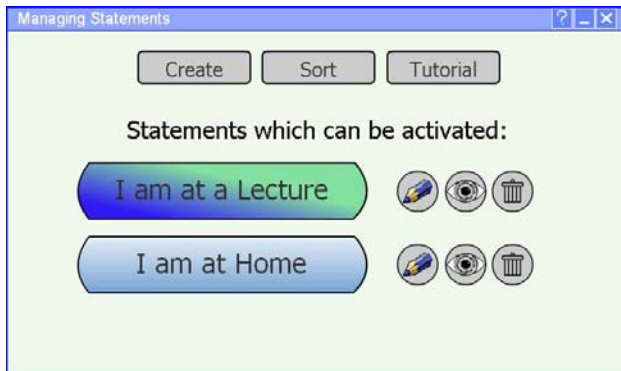


Figure D.1: Main screen – List of statements, where the statement ‘I am at a Lecture is active’ (E1.1-S Main.1)



Figure D.2: Main screen – Process of activating the statement ‘I am at a Lecture’ (E1.1-S Main.2)



Figure D.3: Main screen – Process of deactivating the statement ‘I am at a Lecture’ (E1.1-S Main.3)



Figure D.4: Main screen – Edit-button for the statement ‘I am at a Lecture’ (E1.1-S Main.4)



Figure D.5: Main screen – View-button for the statement ‘I am at a Lecture’ (E1.1-S Main.5)



Figure D.6: Main screen – Delete-button for the statement ‘I am at a Lecture’ (E1.1-S Main.6)

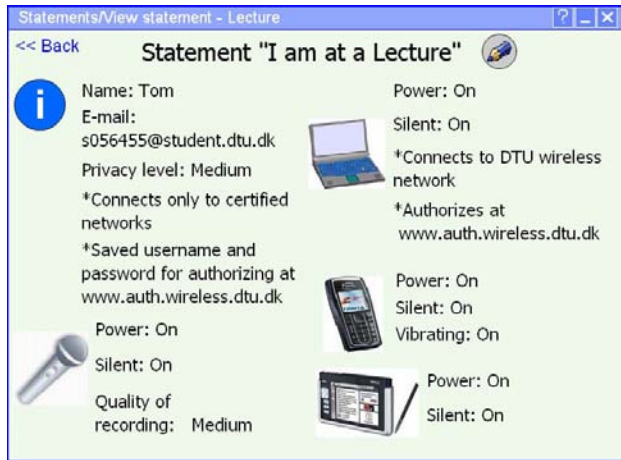


Figure D.7: Overview of the settings for a statement (after pressing the View-icon for the statement 'I am at a Lecture') (E1.1-S3)



Figure D.8: Confirmation message when the Delete-button for the statement 'I am at a Lecture' is pressed (E1.1-S4)

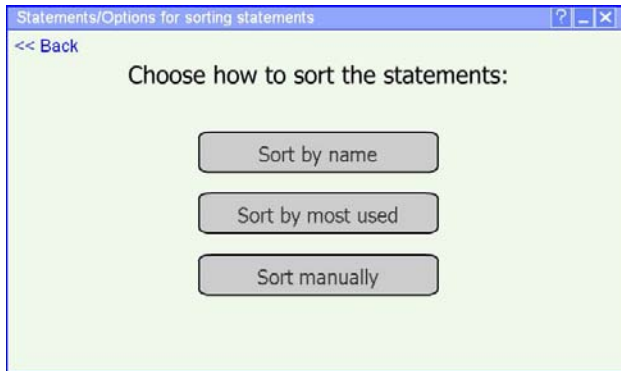


Figure D.9: Options for sorting the statements, shown when the button 'Sort' is pressed (E1.1-S5)



Figure D.10: Overview of the functionalities which are presented in the Tutorial, shown when the button 'Tutorial' is pressed (E1.1-S6)

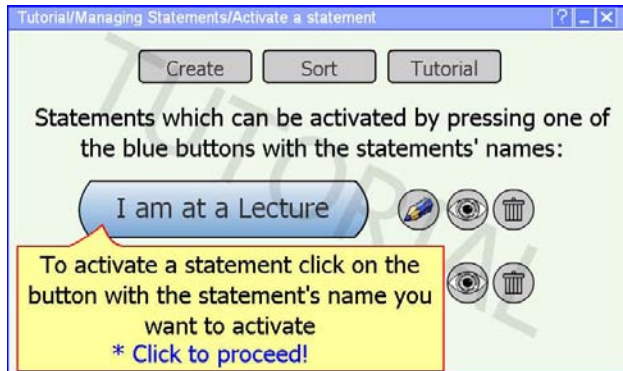


Figure D.11: Tutorial for activating a statement (first part), shown when the link 'Activate a statement' at the main screen of the Tutorial is pressed (E1.1-S6.1)

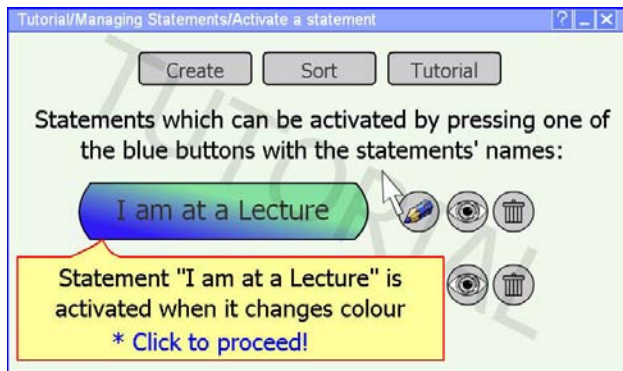


Figure D.12: Tutorial for activating a statement (second part), shown when the first 'Click to proceed' is pressed (E1.1-S6.3)

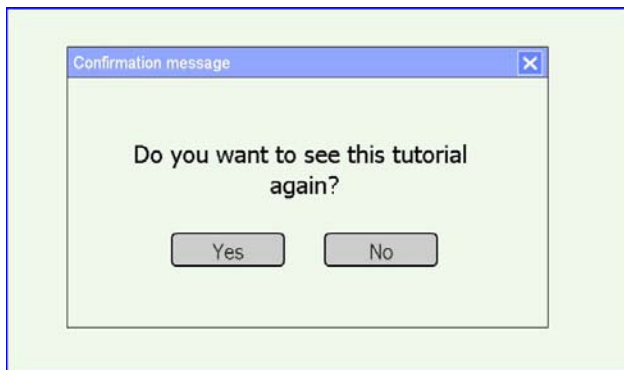


Figure D.13: Confirmation message for repeating the tutorial for activating a statement, shown when the last 'Click to proceed' is pressed (E1.1-S6.2)

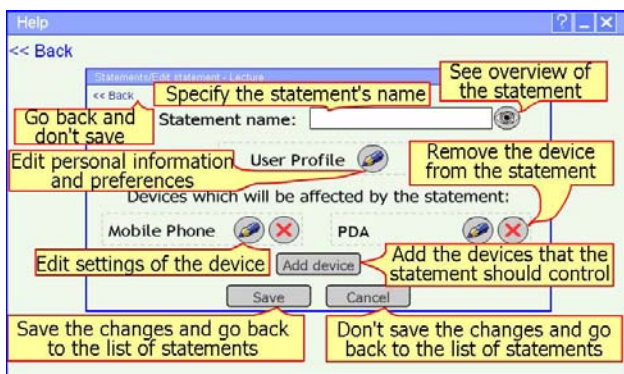


Figure D.14: Help for the screen with devices and user profile for the statement 'I am at a Lecture' (shown when the '?'-icon is pressed) (E1.1-S7)

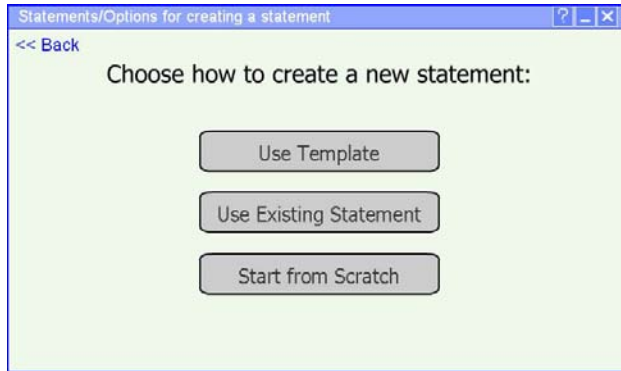


Figure D.15: Options for creating a statement, shown when the button 'Create' at the main screen is pressed (E1.1-S1)

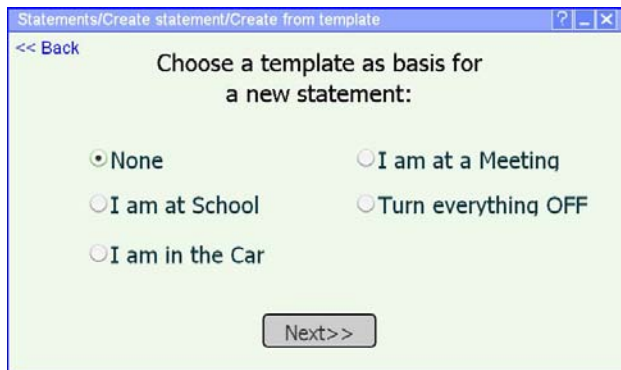


Figure D.16: List of templates, shown when the create option 'Use template' is selected (E1.1-S1.1)

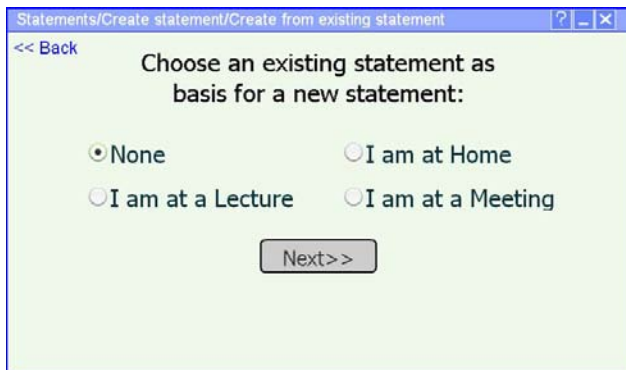


Figure D.17: List of existing statement, shown when the create option ‘Use existing statement’ is selected (E1.1-S1.2)



Figure D.18: List of devices and user profile for the statement, which is being created (E1.1-S2)



Figure D.19: List of devices and user profile for the statement 'I am at a Lecture' and Edit-button for a device (E1.1-S2.4)



Figure D.20: List of devices and user profile for the statement 'I am at a Lecture' and Remove-button for a device (E1.1-S2.5)

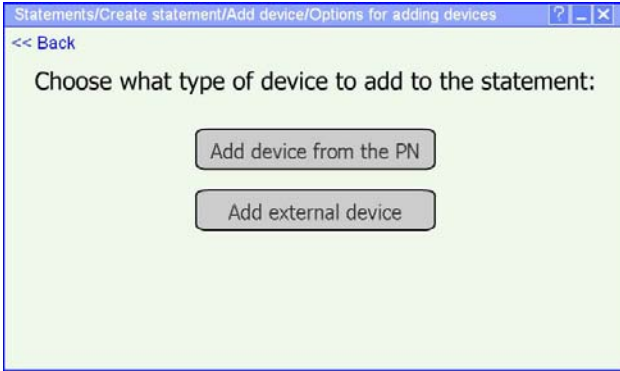


Figure D.21: Options for adding devices to a statement, shown when the button 'Add device' is pressed (E1.1-S2.1)

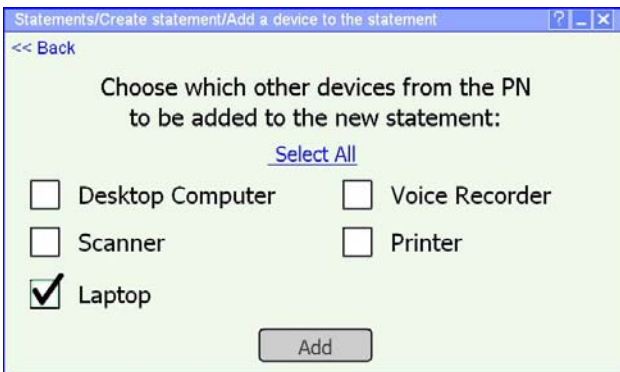
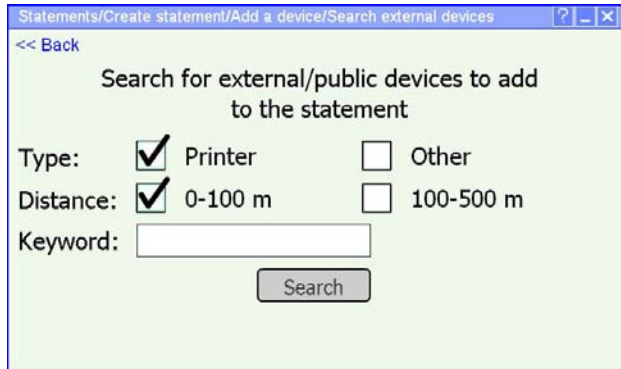


Figure D.22: Adding device from a Personal Network (E1.1-S2.1.1)



Statements/Create statement/Add a device/Search external devices

<< Back

Search for external/public devices to add to the statement

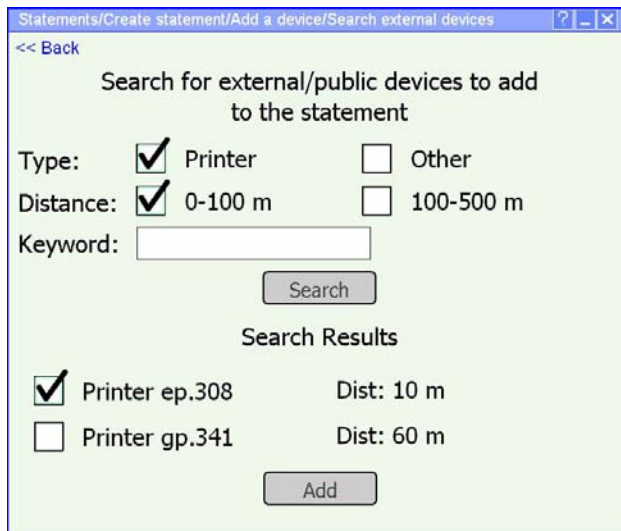
Type: Printer Other

Distance: 0-100 m 100-500 m

Keyword:

Search

Figure D.23: Searching for external devices to be added to a statement (E1.1-S2.1.2)



Statements/Create statement/Add a device/Search external devices

<< Back

Search for external/public devices to add to the statement

Type: Printer Other

Distance: 0-100 m 100-500 m

Keyword:

Search

Search Results

<input checked="" type="checkbox"/>	Printer ep.308	Dist: 10 m
<input type="checkbox"/>	Printer gp.341	Dist: 60 m

Add

Figure D.24: Search results with the found external devices, which can be added to statement (E1.1-S2.1.3)



Figure D.25: Confirmation message for removing a device from a statement, shown when the Remove-button for the device is pressed (E1.1-S2.6)



Figure D.26: List of active settings for Mobile phone, when creating a statement (E1.1-S2.2)



Figure D.27: List of active settings for PDA, when creating a statement (E1.1-S2.7)



Figure D.28: List of active settings for Laptop, when creating a statement (E1.1-S2.3)



Figure D.29: List of programs, which can be chosen when pressing the ‘+’ at the Laptop-screen (E1.1-S2.3.1)

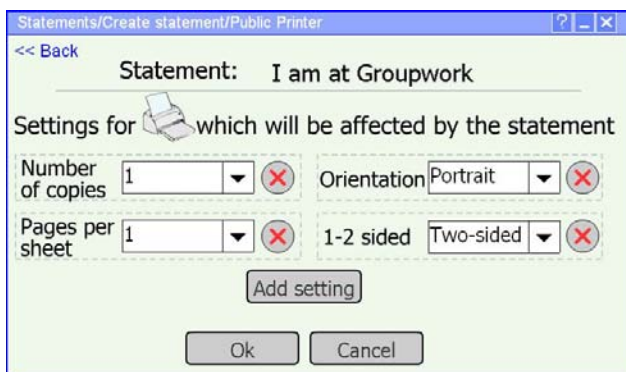


Figure D.30: List of active settings for an external printer, when creating a statement (E1.1-S2.8)



Figure D.31: List of active settings for Mobile phone, when editing the settings of the statement 'I am at a Lecture' (E1.1-S8.2)



Figure D.32: List of active settings for Laptop, when editing the settings of the statement 'I am at a Lecture' (E1.1-S8.3)



Figure D.33: List of active settings for Voice recorder, when editing the settings of the statement 'I am at a Lecture' (E1.1-S8.4)

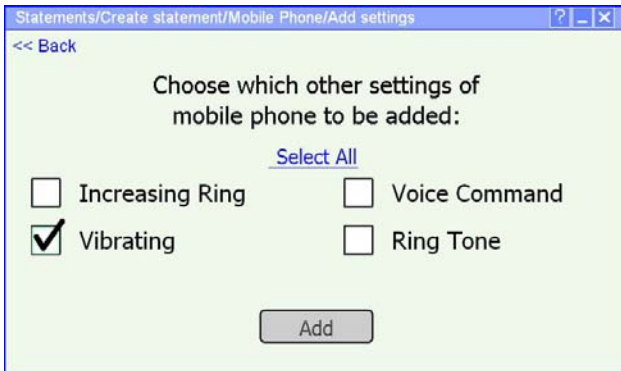


Figure D.34: Adding a setting to a device, which will be affected by the statement (E1.1-S2.2.1)

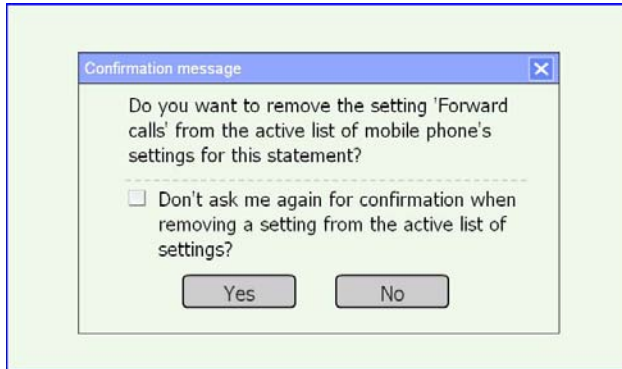


Figure D.35: Confirmation message for removing a setting from a device for the statement, shown when the Remove-button for the setting is pressed (E1.1-S2.2.2)



Figure D.36: Possible User profile information, when creating a statement (E1.1-S2.9)

Statements/Create statement/User Profile

<< Back

Statement: I am at Groupwork

Personal Information

Use the general profile in the system

Name (identity)

E-mail:

Address:

Phone Number:

Security and Privacy Preferences

Ok Cancel

Figure D.37: Selecting the option to use the general user profile in the system in the statement, when creating the new statement (E1.1-S2.9.1)

Statements/Create statement/User Profile/Privacy and Security

<< Back

Statement: I am at Groupwork

Security preferences

Only connect to certified networks

Log all network activities

Authorization information for DTU networks

User name Password

Privacy preferences

Privacy levels Don't share personal information

Ok Cancel

Figure D.38: Security and Privacy preferences, when creating a statement (E1.1-S2.9.2)

Statements/Edit statement - Lecture/User Profile

<< Back

Statement: I am at a Lecture

Personal Information

Use the general profile in the system

Name (identity) Tom

E-mail: s056455@student.dtu.dk

Address:

Phone Number:

Security and Privacy Preferences

Ok Cancel

Figure D.39: Possible User profile information, when editing the user profile for the statement ‘I am at a Lecture’ (E1.1-S8.1)

Statements/Edit statement - Lecture/User Profile/Security and Privacy

<< Back

Statement: I am at a Lecture

Security preferences

Only connect to certified networks

Log all network activities

Authorization information for DTU networks

User name s056455 Password *****

Privacy preferences

Privacy levels Medium Low Medium High

Share personal information with people in my contacts

Cancel

Figure D.40: Editing the security and privacy preferences for the statement ‘I am at a Lecture’. Options for ‘Privacy levels’. (E1.1-S8.1.2)

D.2 Plan and guiding questions for the evaluation of the physical design

This section presents the structure of the evaluation and the questions which are used to guide the evaluation process. The physical design evaluation process includes identifying the user type, presenting the concepts of PN and statements, giving tasks to the user and asking them additional questions in order to find out if they understand the prototype and how it could be made better.

Evaluation plan

Introduction to the overall evaluation process and asking the user if he/she gives permission for recording and taking pictures during the evaluation session.

D.2.1 Interview for identifying the user's type

Age

Gender

Occupation

1. (*Technology*) Do you feel comfortable to use different types of technologies computers, PDAs, mobile phones? (Do you consider yourself experienced in using computers, mobile devices?)
2. (*Technology*) When you buy a new device or install a new program do you check the default settings and apply new ones?
3. (*Control*) Do you want to be in control in general when interacting with a system? (Do you need to know what is happening with the system all the time? Do you need to confirm all the steps the system takes or you have some trust in the system?)
4. (*Privacy and sharing*) What is your attitude to privacy? Are you privacy concerned?
5. (*Privacy and sharing*) Are you interested to know who has access to your data?
6. (*Trust in systems*) Do you have trust in systems in general? (Do you trust that the system is reliable, stable and it works correctly?)
7. (*Social issues*) What is your attitude to strangers? (Do you like to be contacted by strangers?)

D.2 Plan and guiding questions for the evaluation of the physical design**311**

8. (*Automatic issues*) Do you like when the system performs some actions automatically, without asking for confirmation?
9. (*UI-playfulness*) Should the interface be playful? Should it be fancy or plain?
10. (*UI-feedback*) Do you prefer the system to provide feedback about what has been done or what has failed? In which situations?

Introduction to the concepts of PN and statements

Evaluation of the electronic Flash prototype

- Explaining how the evaluation process will be performed to the users.
- The user is also asked to think aloud or to say what he/she thinks so the evaluator will be able to follow the different steps and actions the user performs to solve the task.

D.2.2 Script for user testing of the electronic prototype of the “Statements based profile management application” – tasks given to the user

The script with the tasks is presented in Section 7.3.

D.2.3 Actions necessary to complete the tasks and success criteria

Task	Actions to perform the task	Success criteria
1	Press the View-icon (eye) of “I am at a Lecture” at the main screen.	The View-screen of “I am at a Lecture” is shown.
2	Press the statement button “I am at a Lecture” at the main screen.	The button “I am at a Lecture”. changes colour.
3	<ul style="list-style-type: none"> - Press Create; - Choose one of the create options; - Write down the statement name; - Press Add device → Press Add device from PN → Check Laptop → Press Add; - Press Add device → Press Add external device → Check Printer and 0-100m → Press Search → Choose and check a printer → press Add; - Press the Edit-icon for user profile → Give information → Press Security and Privacy preferences → Choose settings → Press Ok → Press Ok at user profile; - Press the Edit-icon for Mobile phone → Set the Power and Silent settings → Press Add setting → Check Vibrating → Press Add → Remove answering mode and forwarding calls settings → Press Ok; - Press the Edit-icon for PDA → Set the Power and Silent settings; - Press the Edit-icon for Printer at DTU → Set the settings; - Press the Edit-icon for Laptop → Set the Power and Silent settings → Select ‘DTU’ for Connect to Wireless network → Check Authorize at auth.wireless.dtu.dk → Press ‘+’ to choose programs → Press Ok; - Press Save at the list with devices; 	The new statement is shown in the list of statements.
4	Press the Edit-icon (pencil) of “I am at a Lecture” and change settings of the devices.	The Edit-screen of “I am at a Lecture” is shown.
5	Press the Delete-icon (bin) of the statement “Groupwork” and press Yes at the next window.	The statement “Groupwork” disappears from the list of statements.
6	Press the button Sort and choose how the statements should be sorted.	The statements are sorted in the selected way.

Table D.1: Actions to perform the tasks

D.2 Plan and guiding questions for the evaluation of the physical design³¹³

D.2.4 Post test questionnaire for evaluating usability and user interface satisfaction

1. Rate the design by using the given scales below. For each pair of adjectives, put a cross at the point between them that reflects how they describe the design according to you.

Difficult to use						Easy to use
Inefficient						Efficient
Difficult to learn						Easy to learn
Unhelpful						Helpful
Inconsistent						Consistent
Not secure						Secure
Outdated						Modern
Annoying						Pleasing
Bad User Experience						Good User Experience

Table D.2: Rating of the design

2. Do you think that your expectations about managing settings of devices at your PN are met?

Yes No Some of them

3. What are the good things about the application interface?

- _____
- _____
- _____
- _____

4. What are the bad things about the application interface?

- _____
- _____
- _____

- _____

5. Was it easy to understand what you need to do to set your devices and user profile?

- Yes No In some cases

6. What is missing at the interfaces?

- _____
- _____
- _____
- _____

7. Would you use the application?

- Yes No Maybe

8. Do you think that the application would help you in your study process somehow?

- Yes No Maybe

9. Do you understand what the icons are used for?

- Yes No In some cases

10. Would you prefer icons than using text?

- Yes No In some cases

11. Does it make sense to have helpful text for the icons when the pen hovers over the icon, even though it does not work exactly as at the computer and it might be shown when the action is performed?

- Yes No I don't know

12. Are the names of headings, buttons, text-messages clear and meaningful?

- Yes No In some cases

D.2 Plan and guiding questions for the evaluation of the physical design

13. What do you think about the font and the font size of the characters – is it easy to read the characters at the screen?

- Yes No In some cases

14. Do you prefer the screens to have a scroll bar instead of “click-next-screen” solution?

- Yes No In some cases

15. Do you like the colour scheme?

- Yes No In some cases

16. Would you prefer to use the single sign-on concept (or logging in once at the mobile device), instead of having a log-in screen for the application?

- Yes No I don't know

17. Do you have some other comments about the design or the functionalities of the prototype?

- _____
- _____
- _____
- _____

D.2.5 Quantitative performance measured during the test

- Time to complete a task
- Number and type of errors per task
- Number of users making a particular error
- Number of users completing a task successfully

Task #	Press Help/Tutorial	Ask for help	Make error	The user finds something annoying	The user is confused	Completing the task	Mean Time [min]
1							
2							
3							
4							
5							
6							

Table D.3: Coding/Helpful sheet for taking notes

D.3 Overview of the users, who participated in the evaluation

- User 1 – A female Phd student in Maritime section of MEK, DTU, age – 24, nationality – French, Fictitious User 1 (the user has not participated in the interviews, the workshop for gathering needs or the evaluation of the conceptual design).

Technology: She feels comfortable to use computers and mobile phones, because she uses them every they. But she has not used PDAs and that is why she is not experience in using them. She checks the default settings of new programs and devices.

Control: She would like to be in control when interacting with systems. She wants to know how the things work, because in this way if there is an error she will easier be able to find out what is wrong. She does not always know how the things work – it depends on the situation.

Privacy and sharing: She is privacy concerned. She gives personal information to websites only when it is secure or when the information is not going to be made public. She is interested to know who has access to her information. She reads the privacy policies of the websites.

Trust in systems: She says that there is always something that goes wrong with systems. That is why she does not trust the systems fully.

(Social issues): She does not like to be contacted by people, who she does not know, without a meaningful reason.

Automatic issues: She prefers to confirm the actions a system does in order to know what has been activated. That is why she does not like the system to perform the actions automatically or at least not all the time.

UI-playfulness: She prefers the interface to be clear. It does not matter if the interface is fancy or not, as long as it is easy to understand what the user can do and to be easy to use.

UI-feedback: She prefers the system to give feedback in error situations when something fails. In this way she would know what works and what not.

- User 2 – A male master student in Communication Engineering, RWTH – Aachen, Germany, age – 26, nationality – Bulgarian, Fictitious User 3 (the user has not participated in the interviews, the workshop for gathering needs or the evaluation of the conceptual design).

Technology: He feels very experienced in using computers, PDAs and mobile phones.

He checks the default settings of new programs and devices and most of the time he changes them. He does not use the default settings without seeing what they are.

Control: He does not want always to be in control. It depends on the system. It is better when the system supports the user without asking all the time ‘Do you want to do that?’. He does not need to confirm all actions.

Privacy and sharing: He is privacy concerned. He does not give too much personal information to websites and if they use his information, they should at least inform him. He does not read privacy policies, because he knows what is usually written in them.

Trust in systems: He does not trust systems in general. By trust he means how much he needs to confirm the system’s actions. It would be better if the systems are more customer-oriented and not to ask the user too much. There should be a balance when it is needed to confirm and when not to.

(Social issues): He does not mind talking to people, who he does know at a party, but he does not like to be contacted by strangers via e-mail, phone, etc.

Automatic issues: He does not always want the system to perform actions automatically. Simpler actions as updating the time and the date, for example, can be performed automatically.

UI-playfulness: The perfect interface for him has to be adjustable to the user or at least having the option to customize the interface by saying ‘I am a beginner’ or ‘I am an advanced user’. It is important for him that the interface is functional so the user can perform the necessary tasks with it. So it does not matter if it is fancy or black and white.

UI-feedback: He prefers the system to give feedback, but he wants to specify in which situations the feedback should be given. He wants to receive feedback when there are errors or at least fatal errors.

- User 3 – A female Phd student in Telecommunications, DTU, age – 25, nationality – Bulgarian, Fictitious User 1 (the same user as User 1 from the individual interviews for gathering needs and User 4 from the evaluation of the conceptual design).
- User 4: A male Phd student in Cellular and molecular biology, DTU, age – 25, nationality – Turkish, Fictitious User 1 (the same user as User 12 from the individual interviews for gathering needs).
- User 5 – A male student in Informatics, DTU, age – 23, nationality – Danish, Fictitious User 3 (the same user as User 5 from the individual interviews for gathering needs and User 1 in the evaluation of the conceptual design).
- User 6: A female student in Software Engineering, DTU, age – 23, nationality – Danish, Fictitious User 3 (the same user as User 10 from the individual interviews for gathering needs).
- User 7: A female student in Environmental engineering, DTU, age – 31, nationality – Romanian, Fictitious User 2 (the same user as User 3 from the individual interviews for gathering needs and User 3 in the evaluation of the conceptual design).
- User 8: A male student in Computer Engineering, DTU, age – 25, nationality – Polish, Fictitious User 3 (the same user as User 7 from the individual interviews for gathering needs and User 1 in the workshop for gathering needs).
- User 9: A female student in Biotechnologies, DTU, age – 24, nationality – Polish, Fictitious User 1 (the same user as User 8 from the individual interviews).
- User 10: A male student in Electro Engineering, DTU, age – 22, nationality – Danish, Fictitious User 3 (the same user as User 15 from the individual interviews for gathering needs, User 5 in the workshop for gathering needs and User 5 in the evaluation of the conceptual design).

D.3.1 Identifying the user type of the users, who participated for the first time in user sessions

D.4 Users' suggestions for improving the design

Area	Suggestion
General	'Create', 'Sort' and 'Tutorial' should be at the bottom of the screen.
General	There should be written text under or above the icons, which explains what they do.
General	The icons for the actions which can be performed for each statement can be replaced with the button 'Option', which opens a menu with the options for editing, viewing, deleting and help. In this way, it will be easy to add more options, for example 'Rename'
General	The icons for editing and removing a device/setting can be replaced by buttons with just text.
General	There should be an option 'My first visit/tour' for the users who use the application for the first time, so they can be provided with more help.
General	Icons/images can be used for the devices for a statement, instead of text.
General	The statement name, displayed for the screens for the devices should be smaller.
General	The headings for the screens with settings of the device should be renamed to 'Affected settings' in order to make it shorter.
General	The settings should be saved when selected, without need of pressing 'Ok' (as it works on Mac applications).
Activating a statement	There should be a message on the screen, saying which statement is active at the moment, or alternatively marking the active statement with a 'check'.
Activating a statement	The user should be asked for confirmation when activating a statement with giving the options 'Yes', 'No' and 'Help', as well as the option 'Don't ask again'.
Activating a statement	By default the active statement should be on the top of the list of statements, so the user can see it without scrolling.
Activating a statement	There should be a default statement with default settings, which can be used when all specific statements are deselected. In this case there will be always one statement which is activated.

Table D.4: Users' suggestions – Part 1

Area	Suggestion
Activating a statement	Applying the settings when activating a device, can take some time. This is why during the activating, a progress bar can be shown to inform about the progress. The statement-buttons itself can be the progress bar.
Creating a statement	The button 'Create' should not be given as a separate button, but as a statement-button together with the statements.
Creating a statement	The statements can be organized in a rotating menu as in Windows Vista, where one of the options can be to create a new statement.
Creating a statement	The option 'Start from scratch' should be renamed with for example 'Start with empty group' or 'Start empty'.
Templates	There should be information about which devices are included in each template.
Templates	The option not to select a template (or 'None') should not be present.
Templates	The templates can be defined as a certain set of device, for example a Mobile phone and a PDA can be one template. Alternatively the user can be given a list of devices to create his/her own template, as he/she selects the needed ones with their default settings.
Searching public device	The options for giving 'Distance' for search criteria for a device should be replaced with the option 'Find the nearest one'.
Searching public device	The results from searching an external device should not be displayed in the same screen, but in another pop-up screen.
Public/ External devices	There should be a notification if a certain external device from a statement is still there and is ready to use. If the device is present on the list, it should mean that the device is there. If the device is disconnected or 'OFF', a pop-up message should show up to inform that the device is lost and the device should disappear from the list.
Laptop settings	The name of the setting 'Silent' for Laptop should be replaced with 'Mute'.

Table D.5: Users' suggestions – Part 2

Area	Suggestion
Laptop settings	There should be an option for searching wireless networks (or a button 'Search' present next to 'Connect to wireless network').
Laptop settings	The specific option 'Authorize at auth.wireless.dtu.dk' should be replaced with 'Automatic authorization' or 'Authorize at start-up'.
Laptop settings	When the programs, which would be started when activating a statement, are selected, they should be shown on the screen with settings.
User Profile	'User profile' should be replaced with 'User/Personal information'.
User Profile	The default setting for 'User profile' should be the option 'Use the general profile in the system'.
Security and Privacy Preferences	There should be a section/button 'Authorization' at the screen for 'Security and privacy preferences', where the needed information for authorization for different networks should be provided.
Security and Privacy Preferences	The access to 'Security and privacy preferences' should be at the same level as 'User profile', or accessed from the screen with devices and user profile.
Removing settings	The Remove-option for the settings of devices can be included at the end of the drop-down menu for the settings, instead of using the icon.
Deleting a statement	The user should always be asked for confirmation when deleting a statement (or the option 'Don't ask me again' should not be present).
Adding settings	The option 'Add setting' should be renamed to 'Available settings'. When it is pressed, it should show all possible settings with check-boxes, as the ones that have already been included for the device, should be checked.
Adding settings	All possible settings for a device should be at one screen. If there are too many settings, they could be grouped, for example 'Call settings', 'Answering settings'. When a group is selected, a new window opens with the group settings.

Table D.6: Users' suggestions – Part 3

Area	Suggestion
Viewing a statement	The functionality for seeing an overview of a statement should be renamed from 'View' to 'Details' or 'Settings'.
Viewing a statement	The information for the different devices at the View-screen should be separated by using a border.
Viewing a statement	It should be possible to edit the settings from the View-screen.
Sorting statements	There should be an option 'Sort by feature' in order to sort for example by all statements that have a mobile phone on silent mode.
Sorting statements	The statements should be sort by the most used ones by default.
Sorting statements	There should be an option for sorting 'by date of creation' and 'by last modified'.
Sorting statements	There should be a Search-field where the user can write part of the statement name. While writing, a list of the statements, containing the written letters should be shown. When writing more letters the list becomes smaller.
Sorting statements	There should be an option to save the sorting order when the statements are sorted manually.
Tutorial	The '*Click to proceed' at the last screen of the movie-clip for a certain tutorial (functionality) should be renamed to '*Click to finish'.
Tutorial	The user should not be asked if he/she wants to see the tutorial again for the certain functionality, if he/she has just seen it. Instead the user should be returned to the main page of the tutorial.
Tutorial	The user should be able to see/read the whole tutorial from the beginning to the end in case the user does not know what to look for.
Tutorial	The tutorial can be divided in chapters, for example 'Introduction', 'Statements', 'Devices', 'Settings'.
Help	The help can be organized in a way, so when the '?'-icon is pressed a message 'Please click on an element at the screen in order to see additional information' is displayed. When an element is clicked, a yellow remark/bubble is shown for the corresponding element.

Table D.7: Users' suggestions – Part 4

User #	Experience	Control demand	Privacy concern	Trust	Social issues (strangers)	Automatic actions	UI	Feedback
User 1 Fictitious User 1	Medium (experience in using computers and mobile phones but not PDAs)	High, but she does not always know the things work	High	Medium	No	Sometimes most of the times she would like to confirm the actions	clear, easy to use	Sometimes, especially in error situations
User 2 Fictitious User 2	High	Medium - the system should support the user	High	Low	No	Sometimes only simple actions, interfere which can be customized	interfered which can be customized	Sometimes mostly in error situations

Figure D.41: Identifying the user type of User 2

APPENDIX E

Raw Results From the Individual User Sessions

- E.1 Individual Interviews for Identifying User Needs and Establishing Requirements
- E.2 Conceptual Design Evaluation
- E.3 Physical Design Evaluation
- E.4 Previous Versions of the Requirements Specification

CD Contents

The following files have been handed in on a CD together with the thesis:

- **MasterThesis_s041373.pdf** – The report, documenting the master thesis.
- **AppendixE.pdf** – A document containing the raw results from the individual user sessions.
- **electronic_prototype fla** – The Flash source file for the developed electronic prototype.
- **electronic_prototype.swf** – The compiled Flash file of the application.
- **electronic_prototype.html** – The html file, which uses the compiled Flash file (swf-file). It can be used to see the application in a browser.

