Final Report

INF5261

Development of mobile information systems and services

Autumn 2017

BBall StatS

The basketball player statistics system

By Håkon Råen, Linett Simonsen and Kim Urdahl-Aasen

20.11.17

UNIVERSITY OF OSLO

TABLE OF CONTENTS

1. INTRODUCTION

1.1 Group members

Our group consists of Håkon Råen, Linett Simonsen and Kim Urdahl-Aasen. Håkon and Linett attend the master program in Informatics: Design, Use, Interaction, where they are both in their first semester. Kim is taking the course as a single module student.

1.2 Aim

The main objective of this project is to study the transition from paper documents into digital applications. Our aim is to develop a prototype of a mobile application *(app)* that can work as a basketball player statistics system. The question is whether it is possible to make an application for more consistent and reliable data recordings, which additionally can make it easier to present and analyze the data after a game.

1.3 Project motivation and idea

Basketball is a sport where a lot of statistics are written down in every game to better understand how the players perform, and in which part of the game the team needs to improve. This improvement can either be done by letting the players switch player positions, or making existing players do more training on what they are not performing on. To log data the team usually have someone writing down stats by the sideline while the game is on. In professional basketball video recordings are being used to secure the credibility of the statistics, but in the amateur-segment, ranging from kids league to lower division adult teams, it is necessary to get the statistics correctly at game speed.

1.4 Research question

Our key research question is as follows:

- How do we transform a paper based system into a digital application?

In order to refine the scope, we have chosen logging and use of data in basketball games as a case, with a focus on how data is gathered.

To answer our key research question we will also take into consideration:

- What are the advantages of paper documents?
- In what way can we add value to the current system?
- What can potentially be lost in the digitalization process?

1.5 The users

In this project we have decided to divide our user group into three categories of users; primary, secondary, and tertiary (Eason, 1987). Primary users are the users expected to use the system or artifact frequently; secondary users are the ones expected to use the system or artifact occasionally or to use it through an intermediary; and tertiary users are those who will

be affected by the use of the system or artifact, or those who will make decisions about its purchase (Sharp et al., 2007).

1.5.1 Primary user - The statistics gatherer

The statistics gatherer is the person using the application to gather the array of actions which happens during a basketball match.

1.5.2 Secondary user - The statistics analyst

The statistics analyst is the person who reads the statistics after it is gathered and presented in a readable fashion. The statistics analyst might be a player wanting to see how he/she performed during a game, or a team coach/manager who wants to check the performance of a specific player, or the team as a whole.

1.5.3 Tertiary user - The administrator or observer

The person or group responsible for the acquisition of the application or players and fans who are not using the application, but is still included in the statistics.

1.6 How to investigate

We have planned to have a user-centered design (UCD) process, and we will develop our project in accordance with the usability engineering lifecycle model, ISO 9241 (International Organization for Standardization [ISO], 2010). To identify the user needs, specify the context of use and the requirements, we will start the data gathering early in the design process. Later on we will focus on producing and evaluating different design solutions. UCD is an iterative development process, but due to a restricted amount of time, we will have to limit the number of iterations.

1.7 The project process

To gather data we conducted an observation and performed an interview. Later we analyzed and interpreted the data we had collected. We also conducted a literature review, since we wanted to learn more about our problem area, and draw inspiration to take into our own project. In addition to this, we did a review on similar applications. The purpose was to make better decisions on what to focus on, and make sure that our prototype did not try to address needs that are already covered by other applications.

By evaluating our data collection, we derived a list of requirements, and based on these requirements, we designed and evaluated suited prototypes. A *prototype* can be described as “any representation of a design idea, regardless of medium” (Houde and Hill, 1997) or a “limited representation of a design that allows users to interact with it and explore its suitability” (Preece et al., 2002, p. 241). To establish the user needs and requirements we had to be aware of the user context. The first prototype we created was a low-fidelity prototype, a prototype made out of paper, and we used it to test specific parts and elements of the design with our primary user group. We then analyzed the results and started the development of a

high-fidelity prototype, defined as an interactive prototype with complete functionality (Rudd et al., 1996). Our aim was to make a prototype that looked and felt as close to the final thing as possible (Preece et al., 2002, p. 245), but due to time limitations, we couldn't prioritize implementing complete functionality. Our plan was to evaluate the high-fidelity prototype by conducting a usability test, i.e. "evaluating a product or service by testing it with representative users" (U.S. Dept. of Health and Human Services (HHS), 2006), to identify any usability problems, collect qualitative and quantitative data and to determine the participant's satisfaction (HSS, 2006). Unfortunately, because of some problems completing the high fidelity prototype in time for the scheduled basketball match, we had to postpone this evaluation session.

1.8 Report structure

As an introduction, we will briefly introduce some theory related to our research question, followed by a structured review on different kinds of applications that are used for logging and use of activity data. After this we will describe the methods we used for gathering data, what we found out, and how we analyzed the data we collected. We will also have a section where we describe our prototypes, how we designed them, and how we evaluated the low-fidelity prototype. Even though we didn't evaluate our high-fidelity prototype, we will have a section where we briefly describe how we planned to conduct it. We will then have a section regarding our project in relation to universal design, i.e., "the design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design" (The Center for Universal Design, 1997). After this we will have a section where we discuss our research question, and where we will try to make a connection between our own findings and the findings from similar studies. We will finish our report with a brief summary of our work, followed by a conclusion. In this section we will also mention the limitations of our project, and an outlook for possible future work.

2. LITERATURE REVIEW

According to Cambridge Dictionary, a *mobile device* is any piece of electronic equipment such as a mobile phone or small computer that you can use in different places (Cambridge University Press, 2017). On mobile devices, such as smartphones and tablets, the users can install different applications according to their needs. *An application* (app), a shorter form of application program, is mainly a program designed to perform a specific function directly for the user (TechTarget, 2007).

In the article "Using While Moving: HCI Issues in Fieldwork Environments", Pascoe et al. (2000) examine the special needs and environment of the fieldworker, reflecting on the human-computer interaction (HCI) features required for a successful personal digital assistant (PDA) for use in the field. Minimal-attention user interfaces (MAUIs) and context awareness are two general principles that are discussed regarding the development of devices for use in extremely mobile and dynamic workplaces. The most common form of fieldwork carried out

is data collection, and according to Pascoe et al., the unique nature of mobile usage requirements within this context can be identified by four characteristics; dynamic user configuration, limited attention capacity, high-speed interaction and context dependency. Some mobile devices require the direct attention of the user for the whole duration of a particular task. During this time all of the user's attention is focused on the screen, and in a fieldwork environment this distracting process can negatively affect the data quality. The MAUI seeks to minimize the attention, though not necessarily the number of interactions required from the user in operating a device. A MAUI attempts to shift the interaction to unused channels or senses, and in that way take less of the user's attention away from their current activity. Context awareness enables the mobile device to provide assistance based on a knowledge of its environment.

In the article "BlindSight: Eyes-Free Access to Mobile Phones", Li et al. (2008) present a prototype called *blindSight*, an application that replaces the traditionally visual in-call menu of a mobile phone. Users can interact with the application using the phone keypad, without looking at the screen, since the visual interface is replaced with one based on auditory feedback. The application also responds with auditory feedback, but this feedback can only be heard by the user. In this way users can get eyes-free access to the content on their phones.

Mangset (2014) is in the article "Designing for acute stress in emergency situations" examining the effects of stress on human performance in an avalanche rescue scenario and how an avalanche transceiver interface can be designed to account for stressful situations. Some guidelines for the interface are presented covering areas as physical ergonomic features, redundancy, graphical user interface, information acquisition and human error. According to Mangset, it is important that both the device and the controls should fit the body part that is to operate it. It should for instance be possible to operate the transceiver with one hand only, left or right, since this would be desirable in a searching situation. Redundancy refers to repetition of content in a different format, and an avalanche transceiver should provide redundancy in form of both visually, auditory, and tactile feedback. Auditory feedback should be provided while the device is in search mode since the user then is likely to be looking around, and not directly at the display. The amount of information that an individual is able to acquire in a given scenario tends to decrease with the demand of the situation. The amount of information provided in an interface should therefore be minimized, and since attention is impaired under stress, all unnecessary information should be avoided. According to Mangset, the graphical user interface should follow basic principles of layout, and the most important elements should be centred in the display. Elements should be arranged after how frequently they are used, grouped after the function they represent. Because the user is going to move around while using the device, the display should have a high level of glance legibility. Color coding of display elements can be used to draw attention to specific data and aid a faster uptake of information. To reduce human errors, controls should be labelled and arranged in a way that prevents accidental activation. Redundancy should be used to give feedback on any input. The design guidelines provided by Mangset in

this article do not account for how individual differences in various human abilities under stress affect performance. When designing an avalanche receiver, disparities in skills should also be taking into consideration. To address these issues, Mangset states that having different transceivers with different interfaces and functionality could be an option.

In the article “Designing Mobile Devices for Extreme Work Environments Challenges and adequacy of interaction methods”, Håland (2010) presents an overview of different challenges in extreme environments. The article also presents a review of various interaction alternatives, and a discussion on how the different challenges affect interaction. According to Håland, designing mobile devices for extreme work environments can be challenging in many ways. In the article, Håland presents three main areas of challenges to consider when designing mobile devices for extreme work; limited attention and/or visual capacity, possible limitations in cognitive performance and reduction in manual dexterity, precision, and/or mobility. Håland concludes that when attempting to design an adequate interface for mobile devices in extreme environments, audio output and feedback, speech input and Heads-Up-Displays (HUDs) need to be implemented to a larger extent, in combination with more traditional interaction methods. Since the conditions in different extreme work environments varies, it is crucial to analyze the specific work context and identify the challenges and their effect on interaction in the design process, either by doing observations and/or conducting interviews. Interaction alternatives must be chosen carefully to make the design suitable for the specific environment it will be used in.

Luff and Heath (1998) addresses in the article “Mobility in collaboration” the issue regarding the requirements to support mobility within collaboration activities. By examining three different settings, each with differing technological support, Luff and Heath examine the ways in which mobility is critical to collaborative work. In the article, Luff and Heath reconsider the introduction of computer based records into the medical consultation, and explore how the technology has undermined the ecological mobility of traditional, paper records. Luff and Heath explore the range of ways in which the mobility of a simple paper document is critical to the work and communication of the medical practitioner. The document, a medical record for use in primary health care, is increasingly being enhanced and replaced by computerised records. According to Luff and Heath, paper records have some advantages compared to computerized records; they are handleable, manipulable, portable, dismantlable and can easily be reordered and reassembled for particular purposes, and these are critical features of the ways in which such document supports the work and interaction between colleagues, and colleagues and their clients. As a conclusion, Luff and Heath state that when mobile technologies are being developed to support collaborative work, it may be necessary to explore in more detail how objects are used in interaction. It may also be necessary to examine the forms of work where the mobility of participants is critical, so that mobile devices can be shaped to fit the local demands of the participants in the setting.

3. REVIEW OF SIMILAR APPLICATIONS

3.1 Easy Stats

+ Easy to get started.
+ Free (pay for extra functionality).

- Only available on IOS (IPad).
- A lot of different screens.
- Confusing UI.

Figure 1: Screenshot of the Easy Stats interface.

3.2 Basketball Stats PRO

+ A lot of functionality.
+ Big on customization.

- Only available on IOS (IPad).
- Expensive.
- Complicated.

Figure 2: Screenshot of the Basketball Stats PRO interface.

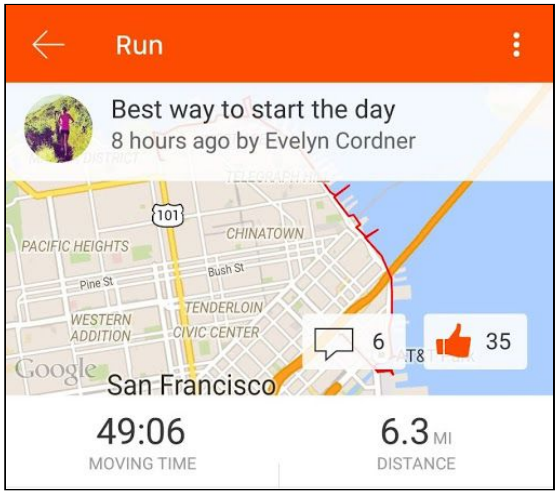
3.3 Håndball Statistikk (Handball Statistics)

+ Attractive User Interface.
+ Easy to use.
+ Works on phones and tablet.

- Only available on Android.
- No export functions.

Figure 3: Screenshot of the Håndball Statistikk interface.

3.4 Strava



+ Social network where users can compete with each other (cycling, running and swimming).
+ Users can challenge themselves to increase performance.
+ Support several platforms.
+ Free (non-premium version).

- If you are not into competition with your workout, this is not the app for you.

Figure 4: Screenshot of the Strava interface.

3. METHODS

In the early phase of the project we used a triangulation of methods to gather data regarding the needs and expectations of users. Triangulation is a strategy involving the use of more than one method in the study of a phenomenon (Taylor et. al., 2006). To capture descriptive data regarding user needs, we decided to conduct an interview, since this is an adequate method for this purpose (Lazar et. al., 2010). According to Håland (2010), it is crucial in the design process to analyze the specific user context and identify the challenges and their effect on interaction, so in addition to the interview, we also conducted an on-site observation.

3.1 Observation

We conducted an observation of a basketball game to gather both qualitative and quantitative data regarding the user context. We observed the logging procedure, and measured the logging frequency in 20 seconds intervals. We registered if the users had challenges with watching the game and taking notes at the same time, and if this had any negatively affect on the data quality (Pascoe et al., 2000). We also registered if the users had any kinds of interruptions when collecting data.

3.2 Interview

We conducted an in-depth semi-structured interview with a basketball coach for an adult Oslo based amateur team. Since we were trying to get deeper and new insight into which problems to solve and what kind of solution to provide, our interview consisted mainly of open questions (Farrell, 2016). The interview was held in the basketball hall, and it was conducted just after we had observed the basketball game, since we wanted to obtain some background knowledge of the user context in advance. Prior to the interview, we informed the interviewee about all aspects of the trial. Thereafter the interviewee signed the informed consent form, a confirmation of voluntarily willingness to participate. In the interview we asked questions regarding the coach’s view on statistics, and the pros and cons of the way logging is done today.

4. EMPIRICAL FINDINGS

4.1 Observation

During the basketball game, we registered that there was a high level of noise in the hall. Speech, whistle- and ball sounds were dominating the soundscape. The alarm that marked the end of each quarter was particularly loud. We also registered that due to the fact that the hall was placed several storeys below ground, there was no internet connection. During the observation we registered that the data collector responsibility was shared between six different people. Some of them were highly concentrated, while others paid no or little attention to their responsibilities as data collectors. We observed that different ink colors were used to separate the data gathered in each quarter from each other. For some reason this was only done in the two first quarters. In the third quarter the data collector used the same colored ink as in the first quarter. We also registered that there was a limited amount of logging activity in the fourth quarter, and for some minutes in this quarter there was no one taking notes.

We registered that the data collectors in general had some trouble finding the right player on the sheet, and to write the incident in the correct place. The logging of data was a time consuming practice, and we registered that the data collectors missed several important incidents on the field due to the fact that they had their attention on the paper sheet. We measured the logging frequency fifteen times in 20 seconds intervals. The average logging frequency in these intervals was 0,93.

Figure 5 and 6: Today data is gathered by pen and paper.

4.2 Interview

The coach was positive to our idea of developing a prototype for logging and use of data in basketball games. In his view, it is better to use an application for gathering data than the sheets of paper that are in use today. Since some of the data collectors forget to write down statistics, and some have difficulties knowing what data to collect, the coach has in general some trust issues regarding the data collected during matches. In the interview we got feedback regarding the coach's wishes for the prototype. Some of the specific wishes included having an interface only showing the five players on the field during a match, from where these players are shooting from and for how long each of the players is on the field.

5. DATA EVALUATION AND ANALYSIS

Based on the data we have collected, we register that the players who are gathering data during games, have their attention on the paper sheet for a considerable amount of time. We observed that this distracting process affected the data quality in a negative way due to several unregistered events. We registered that the data collectors had some difficulties in finding the right player among the long list of players on the sheet, an issue that also was commented in the interview we conducted. To reduce this time consuming practice, having an interface only showing the five players on the field could be an option. We registered that the paper sheet used today contains a lot of information regarding different possible actions, and for this reason, we will focus on tablets rather than mobile phones.

During the observation we registered that the method used to separate the different quarters from each other didn't work in practice. Some of the data collectors used the color coded pens consistently, while others didn't, and this led to unreliable data recordings. In the interview, the coach mentioned that it would be advantageous with a system that can measure how long each player is on the field during a match. We interpret this in the sense that the possibility to tie an action to a time seems like a overall weakness with the current system.

We registered that there was a high level of noise in the hall, in addition to several incidents happening simultaneously. As data collectors, we experienced the environment as demanding, but we assume that the data collectors during matches are more used to sports arenas than we are. Based on our observation, it looked like the frequent change of data collectors negatively affected the data quality. It seems like the responsibility for collecting data was divided between too many people, and that this perhaps led to some uncertainty about responsibility. For several minutes in the last quarter, there was for instance no one logging, even though there was players available for doing this task.

5.1 Data quality

When we were doing our observation, there was some players absent, and it is therefore reasonable to believe that such a frequent change of data collectors as we registered, isn't

usually the case. It is reasonable to believe that some of the data collectors may have been affected by the fact that they were being observed, and that they therefore paid more attention to the task than what they usually do.

5.2 Analysis of the similar application review

There's a lot of published mobile applications within the same scope of functionality. We looked first at two similar applications, EasyStats (ES) and Basketball Stats Pro (BSP), before looking at two popular relevant, but not similar applications, more for inspiration than comparison. The two basketball applications exists in different ends of the complexity-spectrum; ES is an entry level application for simple use, while BSP has a multitude of functions with endless configuration possibilities. We have picked up tips from both applications, but see them as significantly different from what we are trying to achieve. The other applications we reviewed; Håndball Statistik (HS) and Strava, was looked at mostly as inspiration. HS had a pleasant user interface and felt easy to maneuver around in. Strava gave us tips into structuring of tasks and how we can add related features like educational material to our application.

6. PROTOTYPING AND DESIGN EVALUATION

6.1 User needs and requirements

Based on the analysis of the data we have found what we think are the most important features/requirements and user need we should implement:

- An native application with offline storage due to limited internet connection.
- Application should be developed for tablets rather than mobile phones.
- The application should be compatible with different types of tablets and OS.
- An interface only showing the five players on the field during a match to limit the time looking for a player.
- The interface should be easy to use and navigate in, to limit the time on the screen and see more of the game.
- The possibilities to tie an action to a time by recording the quarter and the time.

6.2 Design choices

In the development of the low-fidelity prototype we discussed what design choices should be implemented. We decided to show only five players in the interface simultaneously. In the article presented earlier in section 2. *Literature review* written by Mangset (2014) the author talks about redundancy feedback; "Redundancy can reduce the demand on working memory by increasing the users awareness of the effects of his or her interactions with the system". We decided to take this into consideration when designing feedback for the interface. When an action button was pressed we wanted to have several places of feedback; on the number under each action button, a list showing the actions, and we also discussed a graphic feedback

when a button is pressed. For the measuring of time we decided to have two buttons, one saying which quarter of the game you are in, the second one the possibility to say which minute of the game you are in (1-10). The reason for this is that during a game the clock will stop several times because of timeout, violation, indication of a foul and possible injuries. To minimize the time consumption of having to record the time very accurately we decided to go this way. For a more complex application it could be possible to connect the application to the main clock in the arena for exact time.

6.3 Low-fidelity prototype

We made the low-fidelity prototype with paper. This allowed us to get an early impression of the interface and to get feedback early in the process. We could also make fast alterations of the prototype when discussing the interface. With this prototype we wanted to get feedback on the placement and size of the buttons, and overall impression of the interface.

6.3.1 Evaluation

We tested the prototype in a live game, where two stat keeper's alternated between using the existing system and pretending to press the buttons on the prototype. The feedback we got was that all the needed functionality was present on the prototype; they did not miss any buttons or data fields. The noted however that the positioning of the minutes counter button might lead to too much hand movement for each action, and that they wanted it to be positioned closer to the select player buttons.

The feedback we gathered from their non verbal communication, was that they understood all the functions on the prototype without us explaining it to them, and that we could assume that the layout of our prototype was intuitive enough.

6.4 High-fidelity prototype

We developed a high-fidelity prototype with the prototyping tool Justinmind (Justinmind, 2017). The prototype consists of the three screens, one with a starting screen, one with possibilities of choosing players, and one with the main game interface (see figure 12 in the appendix). Due to time limitation the prototype is not finished, this will need further work, especially regarding color design and more functionality and interactivity. It is also common that "high-fidelity prototyping uses materials that you would expect to be in the final product and produces a prototype that looks much more like the final thing" (Preece et al., 2002, p. 245).

6.4.1 Technology

We want to use a development technology that allows us to create an app for both major platforms (IOS and Android), that enables us to quickly create digital prototypes, and which makes it easy to collaborate while still being able to test on physical devices. We looked at Progressive Web Apps (PWA) with different Web frameworks, hybrid solutions like Cordova/PhoneGap and JavaScript to Native-technologies like React Native (Facebook,

2017) and Fuse (Fuse, 2017). PWA's were considered too risky in an offline-environment and harder to control with the multitude of browsers we had to support. We also discarded hybrid solutions as support for these technologies are not good enough, and have been generally phased out by most companies in favour of JavaScript to Native-technologies. Of those we reviewed React Native and Fuse. Fuse is a local alternative with it's headquarter in Oslo, which focuses on graphics-heavy cross platform applications, while React Native is starting to become very popular within the industry and have a large contributor base with a lot of support. We have selected the React Native Framework, an open source technology from Facebook as our programming language, as it supports both major platforms. We use it with Expo (650 Industries, 2015), a tool that allows quick sketch-up's of user interfaces with React Native, and also makes us able to collaborate on one code base which we can test simultaneously on our own physical devices.

6.4.2 Evaluation

Due to time limitation, we weren't able to evaluate the high fidelity prototype. Our plan was to do usability testing to collect quantities data related to our measurable usability criteria. It would have been interesting to measure if our prototype actually could limit the time the data collectors had their attention on the screen, and if this had any impact on the data quality gathered. We also planned to conduct some interviews for the purpose of collecting qualitative data related to user satisfaction with the artifact. We will write more about how we planned to do the evaluation of our high fidelity prototype in section 8.2 *Outlook for future work*.

6.5 Universal design

According to the W3C Web Accessibility Initiative (WAI), *mobile accessibility* refers to making websites and applications more accessible to people with disabilities when they are using mobile devices, such as smart phones and tablets (W3C, 2017). In this section we are going to use the four principles of accessibility from the Web Content Accessibility Guidelines 2.0 (WCAG 2.0) in the context of our project.

6.5.1 Content must be perceivable

In our project we have tried to make user interface components and information presentable to users in ways they easily can perceive. To let the data collectors see more of the match and less on the screen, we have been working with how to make the content easily understood in a short period of time, for instance by highlighting the most important buttons. We have chosen to use well readable fonts and colors that can easily be distinguished for color-blind users. In addition, we have chosen not to use color as the only visual means of indicating an action or prompting a response, but rather several different formats repeatedly for "increasing the users awareness of the effects of of his or her interactions with the system" (Mangset, 2014).

6.5.2 Interface elements in the content must be operable

We have worked with providing descriptive titles for each screen, in addition to placing the interactive elements in an order that follows sequences and relationships within the content. We have also been working with limiting the number of screens to make the navigation as easy as possible, but we had added information that can help the users keeping track of their location. Another important issue is to save recent updates frequently.

6.5.3 Content and controls must be understandable

Our aim was to design the interface as simple as possible, but how much information is adequate? Due to our expectations regarding disparities in knowledge among users, we have discussed having two different interface levels, for instance one for experienced and one for inexperienced users (Mangset, 2014). We didn't investigate this topic any further, so this is only something we have discussed, not implemented in our prototype. We tried to use the clearest and simplest language appropriate for our content to make it as readable and understandable as possible. We have discussed having different language options, but we haven't implemented this yet. By making the different screens appear and operate in predictable ways, and implementing features that have resemblance with the current paper based system, we aimed at making the interface recognizable.

6.5.4 Content must be robust enough to work with current and future technologies

The ecosystem of mobile technology development platforms are changing rapidly, and we cannot be 100% sure that our choice of technology will be something that is used in years to come, but since we have chosen a technology created and implemented by one of the biggest companies in the world (Facebook) and which is invested in by other big companies like AirBnB, Skype and Instagram, we are fairly confident in the longevity of our technology platform.

7. DISCUSSION

7.1 What are the advantages of paper documents?

There are several advantages with paper documents, but there also some weaknesses. According to Luff and Heath (1998), paper documents are handleable, manipulable, portable, dismantlable and can easily be reordered and reassembled for particular purposes. We would say that some of these characteristics may also apply to mobile devices such as tablets. A disadvantage with these devices worth mentioning, is that they are expensive. For teams in kids league, paper documents may for this reason be a preferable solution. Pen and paper are in addition tools that may be associated with confidence and safety. Everyone has an experience with using them, so for those who aren't digital natives (Prensky, 2001), the fear of "doing something wrong" may be reduced. In addition security may be an issue with

digital devices. Another value with paper documents is that they don't have a battery. This may be an advantage in a sport arena where a lack of electrical sockets can be an issue.

7.2 In what way can we add value to the current system?

If our prototype in some way can enhance the quality of data collected during basketball matches, mainly by limit the amount of time the data collectors have their attention on the screen, this is an improvement which is of great value for the teams using it. With an application it is also possible for several people to look at the data simultaneously, on different devices. If the coach wants to look at the data, he or she doesn't have to borrow the device from the data collector, a practice which can adversely affect the data quality. Another quality we can add to the current system is the possibility to tie an action to a time by recording the quarter and the time. The coach we interviewed wanted statistics showing the amount of time each of the players was on the field during a game, and this is information that is easier to record on a digital device than on a paper sheet. Gathering data digitally will also prevent work duplication, since data currently are inserted digitally after each game to present statistics. Another value with a digital solution is the possibility to design for the avoidance of human errors. In basketball for instance, there are some actions that have to occur prior to others. In a digital application it is possible to design such event chains, and at the same time reduce the number of potential human errors. In some ways, an application can be "smarter" than a piece of paper.

7.3 What can potentially be lost in the digitalization process?

A tablet is an expensive device, so there can be some issues regarding lending it away to others, for instance to opponent team members who want to examine the statistics. Paper can in addition be used as a draft, a potential value that may be lost in the digitization process. Since the sequence order to a large extent is determined on a digital device, some elasticity may be lost in in the transformation process. A digital interface will in addition have some constraints that limit the actions that can be performed by the user. A paper sheet isn't as restricted in number of user actions on a system. By implementing the possibility to measure time, users can no longer log data in exactly the way they want. We registered that the different data collectors had their own way of doing their work; some logged continuously, others wrote down what they remembered when they had the time, i.e. in the breaks.

7.4 How do we transform a paper based system to a digital application?

We argue that when transforming a paper based system into a digital one, it may be necessary to explore in more detail how the current system are used and in what kind of setting it is used in. It may be important to gather information, for instance by doing observations and/or conducting interviews (Håland, 2010) about the users and their work routines. Since the conditions in different work environments varies, it is important to carefully choose interaction alternatives to make the design suitable for the specific environment it will be used in (Håland, 2010). We argue that by identifying the qualities and the possible

improvement potential of a current system, mobile devices can be shaped to fit the local demands of the users in a specified setting. We think that there should be a strive to preserve the things that work well, and if possible, transform them into digital representations.

8. CONCLUSION

In this paper we have addressed one key research question and three additional questions. To answer these questions we have used methods as interviews, observation and prototyping, in addition to literature and similar application reviews. By evaluating our data collection, we derived a list of requirements, and based on these requirements, we designed and evaluated suited prototypes. In our prototypes, we tried to preserve the best from the paper based system, and adding values that the paper based system lacked. When designing mobile devices, analyzing user context and work practices are important. By doing this, artifacts can be suited local user demands. We argue that even with a well functioning and well fitted digital system, pen and paper might a good idea as a backup solution

8.1 Limitations

In this project we only interviewed one potential user, a coach. We do think a broader data collection could have been beneficial in our initial prototyping session. Since our high-fidelity prototype wasn't completed in time for the scheduled basketball match, we don't know how fitted or adequate it is for the specified context, and if it is perceivable, operable, understandable and robust enough for its users. If we had time, it would also have been interesting to examine the users' level of knowledge. We haven't examined if collecting data during basketball matches leads to stress, but when designing for such situations, the amount of information provided in an interface should be minimized, and all unnecessary information should be avoided (Mangset, 2014). If we had more time, we would have examined this topic more thoroughly, aiming to find a suitable amount of provided information. Language translation options is also a thing we would have looked further into if we had the time, in addition to examine further what can be done to limit the amount of time the users spend on glancing on the screen. A tablet require the direct attention of the user for the whole duration of a particular task, a distracting process that can negatively affect the data quality. Only showing five players on the screen is a possible improvement of the current system, but it would have been interesting to examine this problem area even further, for instance using MAUIs (Pascoe et al., 2000).

8.2 Outlook for future work

The end of the scope for the design process of this application is the evaluation of the high-fidelity prototype, and the first action that lies outside the scope will be to make a Minimal Viable Product (MVP) which includes the core functionality of the proposed application. The MVP should include a preset team of players and the ability to record player actions which can be uploaded to a database for inspection. When we have a functional MVP, our plan is to test the difference in quality of recordings between the paper based existing

system and our digital application in a real life game. We will install two GoPro cameras aimed at each end of the basketball court and record simultaneous synchronized video from the game, so we can make a correct data set to compare the recorded data from the two systems to. We will look at the difference between the player action recordings, and also the disparity between the specific stat data collected through the MVP compared to the correct data set from video, to see if some player actions have a bigger error rate than others, and then try to analyse why the difference occurs. In addition to the data comparison we will get feedback from the tester of the MVP for further adjustments into a fully functional application.

We have looked briefly at whether we can use the collected data for educational purposes, as basis for mathematics or statistics assignments for students, but this is a topic that needs more research. Another topic that can be interesting to examine further is how the statistics can be presented in the application.

9. REFERENCES

9.1 Syllabus articles

Li, K., Baudisch, P. and Hinckley, K. (2008). Blindsight: eyes-free access to mobile phones. In *Proc. CHI 2008 Conf. on Human Factors in Computing Systems*, Florence, Italy, April 05 – 10, 2008, pp. 1389-1398. Retrieved from https://www.microsoft.com/en-us/research/wp-content/uploads/2016/11/Blindsight-CHI-2008.pdf

Luff., P. and Heath, C. (1998). Mobility in Collaboration. In *Proceedings of the 1998 ACM conference on Computer supported cooperative work*. DOI: 10.1145/289444.289505

Pascoe, J., Ryan, N. and Morse, D. (2000). Using While Moving: HCI Issues in Fieldwork Environments. In *ACM Transactions on Computer-Human Interaction*, Vol. 7, No. 3, September 2000, pp. 417–437. DOI: 10.1145/355324.355329

9.2 Applications

Klinc, L. (2017). Basketball Stats PRO (Version 2.9) [Mobile application software]. Retrieved from https://itunes.apple.com/us/app/basketball-stats-pro-statistics-and-scorekeeping/id463261464?mt=8

Prager, Z. (2017). Easy Stats for Basketball (Version 6.8) [Mobile application software]. Retrived from https://itunes.apple.com/no/app/easy-stats-for-basketball/id561687907?mt=8

Strava Inc. (2017). Strava Running and Cycling GPS (Version 20.0.0) [Mobile application software]. Retrieved from https://play.google.com/store/apps/details?id=com.strava&hl=no

What The Appz. (2017). Håndball Statistikk (Version 3.2) [Mobile application software]. Retrieved from https://play.google.com/store/apps/details?id=com.whattheappz.handball

9.3 Other references

650 Industries. (2015). Expo (Version 21.0.0). Retrieved from https://expo.io/

Cambridge University Press. (2017). Mobile device. *Cambridge Advanced Learner's Dictionary & Thesaurus*. Retrieved from http://dictionary.cambridge.org/us/dictionary/english/mobile-device

Eason, K. (1987). *Information technology and organizational change*. London: Taylor and Francis.

Facebook. (2017). React Native (Version 0.49). Retrieved from https://facebook.github.io/react-native

Farrell, S. (2016). Open-Ended vs. Closed-Ended Questions in User Research. Retrieved from https://www.nngroup.com/articles/open-ended-questions/

Fuse. (2017). Fuse. Retrieved from https://www.fusetools.com/

Houde, S. and Hill, C. (1997). What Do Prototypes Prototype? In *Handbook of Human-Computer Interaction* (2nd Ed.), M. Helander, T.Ê Landauer, and P. Prabhu (eds.): Elsevier Science B. V: Amsterdam.

Håland, I. (2010). Designing mobile devices for extreme work environments. Conducted from http://www.ivt.ntnu.no/ipd/docs/pd9_2010/ArtikkelIngrid.Haaland.pdf

International Organization for Standardization. (2010). Ergonomics of human-system interaction - Part 210: Human-centred design for interactive systems (ISO/DIS Standard No. 9241). Retrieved from https://www.iso.org/obp/ui/#iso:std:52075:en

Justinmind. (2017). Justinmind. Retrieved from https://www.justinmind.com/

Lazar, J., Feng, J. H. and Hochheiser, H. (2010). *Research Methods in Human-Computer Interaction* (1st ed.). West Sussex: Wiley.

Mangset, E. (2014). Designing for acute stress in emergency situations. Conducted from https://www.ntnu.no/documents/10401/1264435841/Artikkel+Eivind+Lind+Mangset.pdf/9c949ef4-137e-4dc5-9d1d-db6747cb7a34

Preece, J. Rogers, Y. and Sharp, H. (2002). *Interaction Design. Beyond Human–Computer Interaction*. New York: Wiley.

Prensky, M. (2001). Digital natives, digital immigrants. On the horizon, 9 (5). 1-6.

Rudd, J., Stern, K. and Isensee, S. (1996). *Low vs. high-fidelity prototyping debate.* In *Interactions*, Vol. 3, No. 1, pp. 76-85.

Taylor, B. J., Kermode, S. and Roberts, K. L. (2006). *Research in Nursing and Health care: Evidence for Practice* (3rd ed.). Thomson, South Melbourne, Vic.

TechTarget. (2007). Application. Retrieved from http://searchsoftwarequality.techtarget.com/definition/application

The Center for Universal Design. (1997). *The principles of universal design, Version 2.0*. Raleigh: North Carolina State University. Conducted from https://projects.ncsu.edu/ncsu/design/cud/about_ud/udprinciplestext.htm

U.S. Dept. of Health and Human Services. (2006). Usability testing. *The Research-Based Web Design & Usability Guidelines*, Enlarged/Expanded edition. Washington: U.S. Government Printing Office. Retrived from https://www.usability.gov/how-to-and-tools/methods/usability-testing.html

W3C. (2017). Mobile Accessibility at W3C. Retrieved from https://www.w3.org/WAI/mobile/Overview

10. APPENDIX

10.1 Low-fidelity prototype

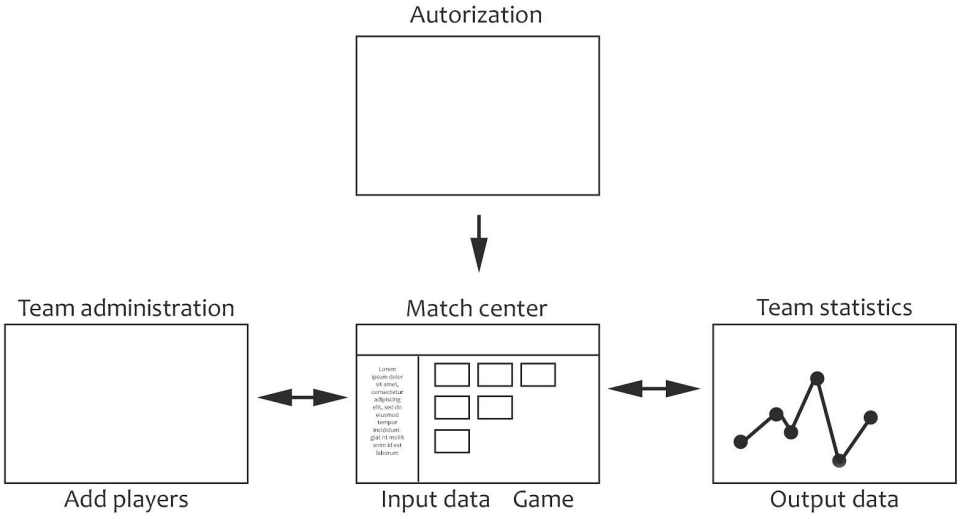


Figure 7: Navigation.

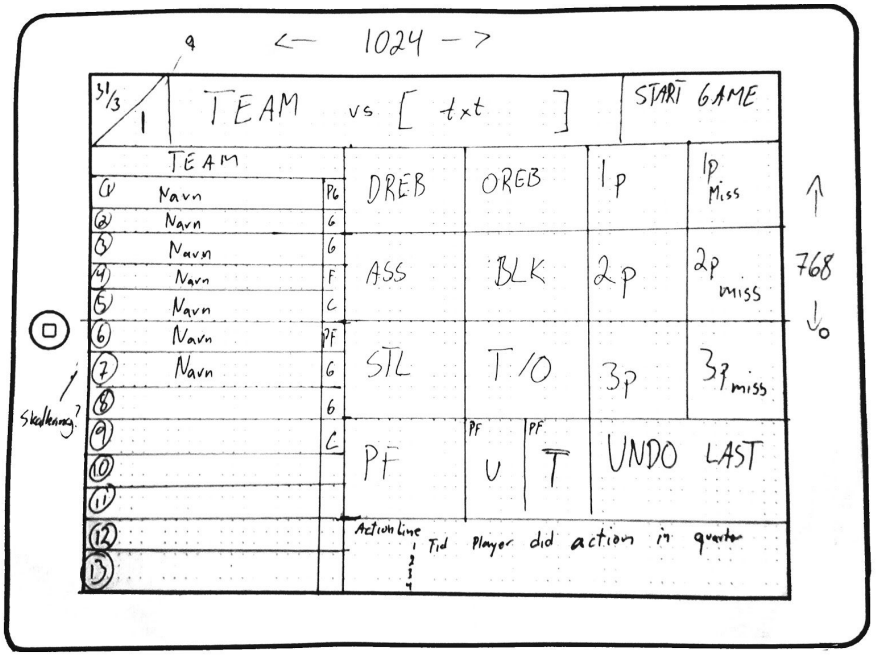


Figure 8: First draft of the interface.

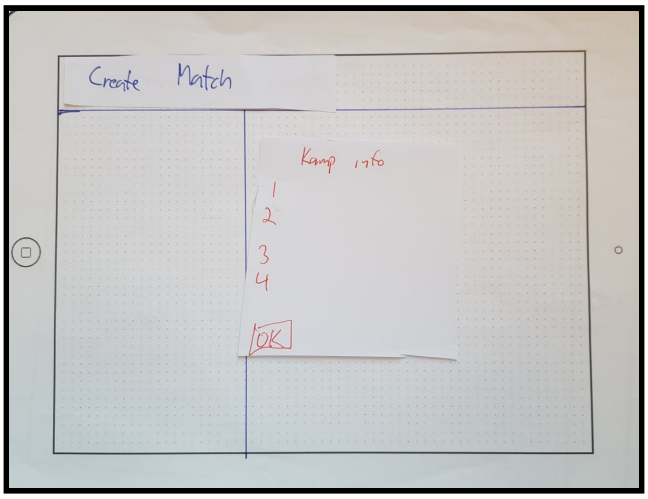


Figure 9: Sequence 1.

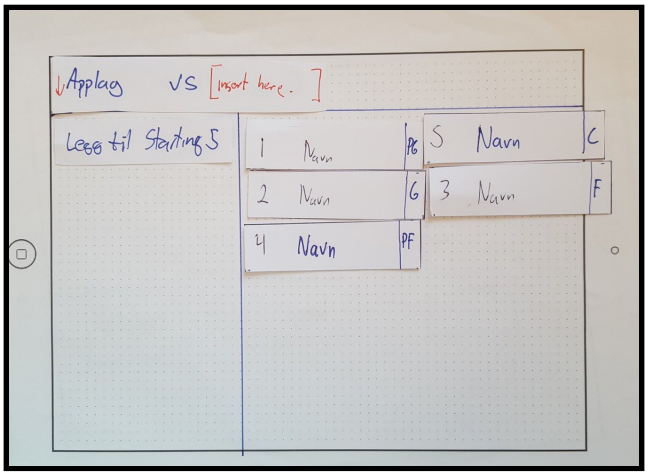


Figure 10: Sequence 2.

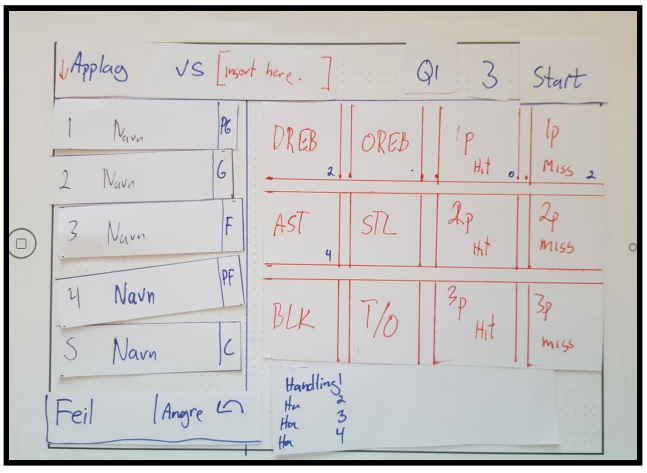


Figure 11: Sequence 3.

10.2 High-fidelity prototype

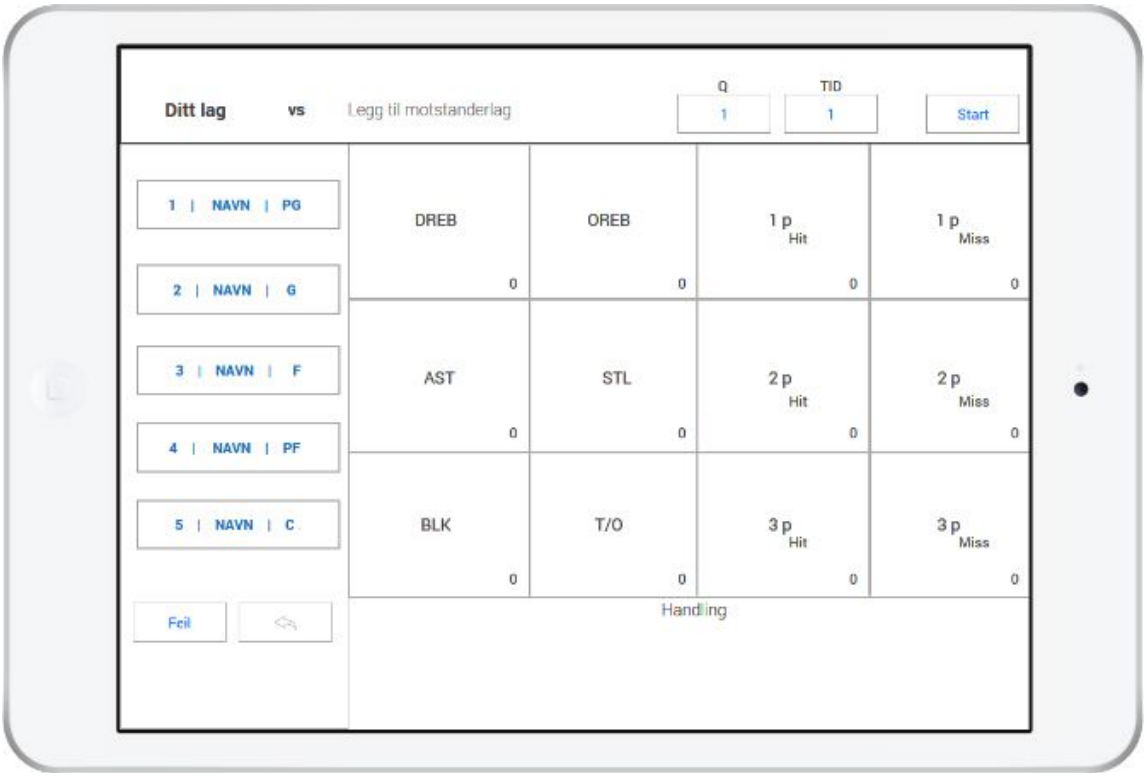
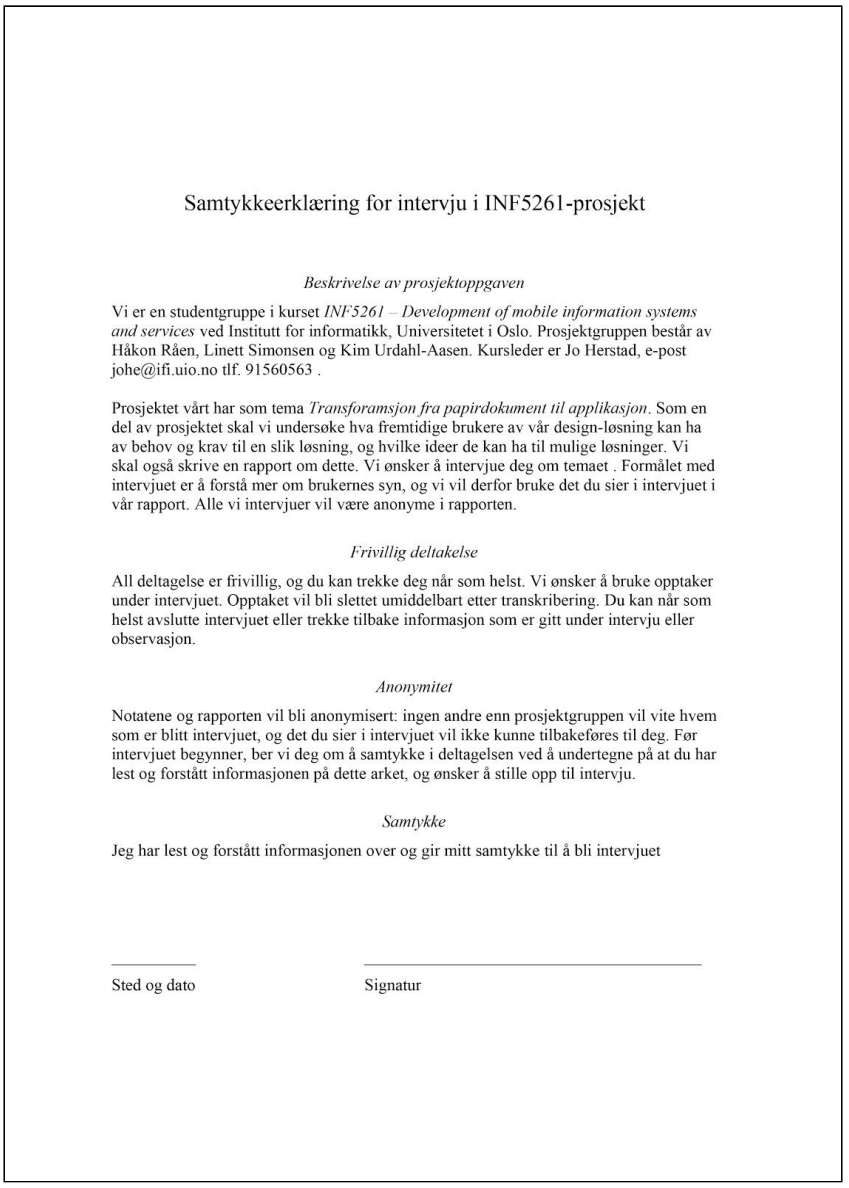


Figure 12: Main game interface.

10.3 Informed consent form



Samtykkeerklæring for intervju i INF5261-prosjekt

Beskrivelse av prosjektoppgaven

Vi er en studentgruppe i kurset *INF5261 – Development of mobile information systems and services* ved Institutt for informatikk, Universitetet i Oslo. Prosjektgruppen består av Håkon Råen, Linett Simonsen og Kim Urdahl-Aasen. Kursleder er Jo Herstad, e-post johe@ifi.uio.no tlf. 91560563 .

Prosjektet vårt har som tema *Transforamsjon fra papirdokument til applikasjon*. Som en del av prosjektet skal vi undersøke hva fremtidige brukere av vår design-løsning kan ha av behov og krav til en slik løsning, og hvilke ideer de kan ha til mulige løsninger. Vi skal også skrive en rapport om dette. Vi ønsker å intervjue deg om temaet . Formålet med intervjuet er å forstå mer om brukernes syn, og vi vil derfor bruke det du sier i intervjuet i vår rapport. Alle vi intervjuer vil være anonyme i rapporten.

Frivillig deltakelse

All deltagelse er frivillig, og du kan trekke deg når som helst. Vi ønsker å bruke opptaker under intervjuet. Opptaket vil bli slettet umiddelbart etter transkribering. Du kan når som helst avslutte intervjuet eller trekke tilbake informasjon som er gitt under intervju eller observasjon.

Anonymitet

Notatene og rapporten vil bli anonymisert: ingen andre enn prosjektgruppen vil vite hvem som er blitt intervjuet, og det du sier i intervjuet vil ikke kunne tilbakeføres til deg. Før intervjuet begynner, ber vi deg om å samtykke i deltagelsen ved å undertegne på at du har lest og forstått informasjonen på dette arket, og ønsker å stille opp til intervju.

Samtykke

Jeg har lest og forstått informasjonen over og gir mitt samtykke til å bli intervjuet

Sted og dato

Signatur

Figure 13: Informed consent form.

10.4 Project plan

Start	Task
35	Initial stages
36	Group formation **Milestone 1: Wonder document 06.09.17**
37	Work with refining the scope. Find out how we want to address our research question(s).
38	Data gathering preparation.
39	Data gathering (Observation and interview).
40	Presentation, analysis and interpretation of data.
41	**Milestone 2: Mid-term report 11.10.17**
42	Prototyping.
43	Prototyping.
44	Evaluation of the different design solutions.
45	Prototyping.
46	Wrapping up the project work.
47	**Milestone 3: Final report 20.11.17**

Table 1: Final project plan.