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Exercise Games for Elderly People

Identifying important aspects, specifying system requirements and designing a concept

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Problem Description

Games are becoming more and more important in the health sector. One specific genre of games is exercise games (exergames). In this assignment, we will look into how exergames can be used to improve elderly people's physical health. We will focus on identifying the criteria that need to lie in ground to make a game customised for this user group. This project can contribute to one of today's many EU-financed projects focusing on exergames for elderly.

In particular, the following studies will be done:

- A literature study of the challenges about developing an exergame for elderly, and what aspects need to be taken into account in a game like this. This includes studying motivating factors for exercising, the importance of usability, video game theory, as well as appropriate exercises for the game.
- Involve relevant users in workshops, after approval from NSD.
- Based on this, we will define system requirements and a concept, for an appropriate exergame for elderly people.

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Abstract

The aim of this study is to identify important aspects of an exergame for elderly, and based on this, specify system requirements and develop a concept for an exergame. Due to "baby boomers" and the fact that people live longer, the share of older people in the world is growing. One common problem elderly people face is reduced balance function and physical strength, which increase the risk of falling. Engaging elderly in physical activity can help overcome this problem. However, this engagement can be challenging. Today, there is a great focus on the use of technology for health related purposes. This includes use of video games with motion sensor technology, like the Microsoft Kinect, to promote physical activity. These genre of games are called exercise games, or exergames, because they require the player to use body movements to play. Exergames have fun and entertaining features, which engage and motivates to gameplay and exercise. The Microsoft Kinect sensor has shown promise for use in clinical practice, and in a previous project we evaluated exergames to fit as a tool in physical therapy. Existing commercial games are made for a younger user group, and many games are therefore not suitable for the older generation. Evidently, there is a need to develop customised games for elderly, where their wants and needs are identified and considered. In this thesis we have developed a concept for an exergame for elderly people. Research on relevant topics has been conducted to identify important aspects of the game. We have looked into guidelines for how elderly should exercise, as well as general motivating factors for exercising. We have studied related research, identifying characteristics of elderly, as well as proposing guidelines on how to develop and design exergames for this group. In addition, official guidelines, proposed by three different organisations, on how to design user-friendly interfaces for elderly are provided. In the development of an exergame for elderly, usability and simplistic design become important. Meeting this, the relevant users have to be involved in the development process. Therefore, we have included a group of elderly in one iteration of the cycle of user-centered design. We conducted two workshops where this group participated. The

first workshop included an experiment, where the elderly got to play three different commercial Xbox Kinect games. During the gaming session, we observed how they interacted with the games, what did and did not work, and how they seemed to like the games. A focus group interview was performed after the gaming session. We learned that the group liked playing the games, but that there were important aspects that could be improved, such as more instruction and feedback, easier menus, and more information about what was expected from them, which body parts that were exercised, and whether they did the exercises correctly or not. There was a wish for real-life activities, and appropriate music. Clear goals and the feeling of mastery were seen as important. Based on the findings from workshop 1 and the research on relevant topics, system requirements have been proposed and a design for an exergame concept has been developed. The exergame includes one compounded game, exercising the whole body, and four single games, exercising specific muscle groups. The games are made with relevant exercises in a familiar environment. Early stage prototypes were made to visually show scenarios from the games. In addition, a menu design was proposed. To include the users, and to get feedback on the concept, a second workshop was held. The exergame concept was presented by showing prototypes, simulating gameplay and explaining scenarios. Focus group discussions were held in order to get feedback on the exergame. The overall perception of the exergame was positive. However, some aspects of the games were unclear, and suggestions for improving the games were made. In this thesis we evaluate existing commercial Xbox Kinect games to not be suitable for the elderly users. This is because they contain elements that do not meet the needs and characteristics of elderly, and that they lack certain functionality. However, the games that contained real life activities were experienced as fun. The concept and design that we presented for the elderly were appreciated, and we conclude that this exergame, together with the proposed system requirements, are appropriate for this user group. However, some adjustments should be made in the future work on the exergame. We acknowledge that the group of users involved was physically and mentally fit, and that their opinions and experiences may differ from another group with other characteristics.

Sammendrag

Målet med denne studien er å identifisere viktige aspekter ved et treningspill for eldre, og basert på dette spesifisere systemkrav og utvikle et konsept for et treningsspill. På grunn av "babyboom" og det faktum at folk lever lenger, har andelen eldre mennesker i verden blitt større. Et vanlig problem eldre opplever er redusert balanse og fysisk styrke, hvor denne reduksjonen øker risikoen for fall. Et bidrag til å overkomme dette problemet er å engasjere eldre i fysisk aktivitet, men dette har vist seg å være utfordrene. I dag er det stort fokus på bruk av teknologi for helserelaterte formål. Dette inkluderer bruk av videospill med bevegelsessensorer, som Mircosoft Kinect, for å fremme fysisk aktivitet. Slike spill kalles treningsspill fordi de krever bruk av kroppsbevegelser for å spille. Treningsspill inneholder morsomme og underholdende aspekter som engasjerer og motiverer til trening. Microsoft Kinect-sensoren har vist seg å være lovende for bruk i klinisk praksis, og i et tidligere prosjekt evaluerte vi treningsspill til å være passende som hjelpemiddel hos fysioterapeuter. Det finnes allerede kommersielle treningsspill, men disse er for det meste laget for en yngre brukergruppe og er dermed ikke like godt egnet for eldre. Dette betyr at det er behov for å utvikle et treningsspill spesielt tilpasset denne brukergruppen, hvor deres ønsker og behov er identifisert og tatt hensyn til. I denne oppgaven har vi utviklet et konsept for et treningsspill for eldre, og for å identifisere viktige aspekter ved spillet har forskning på aktuelle temaer blitt gjennomført. Vi har sett nærmere på retningslinjer for hvordan eldre bør trene, samt hva som er generelle motiverende faktorer for trening. Vi har studert relatert forskningsarbeid, identifisere karakteristikker ved eldre, samt foreslått retningslinjer for hvordan man bør utvikle og designe treningsspill for denne brukergruppen. I tillegg presenteres offisielle retningslinjer, foreslått av tre ulike organisasjoner, for å designe brukervennlige grensesnitt. I utviklingen av et treningsspill for eldre er brukervennlighet og enkelt design viktig. For å møte dette bør de aktuelle brukerne bli involvert i utviklingsprosessen. I løpet av denne prosessen har vi utført en iterasjon av sykelen for brukersentrert design, hvor vi har inkludert en gruppe eldre mennesker. Disse har

deltatt på to workshoper. Den første inkluderte et eksperiment der de eldre fikk spille tre forskjellige kommersielle Xbox Kinect-spill. Under spilløkten observerte vi hvordan de interakterte med spillene, hva som fungerte og ikke fungerte, og vi studerte hvordan de så ut til å like spillene. Etter spilløkten hadde vi et fokusgruppeintervju. Vi lærte at de eldre likte å spille disse spillene, men at det er viktige aspekter som kan forbedres. Eksempler på dette er klarere instruksjoner og tilbakemeldinger, enklere menyer, samt mer informasjon om hva som er forventet av spilleren, hvilke kroppsdeler som ble trent, og om øvelsene ble gjort riktig eller ikke. De eldre ønsket øvelser som kunne relateres til det virkelige liv, samt passende musikk. Klare mål og følelsen av mestring ble sett på som viktig. Basert på funn fra workshop 1 og studie av aktuelle temaer har systemkrav blitt foreslått og et design for et treningsspill-konsept blitt utviklet. Treningsspillet inneholder et sammensatt spill som trener hele kroppen, og fire enkelspill som trener spesifikke muskelgrupper. Spillene består av relevante øvelser i et kjent miljø. Enkle prototyper ble laget for å visuelt fremstille ulike scenarier fra spillene. I tillegg er et menydesign foreslått. For å få tilbakemelding på konseptet inviterte vi de eldre til en andre workshop. Treningsspillet ble her presentert ved å vise prototyper, simulere interaksjon og forklare forskjellige scenarier. Fokusgruppediskusjoner ble holdt for å få tilbakemeldinger på spillet. Den generelle oppfatningen var positiv, men det var aspekter ved spillene som var uklare, og noen forslag til forbedringer ble gitt. I denne oppgaven evaluerer vi eksisterende kommersielle Xbox Kinect-spill som ikke passende for eldre brukere. Dette er på bakgrunn av at de inneholder aspekter som ikke tar hensyn til de eldres behov, i tillegg til at de mangler diverse ønsket funksjonalitet. Likevel ble spillene opplevd som morsomme, spesielt de som inneholdt virkelighetsnære aktiviteter. Konseptet og designet vi presenterte for de eldre ble godt likt, og vi konkluderer dermed med at dette treningsspillet, sammen med de spesifiserte systemkravene, er egnet for eldre. Det er likevel noen justeringer og forbedringer som bør gjøres i et videre arbeid med dette treningsspillet for å møte de eldres ønsker og behov. Vi erkjenner at gruppen eldre som ble involvert var fysisk og psykisk oppegående, og at deres meninger og erfaringer kan variere fra en gruppe med andre egenskaper.

Preface

This thesis is written as a part of our master's degree in Communication Technology at the Norwegian University of Science and Technology (NTNU). The focus of this thesis has been to design an exergame concept for elderly, and it is a continuation of the work done in our project assignment.

We will start by thanking our Professor Lill Kristiansen for valuable guidance and feedback on our work during this final semester. The result of this thesis would not have been the same without her ideas and comments. We would also like to thank Post. Doc. Ather Nawaz and Professor Leif Arne Rønningen for stepping in the last couple of weeks before submission. Their help has been highly appreciated.

Members from "Seniornett" have contributed in our assignment, and for this we are grateful. This, especially, yields Arne Sølvberg, the manager of "Seniornett" in Trondheim. He has helped us a lot with arrangement of meetings, booking of facilities, moving needed equipment, and engaging elderly to join our workshops. We would not have been able to perform these workshops without his help. We will thank the eight seniors from "Serniornett" who had time and willingness to participate in our workshops. Their feedback and opinions have been used as part of the basis for our master thesis.

We will express our appreciation to Jannicke Fiskvik who spent her spear time proofreading our report, correcting errors, and providing us with suggestions and guidance on our writing. This has been very helpful! We would also thank Pål Sæther from the Department of Telematics for always helping us finding the equipment we needed.

The main findings in our thesis were presented in a workshop with the FARSEEING EU-project, and we would like to thank the participants in this workshop for showing interest in our study.

Finally, we would thank our families for the support they have given us throughout our studies. We are forever grateful! And to all our classmates and friends, thank you for all the fun and good memories! The time here at NTNU has been unforgettable. And to each other, this has been a great semester. We finally made it!

Contents

Acronyms

NSD Norwegian Social Science Data Services

USID User Sensitive Inclusive Design

UCD User Centered Design

DTC Dual Task Costs

SDK Software Development Kit

SDI Stepwise Deductive Inductive Method

VR Virtual Reality

HCI Human–Computer Interaction

AI Artificial Intelligence

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Chapter 1

Introduction

Today, technology is used for all kind of purposes, and it has become an important part of people's everyday life. Different kinds of technologies meet a wide range of needs, all from entertainment and socialisation, to education and health. One focus that has got great attention the last years is how to use video games with motion sensor technology to engage people in exercise and physical activity [1], [2], [3]. These games are called exercise games, or exergames, because they require body movements to play. There have been done a lot of research on different motion sensor technologies used for exercise and it has shown positive effect when it comes to improving peoples health.

Due to "baby boomers" and the fact that people are living longer, the world's population now consist of a great share of older people [4]. As a part of growing older, elderly often meet disabilities like physical and psychological decline. Due to reduced balance function and physical strength, one serious problem for elderly people is the risk of falling. Fall is the leading cause of injuries in older people, and can often have serious consequences [5]. These problems, together with the world's ageing population, lead to both strategical and economical challenges for the government when it comes to providing health care services to everyone that need it. This clearly shows that new initiatives have to be taken to identify how to prevent falls, and keep the older population healthy. However, engaging the elderly population in physical activity can be challenging, and it is shown that a great share of elderly do not exercise enough [6]. The introduction of an exergame can meet this problem. This can serve as a more fun and entertaining alternative than regular exercise.

The use of exergames for health related purposes is supported by the new reform "Samhandlingsreformen" in Norway, were one focus is to use welfare technology in the health sector where possible [7]. However, many older people are unfamiliar with technology, and especially with video games. In addition, existing commercial exergames are aimed towards a younger user group, and are therefore not suitable for elderly [1]. A first step to make the older population accept the use of video games for health related purposes, would be to develop a game aimed especially for their needs and interest, where their physical and psychological declines are taken into consideration.

This thesis is built upon our project assignment *Business Opportunities and Economics for an Exercise Game in the Health Sector* [8], where we developed a business model for an exergame, with the physiotherapy service as the customer. In this thesis we will focus on the end users of this game, which are elderly people. Our contribution in this thesis will be to explore and identify the users' needs and wants, gather sufficient knowledge and information about system design, and from this create a concept[1] for an exergame appropriate for the older user group.

[1] We have choose use the term *concept* which means *an idea, or a general notion* http://dictionary.reference.com/browse/concept

1.1 Objectives

Exergames have shown promise in health related purposes like for exercise and rehabilitation. However, previous research suggest that commercial exergames are not suitable for elderly, as they are not specially aimed and developed for this user group [1] [9] [10] [8].

We will study how elderly interact with commercial Xbox Kinect games to see what do and do not work, and to validate previous findings. With this we will answer research question 1 and 2:

RQ1: Are existing commercial Xbox Kinect games suitable for exercising purpose for elderly people?

RQ2: What are the design challenges when developing an exergame for elderly people, and what aspects need to be considered in this game?

Based on the answers to research questions 1 and 2, and theory and knowledge about video game development, usability and system design, we will answer research question 3:

RQ3: What would be suitable system requirements, and appropriate design, for an exergame for elderly people?

1.2 Contribution

Our contribution in this thesis is the development of system requirements and a concept for an exergame for elderly people. Some aspects from our previous project [8] have been used as motivation for this thesis. A brief summary of this will be provided in Chapter 2. To be able to understand the users, we have looked into challenges and motivating factors when it comes to engaging elderly to perform physical activity. This will be presented in Chapter 3. For the reader to get an insight into what exergames are, we provide in Chapter 4 a brief overview of this. As we are making an exergame concept, we have studied important aspects related to game development for the older user, and summarised a set of guidelines that should be followed when developing for this group. This can be found in Chapter 5. Understanding of the different elements included in a video game, as well as general system design, is needed to develop the exergame. We provide an introduction to these topics in Chapter 6 and 7, respectively. In accordance with the importance of user involvement, we have conducted two workshops where we have engaged users in the development of the exergame. Informants were recruited by holding a presentation for "Seniornett", an organisation working with teaching the older population technology. This will be described in Section 8.6. Workshop 1 was conducted to observe and understand how a group of elderly people interact with commercial Xbox Kinect games. In this workshop, methods like questionnaire, participatory observation and focus group interviews were used. These methods are described in Chapter 8. We observed the informants play three games chosen by us, and followed with a focus group interview. A description of the execution, and findings from workshop 1, will be presented in Section 8.7 and in Chapter 9, respectively. The main focus for this thesis has been to specify system requirements and create design for a concept for an exergame for elderly people. This work has been based upon information gathered from theory, previous studies and findings from workshop 1. The design was presented by making prototypes. The exergame concept is the most important contribution in this thesis, and will be presented in Chapter 10. The concept was presented in a second workshop, to be evaluated by the users. The execution of, and findings from, workshop 2 are presented in Section 8.9 and Chapter 11. In our discussion, provided in Chapter 12, we provide a detailed description of future work for an exergame for elderly, based upon findings from workshop 2. This thesis provides general guidelines for how to design an exergame for elderly, and can be used in the continuation of our exergame concept, or in the development of a new exergame. The main findings in this thesis, together with the design proposal, have been presented in a workshop with the EU-project FARSEEING [2].

1.3 Work Process

Figure 1.1 presents the work process for the present thesis.

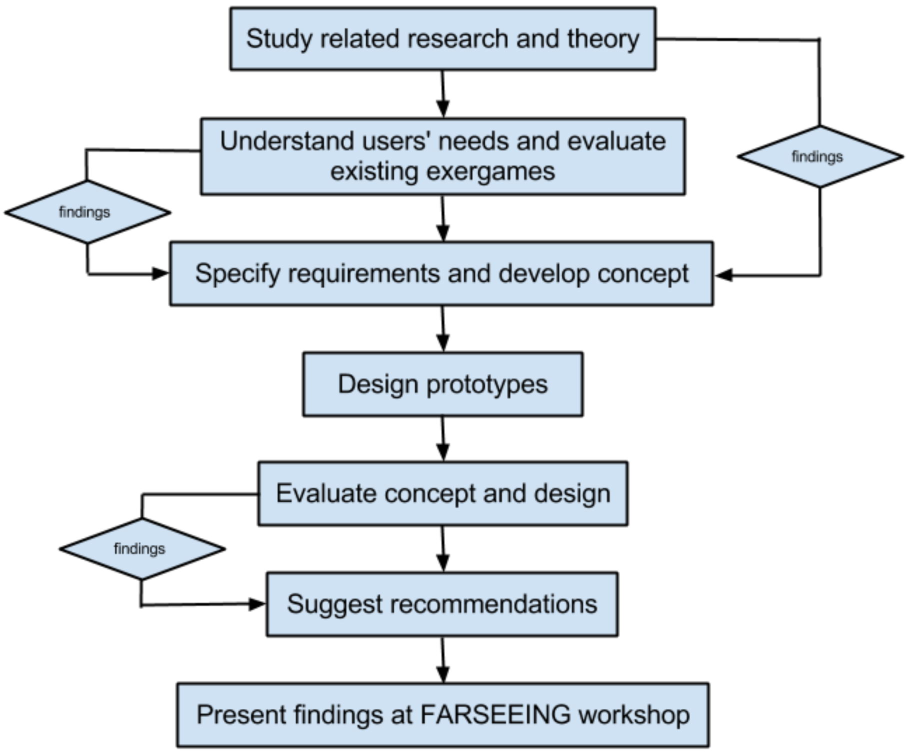


Figure 1.1: Work process

[2] FARSEEING is a collaborative European Commission funded research project, which are working on promoting healthy, independent living for elderly people with the use of technology. See http://farseeingresearch.eu/ for more information.

1.4 Scope and Limitations

One important limitation of this thesis is the sample of informants in our workshops. Elderly cannot be seen as one common group of people. They are people with different interests and needs. In this thesis, we only included one small group of elderly. Due to time limits before the first workshop, which was critical for our further work, we only recruited informants from the organisation "Seniornett". We did not have the time to look into other arenas for recruiting. The informants had never played video games before, which made it challenging to include them in the development process of the exergame concept. Gathering a group of elderly, and observing them while they played different Xbox Kinect games, is not observing a natural setting. This made it difficult to fit this study into defined research methodologies. The last limitation concerns the choice of how we presented our design. We used prototypes, but limited them to not involve any interaction, even though they represent scenarios for a highly interactive game.

1.5 Outline

The report is structured in the following way:

- In **Chapter 2** the main background and motivation for this master thesis will be presented.
- To make a video game aimed for exercising, there is a need to understand what actually motivated elderly to exercise in general. This will be provided in **Chapter 3**. In addition, we will briefly discuss how elderly should exercise.
- In **Chapter 4** we will describe what video games, and in particular exergames, are. We will also present the exergame technology we have made an exergame concept for, namely Microsoft Kinect.

- Elderly people are a group with diversity, and have some typical characteristics. A lot of research on how to make appropriate exergames for elderly people, where these characteristics are been taken into account, have been conducted. In **Chapter 5** we summarise interesting research and provide a list of typical characteristics of elderly, as well as guidelines for how exergames and user-interfaces should be made for this group.

- In **Chapter 6** we present video game design in general. This is to make it easier to structure our exergame proposal, and to include important elements that a video game should consist of.

- It is also important to understand how to design systems in general. In **Chapter 7** we will discuss the four pillars of design, system requirements and the importance of usability. At last, we will present a model that can be used for usability evaluation of games or as guidelines in an early development phase.

- It is important to involve the user in the development process of a system. This can be done with several methods, which we will discuss in **Chapter 8**. This includes; experimental simulation, participatory observation, focus group interview, questionnaire and video and audio recording. At last in this chapter, a thorough description on how we have worked, and how we have used the different methods will be described.

- In **Chapter 9** the findings from workshop 1 will be presented.

- Based on the theory discussed in the previous chapters together with the findings from workshop 1, we will present the functional and interface requirements and the exergame concept. This can be found in **Chapter 10**. As a part of this, prototypes of some scenarios in the game will be shown.

- The exergame was evaluated by a group of elderly in a second workshop. In **Chapter 11** the findings from workshop 2 will be presented.

- In **Chapter 12** our findings and result will be discussed and we will provide recommendations for future work on our exergame, based on the feedback gotten from workshop 1. The quality of the research will also be discussed.
- Finally, in **Chapter 13**, we provide a conclusion on the work done and we suggest future work.

Chapter 2

Motivation

The main goal for this thesis is to develop a concept for an exergame for elderly. In our project *Business Opportunities and Economics for an Exercise Game in the Health Sector* [8], conducted the fall of 2012, we evaluated exergames to have great potential as a tool for exercising and rehabilitation, at physiotherapy clinics or in training groups. We found physiotherapy clinics to be the main customers for the exergame, while elderly are the end users. As future work we recommended to find a way to make an entertaining and motivating game concept, that should be easy to use and that should fit the needs of the end users. This is our main motivation for this master thesis. Thus, the motivation for our previous study is also relevant for the current study, and we will therefore provide a brief summary of important aspects from that report. We will provide some relevant references, however, for a complete set of references related to the topics, the reader will be referred to the relevant report [8].

A great share of the world's population is old. This is because of the so called "baby boomers", as well as the fact that people live longer. In 2007, 20 percent of the population in the developed world was over the age of 60 [4], and it is expected that 25 percent of the population in Europe will be over the age of 60 by 2020 [11]. A problem with such a great share of elderly in the world is that it will be difficult to provide health care services to everyone that might need it. Cognitive impairments, decreased mobility functions, and visual and auditory decline are common problems related to ageing and the older population.

The initial motivation for making an exergame is the problem of falls related to elderly. As a part of the natural ageing process, comes decline in physical health, where the main declines are in strength and balance. Falls have shown to be a very common event, and as much as 30 percent of people over 65 years old fall at least once a year [5]. The consequences of falls can often be critical, with the most serious outcome being death. After experiencing a fall, it is common for elderly to be afraid of falling again. This often results in them being less active and the feeling of loss of confidence in carrying out the activities they wish to do. Many elderly are afraid of leaving their house and suffer from total inactivity. This might also lead to loneliness and depression. With such a great share of elderly, this has become a public health problem. To slow down this ageing process, and keep the older population healthy longer, engaging them in physical activity can be a part of the solution. There has been shown that exercising only once a week, which is what elderly get from visiting their physiotherapist or attending a once a week training group, does not improve physical health. However, with a supplement there have been seen improvements. The challenge is to get elderly to exercise as much as they should [6]. This could be achieved by offering a more motivating training method, like with an entertaining game.

Because of the great share of elderly in the world's population, there is a focus on how to keep people healthier and postpone peoples' need for health care. In the health sector in Norway the focus is now on; prevention, early intervention, and close collaboration between entities. This is stated in the reform, "Samhandlingsreformen", which was put in place the 1st of January 2012. This reform also request more focus on welfare technology. Welfare Technology is in [7] defined as: *"Technological assistance that contributes to increased safety, social interaction, mobility, and physical and cultural ac-*

tivity. In addition welfare technology can help to strengthen an individual's ability to be independent despite sickness and social, mental or physical disabilities. Also it can work as technological support for relatives, as well as contribute to improving the services offered, when it comes to utilisation of resources, availability and quality. In many cases welfare technology can prevent the need for health services or admission to an institution" (Translated from Norwegian from [7]). The ultimate goal with the use of welfare technology is that people can take care of themselves longer [12]. When there is a need for it, every person should be provided with health care services that can be used in their home. With this, the demand in nursing homes can be decreased. The main focus in the new reform is based on "hverdagsrehabilitering", or "everyday rehabilitation" in English, where the goal is to postpone peoples need for help. The main actors here are the ergo-therapists and the physiotherapists. The new focus in the Norwegian health sector, suggest that an exergame can have a potential for health related services.

There has been great attention around the potential for exercise games in the health sector, and a lot of studies have been conducted. Examples are [1], [2], [11] and [3], to mention some. In our previous project we studied several research which evaluated exergames to have great promise for exercise and rehabilitation, both for young and older people [8]. This was because of the games' fun and entertaining nature, which could serve as a more motivating way to exercise. At the same time as possessing elements that might motivate people to exercise, playing games can also be a way to distract players from boring and painful treatments [13]. Studies have been performed to test different exergames on a group of elderly. These elderly were positive, and believed they would use games like these if they were more available [14]. Even though exergames show great potential, the commercial games are shown to be not suitable, as they are made primarily for fun and entertainment, and not for rehabilitation. These games do not take elderly people's characteristics and limitations into considerations, and are therefore experienced as too complicated, including loads of information and rapid movements [1].

In *Business Opportunities and Economics for an Exercise Game in the Health Sector*, the focus was to analyse the business potential for video games for use in exercise and rehabilitation for elderly [8]. Because of older people's inexperience with video games, and based on the new focus in the Norwegian health sector, we found the exergame relevant to use in a physiotherapy setting. We interviewed three physiotherapists in Trondheim. All of the interviewees were positive to the exergame, however, without seeing the actual game, they could not say whether they would use it in their treatment or not. We were told that every patient is different, and whether they are eager to exercise or not really depend on whether they have a background as an active person or not. Therefore, it is important to not think of elderly as one common group of people, but people with different interests and needs. The physiotherapists mentioned different features the game have to offer. The game has to offer something better than what they are already offering, and at the same time ease their workload. Because of the differences in each patient's case, the game should have the ability to be customised, so that every patient can get an exercise program suited for their specific problems and needs. The game should be easy to use and understand, and it should provide feedback both to let the player know if the exercises are being done correctly, and to motivate and engage the player to continue playing.

With support from "Samhandlingsreformen", the new focus around welfare technology, and the interviews conducted, we concluded that an exergame has the best potential in a market where physiotherapists are the customers. The exergame could be used as a tool by the physiotherapists to engage their patients to exercise, and in that way prevent patients' decline in physical health. This can be in an individual training session with a physiotherapist, or as an activity in training groups. One of the clinics we interviewed offered a weekly training group for seniors. Training groups are also offered at various institutions in the different municipalities in Norway. This is an arena where the game could serve as a new, social, and entertaining form for exercise. The game could be a more motivating way for the patient to exercise at physiotherapy clinics, in group sessions, and possibly at home in the future.

Having physiotherapists as the customers, while elderly are the end users, means that both actors need to be taken into account when developing the game. In this thesis we will look into aspects to consider when developing an exergame, seen from the end users point of view. Concentrating on the end users only will include creating a motivating story that the users will enjoy, and designing an appropriate user-interface. To figure out these aspects we have to meet the users to learn and understand their needs and interests. This will be done by including a group of elderly in the design process. This thesis will not focus on the exergame from the physiotherapists' perspective. Neither will we focus on how and where it will be used. In our previous project we discussed the exergame to be for both exercising and rehabilitation. In this thesis, we will only focus on making a game for "general" exercising for elderly people.

We will start by discussing different challenges related to engaging elderly people to perform physical activity, and what factors motivate them. This is important to understand, as the game we are going to develop is aimed for exercising.

Chapter 3

Barriers and Motivation to Exercise for Elderly People

An exergame aimed at elderly users, needs to include the right exercises, as well as motivating elements. Meeting this, we have to understand what motivates elderly to exercise in general. There are different challenges and barriers that keep older people from exercising, and it is shown that only a small share of elderly people meet official requirements of physical activity [6]. There exist various proposed guidelines on how elderly people should exercise, and there are different services that both can be implemented at home, and performed outside the home. Introducing an exergame, which integrates already existing exercises in a story with focus on entertainment, can be a fun, motivating and effective alternative to existing services.

In Section 3.1 we will discuss older people's attitude towards exercising, and look at numbers that support the need for an alternative way to exercise. Guidelines on how elderly should exercise will briefly be discussed, but the interested reader are referred the original references for more information, as this is out of our area of competence. In Section 3.2 we will discuss typical barriers and challenges that keep elderly from exercising. At last, in Section 3.3 we will discuss motivating factors that will be taken into account in the development of the game concept.

3.1 Elderly and Exercising

Physical activity is important for all people, including elderly. It can improve quality of life by reducing risk of some chronic diseases, alleviate depression, and help people towards a more independent life. Improving health by physical activity does not just apply for healthy elderly, but also for frail and very old people. Guidelines are proposed by different entities, like The Norwegian Directorate of Health and the U.S. Department of Health and Human Services, recommending physical activities like aerobic activity, as well as strengthening exercises [15] [16]. A set of guidelines for how to exercise may seem easy to follow, but it is challenging to motivate elderly to exercise, and it is shown that there is only a small percentage of elderly who actually engage in physical activity [17]. To be able to engage seniors to be more physically active, they should be provided with programs that will motivate them to actually perform the exercises. In this thesis, we will come up with an exergame concept for this purpose. As discussed in our previous project [8], keeping the older population healthy can, in addition to decrease the risk of falling, reduce the need for health services, and also decrease economic challenges related to this. It is therefore important to have focus on the older populations' physical health.

Norwegian elderly, aged 67-79 years old, have become more active the last years, with as much as 40 percent of this population exercising regularly several times a week [18]. However, only one fifth of adults meet the minimum requirements recommended by The Norwegian Directorate of Health, which is 30 minutes of exercising per day [6]. 23 percent of the group between 67-79 years old in Norway exercise less than once a month or never [18]. It is shown that some exercise is better than none, and that exercising only once a week can have positive effects on elderly [19]. They should therefore be engaged in some physical activity. The numbers are worse in other parts of the world. The Federal Interagency Forum on Aging Related Statistics [17] presented numbers in their latest report, revealing that only 11 percent of Americans aged 65 years and older, meet the 2008 Federal Physical Activity Guidelines [16]. The percentage decrease with increasing age, where 14 percent of older people aged 65-74 years old meet these guidelines, while this is the case for only 4 percent of people over the age of 85. It is quite common that the amount of physical activity decreases with age and that after the age of 65 years old, the level of activity is at its lowest [20].

The Norwegian Directorate of Health has made a handbook for physical activity for prevention and treatment [15]. They recommend that regular activity should be performed 2-3 days a week, 20 minutes each time. Different activities suggested include cycling, swimming, walking, jogging and cross-country skiing. Activities that involve resistance training have shown positive effect also for elderly people. It is recommended that exercises should be performed 1-2 times a week, be done for 10-12 repetitions, and be progressive. Physical activity should include all major muscle groups. In addition, it is recommended to perform exercises that will strengthen mobility, gait and balance function. Exercises for improving balance, should be customised for each individual's needs. Mobility is best maintained by regularly moving the body, both with everyday movements and physical activity. Exercises that have proved good for enhancing balance functions include: standing on one foot, or walking in circles, sideways, or over obstacles. In addition, a regular walk in various terrain is a good and convenient activity to maintain balance function, gait and mobility [15]. The readers who are interested in the specific guidelines proposed by The Norwegian Directorate of Health and the U.S. Department of Health and Human Services will be referred to [15] and [16].

In our previous project we presented different training programs that are made especially for elderly [8]. One of these is "Øvelsesbanken", which is created by the physiotherapy service in Trondheim, Norway. "Øvelsesbanken" is a service primarily meant for physiotherapists to in a convenient way put together exercise programs for their patients to perform at home. However, private users have the possibility to register, and put up their own programs, as well. The main purpose with this service is fall prevention, and it therefore includes exercises to increase balance and strength [21]. We found these exercises relevant for the exergame. We have chosen to build the concept around these exercises, together with the activities proposed by The Norwegian Directorate of Health. This will give us a set of exercises that are shown to be good for elderly, that we could not have put together ourselves, as we do not have the competence to recommend exercises.

Age-related physically and mentally changes can be reduced with regular physical activity. There exist several guidelines on how and what to exercise; however, there are various challenges when it comes to motivating elderly people to exercise. These will be discussed in the next section.

3.2 Barriers and Challenges

It is hard to get people to be physical active, and this might especially apply for elderly. Because of the high fall statistics there is important to engage elderly in physical activity, as the main reason for falls are reduced physical strength and decreased balance. General guidelines suggest that elderly should perform exercising programs that contains exercises that strengthen muscles, balance, endurance and mobility [15] [19]. There are some unique challenges and barriers when it comes to engaging elderly in physical activities, discussed in the literature. Understanding these barriers will make it easier to identify how to motivate them to exercise. It is crucial when developing exercise programs, to understanding the motivational factors behind exercising [22].

One common barrier is that elderly think their health is not good enough to start exercising [20], and may believe exercising will do more harm than good [22]. Their poor health and the pain related to this, hinders them from exercising. In addition, elderly have a tendency of thinking they are too old to start exercising [20]. A significant challenge is to get people to exercise long enough to see positive results. Many associate exercising with pain, sweating, and muscle soreness, and the time before positive outcomes are noticed can be long. At the same time, the negative effects of not exercising, may not be that apparent [22].

The importance of having available and convenient resources is significant, as it is shown that people living far away from training centres, parks and walking paths are less active than people living near these facilities [20]. With this come also time constraints. It is shown that many elderly look at physical activity as time consuming, thinking about the time doing the activity, as well as the time getting to the exercise site [20] [22]. It can be challenging to get people to perform unstructured, free-living, exercise programs, compared to structured programs. This is because people themselves have to decide when, where, and what to do. This is pretty much based on self-motivation [22].

Physicians play an important role when it comes to advising elderly to exercise, because most people have respect for and trust their physicians. This was also discussed in [8], where we found physiotherapists to be an appropriate and reliable mediator for the exergame. However, in [20] and [22], it is discussed that physicians do not always give sufficient exercise advice. Instead of giving a specific exercise program for the patient to perform, they simply just tell them to be more active. Many elderly have little knowledge about physical activity and its advantages. This can come from the fact that many elderly grew up in a time where people generally were more active in their everyday life, and where there were not that much attention around the importance of physical activity [20]. In addition, many think of physical activity more as a recreation activity, or activities done for competition, and do therefore not think of it as necessary for keeping a good health [22].

3.3 Strategies and Motivators

Understanding barriers and challenges gives insight into what factors motivate people to exercise. Having more time, more information, and living closer to exercise offerings, are basic goals that can serve as good motivators for exercise. Chao et al. [22] propose that a structured program offered at a set time, probably will be a good solution for this user group, as a common problem is to find time, as well as decide which exercises to do. A strategy is to focus on what physicians are telling their patients. It is important to remember the common limitation of memory capacity among elderly. Therefore, information should be given in a precise and accurate way [22].

Chao et al. discuss some strategies for motivation [22]. One must understand different peoples' needs and expectations, and take into account race, gender, ethnicity etc. To meet these expectations, contact with the relevant people is important. The researchers suggest this to be done with for example interviews and focus groups [22]. Self-regulatory skills, including goal setting, self-monitoring of progress, and environmental management, are important to keep peoples' exercise behaviour [22] [20]. The feeling of pleasure and satisfaction are also important [20]. Clear goals should be set to let the participant understand that the activity has a purpose and is going through an end, and that skills will be developed through practice. To easily monitor the exercising, goals should be separated into small and manageable parts. Implementing decision-making models, modifying cognitive thoughts during activity, and increasing social support are also strategies to promote adherence to physical activity [22]. Exercising should be looked at as an ongoing process, and it is important to remember that people's behaviour towards exercising can change with age. Therefore, prevention of relapse should be included in the planning process, to maintain physical activity routines [22].

Self-efficacy seems to be an important determinant for exercise behaviour. Self-efficacy is defined in [20] as *"individuals belief in their ability to suc-*

cessfully perform a specific behaviour", and it is said that it is more likely for a person with strong self-efficacy expectations and outcomes to adapt to a specific behaviour. In [23] they evaluate self-efficacy to play an important role in the relationship between physical activity and quality of life. White et al. did a study where they measured a sample of community dwelling adults' physical activity, self-efficacy, global quality of life, physical self-worth, and disability limitations. They concluded that *"being more active was associated with being more efficacious, having fewer disabilities limitations, reporting higher physical self-worth, and being more satisfied with one's life"* [23]. In addition, they stated that self-esteem is an important component of the physical activity and quality of life relationship [23].

Schutzer et al. suggest some alternative motivating factors which can help preventing relapse [20]. They suggest prompts, like e-mail and telephone contact. These prompts are typically used for home based training programs, and are shown to be at least as effective as supervision face-to-face. Telephone contact works well in a starting phase, when trying to get a person to adapt to a more active lifestyle, while e-mail contact works well to help maintain this lifestyle. These ways can actually be more effective than prolonged exercise session with face-to-face contact [20]. For home based training programs, telephone contact is seen as valuable for encouraging, rewarding and monitoring the person's progress [22].

The last important motivator discussed in [20] is appropriate music to enhance the exercise experience, and to divert from pain coming from the exercises.

3.3.1 Summary of Motivating Factors for Exercising

From what have discussed in this chapter we have drawn out 13 motivating factor for exercise behaviour. These are listed below, and will be taken into consideration when specifying requirements for our exergame concept.

m.1 Convenience of activity facilities [22], [20]

m.2 Precise information about what to exercise [22], [20]

m.3 Sufficient information about the benefits of exercising [22], [20]

m.4 Self-efficacy and self-esteem [20], [23]

m.5 Self-regulatory skills [22], [20]

m.6 Small and manageable goals [22], [20]

m.7 Self-monitoring of progress [22], [20]

m.8 Modifying cognitive thoughts [22]

m.9 Decision making [22]

m.10 Social support [22]

m.11 Meet different peoples' needs and expectations [22]

m.12 Prompts, either face-to-face, by telephone or e-mail [22], [20]

m.13 Appropriate music [20]

When designing physical training programs, understanding the factors that motivate people to exercise is very important. The factors discussed in this chapter will be taken into consideration when specifying requirements for an exergame for elderly people. In addition, the different activities presented by The Norwegian Directorate of Health as well as the exercises presented in "Øvelsesbanken" will be considered. There are additional factors that are more related to video games and elderly people that need to be studied. This will be looked into in Chapter 5. First we will briefly present what video games are, and how they can be used for exercising.

Chapter 4

Exercise Games

In this chapter we will present what exercise games, or exergames as it is commonly called, are and how it can be used for exercising.

To understand the concept of exergames and where it originates from, we will start with a brief presentation of video games and its sub-genre serious games. This can be found in Section 4.1 and 4.2, respectively. What exergames are will be presented in Section 4.3, while a brief presentation of the technology our exergame will be built on will be presented in Section 4.4.

4.1 Video Games

Video games is a genre within digital games that has become extremely popular all over the world. There exist several different gaming consoles, and for each console there has been developed an endless amount of various games that meets almost every need and interest. Video games can be described as *"electronic, interactive games known for their vibrant colors, sound effects, and complex graphics"* [24]. Hand held controllers or devices that capture movement are used to interact with the video game. The variety of video games makes it usable for many different purposes, like learning, education, physical activity, or just for the sake of amusement [8].

One might associate video games with children and teenagers, and many hours of game play. Generally, this is a right assumption to make. In USA, video games are played for several hours every week [25], and one third of all gamers are under the age of 18 [26]. Gaming is usually associated with being anti-social, because of all the time spent looked up alone in a room, playing. However, the gaming lifestyle has changed. Video games have emerged from sedentary, lonely gaming, to gaming involving social interaction and movement, and it has taken a great part in people's everyday life. In Norway, 6 percent of the population in the age range 45 - 79 uses computer or video games every day [27]. This might indicate that not only children and teenagers use video games, but also the elderly population has started to use this type of technology. Statistics from the USA in 2011 provided numbers that might support this assumption, as they show that as much as 29 percent of all gamers where over the age of 50 [28]. Elderly people contribute to a great share of the world's population, and if the entertainment industry could see this group as potential customers, it would open up a new and inexperienced market for video games [11].

4.2 Serious Games

The widespread and assorted use of video games have made a great potential for the entertainment industry regarding development of new games, and also in terms of developing games for additional purposes beside pure entertainment. A new way to use video games is to include it in training, education and learning. This is called serious games. Serious games can be described as *"a mental contest, played with a computer in accordance with specific rules, that uses entertainment to further government or corporate training, education, health, public policy, and strategic communication* *objectives"* [29]. The idea is to use the fun, motivating and captivating features that video games possess and combine it with pedagogy.

The first serious attempt of developing video games with the main focus on learning did not become very successful [30]. The failure that time was that the focus in these video games were on pure learning, which resulted in boring games that did not create motivation and curiosity [30] [31]. About serious games Michael Zyda states that pedagogy has to be subordinate to the story and entertainment component of the game. It is highly important that fun and amusement is the main focus in the game [29]. For a video game to function as a pedagogical tool it has to focus on motivation, effectiveness, and intuitiveness. These games have to provide motivating factors that engage people to play the game, and they have to be effective in the matter of learning outcomes. When it comes to intuitiveness, people have to be able to play and understand the video games without the need for guidance [30].

There exist several genres of serious games, where edutainment and game-based learning, advertaintment, games for politics, simulation games, and games for health are some of them. The genre of edutainment and game-based learning combines fun and entertainment with education and learning. Advertainment is about using video games as a media for marketing, and games for politics influences players through hidden, underlying political messages in the game. Simulation games are about bringing various activities into life with the use of video games, and gaming for health is about using video games to engage activity, to become physically stronger, and to improve quality of life [30] [32].

An important feature with serious games is that they provide the opportunity to experience real-life situations and adventures one may otherwise not be able to enjoy. This might be due to expenses, time, distance, risk, or physical capabilities. With serious games it is possible to play golf, be the star of a boxing match, paddle down turbulent rivers, and explore nature and creatures one have never seen before. In a more serious matter, video games can be used to simulate brain surgery or a battle in a war zone.

This can teach students how to perform medical procedures or it could prepare soldiers for war. Serious games can also be used for students to learn their curriculum through quiz games, and people can be motivated to work out with exercise games. Serious games can be used for several purposes and situations, and it can help people to develop a wide range of different skills.

Research on the use of serious games shows positive development of skills and knowledge, in addition to positive effects on health, which has resulted in motivation for further research and development. In addition, the new technology involving physical interfaces and improvement on graphics and animations, initiates to new types of games. The market for serious games are inexperienced and unexplored, so there are a great potential for further research [32]. Market sales the last couple of years also show promise for serious video games in the future. In 2008, the market for serious games sold for about 1,5 billion USD around the globe [32], and in 2010 it reached about 2 billion USD [1]. The market is expecting an annual growth rate of 47 percent, up to impressive 13,5 billion USD [2] in 2015 [33].

We will look closer into one genre of gaming for health, which is exergames.

4.3 Exergames

Exergames are a type of serious video games that combine traditional game play with physical activity. The combination of movement and amusement is used to stimulate exercise and engage people to be more physically active in a fun and motivating way. A lot of research have been done within this topic, and results show that exergames can have a positive effect on users health [14] [3] [13]. In addition to being a new and more amusing way to work out, exergames provide an opportunity for social interaction. A

[1] Converted from EUR from [33]
[2] Converted from EUR from [33]

great amount of today's existing computer and video games possess this feature, and as much as 62 percent of all gamers say they play with others either in-person or online. One of the two top-selling video games in 2011 was Just Dance 3, which is an exergame that has the possibility to play with others [34]. This shows that the social aspect of gaming is important. The social aspect these games provide may also be especially important for people who experience loneliness in their everyday life [1].

Exergames use technology like remote hand held controllers and motion sensors to capture body movements. Users are therefore required to get up and move their body to be able to play the game. There exist several consoles that support this technology, where Nintendo Wii, Playstation Move, Dance Dance Revolution and Xbox Kinect are some of them. The existing consoles use different type of devices to capture body movement, like hand held controllers, different boards and pads with embedded sensors, and video cameras with motion sensors. In this assignment we will focus on the Kinect sensor technology. This is because we in our previous project evaluated Kinect to be an appropriate choice as it provides the possibility to play without holding on to any devices, and because the sensor has proved to measure different body movements accurately so that the parameters are applicable for use in clinical practice. The reader will be referred to Section 4.2 in our project assignment [8] to read what this is based on. We will now provide a brief description of the chosen technology.

4.4 Microsoft Kinect for Xbox 360 and Windows

Microsoft Kinect is a motion sensor that captures movement without the use of any controllers. This gives players the opportunity to play and interact with the game only by gestures and body movement. Xbox presents the Kinect experience this way: *"Kinect for Xbox 360 brings games and entertainment to life in extraordinary new ways without using a controller"* [35]. The word Kinect is a fusion of two words, *kinetic*, which means movement, and *connect*, which relates to the social aspect [36]. The Kinect sensor was

Figure 4.1: The Kinect sensor (a) together with the rest of the needed equipments, and (b) alone

released by Microsoft in November 2010 as an input device to the Xbox 360 console, and it did not take long before it got extremely popular. Only ten days after the release in 2010 it had been sold 1 million Kinect sensors, and in January 2012, sales numbers had climbed up to over 18 million sold units [37]. These sales numbers put Kinect into history, as no other consumer electronic device has experienced such great sales numbers in such a short amount of time [37] [38]. The Kinect technology has the possibility to be experienced without the Xbox 360 console, as it exist a separate Kinect Sensor compatible with Windows computers [39]. More detailed information about developing for Kinect, and a presentation of the technology provided by the Kinect Sensor, will for the interested reader be presented in Appendix A.

Kinect has not just experienced success as an entertainment device within the living room, researches have also started to see the possibility to use the Kinect for other non-gaming purposes, like within healthcare, education and industry [38]. The key reasons for the broad use of Kinect are its accessibility and low price, in addition to the ground breaking technology it provides. The release of the Kinect for Windows Software Development Kit (SDK) is also a reason for the wealth of non-gaming applications, as it makes the Kinect platform available for everyone to develop on [38].

As mentioned, the use of exergames for health related purposes has gotten great attention. However, there are challenges related to the use of existing commercial games for this purpose, and especially when elderly people are the end users. This will be discussed in the next chapter.

Chapter 5

Designing Exergames for Elderly

Exergames for elderly have become a popular topic in the past couple of years, and several research on how games can be developed for this particular user group have been conducted. Most of the research done on Human–Computer Interaction (HCI) are performed on young people [4], and it is common to develop technology systems for a homogeneous user group. This means that the characteristics of specific user groups, like the elderly, are being ignored. With the wave of elderly ahead of us system designers have to put a greater focus on older people and their needs. Elderly in particular, have some special characteristics due to ageing that needs to be taken into account when developing technology systems for them. Studies indicate that most existing video games have not considered these characteristics, and are therefore not suitable for this group.

In this chapter we will discuss elderly as users of a technology system. We will discuss characteristics of elderly that are important to acknowledge when designing technology systems for them. Based on previous research done on exergames for elderly people, we will draw out some specific guidelines that need to be considered when developing for this group. This can be found in Section 5.1. We will also provide previous research on elderly and user interfaces, as this is an important part of the gaming experience. In addition, we will present some official guidelines for developing user-friendly interfaces for the elderly user. This will be provided in Section 5.3.

5.1 Related Research

There have been done a lot of research on how to make exergames for seniors. In this section, we will review research that we have found to have interesting findings.

Billis et al. [40] discuss important issues that need to be taken into account when developing games for elderly. Elderly often suffer from decline in visual acuity, decreased audition, mobility changes and cognitive functions' decline. In addition, many elderly are not familiar with technology. The writers suggest that it should be possible to customise the game for every player's special needs. Font, size and colour should be adjustable, and information should be provided in different multimedia alternatives, like text, voice and images. The objects should be of sufficient size and the elements should not move too fast. The overall interface should be as simple as possible, without the need to remember information given earlier in the gaming process, and it should be given sufficient information and guidance throughout the whole game. Games should also provide motivating messages to encourage the player. The writers also stress the importance of the social factors of the game, and suggest the ability to multi-play. At last, for the players to get interested and engaged in the game, they suggest that the content of the game should match the users' cultural and lifestyle diversity [40].

de Bruin et al. [10] write about the potential of Virtual Reality (VR) environment, like exergames, for exercise. VR platforms can evoke naturalistic movements in a safe environment that can be customised according to the patients' needs. It can offer a consistent program that enables for comparison over time. In addition, the use of games can distract the player from any pain they may have. They suggest stepping exercises to be suitable, because they have found that stepping exercises can be a good predictor of falls. It is also proved that a repetitive training program with stepping exercises can improve balance in elderly. Like they indicate in other research, [2] [1], they also here express that the problem with already existing exergames is that they are too complex for the older user group. Therefore, there is a need to develop games specifically for this group where physical and cognitive limitations, as well as typical interests, are taken into consideration. The writers also present a study where it was shown a clear decrease in relative Dual Task Costs (DTC) of walking for elderly. These elderly were training physically, combined with a virtual reality dance game that required decision making. Training traditionally, without the additional cognitive challenge, did not change these walking parameters. This comes from the fact that elderly people often face problems when they have to do more than one task at the same time [10].

Brox et al. [1] suggest some persuasive strategies for motivating elderly to exercise with games. They suggest that too much detailed information about the player's progress should be avoided. The information should rather be shown visually, like a fish that gets larger and healthier as the player is exercising. Information from previous sessions should be provided, to help players set new goals for the next session. The player should be provided with positive feedback as they achieve goals, and should not be punished if they do not achieve goals. This information and feedback should be given at an appropriate time, and should not disturb the player. The game should have an easy, understandable and good looking interface. The writers see social interaction as very important and suggest that this should be combined with exergaming. This is because it is shown that people get more engaged in activities when doing them with others, and because this group of people often suffer from loneliness and depression [1].

John et al. [41] write about the development of an interactive training system for seniors, called "Interactive Trainer". The main motivation for this system was the problem of falls. They refer to studies where it is shown that strengthening exercises, and balance and functional training, are suitable in the matter of reducing the risk of falls. They did a review of studies done on therapy for people over the age of 50, to find appropriate exercises to use in their training system. They found 12 concepts suitable for the "Interactive Trainer" system, where exercises for balance and strength were integrated. Their first exercises were (directly drawn from [41]: "walking while sitting", "weight shifting while sitting", "weight shifting to both sides while standing", "weight shifting to the front and rear while standing", "one-leg standing", and "sit-to-stand from chair".

The system consists of a computer and two motion sensor cameras. The movements tracked from these sensors are portrayed on a TV-screen or PC monitor. Ordinary internet connection makes it possible to communicate with the therapists through the system, both to get assistance and to transmit training results. The idea of "Interactive Trainer" is to provide individual therapeutic help to elderly, which they can benefit from in their own living room. They will be given a customised exercise program, and they will be provided with an evaluation of quality of the performed exercises. The seniors will be introduced for this game by therapists, where they together create a user profile, set up a training program, and choose avatar and preferred scenery. The seniors will then take the game home, where they will be guided by a virtual trainer. The exercises in the program have to be completed in a specific sequence, and a completion of one sequence of exercises will be rewarded with an "unlocking" of a new game. The therapist can follow the training from their "Interactive Trainer" editor, where they can supervise exercises, progress and success, and adjust the game accordingly. The writers acknowledge that success for the system is dependent on user acceptance, and essential for this is a good user interface and integration of motivational factors. To achieve this they use [41]:

- Avatar design in 3D
- Virtual therapist in 3D

- Motivational feedback systems, which will be used as encouragement to reach goals
- Corrective feedback systems, which will be used as guidance for exercise
- Tutorials for how to learn the system and chosen exercises
- Target group-specific environment, with the use of familiar and real-life activities and exercises

Gregor et al. [42] discuss some particular issues when designing for the older population. They propose a paradigm and methodology to support the process of designing software as close to the universal accessibility ideal as possible [42].

They describe older people through three different groups: Fit older people, frail older people and disabled people who grow older. In addition, they define some important characteristics of older people [42]:

- As people get older the individual variability of physical, sensory and cognitive functionality will increase.
- Functional decline will go faster when people gets older.
- Cognition problems, like memory dysfunction and the ability to learn new things, are widely appearing.
- Based on where they are in life, elderly may have different wants and needs.
- How people live, like if they are needing a walking frame or needing warm glows, can change their usability function.
- Elderly have more life experience than younger people, and can therefore have more knowledge of the world, as well as a more mature ways of solving problems.

To make it easier to develop a technology system for the older user group with different characteristics, Gregor et al. proposed a modified version of the User Centered Design (UCD) principles, which they called User Sensitive Inclusive Design (USID). The issues this methodology addresses are (directly drawn from [42]):

- "Much greater variety of user characteristics and functionality".
- "Finding and recruiting "representative users"".
- "Conflicts of interest between user groups (including "temporarily able-bodied")".
- "The need to specify exactly the characteristics and functionality of the user group".
- "Tailored, personalisable and adaptive interfaces".
- "Provision for accessibility using additional components (hardware and software)".

As an example of the advantages of the proposed methodology, the writers present a case study where a web browser for people that are visually impaired was developed. 200 visually impaired users evaluated the system. The findings they did and the conclusions they made from this study were [42]:

- Elderly seemed to lack confidence in handling IT systems. However, the confidence increased after they had experienced a successful interaction and decreased after experiencing an unsuccessful interaction.
- Many elderly had difficulties remembering too much information. This indicates that there are important memory related factors that need to be taken into account when designing for elderly.
- Following a need for less information, will most likely also mean less functionality. From another study they found that it was a need for the possibility that more functionality could be added after the user had mastered the initial, simple functionalities.
- After some kind of assessment is passed, the user should be moved

to a higher level. This can be done by self-assessment. To reinforce user-confidence the user should be able to reach goals.

Gerling et al. [2] discuss possibilities and challenges when developing a game for elderly users, and they suggest four major guidelines to be followed:

- The player should have the possibility to interact with the game both when sitting and standing.
- Avoid too extensive and sudden movements.
- It should be possible to adjust the level when it comes to difficulty, game speed and device sensitivity. These changes should be possible to be adjusted by the player.
- Interaction mechanisms should be simple, player frustration should be avoided, and the game should provide constructive feedback.

To verify these guidelines, the research group prototyped an exergame, called SilverBalance, made for the Wii Balance Board. SilverBalance consists of two balance tasks and has the possibility to be played both when sitting and standing. The game was tested on nine seniors with an average age of 84. The following observations were made [2].

- All of the participants were able to play the game adequately.
- Participants expressed that the fact that the design was so minimalistic, made it possible for them to focus on the purpose of the game.
- The possibility to sit while playing the game was necessary because all participants were dependent on devices to assist them when standing and walking.
- The players started to compare their results and comment on each other's results.
- Impairments and diseases made it difficult for some participants after a longer period of playing, suggesting that alternative interactions

should be included in such games.

The testing of SilverBalance shows that the four guidelines can contribute to the development of exergames for elderly people, but the writers state that further studies on how age-related changes can affect games, should be carried out [2].

In another study, Gerling et al. present a case study where they introduce and evaluate an additional video game for elderly, called SilverPromenade [9]. SilverPromenade is developed for the Nintendo Wii technology and utilises the Wii Remote and Wii Balance Board. The game is stripped from complexity in functionality and design to be senior-friendly. The theme of the game is a virtual "walk through the forest" and it can be played both as a single-player and multi-player game. In each mode of the game it is possible to engage three different roles: walking through the forest by stepping on the Wii Balance Board which requires physical exercise, catching a butterfly by pointing at it with the Wii Remote, and counting rabbits by shaking the Wii Remote when a rabbit appears. The scenarios are simplistic, which is important when including elderly in digital game play. The concept of the game was chosen because it appeals to elderly living in nursing-homes, as it offers them the possibility to "visit" the forest, which generally might be inaccessible for them. Playing this game requires the older player to focus on cognitive, mental and physical abilities.

SilverPromenade has an easy and understandable user interface. Complex graphics and visual effects are avoided, while important elements are highlighted. It consists of a menu structure which easily guides the user to the playing-mode. The input devices used for playing makes it possible for elderly to both sit and stand during game-play, which takes the different individuals abilities into consideration. If one of the three roles is not suitable, SilverPromenade offers the possibility of not including one or more roles.

A case study with SilverPromenade was executed on a group of frail elderly living in full-time nursing homes. The participants were asked to play the game and afterwards fill out a short questionnaire. Two groups of elderly participated, one group with experience with this type of technology, and one group without any experience. During the game play the researchers observed how the elderly used the controllers, how they understood the menu, and how easily they perceived the game behaviour. The gaming results were also observed.

Results from this case study show that experienced players clearly had an advantage over inexperienced players. It was observed during game play that some roles were difficult to execute, like when pointing at the butterflies they had difficulties using the Wii Remote because it required that one point it directly towards the sensor. However, the results showed that the overall experience was positive. SilverPromenade gave an impression of being outside, and the use of a real-world scenario engaged elderly to play. The concept of the game led to communication in terms of identifying objects, and helping and encouraging each other. One important observation was that the participants were sharing and discussing their scores. The conclusion of the case study was that elderly enjoyed playing digital games, and that SilverPromenade could be an appropriate game to use in this age group [9].

Most studies done on elderly and the use of digital games, suggest that social interaction is important to include. Social interaction can be multi-play both in person in the same room and online. Online multi-play could be a good way to socialise for elderly who are less mobile and are lonely. However, not many studies on playing games together over the Internet have been conducted. We know that elderly often are unfamiliar with this type of technology [40], [42], and it is therefore important to acknowledge the challenges that can be faced by introducing multi-play over the Internet for this group. Gajadhar et al. [43] did a study, where they wanted to find out how players experiences playing together with different social presence. They tested a digital game on 40 participants in pairs with three different degrees of social presence: playing in the same room at the same time, playing against a computer controlled player, and playing together online. Results showed that while playing online elderly experienced low enjoyment, competence and challenge score, which indicates that they did not like playing online. It was also shown that they had more fun when playing alone, than when playing online with others. When playing together with others, they preferred seeing their co-players, and be able to speak with them. Seniors experienced more fun, competence, challenge and immersion when playing together in the same room than when playing with others over the internet. It was also found that seniors seemed to not care if they were winning or losing. They appeared to not be very competitive. Instead they enjoyed helping each other. The writers link this to previous studies that had found that elderly rather liked to help and teach others how to play games, than compete. The writers suggest that when including social interaction in games, the focus should be on cooperation rather than competition [43].

5.2 Summary of Findings from Related Research

It is clear that elderly people have some specific characteristics that need to be considered when developing technology systems aimed for them. Based on the reviewed research we will summarise and list the discussed characteristics. In addition, we will draw out important aspects found in the literature, and list these as a proposal for guidelines to follow when designing an exergame for elderly.

5.2.1 Characteristics of Elderly

c.1 Cognitive functions' decline, e.g. dementia, memory dysfunction, and the ability to learn new things [40], [42].

c.2 Decline in sensory functionality, like visual acuity and audition [40], [42].

c.3 The problems elderly face, often increase significantly with increasing age [42].

c.4 Mobility change [40].

c.5 Needs and wants related to cultural and lifestyle diversity, as well as at what stage they are in life [40], [42].

c.6 Many are in need of assistant tools (for example when standing and walking) [42].

c.7 Inexperienced with technology. Many elderly people seem to lack confidence when it comes to IT-systems. A better confidence can be achieved when experiencing a successful interaction with an IT-system [40], [42].

c.8 It is important to take into account memory related factors. Many elderly have difficulties remembering too much information [40], [42].

c.9 It can be challenging to do more than one task at the same time [10].

5.2.2 Proposed Guidelines from Related Research

g.1 The game should have the possibility to be customised for every user's needs, conditions, interests etc. [40], [10], [42], [2], [41].

g.2 The interface should offer adjustable font, size and colours [40].

g.3 The interface should have different alternatives for multimedia presentation, for example, text, voice and images [40].

g.4 The interface should be simple and not too extensive. The objects should be of sufficient size and there should be no sudden movements. Important elements should be highlighted [1], [40], [2], [9].

g.5 The game should have a menu, which easily guides the user to the gaming session [9], [41].

g.6 Sufficient guidance and information should be given before and during the process. There should not be a need to remember earlier given information [40], [42], [41].

g.7 Motivating feedback should be given to encourage play [40], [2], [1], [41].

g.8 Constructive feedback should be given to guide and correct exercises [41].

g.9 Information and feedback should be given when appropriate, to not disturb the player [1].

g.10 The story of the game should match cultural and lifestyle diversity [40], [42], [9].

g.11 The game should use environments and activities that are familiar to the target group. An example presented in [9] is a game with a real-world scenario, where the players have to walk through a forest. [41], [9].

g.12 Social factors should be included by offering the possibility to multi-play [40], [9], [2], [1].

g.13 Multi-play should focus more on cooperation than competition [43].

g.14 It should be offered variety in user characteristics and functionality [42], [2].

g.15 The game, with its environment and characters, should be in 3D to enhance the gaming experience [41].

g.16 The game should not have too much functionality, but instead offer the possibility to add more functionality after the existing functionalities are managed [42], [9].

g.17 The game should offer different levels with different difficulties. With this comes the possibility to reach goals. The device sensitivity and the game speed should also be adjustable [42], [2], [41].

g.18 The game should give the player information about progression and results. This information should not be too extensive [1], [41].

g.19 It should be possible for the player to adjust levels themselves [42], [2].

g.20 The possibility to interact with the game both when sitting and standing is important [2], [9].

g.21 The game should use exercises which are proven to be good for elderly [41].

g.22 Exergames for elderly should have the opportunity to be used in a clinical setting [40], [9], [41].

g.23 There should be made a profile where the user's progress and results can be saved. If the game is used in a clinical setting, it should be possible to share this profile with therapists [41].

As an additional guideline, it is worth mentioning that both [10] and [9] discuss stepping as a relevant exercise for elderly. This is because this kind of exercise has proved to be a good predictor of fall and that repetitive stepping exercises can improve balance. Stepping requires significant physical activity, which is important when improving physical health. Walking or stepping exercises are also recommended by the Department of Health and Human Services, discussed in Chapter 3. In addition, [41] mentions balance and functional training, together with strengthening exercises, as appropriate for elderly as it can lead to reducing the risk of falling.

5.3 Guidelines from Official Organisations for How to Design User-Friendly Interfaces for Elderly

As seen from the characteristics in the previous section, ageing will often lead to both physical and psychological negative changes, like decline in cognitive skills, visual and auditory acuity, and in balance and physical strength. An important part of game development is designing the user interface, where having an intuitive and user-friendly interface is crucial for the game to experience acceptance and success. When working on interface design, the users' needs have to be taken into consideration, and designers should therefore take into account the characteristics of elderly when developing a game for this user group [44]. Especially, when designing an interface for elderly, the aspect of visual decline is important to focus on [45].

There exist various examples of guidelines for how to design good and user-friendly interfaces for elderly, or people in general, that are partially sighted or visually impaired. Visual decline implies less contrast sensitivity, decrease in peripheral vision, and more dark adoption [11]. Therefore, some of the main guidelines are simple design, large font size, and sharp contrast between background colour and font colour. The users might have different levels of visual decline, so it is preferable to allow users to change settings themselves [45] [46] [47]. Design guidelines are provided by various organisations, as e.g. "Blindeforbundet", a Norwegian federation for everyone with poor vision [48], "Action for Blind People", a charity in the UK which provides support to people that are blind or partially sighted [49], and "World Wide Web Consortium (W3C)", a community working together to create web standards [50]. These web standards are meant to be used as guidelines for making usable interfaces for the general user, regardless of age or disabilities [47]. These three organisations are just a few out of several others with focus on making technology accessible for elderly and people with visual disabilities.

We will now present a summary of guidelines to consider when designing an interface for elderly, gathered from the three organisations mentioned above. The numbering of the guidelines will continue from the numbers presented in the previous section as all these will be used together as guidelines when developing the exergame.

X	This is the letter X in Times New Roman, a widely used font. The lines have various widths, and there is a broader design at the ends.
X	This is the same letter in Arial. This font is easier to read for those with visual decline. Here the lines are equally wide all over, without the expansion at the ends.

Table 5.1: Fonts with and without serifs [modified from [45]]

Make the text easy to read

g.24 Use a relatively large font size, minimum 12 pt [45]. A font size of 14-16 pt is preferable for those who are visually impaired. For large prints 16-22 pt should be used [46]. Use of font size larger than 20 pt will not increase readability in a text [45].

g.25 Use a clear print. This mean that a sans serif font should be used (see Table 5.1). Arial, Helvetica and Futura are fonts that are easy to read [46].

g.26 Avoid fonts with special styles [45] [46].

g.27 For titles, use upper-case letters in beginning of words [46]. Do not use capital letters in large amounts. They give little variation, which makes the text difficult to read [45].

g.28 Do not use italics, underlining and bold typing in a larger coherent text, that will disturb the reading [45] [46].

g.29 If possible, allow the users to change font and text settings themselves [45] [47].

g.30 Use a language with ordinary, well-known words. This makes the text more easy to understand [47].

Use simple design

g.31 Use simple design, as this makes it easy for important elements to stand out [46].

g.32 Be consistent in design and layout throughout the system [46].

g.33 Always use left-aligned text. Centered text appears unclear [46].

g.34 Keep spacing between words permanent. Do not stretch the text to get an even right margin, as this will change the spacing randomly. An uneven right margin is good for readability, as it help leading the eyes to the next line [45] [46].

g.35 Do not use too much or too little spacing between lines [45] [46].

g.36 Avoid big blocks of text. The text will be easier to read and understand if it is divided into smaller sections [45] [46].

Use of colours and contrasts

g.37 It is important with sharp and clear contrast between background colour and font colour to ensure good readability [45] [46]. The actual choice of colours is not that essential.

g.38 In general, the most preferred combination of background colour and font colour is black text on either white or yellow background [46]. Black on white or yellow creates a very good contrast [45].

g.39 People are different. Some might prefer the opposite, like light font colours on dark background [45]. This again suggests that it should be possible to customise settings. When using light font colours on dark background, the font should be both bigger and bolder to make the text more readable [46].

g.40 Avoid pale colours on coloured background [45].

g.41 Choose a one-coloured background. Try not to write text on pictures. The picture will take the attention away from the text, and make the text harder to read. If necessary, put the text where there is light areas in the picture [45].

g.42 Reading speed is also highly connected to colours and contrast [45]. Black text on white background provides the highest reading speed in a text. For more combinations, see Figure 5.1.

Reading speed
Black on white
Green on white
Blue on white
Black on yellow
Red on yellow
Red on white
Green on red
Orange on black
Orange on white
Red on green
Black on purple

Figure 5.1: Relationship between choice of text and background colour, and reading speed. The best combinations are those shown on top. (Translated from Norwegian, [45])

g.43 By choosing text and background colour according to the surrounding environment, readability can be increased [45]. Table 5.2 shows appropriate colour combinations for four environments. These combinations are meant for digital information boards out in the real world. The choice of colours will also make the board stand out from its environment.

Environment	**Background**	**Text**
Red brick, dark stone	White	Black, dark green, dark blue
Light brick, light stone	Black, dark	White, yellow
Whitewashed wall	Black, dark	White, yellow
Green vegetation	White	Black, dark green, dark blue

Table 5.2: This figure shows how text and background colour should be chosen according to the environment to ensure good readability. (Translated from Norwegian, [45])

Provide accessible information

g.44 Provide alternatives for how to present information. For those who are visually impaired, an audio presentation might be preferable [45] [47].

g.45 Text is a better way to present information than use of images and icons [47].

g.46 Give the users time to read the given information. Let them tell the system when they are finished reading [47].

g.47 Help users to easily navigate to the content of interest [47].

g.48 Assist users on how to avoid and correct mistakes. Describe the error for the user, and provide a suggestion for how they can undo the action that caused the error [47].

The characteristics and guidelines drawn from previous studies together with the official guidelines proposed by "Blindeforbundet", "Action for Blind People" and "World Wide Web Consortium (W3C) will become very important when we develop a concept for an exergame for elderly. To understand how to design this exergame, we also have to understand how video games in general can be designed. This will be described in the next chapter.

Chapter 6

Video Game Design in General

Developing a concept for an exergame require us to understand what elements a video game is built up from. There are different phases of video game development, where making a design document is the phase video game designers are mainly concerned about. This design document consists of several aspects of the video game, which are important for the developer to describe. These aspects will be important in our further work on the exergame.

First, in Section 6.1, we will present what a design document is. Then we will describe important elements that a video game should consist of, and that should be included in the design document. This can be found in Section 6.2.

6.1 The Design Phase

Four phases of video game development are discussed in [30]: *a conceptual phase*, *a design phase*, *a pre-production phase* and *a testing phase*. The phase game designers are mostly concerned about is the *design phase*. This includes making a design document, which goal is *"[...] to fully describe and detail the gameplay of the game"* [51]. The design document should at least include the overall story line of the game, the different levels in the game world, what the players are allowed to do in the game and how they do it. In addition, the design document will describe what characters and objects will be included in the game world [51]. With a complex story line, the details can be described in a separate document. Text illustrations, mock-ups and concept drawings can be included [30], however, these can also be presented in separate documents [51]. Flow charts can be used in the design document to visually show decision making in the game, and are quite useful for scenarios where a lot of branching are involved. The design document can include technical details [30] or not [51], depending on who specifies the document. The technical specification focus on how the functionality will be implemented.

How a design document is made varies, and there are no definite solution on how to make them [51]. In this section we have provided a brief overview of what a design document usually includes. When we in Chapter 10 describe our concept, this can serve as a beginning of a design document for developers.

We will now move on to the next section, where we will describe the different elements that need to be included in video games.

6.2 Characteristics of Video Games

Game designer Sid Meier came up with one of the most famous definitions of a game: *"A game is a series of interesting choices"* [30]. This of course, does not apply for every video game. A very useful tool for designers to understand games, was developed by Robin Hunicke, Marc LeBlanc and Robert Zubeck, and is called the MDA-model. This model divides games into three elements: *mechanics*, *dynamics*, and *aesthetics*. *Mechanics* are not what we can see or hear, but rather the rules and basic code of the game. An example is the algorithms that lie in the ground for creating the reaction pattern of a computer-controlled character. *Dynamics* are based on the mechanics and describe what events do and can occur during the gameplay, seen from the players point of view. *Aesthetics* are about everything that can be experienced by the player [30].

The MDA model has its limitations. It is very simple and it does not really represent how gameplay works. Also the aspects around playing experience fall outside this model, as well as the expressive side of the game. However, the writers of the book we have used as a foundation to describe video games, "Understanding Video Games", suggest that Sid Meier's definition and the MDA-model provide the most salient definitions of a game, and works good for helping developers in their design work [30]. In this thesis the *aesthetics* is the most important element, because this involves all the aspects that players experience, and it describes the entities that actually form a game. Gameplay is in [30] an entity that falls under aesthetics. However, since this is an important entity, we will provide an own section for this. We will also describe the importance of a story, with settings and characters. First we present what aesthetics are and represent. Some definitions and words used in this chapter might differ from how these words are used in real life. We will remind the reader that this chapter describes video games, which have virtual worlds, and it will therefore include some terms that would not be used in the same way in real life.

6.2.1 Aesthetics

The aesthetics describe everything that can be experienced by the player. These are the elements that actually make the game. The aesthetics can be divided in three, namely *rules*, *geography and representation*, and *number of players*. The rules say what the players can and cannot do, as well as what actions will make the score increase or decrease. The geography and representation element says how the video game is represented through graphics and sound. Here there are a lot of different design possibilities. The number of players is important, because there are big differences between a single-player game and a multi-player game [30].

We will now look closer into the three different categories.

Rules

In "Understanding Video Games", they distinguish between two types of rules [30]: *interplay rules* and *evaluation rules*. The former are the physical laws in the gamespace, and determines what properties the different elements in the game should have, what can be done, as well as what will happen corresponding to the player input. An example of this is "What will happen when the player presses button A? Jump". The latter defines what rewards and punishments that will be given at certain actions [30].

Geography and Representation

Geography and representation are about how the game is represented through graphics and sounds [30]. Graphics and sounds are used to set the games environment and enhance the players enjoyment of the game, but has no effect on how the game is played [52].

Graphics
Graphics are needed in a video game to in a best possible way imitate

Perspective	First person	Third person		
Dimension	2	3		
Space type	Torus	Abstract	Free	
Off-screen	Dynamic	Static	None	
Scroll	Vertical	Horizontal	Free	None
Exploration	Forced	Free	None	

Table 6.1: Basic graphical game characteristics [30].

reality and enhance the player experience. This means that, instead of telling the players what is going to happen, it will be shown visually [52]. There are many aspects to consider when it comes to how the game should be represented. Table 6.1 shows an overview of basic geographical and representational characteristics [30]. We will only discuss the choice of perspective, dimension and exploration.

It has to be decided if the game will be two-dimensional or three-dimensional and if it should be in first-person or third-person [30]. Two-dimensional graphics are represented by only two coordinates and do not have any depth. This makes a very unrealistic scene. Three-dimensional graphics, on the other hand, have depth, and are therefore more realistic. All games will either have a first-person perspective, a third-person perspective, or a mix of both. In a first-person perspective, the game is played through the characters' eyes, while in a third-person perspective; players can see the characters they control through the game. Games will also either have an isometric perspective or a top-down perspective. Isometric perspective is when three-dimensional objects are presented in a two-dimensional form, like in an architectural drawing, while a top-down perspective is, as the name suggests, when the scene is shown from above. The choice of perspective is important because it decides how the player will perceive the game world. It is important to choose the right perspective with the right dimension. A third-person game can be played in a two-dimensional and a three-dimensional space, while a first-person game should only be played in a three-dimensional space. Exploration says whether the player can move in the game at forced or desired pace [30].

There are various ways to present a game graphically. Aki Järvinen identified three different styles common for video games [30]:

- *Photorealism:* is defined as *"a style of painting that tried to completely mimic photographs"* [30]. There are two subcategories of photorealism: *Televisualism* tries to give the same visual look as shown on the television. This is commonly used for sports games. *Illusionism* is the other category. Here it is non-realistic content presented as photorealistic content. An example of this is when zombies or similar objects are presented in a way that seems like it is in real life.

- *Caricaturism:* Here so called caricatures are used. Caricatures are drawings that present an object by exaggerating the prominent features of the object, and often give the feeling of a cartoon.

- *Abstractionism:* In this category there are no real people or real-life objects involved. Instead the game has a rather abstract form. An example is the well-known game Tetris. A problem with these kinds of games is that they often face a hard time on the market. This is because humans mostly get attracted by the story, and it can therefore be hard to create attention just around the mechanics of the game. Therefore, it is within this category very important with the story [30].

Sounds
Sounds are important in video games for the same reasons as why graphics are important. Background music can set the atmosphere of the game, as well as give an indication on when actions will change and if the atmosphere is changing, like from happy to sad. Sounds can also be used as feedback to the players [52]. It can be distinguished between four categories of different sound types in a video game [30]: *vocalization*, which is the voice of the characters in the game, *sound effects*, which are sounds made by the different objects in the game, *ambient effects*, which are non-specific sounds that makes the atmosphere in the game, and *music*, which is the game's

soundtrack, and also a part of setting the atmosphere. The latter is a very important part of the game. Elements that can affect sound effects are *the environment*, *spatiality* and *physics*. An example of how the environment can affect the sounds is what kind of floor the characters are walking on or what kind of weather conditions there are in the scene. The sound will also be affected by where in space it will come from. For example, a sound from far away sounds different from a sound close up. In addition, sound will be affected by movements. Imagine the sound of the sirens on a fast passing ambulance [30].

Number of players

The number of players is an important choice because it affects a number of game elements. In a single-player game, artificial intelligence (Artificial Intelligence (AI)) is important because the player has to play against the computer and not real humans. The computer can never be as intelligent as the human brain, and generally has a very limited set of strategies. Therefore, it can be easy for an experienced player to win over the opponent. When designing multi-player games, AI is not necessarily needed, as the player will play against other human players. In multi-player games it has to be possible to distinguish between characters. This can be done by giving them different unique features. At the same time, making any character superior should be avoided. It is also important to facilitate social interaction between the players, like for example cooperation or competition. Often in multi-player games, it is possible to chat with the opponents or team members [30].

6.2.2 Gameplay

Siang et al. states that *"[...] gameplay is the most important element when designing a game"* [52], and it is defined in [30] as *"the game dynamics emerging from the interplay between rules and game geography"* . Gameplay

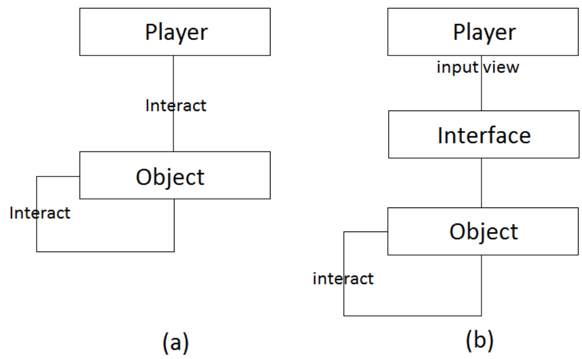


Figure 6.1: (a) Gameplay independent of player experience, (b) Gameplay depended of player experience (modiefied from [52])

is a result of the game's rules, while the feeling of the gameplay is influenced by the sounds and graphics. The dynamics can be of different types. They can be entertaining or they can be predictable, or they can be none of those. In a video game, everything really depends on the gameplay because it defines how the game is played. In short, gameplay can be describes as the interaction between the player and the game [52]. There are two different kinds of interactions: player-object and object-object [52]. When creating a game, a set of rules about what kind of interactions can be made have to be set. These rules are set by determining which kind of interactions that are allowed between the two components: players and game objects. Siang et al. describe the player-object interactions in Figure 6.1 (a), which is a description of gameplay, set aside the players experience [52].

As a part of gameplay there is a user interface. The interface is necessary to enable interaction between the player and the object. The visual representation of gameplay is shown in Figure 6.1 (b). The interface is where and with what the player interacts with the game and includes the input that is sent through the input devices, like a game control, and the output the user receives on the screen and through the speakers [52].

6.2.3 Story

One important element of a video game is the story, or the narrative. The story is included in the game to make the involvement and enjoyment better for the player [52]. Different events make up the narrative and will usually contain settings and characters [30]. The story is just a part of the game, and not the actual the game. Unlike literature and film which centres on the story, the game centres on play. Therefore, the narrative should be looked at in a player-centric context [53]. Players often make their own story throughout the game [52]. This means that the game designer creates the background story line, while the player creates the experimental story while interacting with the game.

Narratives can be described through three different categories: *The fictional world*, *Mechanics*, and *Reception* [30].

The fictional world

This category includes settings and actors, which also can be thought of as the *what* and *who*. In [54], these are described as objects. Objects are defined as the elements that form the gameplay by adding depth, atmosphere and interactivity to the setting.

There are defined three categories of objects [54]:

- *Structural-objects (static):* These objects do not change visually and are in the game to add functionality. Examples are trees, table, walls.
- *Interactive-objects/entities (dynamic):* These objects will react to the input from the player and other events in the game and will add more functionality to the game. The character is an example of an interactive-object.
- *Scripting-objects (behaviour):* These objects are not physical, but they are conceptual parameters that adds functionality to the the

other object-types. The parameters say how the objects will react to events. One example is a game manager that contains parameters like number of life and high scores [52].

The game space, which is the *game setting* or *location*, is an important part of a game. The game space is a reproduction of the features from the real world and contains specific rules to make it possible to play the game. There are different characters in a game, which can be divided into four categories [30]:

- *Stage Characters:* These characters can not be interacted with, and serve more as a part of a scenario.

- *Functional Characters:* These are also just a part of a scenario, but in addition, they have a general function, which makes it possible for the player to interact with them.

- *Cast Characters:* These have specific functions in the game that have to do with the story.

- *Player Characters:* These are the characters that the player is in control of.

The different characters can be constructed in different ways. They can be constructed through description, which means through the way we can see them on the screen. This can be done in a symbolic, naturalistic or a "real-life" way. See Table 6.2 for examples.

Type of description	**Example**
Symbolic	Red haired girl is diabolic
Naturalistic	Villains are ugly, while heroes are good-looking
Real-life	David Beckham as a football player

Table 6.2: Different ways to describe characters [30].

The characters can also be described through their actions, through their relationship to space, through other character's views, or just through a meaningful name. The player character is the most important type, and was by Toby Gard divided in three different categories, in accordance to how easy the player will identify with them. The different categories are *avatars*, *actors* and *roleplaying*, and are defined as:

"Avatars are a non-intrusive representation of ourselves, actors are always part of a story (or have a story, albeit minimal sometimes), and roleplaying characters have very different abilities that we can raise according to our performance". [30]

Usually, use of avatars implies that the view is in first-person, which means that the avatars cannot be seen. With the use of actors, the view will be in third-person, making it possible to see the characters in the game. In addition, actors will usually have a personality and they are well integrated in the story, while an avatar usually does not have a personality at all. Roleplayers are quite different. Here the players create their own characters. The player can choose their name, and their abilities, as well as if they want to play in first-person or third-person.

Mechanics

This category describes how to organise narrative actions. There is a basic concept for how to organise the story in a game, which is called "branching". This means to have multiple paths in the story.

Figure 6.2 shows the standard progression of a story of linear fiction. In traditional stories, it goes through a resolution. This cannot be applied in a game, because it would not let the player do anything. Therefore, a model of interactive fiction is applied for a game. As shown in Figure 6.3, this model has no continuous curve. In this model it is more about finishing each chapter by solving puzzles, and it relies on the emotional satisfaction the player gets from the victory of solving a puzzle. Even though an action

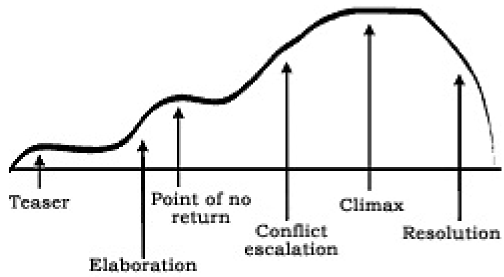


Figure 6.2: A model of classical linear fiction [30]

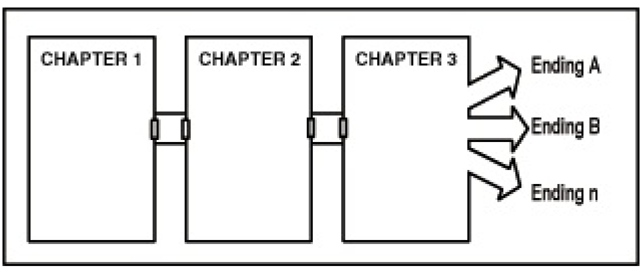


Figure 6.3: A model of interactive fiction [30]

in a game can lead to different endings, the player is actually solving a story. These games are called *progression games* because the player has to finish different actions and chapters, before proceeding. The different chapters are cumulative, meaning that each chapter is building on each other. It is very common in these kind of games that it is a climax or a resolution at the end of each chapter, like "fight the boss" [30].

The other structure of narratives is *emergence games*. This structure depends on a more active artificial intelligence (AI) where all the objects in the game have behaviours. To understand the difference between progression games and emergence games we provide an example directly drawn from "Understanding Video Games": *"In a progression game, the dragon will always attack the player when she steps into the cave, but in an emergence game, this might depend on how the player behaves towards the dragon, which is a more "active" object with a few possible different responses"* [30].

To be able to easily explore the smaller events in a game, game designers are making so called "quests", which are the missions players have to perform in the game. When the different quests are defined, it can be put together and be told as a story. The role of the quests can be described in this way: *"ideally, quests are the glue where world, rules and themes come together in a meaningful way"* [30].

In this chapter we have discussed different elements of a video game. These are important elements that need to be studied to understand video games, and can be used both for evaluating existing games, and for developing new games. These elements will be used as a framework for structuring the functional design of the exergame concept. This can be found in Section 10.3.

Chapter 7

System Design in General

In the previous chapter we learned about the different elements that need to be included in a video game, and we will now look into system design in general. When developing a system, there are several aspects to take into consideration. What is the system going to be? What functionality shall the system hold, and what should the system look like? Who are the users, and what are their needs? What software should the system be built upon? There are many questions to be asked and figured out before starting with the development. In this thesis the system is an exergame, the users are elderly people and the exergame will be developed for the Microsoft Kinect technology.

In this chapter we will present theory about some important aspects of system development. We will in Section 7.1 look into general guidelines for how to design a system. An important part of system design is to set up system requirements. This will be presented in Section 7.2. We will also discuss various aspects of usability, which is important to take into account in the process of system development. This will be found in Section 7.3. The aspect of usability is especially important when developing this exergame, due to the users' inexperience with technology. At the end of this chapter we will present a list of heuristics for games, implemented in a model of "flow". This model will serve as a good way to evaluate video games' usability and for developing games in an early phase.

7.1 The Four Pillars of Design

It is the work of an interactive system designer to combine the sense of what attracts the user with system functionality. To help these designers develop successful systems, a theory called the four pillars of design has been developed. The four pillars of design does not guarantees brilliant systems, but it could be helpful along the way in a development process. The four pillars of design consist of *user interface requirements*, *guidelines documents and processes*, *user-interface software tools* and *expert reviews and usability testing* [44]. Each of these pillars will be briefly described next.

User Interface Requirements (Ethnographic Observations)

As a part of a development process, designers have to specify system requirements. Here, a key to success is to identify and understand the users and their needs, and from that specify user requirements. The way to state these requirements differs from system to system, but what the final result always should include is the same, the system's *context of use*: who should use the system, where should it be used and what should it be used for [44]. A good way to understand the users well enough to specify user requirements, is to observe users in action with the system's context and environment. However, the user requirements are only a part of the system's overall requirements. These overall requirements, will, in addition to the user requirements, include specification of software, hardware, response time, etc. All these aspects are important to specify, as it is the overall requirements that form the foundation for the development of the system [44] [55].

Guidelines Documents and Process (Theories and Models)

It is important for the interactive system designer to generate a document that obtains a set of guidelines which specifies how the design should be. This could be design guidelines for the whole system, or it can be design guidelines for parts of the system, like functional design, implementation design, and interface design. Companies like e.g. Apple uses guidelines documents to specify design principles developers should follow. This is to create consistency in design across systems and products. Design may differ as different systems have different needs, but there are still some elements that should be considered in the guidelines document. It is important that the guidelines are flexible, so that they can adapt to changes in needs and experiences [44]. Examples of what guidelines should describe are:

- Words, icons, and graphics.
- Screen-layout issues.
- Input and output devices.
- Action sequences.

User-Interface Software Tools (Algorithms and Prototypes)

In the early stages of development, it is difficult for users to picture what the final result will look like. One way to address this problem is to let the users get a realistic impression of the final result, by presenting different types of mock-ups and prototypes of the system [44]. What prototypes are, and how and when they should be used, will be presented in Section 8.1.1. When deciding on which development environment to use, there are numbers of good products to choose from. Most of them are easy to use, and offers good features. The important part is for the developers to choose the development environment that is most suitable for the product they are going to make, due to performance, cost, and how easy it is to use and learn [44].

Expert Reviews and Usability Testing (Controlled Experiments)

To be able to launch a successful system, it is important with testing along the way in the development process. System testing could involve both experts and the intended users [44].

These four pillars of design form the basis for system development, and, as we see, includes the users along the way in the development process, from system specification to the testing and evaluation phase. This relates to the cycle of user-centered design, which will be described in Section 8.1.

7.2 System Requirements

To be able to make a system, designers must start by finding out what the system actually is going to be, what it should do and what functionality that should be included. Finding out and documenting all this is called a requirement analysis. The requirements in this analysis should focus on the role and the purpose of the system, in accordance to the environment the system should be used in. They should include what is essential to the system, and avoid details that are unnecessary. *How* the system is going to be realised, is not common to include in the requirement analysis. From a requirement analysis it is natural to produce what is called a requirement specification [56]. Requirements specification is defined in [55] as *"A specification that sets forth the requirements for a system [...]. Typically included are: functional requirements, performance requirements, interface requirements, design requirements and development standards"*. The different requirements are often separated into two categories, *functional* and *non-functional requirements*. The former specifies *what* functionality the system shall offer, while the latter is about *how* the system shall realise the functionality.

7.2.1 Functional Requirements

Functional requirements specify which behaviour, services and functionality the system shall offer its intended users [55] [44]. Functional requirements are related to the system's context of use, and describe functionality that will be seen by the user. Some examples are listed in [55]:

- *Requirements to ideal functionality and services according to the users' needs and wants.*
- *Requirements to knowledge about the role of the system, and the environment the system should be used in.*

Functional Design

Functional requirements will be used as a primary input to functional design. Functional design should describe the complete functionality of the system that can be seen by the users, and is defined as *"what the system shall do in a way that can be compared to the functional requirements. [...] it provides a basis for selecting the implementation. It is therefore idealised with respect to the concrete system and will hold for a range of technical solutions"*. Functional design is independent from technology and will not say anything about how the system is going to be implemented [55].

7.2.2 Non-Functional Requirements

Non-functional requirements include performance requirements, interface requirements, reliability and availability requirements, error handling, and constraints. Performance requirements address speed, capacity and memory usage. Reliability and availability requirements specify reliability in quantitative terms, and the amount of time the system should be available to the users. Error handling is about how the system should respond to errors, and interface design says how the system will interact with the users. Constraints restrict how the system should be designed and implemented. This is done by describing accuracy, tool and language to be used, design constraints, which standards that should be used, and the hardware platform the system should be built upon [56]. To summarise: making non-functional requirements is done to ensure quality of a system, and it describes constraints on hardware, software, and the implementation of the system in general [44]. These requirements are hidden from the users' point of view. Examples of non-functional requirements are presented in [55] as:

- *Requirements to physical interfaces.*
- *Requirements to physical conditions like temperature, humidity, power, consumption etc.*
- *Requirements to processing capacity: response times, traffic load etc.*
- *Requirements to exception handling.*

Implementation Design

Non-functional requirements form a basis for implementation design. While functional design is about what the system shall do, implementation design describes how the system should be realised. Implementation design connects the technical solution with the functional design, which makes the "manual" for how the final system will be implemented [55].

An important part of developing a system is to decide and specify functional and non-functional requirements. It is not always easy to distinguish between the different requirements, in terms of which category they belong under. It is important to notice that categorisation of requirements is not the essential part. What is the main goal is to define and express the requirements as clear, simple and understandable as possible [55]. A visual representation of the development process, from requirement specification to implementation, is shown in Figure 7.1.

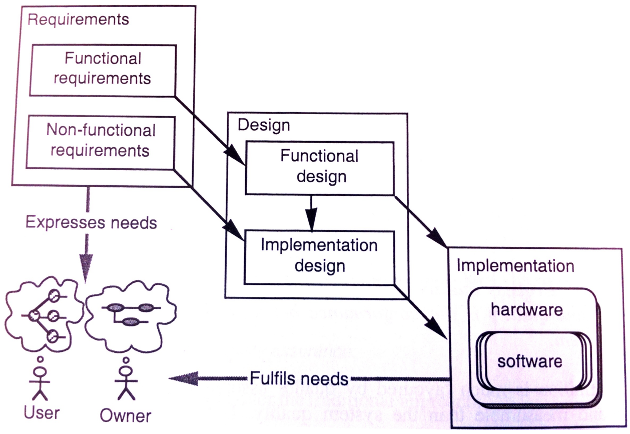


Figure 7.1: This figure shows the development process from requirement specification to implementation of the system [55].

7.3 The Importance of Usability

When developing a system it is important to keep usability in mind. This term says how easy it is to use, learn and understand a human-made system [44]. Usability is often used in association with technology development, in terms of making digital systems understandable and intuitive for the users through user-friendly interfaces. Usability has played a huge part in the evolvement of bringing digital systems into people's homes and everyday life. The first computers and digital systems that were developed consisted of complex and not understandable applications that only professionals with special knowledge could use. There was little focus on simple and accessible systems, and complex interfaces were actually appreciated and gave the system credibility. First, when computers and digital systems were developed with the intention of being used by the normal user, developers had to think about usability. The developers had to put the user in center of the computer system, and not only focus on functionality and system features [44]. Users are no longer just "computer professionals", but normal people in all age groups, with different skills and interests, that are both experienced and inexperienced with technology. Putting the users in the center of the system means that the users have to be included in the system's development process. This will be discussed in more detail in Section 8.1.

Usability is a wide and quite abstract term, and it is not easy to understand, measure, or practise right. ISO 9241-11 states usability as *"the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use."* [57]. From this definition we can see that there are three elements that could be helpful in evaluating a system's usability; *effectiveness*, *efficiency* and *satisfaction*. *Effectiveness* measures to which degree systems cover all necessary functionality, and how easy they are to use and understand. *Efficiency* is about how well different tasks are performed. This requires measurement on how much time that is used to accomplish a task. The last element is *satisfaction*, and is about the overall user experience. This could be measures through interviews, studies, questionnaires etc. The degree of satisfaction is important for the system to be accepted [44].

7.3.1 Context of Use

Context of use is an important concept within the definition of usability, and is defined in ISO 9241-11 as *"users, tasks and equipment (hardware, software and materials), and the physical and social environment in which a product is used"* [58]. The degree of usability and quality of user experience of a system is dependent on how well it is related to its specified context of use [59]. A system will be used by a specific population for specific reasons within a specific environment. It is therefore crucial that the system fits the needs of its intended users, tasks, equipment, and environment. Analysing a system's context of use will help developers to specify who the users are, what are their characteristics, which functionality do they want, and where and in which circumstances do they want to use it. This understanding about a system can be used all through the development process, from system specification to the testing phase [58].

7.3.2 Simplicity

"KISS" and "Less is more" are terms related to usability. "KISS" is an acronym that stands for "Keep it simple, stupid" [60]. This principle was formulated by the American aircraft designer Kelly Johnson in the middle of the 1900s [61], and it states that simple systems work better than complex ones. KISS is not related to stupidity, but rather to intelligent systems that due to their simplistic design may be perceived as stupid. The KISS principle has been adopted into software engineering, and subjects as design and usability. It states that simplicity should be the main focus in design, and that every element that leads to unnecessary complexity should be avoided [60]. Ludwig Mies van der Rohe was a German architect that used the term "Less is more" to describe his extreme simplistic and minimalistic design style. His use of that term became a guiding principle in modern design, and it has also been adopted as a widely used slogan in association with usability [62]. Minimalistic design can be described as *"design at its most basic, stripped of superfluous elements, colors, shapes and textures"* [63]. With minimalistic design, the most important elements are brought into focus. In this way the user will not be distracted from, or miss out on, the content that is important [63]. Also big companies, like Microsoft, focus on simplicity in their design. Microsoft has launched an article called "The Importance of Simplicity" in their developer network. This is about how to design user-friendly systems while still keeping good functionality. In this article, Microsoft presents a topic called "Simple Can Be Powerful", which means that simplistic design not necessarily implies lack of functionality. Simplistic design will provide ease of use for first timers. The idea is to present a design that is intuitive, understandable and easy to learn, with a possibility for the experienced user to choose to add more functionality. A possible solution could be to include customisation so the users can set up their own workspace, and include more features if wanted [64].

Making good, intuitive, easy to understand systems is essential for a system to be successful, accepted and used. A system can possess the best functionality there is, but if the users do not understand how to use it, the system will fail.

7.4 Design Guidelines

In order for a system to become successful it has to be easy to interact with, and it has to offer functionality that is attractive to the user. There have been developed several guidelines to help designers make successful, user-friendly systems. In this section we will present a list of eight principles with focus on interface design, called "The Eight Golden Rules".

7.4.1 The Eight Golden Rules

The "Eight Golden Rules", presented in [44], are a set of guidelines that have been developed over three decades with research and experiences. It does not exist a solution for how to make good and user-friendly interface design, but these "Eight Golden Rules" can serve as a starting point and a helpful design guide if they are used correctly. When using the "Eight Golden Rules", it is important that designers refine and implement the principles into the environment they are working in.

We will now present the "Eight Golden Rules" [44]:

e.1 *Strive for consistency:* Consistency in interfaces requires identical terminology for actions and layout. This is important for users not to wonder whether words, icons or situations mean the same.

e.2 *Cater to universal usability:* Designers have to see the need for making a design that fits the diversity of users. There could be differences in age and technology experience that require transformation of content. Beginners would need guiding and explanations, while experts should have features for shortcuts. This could improve quality of the system experience.

e.3 *Offer informative feedback:* The users should always receive feedback on their actions. Appropriate system feedback should be chosen in accordance to the importance of the actions performed. Process bars, sound as a response for clicking a button, or visual presentation for showing objects in actions, are possible ways to give users feedback on actions.

e.4 *Design dialogues to yield closure:* It is important to create distinct work steps in dialogues. This means organising similar actions into separate groups with a clear start, middle, and ending. To provide users with a feeling of accomplishment, feedback should be provided when a particular sequence is finished.

e.5 *Prevent errors:* The best solution to this problem would be not to experience any errors at all. Designers should prevent users from doing serious errors by e.g. not allowing inappropriate digits in a field or "hiding" buttons that could cause errors. However, when errors do occur users should be provided with informative instructions for how to recover from the problem.

e.6 *Permit easy reversal of actions:* Users should always be provided with the possibility to regret a performed action. This will make the system easy and comforting to use, as users know that every action can be undone.

e.7 *Support internal locus of control:* Users should feel that they are controlling the interface, and not the other way around. This might be especially important for experienced users. Surprising changes in design and actions, in addition to boring, time-consuming situations, will not be well received.

e.8 *Reduce short-term memory load:* Designers should reduce the need for memorising information and how actions should be performed. The focus should be on designing an interface with visible information and intuitive actions.

These presented guidelines are far from being the only guides for how to design a user interface. There have been done a huge amount of research in the area of usability. Jacob Nielsen is one of the researchers [65]. He is a Ph.D from Denmark, and an expert in human-computer interaction. He has established a movement for how to easy improve user-interfaces, invented several methods for how to achieve good usability, and he has also published a great amount of articles and books with usability as main subject [66]. As a part of his work Nielsen has created a list of ten usability heuristics, which can be used as general principles when designing a user-interface [65].

7.5 Heuristics

Heuristics are guidelines made to assess how good software design is, and it has become a widely used method for usability evaluation in software development. As learned from this chapter so far, it is important to develop software interfaces that are easy to understand, learn and conduct by the users. Heuristic evaluation methods allow for insight into users' point of view, even before there is an actual system. It is actually best suited in an early phase, before spending a lot of money on expensive prototypes [67]. The heuristics developed by Jacob Nielsen are made for software development in general. These can be found in [65]. We sought to find heuristics that were more applicable for game development.

We found that a lot of research has been done on heuristics for games and different sets have been suggested. Some worth mentioning are Desurvire et al. [67], Malone [68], Shelley [69], and Federoff [70]. Many of the heuristics overlap, and in some way, they all tell the same.

Sweetser and Wyeth [71] discovered that many of the heuristics proposed in the literature, did not evaluate the enjoyment in games. They argue that the many valid sets of heuristics presented in the literature should be integrated into a model where also player enjoyment can be assessed. How much someone enjoys something can be described by the concept of flow. The concept of flow was first proposed by Mihaly Csikszentmihalyi, when he many years ago started to study how people could be so immersed and engaged in something they did not get money for. He wanted to find out why they did these things. He found that the reason was the enjoyment they felt when doing it. He called this state "flow" because *"many of the respondents described the feeling when things were going well as an almost automatic, effortless, yet highly focused state of consciousness"* [72]. Sweetser and Wyeth integrated the already existing heuristics into the model of "flow", and called this new model "GameFlow". They argued that the nature of flow fits well as a way to structure the different heuristics found in the literature, into a model of player enjoyment. The "GameFlow" model has eight core elements which are related to Csikszentmihalyi's defined elements. The core elements are: *concentration, challenge, skills, control, clear goals, feedback, immersion* and *social interaction* (see Table 7.1, 7.2, and 7.3) [71].

These heuristics are proposed generally for games, and every aspect does not have to fit every type of game. However, based on guidelines discussed in Chapters 3 and 5 we find most of these aspect relevant also for an exergame for elderly. Therefore, the GameFlow model will be used in our further work, both when evaluating older people's enjoyment of existing commercial games, and when designing the exergame concept. How this model relates to our exergame concept will be presented in Chapter 10 and discussed in Chapter 12. To come up with a game suitable for elderly people, this user group has to be involved in the development phase. We will now move on to the next chapter, where we will discuss the methods used to involve the user in the development process.

Element	**Criteria**
Concentration Games should require concentration and the player should be able to concentrate on the game	Games should provide a lot of stimuli from different sources.
	Games must provide stimuli that are worth attending to.
	Games should quickly grab the players' attention and maintain their focus throughout the game.
	Players shouldn't be burdened with tasks that don't feel important.
	Games should have a high workload, while still being appropriate for the players' perceptual, cognitive, and memory limits.
	Players should not be distracted from tasks that they want or need to concentrate on.
Challenge Games should be sufficiently challenging and match the player's skill level	Challenges in games must match the players' skill levels.
	Games should provide different levels of challenge for different players.
	The level of challenge should increase as the player progresses through the game and increases their skill level.
	Games should provide new challenges at an appropriate pace.

Table 7.1: GameFlow criteria for player enjoyment in games, part 1 [71]

Element	Criteria
Player Skills Games must support player skill development and mastery	Players should be able to start playing the game without reading the manual.
	Learning the game should not be boring, but be part of the fun.
	Games should include online help so players don't need to exit the game.
	Players should be taught to play the game through tutorials or initial levels that feel like playing the game.
	Games should increase the players' skills at an appropriate pace as the progress through the game.
	Players should be rewarded appropriately for their effort and skill development.
	Game interfaces and mechanics should be easy to learn and use.
Control Players should feel a sense of control over their actions in the game	Players should feel a sense of control over their characters or units and their movements and interactions in the game world.
	Players should feel a sense of control over the game interface and input devices.
	Players should feel a sense of control over the game shell (starting, stopping, saving etc.).
	Players should not be able to make errors that are detrimental to the game and should be supported in recovering from errors.
	Players should feel a sense of control and impact onto the game world (like their actions matter and they are shaping the game world).
	Players should feel a sense of control over the actions that they take and the strategies that they use and that they are free to play the game the way that they want (not simply discovering actions and strategies planned by the game developers).

Table 7.2: GameFlow criteria for player enjoyment in games, part 2 [71]

Element	Criteria
Clear Goals Games should provide the player with clear goals at appropriate times	Overriding goals should be clear and presented early.
	Intermediate goals should be clear and presented at appropriate times.
Feedback Players must receive appropriate feedback at appropriate times	Players should receive feedback on progress toward their goals.
	Players should receive immediate feedback on their actions.
	Players should always know their status or score.
Immersion Players should experience deep but effortless involvement in the game	Players should become less aware of their surroundings.
	Players should become less self-aware and less worried about everyday life.
	Players should experience an altered sense of time.
	Players should feel emotionally involved in the game.
	Players should feel viscerally involved in the game.
Social Interaction Games should support and create opportunities for social interaction	Games should support competition and cooperation between players.
	Games should support social interaction between players (chat, etc.).
	Games should support social communities inside and outside the game.

Table 7.3: GameFlow criteria for player enjoyment in games, part 3 [71]

Chapter 8

Methodology

When creating technology systems, focus on usability is important. Meeting the users' needs and wants is essential to make a successful product or service. To achieve this, the user needs to be involved in the development process. Data gathering is crucial for understanding what users want and to establish requirements for the systems. The primary methods used in this thesis are experimental simulation, and qualitative research methods like participatory observation and focus group interviews. In addition, support methods like video and audio recording, and a questionnaire are used. We arranged two sessions, which we have called workshops. The definition of a workshop is *"A meeting at which a group of people engage in intensive discussion and activity on a particular subject or project"* [73]. This definition fits well with both our sessions. Workshop 1 was organised as an experimental simulation, as defined by McGrath [74]. A group of relevant users was invited to participate in an experiment that was created as natural as possible. Based on the findings from workshop 1, in addition to findings from the literature, we developed requirements for a video game concept, as well as a design which we have presented both textually and by medium-fidelity prototypes. This concept was presented in a second workshop with the use of prototypes, storytelling and acting. The users were engaged to discuss the concept in a focus group. This session is described as workshop 2.

In the first part of this chapter we will discuss the importance of user involvement. Then, in Section 8.2 and 8.3, the relevant research strategies and methodologies used in this thesis to meet the requirements of user involvement will be discussed. As a part of this, ethical challenges with the research methods chosen will be acknowledged. We will also discuss the different criteria that can be used to evaluate the quality of the research. This will be provided in Section 8.5. At the end of this chapter we will give a thorough presentation of the executions of the two workshops conducted in this thesis, as well as how we worked on developing the exergame concept. We will here describe how we have used the different methods described in the first part of this chapter. This will be found in Section 8.7, 8.9 and 8.8, respectively.

8.1 User Involvement

There is no definitive solution on how to make a good and user friendly system, and it is challenging and time consuming to find the users' needs. For a system design to experience success interaction designers have to pay attention to various aspects of the user. The best way to do this is to involve users in the process of developing the system, from requirement definition and the design phase, to prototype and system test, all to the end of the system's life cycle [44]. ISO 9241-210 describes why it is important to include users in system development:

"Involving users in design and development provides a valuable source of knowledge about the context of use, the tasks, and how users are likely to work with the future product, system or service. User involvement should be active, whether by participating in design, acting as source of relevant data or evaluation situations [...]" [75].

User involvement focus on finding future users of the system to be made, and let them take part in decision making during the development process [76]. User involvement provides the opportunity for developers and future users to meet and discuss topics and issues related to the system. This gives the users knowledge about system features and functionality, and it makes it possible for developers to get to know and understand their potential users and what they want and need. Participating in the development process will give users the possibility to influence how the final system will be. This could lead to a feeling of ownership, which again will increase the probability for users to accept and employ the final system. User involvement will also make it easier for developers to make good and user-friendly interfaces [77] [44]. The importance of user feedback is also supported by ISO 9241-210:

"Feedback from the users is a critical source of information in human-centered design. Evaluation designs with users and improving them based on their feedback provides an effective means of minimizing the risk of a system not meeting user or organizational needs (including those requirements that are difficult to specify explicitly)" [75].

Often the users themselves do not know what they want. It will not be possible to walk up to a potential customer and ask what he or she wants to have. However, this does not mean that a developer should be creative, come up with a great idea and bring it into life without ever talking to the user group. The development of a new system should be done as a cyclic process, where development and user involvement go hand in hand [44]. ISO 13407 presents four main activities included in this cyclic process of user-centered design. As shown in Figure 8.1, this process consists of; *understand and specify context of use*, as discussed in Section 7.3.1, *specify the user and organizational requirements*, which is about creating requirements for usability, design and constraints, *produce design solutions*, which is to use knowledge about human-computer interaction (HCI) to develop design solutions, and *evaluate designs against requirements* [57]. In addition, there are an initial activity, *identify needs for human-centered design*, which is about learning how to perform user-centered design. This includes aspects like understanding the users, reserving time and resources, and to plan when and where users should be involved during the development process.

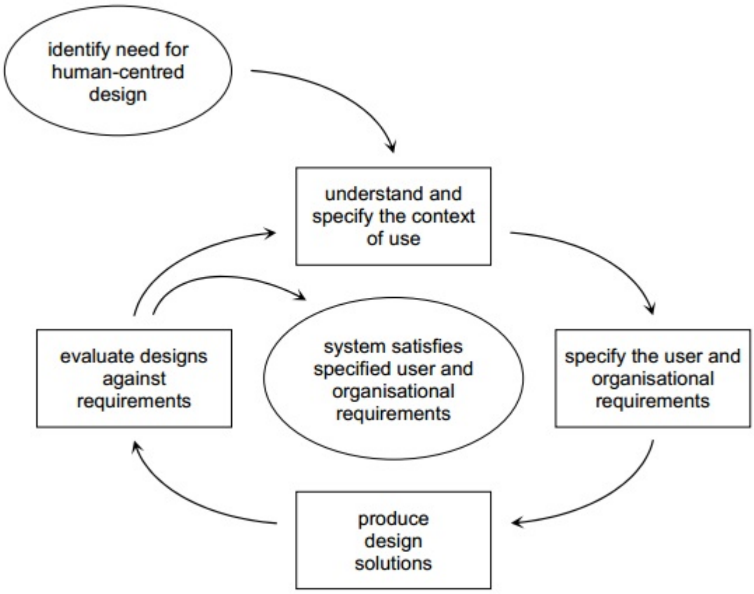


Figure 8.1: Activities of user-centered design, from ISO 13407 [57]

8.1.1 Use of Prototypes

We have now presented the importance of involving users from the start to the end in a system's development process. What might be difficult in the early stages of this process is to, in a realistic way, present for the users what the final system will look like. If the users start to get the wrong impression of the final system, it may lead to situations where the system design is finished and the users are left with the feeling of not being satisfied. This would be a problem, because of the high costs associated to making changes in the already implemented system. To try to avoid situations like these, designers introduce the use of prototypes [44].

Prototyping is a method used to evaluate, explore and express functionality and system design [78]. Prototypes are defined as *"a concrete representation of part or all of an interactive system. A prototype is a tangible artifact, not an abstract description that requires interpretation. Designers, as well as managers, developers, customers and end-users, can use these artifacts to envision and reflect upon the final system"* [79]. The use of prototypes is helpful for designers in terms of creating and presenting ideas in a realistic way, and to get feedback from users on what they have created. Prototypes are also helpful when designers have to choose between various design alternatives. They make it easy to express and consider ideas, and they support creativity among all people, regardless of their experience with technology. They also communicate functionality and system design between designers and the users and customers, which makes it possible to evaluate the system early in the development process [79] [44]. *"Prototypes reveal the strengths as well as weaknesses of a design. Unlike pure ideas, abstract models or other representations, they can be contextualized to help understand how the real system would be used in a real setting"* [79]. Not only do prototypes make it possible for designers to get feedback from users, but it also helps them further analysing the users' needs.

There are several ways to make prototypes, from simple sketches on paper, to up-and-running software systems. Designers distinguish between low- and high-fidelity prototypes [79] [78] [44], where "fidelity" refers to how close the prototype is to the final design. Low-fidelity (lo-fi) prototypes are usually presentations of design concepts on paper [44] [80]. Normally these are paper sketches, story-boards, and mock-ups. Advantages with the use of lo-fi prototypes are that they promote creativity, and that they are fast, cheap and easy to make and change. Generally, no software systems are used to make these prototypes [80], which makes it possible for all sorts of people to take part in the design, as no specific knowledge is required to participate. High-fidelity (hi-fi) prototypes present the final result in a more realistic way than lo-fi prototypes [44]. These can be related to what is called "software prototypes", because they are computer dependent. This could be videos, programmed systems, animations, or applications made with various design tools [79]. Hi-fi prototypes include partial or finished implementation of functionality. What is negative with these prototypes is that they require more time, cost and knowledge to be made, and that the use of various programming languages or development tools could restrain creativity.

In addition to lo-fi and hi-fi prototypes, there are horizontal and vertical prototypes. With horizontal prototypes a wide range of functionality are shown, without the underlying functionality implemented. This gives an overall presentation of the functionality and design from the users' point of view. With vertical prototypes, fewer functions are shown, but in return, these functions are implemented. These prototypes will usually show functionality from the system level [79] [81].

"An important characteristic of HCI systems is that they are interactive: users both respond to them and act upon them" [79]. Interactive systems can be complex, and it can therefore also be difficult to design prototypes that present these systems. In addition, when designing a prototype, the designer has to think of how the user can interact with it. How the prototypes are presented to the users is critical on how they will understand the system. There can be designed prototypes that the user will not be able to interact with. These are usually used to present scenarios. There can also be made prototypes, both paper prototypes and software prototypes that users can interact with. In between these situations, there is something called the "Wizard of Oz" [79]. Here one person will control or act as the interactive system, while another person is in the role as the user. Which method used to present the prototype is not the main issue, what is most important is that the users *feel* that they are interacting with the system.

To be able to identify crucial design questions, it is highly important that designers figure out what the prototypes are meant to prototype. Houde et al. present in [78] a model which addresses this particular issue. This model takes the systems *role*, *implementation*, and *look and feel* into consideration. *Implementation* is about the techniques and components used in the system.

The *role* is about the systems function in the users lives. *Look and feel* involve the users experience and perception of the system, like what the users can feel, see and hear. The model is presented in Figure 8.2. Placing the prototype in this figure will describe what the prototype is meant to explore [78].

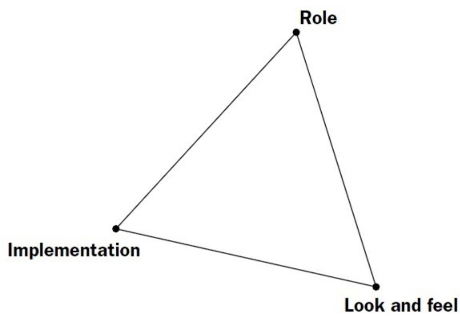


Figure 8.2: A model of what prototypes prototype [78].

8.2 Choosing the Setting for Our Study

When doing research there are three criteria you would like to maximise [74], [82]:

- Generalizability of the evidence,
- Precision of measurements, and
- Realism of the study context.

However, it is not possible to maximise all three criteria because if you do something to increase one criteria, you are likely to decrease another. In our study, we have conducted two workshops. The first workshop was an experiment we put together, which we tried to make as realistic as possible.

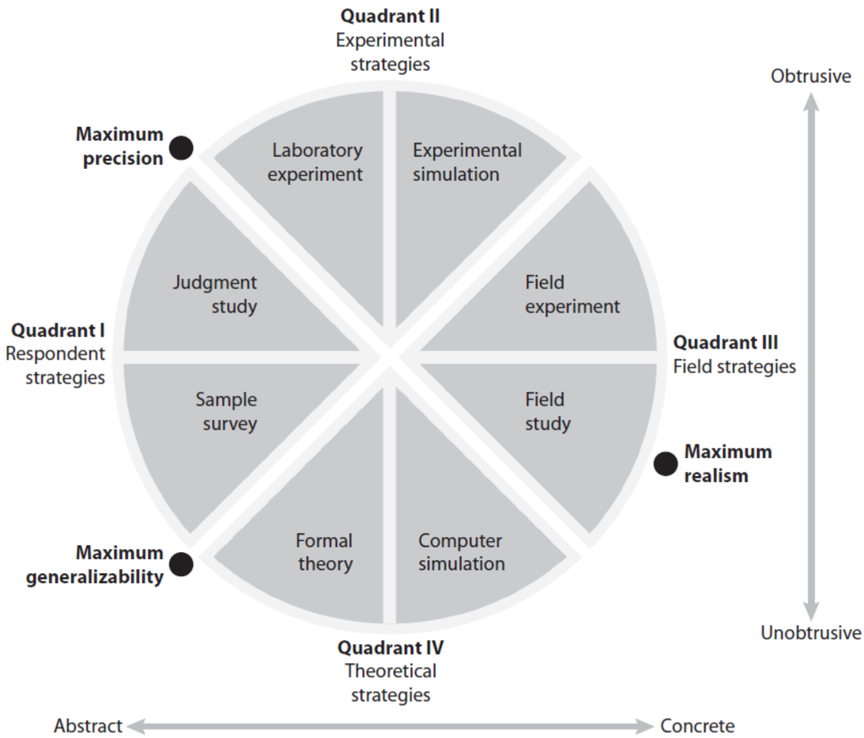


Figure 8.3: The strategy circumplex (modified by [82] from [74])

Therefore, realism is the most important criteria and is the one we want to maximise as much as possible.

There are different research strategies that can be used. Sometimes it is hard to find one that fits exactly to what you as a researcher want to do. The strategy circumplex by McGrath is shown in Figure 8.3. This figure presents eight different strategies [74]. As can be seen from the figure the different strategies are arranged in a way on whether they are abstract versus concrete, and obtrusive versus unobtrusive. The figure also shows at which strategy the three different criteria, generalizability, precision and realism, are at their maximum. We studied this circumplex to find where our study fits in. We found one of the strategies from quadrant 2 appropriate. Within this quadrant there are two different strategies, *laboratory experiment* and *experimental simulation*. In the former strategy the researcher puts together a setting and invites some individuals to enter the setting and act by the defined rules. Here the researchers typically know what behaviour they are looking for and can within this setting study this with precision. The second strategy is *experimental simulation*. At the same time as trying to get the precision, as in a *laboratory experiment*, the researchers also try to get some more realism like the strategies in quadrant 3 do. This means that the researchers are setting up a situation like in the *laboratory experiment*, but at the same time are trying to get some realistic behaviours from the participants, and at the same time keeping precision and control. The *field experiment* strategy within quadrant 3 was also considered because we found it in some ways suitable for our study. This strategy, compared to *field study* which has maximum degree of realism, opens up for being a little more obtrusive, and in that way give up some of the realism. We wanted to create an as natural setting as possible, and to implement the study in a place familiar to the participants. However, as defined in [74]: *"The essence of both of the strategies in quadrant 1 [shown as 3 in this figure], the field study and the field experiment, is that the behaviour system under study is "natural", in the sense that it would occur whether or not the researcher were there and whether or not it were being observed as part of a study"*. In contrast, the behaviour derived from the two strategies within quadrant 2, would not have been apparent if it were not for the researchers doing the study, which is the case in our study. Even though no study is fully under only one strategy, we define workshop 1 as an *experimental simulation*. It is important to understand that even though this strategy is less realistic, the study is still real and the behaviours gotten from the participants are real, however influenced by the setting [74]. Because the *experimental simulation* never can be as realistic as the *field study*, there will be an error in the information gathering, which can pose validity issues [82]. The validity of our research will be discussed in Section 12.4. How the experimental simulation (workshop 1) was set up will be discussed in Section 8.7. We will now discuss the research methods used to gather data from workshop 1 and 2.

8.3 Qualitative Research

Qualitative research is a method used to get an in-depth understanding of a phenomenon [83]. This research method is well suited when studying sensitive and personal topics, in addition to when studying topics where little research have been done. The focus is on how and why things are done, and not on how many who does it, like in quantitative methods. Quantitative methods include huge samples, while qualitative methods can give more information about a small sample. Interpretation is very important in qualitative methods, as well as flexibility and openness. With flexibility it means that the scheme should have the possibility to be changed during the research, if needed [83].

The qualitative research process can be divided into phases, which partially overlap [83]. The first phase consists of defining what the research will find out. We have done this by defining research questions which we have presented in Section 1.1. The next phase is the data gathering phase. This phase can be performed with several methods. The following phase includes interpreting and analysing the data, as well as formulating theories. In the last phase, the results will be presented. There are four different data gathering methods described by Thagaard [83]:

- Observation
- Interview
- Document analysis
- Analysing of video and audio recordings

The most common methods are interviews and participatory observation. It is common in qualitative research to have a close connection between the researcher and the people who is being studied [84]. This especially applies in these two methods. The people that the researchers get information from can be described by the term *informant* [83]. The contact between the researcher and the informants is important for the data the researcher will gain from the study [83]. The interview method and the observation method will be described in more detail later in this chapter.

In most qualitative methods it is common to textually document the data that is being analysed. The documentation can include what people do, their statements, their intentions or their perspectives. The text can be notes from the field or printouts of recorded interviews [83].

8.3.1 Ethical Challenges

The close contact established between the researcher and the informants introduces some ethical challenges. All results conducted from the research need to be precisely and correct when presented. This also includes other researcher's work, which must be cited properly to avoid plagiarism. When working in close contact with informants, the researcher often gets personal information about them. Personal information means information that can be linked to individuals. When information like this is going to be gathered, the project needs to be reported. In the case of research projects performed at universities in Norway, the project needs to be reported to Norwegian Social Science Data Services (NSD), which is an entity in care of data protection for these institutions. NSD will evaluate each project in accordance to research ethical rules [83]. In this thesis we will arrange two workshops. The data gathering methods used here will require us having a close connection with the informants, as well as gather personal information about them. In addition, we will video record and audio record the workshops. Therefore, this thesis has been reported to NSD (see Appendix E).

Ethical Guidelines:

Tjora suggests that common politeness should be a basis for ethical research [84]. However, some additional rules need to be followed.

Informed Consent:
In a research project with people involved, there is a requirement that the researcher has the informant's informed consent. This means that the informants have gotten all the information they need to know about the participation. They have self-chosen to participate, and they know that they can withdraw at any time without any consequences. [83]. To get informants to our study we held a presentation for a group of relevant people, where we described the project and the workshop. In addition, all informants got an information letter, with a short description of the project and information about what they were going to participate in, and their rights. Every senior that participated in the workshops gave us their written consent.

Confidentiality:
The researcher is required to keep all the information they collect about an informant confident. This means that the information has to be anonymous. This also involves strict requirements to how personal data, that makes it possible to identify individuals, should be stored and annulled. There are rules about how long data can be stored. General principles say that data should be stored for only the amount of time there is use for it, and that data which can be directly linked to an individual should be stored separately and not electronically. Reuse of data is not allowed without consent from the informants [83]. In this thesis we have signed a non-disclosure agreement to assure the informants that we will not reveal any confident information about them. In addition, we have assured the informants that all data collected will be deleted within 3 years after the project's end.

Consequences of participating in research projects:
The researcher is responsible for the informants' safety and should respect their wishes. It is important to have thought through what consequences the execution of the research may have for the informants. The researcher is required to protect the informants' integrity during the process [83]. In our workshop, all informants were allowed to choose what they were comfortable with doing and not doing. In addition, they were, as mentioned, allowed to withdraw at any time without consequences.

The consent form with all its information and confidentiality agreements can be found in Appendix F. This form was signed by all informants, and by us. Every informant got a version signed by us.

8.3.2 Observation

Observation, or as often called ethnography [84], is used when researchers want to see how a group of people behave in a specific setting [83]. The social world will be studied in its natural setting, to get a real and natural view of it. Researcher can understand what people actually do, instead of just getting what people say they do, like in an interview [84]. When doing observation, an important decision to make is how to perform in the field. This varies from project to project. The observer can be a participant or just an observer, and the observation can be open or undisclosed. Participatory observation is something in between being a complete observer, where the researcher keeps herself in the background, and a complete participant, where the researcher participates in the same way as the informants. This involves the researcher being present in the setting with the participants while observing how they act. The researcher participates in the session, in the sense of interacting with the informants while they are performing the tasks. However, this does not mean that the researcher does the same as the informants. Participatory observation is well suited in research of a new and immature topic [83].

In most research it is important to study behaviour in the informants own environment, because this will give a more natural behaviour. However, it is important to acknowledge that the informants may not find the environment "natural" when the researcher is observing them. How the researcher presents the project to the informants is important to gain interest among the people they want to observe. The researcher should in a trusting way, present herself and the project [83].

Video Recording

An advantage with using video as a tool for observing a situation is that you get a detailed representation of what happened in the situation. Together with the field notes taken, this will give a close to complete representation of the situation [84]. To get an as realistic rendering as possible, it is important to decide the right camera angle. The quality of the recordings will also have an important impact on the data you get from it. Therefore, the video recordings have to be seen as one of more possible representations of a situation. An advantage about using video recording is that it gives the researcher the opportunity to look through the recordings and see the situation over again. In this way, events that the researcher might have missed during the observation can be discovered. Video recording is also a useful tool in a situation where the researchers are unfamiliar, and when they do not know what they are looking for. In addition, this method makes it easier to do the data analysis together with other researchers, which can make the quality of the research stronger, giving more diversity, as well as detailed, complete and accurate interpretation [84].

It is very common to combine observation with interviews. This is for the researchers to verify or discard the understanding they have acquired during the observation. We will now describe in more detail the use of qualitative interviews and focus groups interviews.

8.3.3 Qualitative Interviews

Interview is one of the most important tools used in qualitative research [85]. Interviews are typically used when a researcher wants to get comprehensive information about peoples' views and opinions about a topic. There are two extremities in interview methods: unstructured and structured [83]. The former is more like a conversation between the researcher and the informants. The topic is chosen, but there is no interview guide involved. In that way questions can be adjusted during the interview. The latter has a structured form, with chosen questions. The advantage with this method, is that all informants will answer the same questions, and the answers can therefore be compared. The most common type of interviews is called semi-structured interview, or qualitative interview. This method is something in between the two extremities [83]. It includes an interview guide, where some questions are decided beforehand, but the order in which the questions are asked is chosen during the interview. In this way it is easier to follow the story of the interviewee. In addition, the researcher needs to be open to discuss other topics that might appear during the conversation. The most common interview setting is with only one individual. However, focus groups have become more and more common. In a focus group interview, several people discuss a topic, while the researchers serve as moderators. This can be more effective, because more data can be gathered. It can also seem less intimidating for the informants, as they are discussing topics, instead of having an in-depth interview alone. The informants stimulate each other, which can give more aspects of the informants' experience, as well as more spontaneous answers. In addition, this stimulation can be a source for new thoughts and reflections [84].

Tjora discusses how a focus group can be organised [84]. Basic rules presented are that a session should last for one to two hours, and have 6-12 participants. But there can also be mini-focus groups with 3-4 participants. Usually in the latter setting, the participants are experts on the topic. In a focus group, one or more moderators are used to lead the discussion. They will take notes to be able to follow up topics that appear during the session, and to come up with new topics [84]. To get a successful interview, it is important that the researcher has an understanding of the informants' situations for the questions to be relevant. Questions should be asked in such a way that the informant can reflect over the question and not only answer "yes" or "no" [83].

Audio Recording

To be able to get everything that is being said in the interview, it is common to use audio recording. When this is used, it is necessary with a complete transcription of the material after the interview is finished. One smart rule is to always transcribe a bit more detailed than what the researcher think is necessary. When going from audio to textual presentation, it is common to lose some visual clues, as well as the tone in the interview. However, if the same researchers are performing the interviews, the transcribing, and the analysing, they will most likely remember the different events [84].

8.3.4 Questionnaire

Questionnaire is an information gathering method used to collect the same kind of information about a huge amount of people [86]. From its nature, this method often falls under the category of quantitative research, but it can also be used for other types of research. Questionnaires give the researchers an effective way of gathering a lot of information that they can analyse. Questionnaires contain predefined questions for the informants to answer, and are usually used if the researcher wants to find a pattern so that the results can be generalised to a larger population [86].

8.4 Analysing Qualitative Data

After the data gathering phase is completed the data has to be analysed and interpreted. This analysis is important so that the reader of the research can understand the field being studied without having to go through every detail of the data material. Tjora presents a way to do this which is called Stepwise Deductive Inductive Method (SDI) (directly translated from Norwegian) [84]. He proposes this method as a tool for inexperienced researchers to get help with the data generation and data analysis. The goal of this method is conceptualising. From Figure 8.4 you can see that you can work both upward and downward. The upward model is inductive, and means that you are working from data to theory, while the downward model is deductive, and works the other way around. We have applied the first analytical approach to process and analyse our data.

The first step in this model is data generation and processing of data. This forms the analysing data. In the next step, coding of this data will be done. This means to put notes on interesting findings. The codes can be words and phrases describing interesting parts of the data material. The point is to try to reuse the codes if they fit to other parts of the findings, or to come up with new codes when new, interesting findings are discovered. After finishing through all the data material, you end up with a set of codes. The codes should only be developed from the data gathered from the research, and not a priori. A natural link between the set of codes and the data material should exist. Usually, from a large data set you get too many codes to structure the data analysis properly. The next step is therefore to categorise the codes. This means to gather relevant codes in groups within the same category. Here it is the research questions which lies in ground for what is relevant. The categories will usually be the main topics for the research's results. All work that has been done up to this point has been done with the gathered data from the research as a basis. The next step from here is to develop concepts. The categories, or main topics, that were developed in the last step, will now be related to theories about the topic. Tjora distinguishes between concepts and theories [84]. He

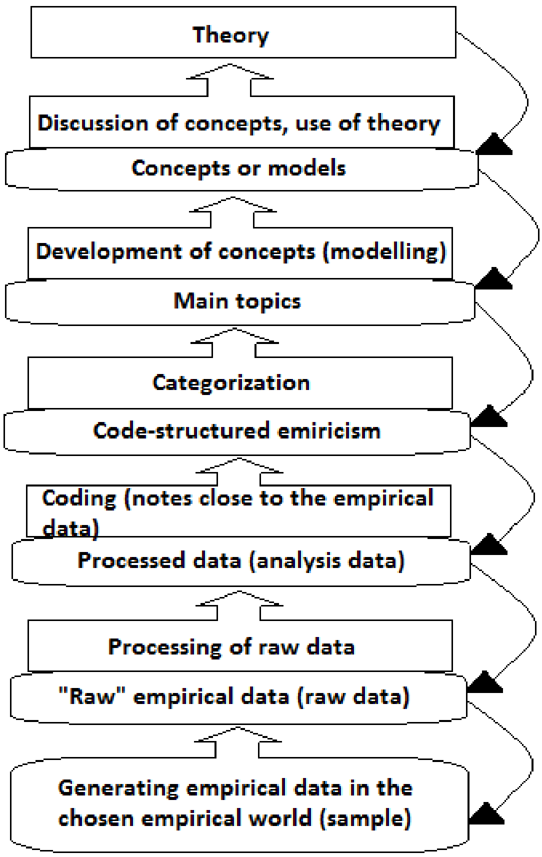


Figure 8.4: Stepwise deductive inductive method (SDI) (The figure is translated from Norwegian from [84])

defines a theory like this: *"For a concept to have status as a theory, it has to be falsifiable and verifiable"* (translated from Norwegian) [84]. However, development of theories is not done in all research, and it is quite common to use the concepts as legitimate results. In some type of research, setting up the main topics or categories and a discussion of these, can also be accepted as publishable results [84]. This is what we have done in this study.

8.5 Quality of Research

It is important to evaluate the quality of the research. As discussed earlier in this chapter, we want to maximise realism as much as possible in workshop 1. However, experimental simulation is not completely realistic, and will therefore introduce an error which can pose validity issues [82]. This error must be acknowledged and discussed. To evaluate the quality of the research, we will use the three criteria discussed by Tjora in [84]: *Reliability*, *validity* and *generalizability*. In addition, there are some possible pitfalls when doing qualitative research that need to be acknowledged. We will discuss these elements in the next sections, and further discuss the quality of our research in Section 12.4.

8.5.1 Reliability

It is important to distinguish between what is data from the research and what is the researcher's own analysis. By using direct citation the reliability of the research will be strengthened. How the informants have been chosen, and the relationship between the researcher and the informants, are important aspects for the reliability. Tjora also discusses the researcher's role in the study, which should idealistically be neutral. However this is impossible to maintain and it is therefore important to discuss how the researcher's position in the study can have an impact on the result [84].

8.5.2 Validity

"Is what we have found the answers to the questions we were actually trying to answer?", is a relevant question when evaluating the validity. Tjora talks about communicative and pragmatic validity [84]. The former gets tested with the research environment. This means that the research is related to relevant theories and to previous studies done within the same topic. The latter can be tested with the question on if the research leads to changes or enhancements. The former is the one we primarily care about in the type of research we have done and in other types of social science research. The validity of the research will be even more strengthened by being open about how the research has been performed and by explaining why certain data gathering methods have been used and the reasons for theoretical input [84].

8.5.3 Generalizability

Some type of generalizability is a goal for most research. Tjora presents three kinds of generalizability within qualitative research [84]: *naturalistic generalizability*, *moderate generalizability*, and *conceptual generalizability*. The first is when the researcher describes the details of what have been done in the study so good that the readers of the study can evaluate for themselves whether the findings are valid for their research or not. The second is about the researcher describing in what type of settings the findings will be valid, i.e. at what time, at what places, or in what context. The last one, and also the one Tjora expresses his interest over, is about developing concepts, typologies, or theories that also can be relevant for other cases than the ones being studied. One of the reasons why Tjora has his interest in the last form for generalizing is because this relates to the goal of the SDI-model [84].

8.5.4 Other Quality Aspects

In addition to the three main criteria, Tjora also discusses the importance of transparency [84]. The goal about this is that the readers should get good enough insight into the research so that they can evaluate for themselves the quality of the research. Thus, transparency is about presenting and discussing questions, such as how the research has been conducted, the different choices that have been made, and what kind of problems that arose. In addition to the criteria presented by Tjora, we have looked into some issues discussed by Myers and Newman [85]. They summarise a set of possible pitfalls when doing qualitative research, and in particular when doing qualitative interviews [85]: *artificiality of the interview*, *lack of trust*, *lack of time*, *level of entry*, *constructing knowledge*, *ambiguity of language*, *elite bias*, *interviews can go wrong* and *Hawthorne effects*. The only two of these aspects we believe might have affected our data gathering are *elite bias* and *Hawthorne effects*, where *elite bias* is about issues related to only interviewing one type of people, and *Hawthorne effects* are related to people behaving differently because they know they are being observed. This will be discussed in more detail in Section 12.4.

We will now move on to describing the different phases of our work, which methods that have been used and how we have been working.

8.6 Recruitment of Informants for the Workshops

In line with the importance of user involvement we had to recruit a group of relevant users of the exergame. The relevant user group consists of senior males and females, both healthy and frail. Because of time and practical limitations, we contacted an already established group, called "Seniornett". "Seniornett" is an organisation in Norway which works to include the older generation (55 years +) in the emerging information technology and to help them gain digital competence. The organisation was founded in 1997, and is represented in every county in Norway. Each semester the local clubs arrange 3-4 meetings with different topics related to technology, as well as an one-hour weekly meeting with technology assistance [87]. Even though this group includes elderly people who are interested in learning about new technology, which we have learned is not common for all seniors; we decided that this was a natural place to start recruiting for our workshop. This group could still have the same physical limitations, but may have a higher understanding of technology than other seniors.

We contacted the manager of the club in Trondheim and briefed him about our project. He invited us to present the topic of our master thesis in their next meeting, which was 25th of February 2013. This presentation would both serve as a contribution to this organisation, as well as a promotion of our project. The latter was mostly to gain interest in participating in the planned workshop. The presentation was mainly about the evolution of computer and video games from the beginning until today. As a part of this, we provided a presentation of serious games, and in particular exergames. We also had a demonstration where we played two games from "Kinect Sports: Season 2", shown on a big canvas. We played tennis with only one player, and showed them the possibility of multi-play with the skiing game. Since the main topics for the presentation we held for "Seniornett" are not the main interest in this thesis, we will not discuss the presentation any further.

After the demonstration and the following discussion, the aim for the workshop was presented and the audience were invited to participate. They were told that to make a user-friendly game, it is important to involve the relevant users, and that their help would mean a lot for our work on developing an exergame concept. We also explained what was expected from them in the workshop, and that it would be video and audio recorded. In addition, they were informed that participating was voluntary and that the project is legally reported to NSD. Everyone in the audience got a document containing information about the project and a consent form, see Appendix F. Four people signed up at that time. Four people signed up later by e-mail.

During and after the presentation the audience had some comments and questions. This feedback will be taken into account in our further work, but for convenience, we will discuss them together with the findings from workshop 1 in Chapter 9.

8.7 Execution of Workshop 1

The preparation and the execution of workshop 1 will now be described. We will describe the purpose of the workshop, provide general information about informants, location and equipment, and present how the workshop was set up and performed.

The primary goal for the first workshop was to introduce the informants to the Xbox Kinect technology and to three commercial games. We wanted to observe how they interacted with the technology and how well they enjoyed playing. This does not fall under the immediate understanding of the definition of observation, as this is to gain understanding of a "natural world" [84]. This setting can rather be a future scenario of a possible "natural world". An experimental simulation was therefore performed. The planned exergame was in our previous study [8] evaluated to suit well in a clinical setting at physiotherapy clinics, or/and in a training group setting. Therefore, we tried to create an as realistic small training group session as possible, in an environment familiar to the informants. Even though the environment was familiar, playing Xbox Kinect is not. However, we evaluate the setting, to be as natural as possible at this time. After the play session, we had a focus group interview. This was to verify or discard some of the things we observed, as well as discuss the informants' experiences. The interview was semi-structured. We had an interview guide with some predefined questions, but at the same time held the conversation open, so that potential new topics could be included. The questions were developed from what we have learned from the literature to be important aspects when it comes to elderly and exergames, and technology in general. The guide also covered questions about their attitude about the use of an exergame. The questions were adjusted from what we observed during the workshop. The interview guide can be found in Appendix H. In addition, a questionnaire was used to in an efficient way gather information about who the informants were, and their attitudes towards exercising and technology in general. The questionnaire can be found in Appendix G.

From the observation and the focus group interview, we wanted to learn what did and did not work with the existing games. From this, we wanted to understand and specify the context of use for the new exergame, in line with the first activity of user-centered design (see Figure 8.1).

8.7.1 General information

The workshop was held over a two day period, the 13th and 14th of March, with location at "Gulhuset, Voll gård", a place familiar to the informants from "Seniornett". The workshop started around 2 pm and lasted approximately three hours. Eight informants were recruited from "Seniornett" to the workshop, three males and five females. They were divided into two groups, one for each day. One of the recruited females had an accident, which hindered her to participate in the workshop. We therefore ended up with seven informants. The informants average age was 70.6 years (with a standard deviation of 7,9 years). In addition to us and the informants, we had two other researchers with us the first day who assisted us. The second day our supervisor, Professor Lill Kristiansen, assisted us.

In advance we had sat up an agenda for how we wanted to carry out the two workshop days, see Table 8.1.

Introduction	15 minutes
Questionnaire	10 minutes
Single-play	15 minutes for each informant
Multi-play	10 minutes for each informant
Group discussion	65 minutes

Table 8.1: Agenda for workshop 1

Location and Equipment

We used "Gulhuset, Voll gård" as location for our workshop, because it is a location well known for the informants. This location is used for various events, like theme lectures, song meetings, and story-telling gatherings, and has couches, tables and chairs, and a small kitchen where it is possible to make coffee and something to eat. "Gulhuset" was ideal to use for the workshop, not only because it is familiar to the informants, but because it was possible to make a living room-like atmosphere. It was also appropriate because it is a place where we imagine that elderly could meet and play a future exercise game. "Gulhuset" also possesses a screen and a projector, which we used for our introduction. However, during the gaming session we chose to use a 46" Samsung flat screen. This was to make the gaming experience as natural as possible, as most people do not have screens and projectors. We borrowed the flat screen from our department at NTNU. In addition to the flat screen we had a Xbox, a Kinect sensor and three commercial games, which were used for the gaming session. This equipment was bought with support from NTNU's research program on video games.

In the workshop both video and audio recording were used to be able to give our complete focus on the informants. We rented a dictaphone, two video cameras (a Sony Handycam and a Panasonic 3MOS) and racks for each cameras. We wanted to use two video cameras to be able to make recordings from different angles. One video camera was placed in the front of the room to capture movements and facial expressions. The other one was placed in the back to see movements from behind, in addition to the interaction with the Kinect sensor and the games. The dictaphone was used for the focus group interview. Coffee and cake were served to make a cosy atmosphere.

8.7.2 Chosen games

We spend some time looking for suitable games for the workshop. We evaluated the different games by reading reviews, looking at videos on YouTube and trying some free demos online. We chose three different commercial games: "Fruit Ninja", "Your Shape Fitness Evolved 2012", and "Kinect Sports: Season Two". These games all provide some different properties that we found important for our study.

Fruit Ninja

"Fruit Ninja" is a game where the player has to use her arms like a ninja to slice fruit that is thrown up into the air. The goal is to slice as much fruit as possible in a short period of time, without hitting bombs that are thrown up together with the fruit. This game features simultaneous multi-play with both competition and cooperation. Figure 8.5 shows a screen-shot from the game where two players cooperate to slice as much fruit as possible. The reason for why we chose to use "Fruit Ninja" in the workshop was to present the informants for a game based on pure fun and entertainment, with a concept far from something one might experience in real life.

Figure 8.5: A screen-shot of two players playing "Fruit Ninja" together [88]

Your Shape Fitness Evolved 2012

"Your Shape Fitness Evolved 2012" is a popular exercise game for Kinect. This game has over 90 hours of activities, which can be used to design individual workout programs. "Your Shape Fitness Evolved 2012" follows the player's shape, fitness level and goals, and uses this to schedule the difficulty for the activities. The player has the possibility to choose exercises for specific muscle groups, she can join classes like jump rope, cardio boxing and yoga, or she can take a virtual run in New York or Paris [89]. In addition, "Your Shape Fitness Evolved" provides three Humana-sponsored [1] exercising games. These games are aimed to encourage fitness for two specific age groups: kids and elderly. In addition, it has a program to reduce high blood-pressure and strengthen the heart [90]. We chose to use the Humana game "Aging with Grace" to present a program that is specifically designed for elderly. This game is designed with exercise as the main purpose, and provides different aerobic movements. A virtual

[1] Humana is a health care provider, see http://www.humana.com/ for details.

personal trainer shows the player how to do the exercises and offers real-time feedback. In Figure 8.6 you can see a picture from "Aging with Grace", where the player (to the right) performs step touch together with the virtual trainer (to the left).

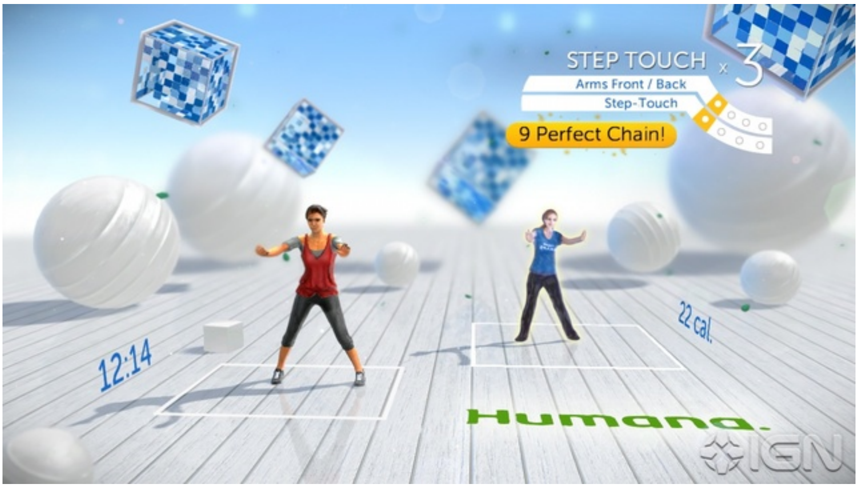


Figure 8.6: A screen-shot from a Humana-sponsored game in "Your Shape Fitness Evolved 2012" [90]

Kinect Sports: Season Two

"Kinect Sports: Season Two" is a game that consists of a bundle of six sports, which are tennis, darts, baseball, American football, skiing and golf. These sports stimulate movement and activity in a fun and motivating way; however exercise is not the main focus. "Kinect Sports: Season Two", depending on the sport chosen, offers both competitive and cooperative multi-play. Figure 8.7 shows the two chosen games: skiing and tennis. Figure 8.8 shows two informants playing the skiing game together. We wanted to present this game for the informants because of its amusing and real-life activities.

(a) (b)

Figure 8.7: A screen-shot from (a) skiing, and (b) tennis in "Kinect Sports: Season Two" [91]

Figure 8.8: Two informants compete in the skiing game offered in "Kinect Sports: Season Two"

8.7.3 Execution

In the introduction we shortly presented ourselves and the background and main goal for our master thesis. We also informed about the purpose of the workshop, and presented the agenda for the day. The main part of the introduction was a review of the consent form, where we highlighted important aspects as video and audio recording and that participation was voluntary. After the introduction, the informants had some time to look over the consent form before they signed two copies, one for themselves and one for us. We then handed out a short questionnaire, where they were asked a few questions about themselves, their technology experience and their attitudes towards exercising (See Appendix G).

After finishing the first part we started the gaming session. This was divided into two parts, one part where the informants played games individually, and one where they played together in pairs. The order of which part that was played first was for randomisation changed from day one to day two. In day one of the workshop there were only three informants, so they took turns playing during the multi-player part. "Your Shape Fitness Evolved 2012" and tennis from "Kinect Sports: Season Two" were used for single-play, while "Fruit Ninja" and skiing from "Kinect Sports: Season Two" were used for multi-play.

Initially we wanted to start the play session without helping the informants. The setting was put together as close to a real group setting as possible. We wanted to observe how well the informants understood the technology and the games presented for them. We believed that this would give us a more realistic result. We started out like this on day one of the workshop. However, we experienced that the informants had problems understanding what they were supposed to do, which lead to frustration and a bad experience. Therefore, after finishing the individual games, and before starting the multi-player session, we explained how the Kinect sensor works and showed how to interact with the sensor. We also described the games they were going to play next, and the goal of the games. On day two of the workshop we started with the multi-player session and the informants were provided with the same introduction to the technology as before this session on day one. In the games that were played individually they had to go through the menu. We guided them when necessary.

After the informants had played individually and together in pairs we had a focus group interview. We asked them open questions about their experience of the technology and the gaming session. We wanted to know if they liked the games or not, and if so why or why not. It was also in our interest to find out if this technology was something the informants would use, and if they could imagine using it for exercise. Most of the time, the informants talked freely with us and each other.

The findings from this workshop will be presented in Chapter 9.

8.8 Defining System Requirements and Developing the Exergame Concept

We will now describe how we worked with the two next activities of user-centered design as presented in Figure 8.1: *specify the user and organisational requirements* and *produce design solutions*.

Before developing the requirements and the design we had to analyse the datya gathered from workshop 1. We textually transcribed every detail from the video and audio recording, and used stepwise deductive inductive method (SDI), as described in Section 8.4, to analyse this data. The transcribed data formed the analysing data. We ended up with a huge amount of analysing data constituting for over 25 000 words. The next step included the "coding" of this data, which means to put notes on interesting findings. In this project we did the coding by putting colours on the different areas in the material that had the same type of finding. We handled the transcribed audio and video recordings equally and ended up with 88 codes. The codes are many, which make it hard to structure the data analysis properly. Therefore, in line with SDI, we categorised the codes. We narrowed it down to 10 main categories (main topics), and this is the way we have presented the findings in our report. This can be found in Chapter 9.

From findings from the workshop, together with the findings done in the literature, presented in the earlier chapters, we specified system requirements for the exergame, with emphasis on functional and interface requirements. After these requirements were set, we had a creative brainstorming, where we tried to come up with a concept for the exergame (see Figure 8.9). As a part of this we looked through "Øvelsesbanken" [21] for relevant exercises. Defining requirements and coming up with a design, constituted for about two weeks of work. When the concept for the exergame was chosen, we used theory about video game design, as presented in Chapter 6, to describe the elements in the game.

Figure 8.9: Brainstorming on an exergame concept

We have developed prototypes to be able to present our concept. The different types of prototypes are discussed in Section 8.1.1. The prototypes we have made are horisontal showing all functionality and information that will be in the game, but they are not implemented. This means that interaction with them will not be possible. They only present the various functionality and scenarios from the exergame concept. Our prototypes are hi-fi in terms of being developed with software drawing tools like Photoshop, and because the prototype is quite realistic compared to what the final interface design will look like. However, they are lo-fi because no functionality is implemented. We will therefore describe our prototypes as medium-fidelity, including "the best from both worlds" [92]. In addition to the scenarios, we prototyped a menu with the use of PowerPoint. In Figure 8.10 we have placed our prototypes within the prototype model. Our prototypes are represented by a red circle by the corner that represents *look and feel*. This is because we wanted to get feedback on the experience of our exergame concept. The circle is directed a bit towards the *role* of the system, as we also had some focus on where the final system could be used. The prototypes were made with PowerPoint and Photoshop, because these are tools familiar to us, and it did not require a lot of extra time to learn how to use them. Since we were in an early stage of the development process of a potential exergame, we focused on simple and not too time consuming prototypes. We spent about one week making the prototypes. The complete presentation of the exergame concept can be found in Chapter 10.

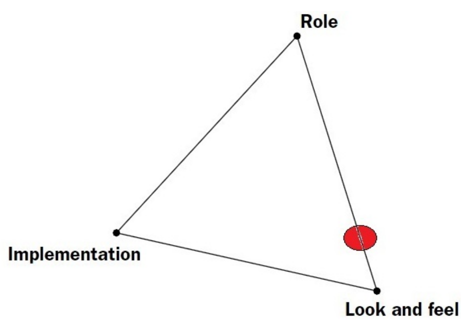


Figure 8.10: The red circle are placed to show what our prototypes prototype.

8.9 Execution of Workshop 2

The preparation and the execution of workshop 2 will now be described. We will describe the purpose of the workshop, provide general information about informants, location and equipment, and present how the workshop was set up and performed.

In line with the forth of the activities in the cycle of user-centered design, workshop 2 was performed to involve the user group in the development process, where they were to evaluate our design proposal. We invited all the informants that participated in workshop 1 to a second workshop where we presented prototypes of our exergame concept. The reason for inviting the informants to this second workshop was to get feedback on the prototypes, which is important when creating a user-friendly exergame for this group. This group of informants represents potential future users of the system, and can provide with knowledge about the interests and needs for this user group. In this workshop, we tried to give the informants a realistic impression of what an exergame could look like. The presentation was divided in three sessions. In between each session we had a focus group interview. We had an interview guide, but tried to keep the conversation as open as possible. The questions were directed towards the prototypes presented. The interview guide can be found in Appendix I.

8.9.1 General information

Workshop 2 was held the 25th of April at "Gulhuset, Voll gård", the same location used for workshop 1. We met at 1 pm and the total duration was approximately two hours. Four of the informants from workshop 1 chose to participate in workshop 2. In addition, the one female that was hindered to attend workshop 1 chose to participate in this workshop. The group consisted of three male and two female informants, with an average age of 74,5 years (with a standard deviation of 7,5 years).

Beforehand, we had sat up the agenda shown in Table 8.2.

Welcome and practical information	10 minutes
Findings from workshop 1	10 minutes
Presentation of our "Out in the Nature" concept	20 minutes
Feedback	30 minutes
Presentation of our "Picking Apples" concept	10 minutes
Feedback	20 minutes
Presentation of our menu proposal	10 minutes
Feedback	20 minutes
Summary and finish	10 minutes

Table 8.2: Agenda for workshop 2

Location and Equipment

We used the same premises as in workshop 1: "Gulhuset, Voll gård". For this presentation we only needed a laptop, a projector, and a screen. We used a private laptop, and the premises' screen and projector. Because of our desire to give our full attention to the presentation and discussion, we also video recorded this workshop [2]. This was done with the use of a video camera in front, because we wanted to capture facial expressions in addition to the oral feedback. The video camera was a Panasonic 3MOS, and was borrowed from our department at NTNU. To make a cosy and comfortable atmosphere, we served cakes and coffee.

8.9.2 Execution

We started the presentation with an introduction, presenting ourselves, the goal of the workshop, and the agenda for the day. Some practical information about duration, the video recording, and requirements due to anonymity were also presented. Then a short summary of workshop 1 was

[2] We were supposed to audio record the focus group interviews with the use of a dictaphone. Unfortunately, this went out of battery. However, we got all the data we needed from the video recording, so this did not limit our data gathering

given, as well as the most important findings from this workshop. We did this both to fresh up the informants' memory, and to give the new informant a recap of workshop 1. This was also done to give the informants an idea of what we have focused on when creating the exergame concept.

In this workshop we alternated between presentation and discussion, so that there would not be too much information to remember for the informants. First, we presented the overall idea of the concept, before we proceeded with a more detailed description of the exergame. We showed them prototypes of two different games. The games were presented one by one, with a focus group discussion for each of them. To make it easier for the informants to comment and discuss we handed out pictures of the prototyped scenes.

We showed the various prototypes and described what happened in each scenario. There was no interaction between the prototypes and the users. However, one of us stood in front of the prototype presenting a scenario, simulating the movement of the avatar on the screen, trying to show interaction.

The menu prototype was also presented. We tried to present the menu in a way to make it look as realistic to a Kinect video game as possible. The "Wizard of Oz" method was used for this. One of us stood in front of the screen simulating game-play by pretending to "push the buttons", while the other controlled the PowerPoint presentation. In that way we went through the menu "as in the game". After the menu presentation we had a final focus group discussion.

After the final group discussion was over, we took a few minutes to greet the informants, and thank them for their feedback, time, and participation.

The video recordings from workshop 2 were transcribed in the same way as we did after workshop 1. This gave us analysing data constituting for about 6 000 words. From this we got 44 codes, which we categorised into 4 main topics. This is how we have presented the findings from this workshop.

This can be found in Chapter 11.

From the findings done in workshop 2, it would be natural to adjust the exergame concept accordingly. This is out of the scope of this thesis, due to time limitations. However, this will be discussed and suggested for future work on this exergame. This can be found in Section 12.2.

Chapter 9

Findings from Workshop 1

In workshop 1 we wanted to test commercial Xbox Kinect games, seeking to identify the needs elderly people have when it comes to a system such as this. This meets the first step of the activities in the cycle of user-centered design, understanding and specifying the context of use (See Figure 8.1). A description of the execution of workshop 1 can be found in Section 8.9.

In this chapter we will present the findings from this workshop. These findings are based upon feedback from the informants, and our own observations during the workshop. The seven informants are referred to as I1 to I7, and we have due to requirements to anonymity decided to not distinguish between male and female. Therefore, we refer to all the informants as females. Quotes are translated from Norwegian to English to preserve the meaning. Based on the data from the questionnaire we will start by describing the informants as a group.

9.1 The Informants

The group of informants consisted of three males and four females, with an average age of 70,6 years. From the questionnaire we learned that they use various technical equipment like; TV, mobile phones, tablets, DVD-players, computers, and music players. All of the informants have their own computer, where five out of seven use this several times per week. E-banking, e-mail and news are the general reasons for using the computer. Most of the informants see social activities as important. Four out of seven said that they like to share information with family and friends through social media. When playing games together with others, two informants preferred collaboration, while the rest liked to both collaborate and compete. All the informants, but one, said that they are regularly physically active, both from doing everyday tasks, and from exercising. Motivating factors for this includes: being in activity, socialising, achieving a good mood, and maintaining a good health.

9.2 Perceived Usefulness and Value of Entertainment

"Mostly, it was quite amusing". This was the general feedback from the informants after the gaming session. The informants were divided in their opinions about whether they would buy a game like this or not. Some of them would rather exercise for themselves or go to training centres, while others saw the gaming as more amusing than using a treadmill or an exercise bike. I5 stated that *"I think this was very fun, so I would like to buy one of these. I have one of those exercise bikes in my basement, but it is so boring that I cannot bear it"*. Some of the informants stated that one of the reasons why it was fun playing was because it was a completely new experience, and they found it as a fun way to exercise. I6 said *"Now I have been involved in something I have never been a part of before. [...] It is a new world that has opened up, that is for sure"*. They liked the idea of

combining gaming and activity. I4 said that *"elderly might think it would be fun to do this and be active at the same time"*. I6 explained that she felt different from when she was watching the other informants play, to when she was playing herself. *"The participation was more insightful to me than I had first anticipated. When I watched the others play, it felt so unreal to have someone on the screen, but in the activity, when you got into it, it was not so stupid after all"*. The observations we did during the gaming session support the feedback the informants gave us. There were a lot of smiling and laughing, and it seemed like they had fun.

The informants liked some games better than others. The two games from "Kinect Sports: Season Two", tennis and skiing, were the games they liked the most. They thought the activities were fun and they liked the challenges the game provided. *"I liked it very much. I like that kind of activity"*, was I4's opinion. The informants also liked that the game required something from them. About skiing, I3 said *"This was fun, because, here you have to pay attention and spend some effort"*. I3 also liked tennis for the same reason. It was mentioned that the pace in the skiing game might be too fast for some of the target users, like frail older people. This was also mentioned by one in the audience in our first presentation for "Seniornett". She suggested that the player should be able to choose pace herself. However, the informants liked the fast pace, because it made the game exciting and fun. The same lady from the audience also commented on too many elements in the skiing game, which could make people with decreased balance function dizzy.

"Your Shape Fitness Evolved 2012", with its "Aging with Grace", and "Fruit Ninja" were the two games the informants as a total liked the least. They did not see the need for playing "Aging with Grace", as they rather would do these types of exercises in a training centre or by themselves. I3 said she did not like this game because it did not require anything from her. *"The aerobic game I did not care for. Anyone can do that anywhere"*. However, when I1 chose which game she liked the most, she chose "Aging with Grace" as her favourite. She thought the other games had too much noise and loud sounds. Other aspects that were reasons for why the informants did not like a game were because the game did not present what they gained from doing the exercises, and it was hard to get points because of significant delay.

The informants did not see the usefulness of "Fruit Ninja". They laughed a lot while playing, but they thought the game itself was stupid. I3 said *"I think it was stupid. It does not put any requirements on you. I was just waving my arms"*. We did ask the informants if they thought the game was fun, even though it was an unrealistic game. I1 answered *"I think it was a bit fun. You see all the fruits that smashes. That was lovely"*. Even though some of the informants thought the game was fun, they did not see the point in playing it. One reason was that they did not see a connection between their movements and the outcomes on the screen. *"You did not get any sense of whether you hit something or not"*. This was perceived as confusing as they did not understand how to do things the right way.

The informants said that if they were just going to do basic exercises, like in "Aging with Grace", they would rather do this without a game. It was mentioned several times that they would rather go to their local training centres and attend group sessions there. To want to use a game for exercising, it would need to contain a sport, or something else related to real life. *"It would have been better to chop wood"*, I6 said after playing "Fruit Ninja". Other possible game themes mentioned by the informants were swimming, rowing, picking apples, biathlon, interval exercises, dance and a walk in the nature. *"You mentioned apples. When playing together, you could pick apples and summarise the number. That might be a competition"*, I4 said. The same informant also suggested doing puzzle games on the map of Europe. In that way the player could learn geography at the same time which would make the game more meaningful.

9.3 Motivation and Mastery

"Motivation is extremely important", was I5's opinion about playing games for exercising. Motivation was one aspect the informants mentioned as very important for an exergame. They told us that for elderly to use a video game for exercising, it has to possess features that will make them wanting to play. The informants stated goals and socialisation as motivational aspects for a game. Goals could be either achieving a high score, or just moving their body to music. *"Moving to a rhythm is always positive."*, I6 said. Social aspects of gaming were expressed as important. I4 said that she felt that meeting others for exercising was motivating. Another aspect that was considered as motivating was to get information about why they should play the game. The informants stated that if they could get to know the training benefits from doing the different activities, it would be more fun and motivating doing them. *"We should get information about which body parts we are exercising, and why we should do it. [...] I think this information is very important for people as grown up as we are. We have to know why we should do this"*.

One interesting observation we did during the gaming session was that the features in the games that were supposed to be motivating, were perceived as the opposite. Cheering, loud music, encouraging comments, fans and high scores were perceived as noisy and annoying, and not motivating by some, and were not noticed at all by others. *"I became a bit irritated when it was a cute voice saying "yeah, that is great!", "hurray!". I think it was stupid, I have to admit"*, said I1, while I3 said *"I did not notice it at all"*.

"Motivation and mastery are very important!". Mastery was also mentioned by the informants as a motivational factor. I6 said *"It is all about the experience of mastery, which is essential. And the older people get, the more important it is"*. I6 emphasised how important the feeling of mastery is for elderly, in particular, because they would not continue doing something they do not master. However, the desire to master could lead to wanting to

play the game over again. This is shown by I1's comment: *"I want to play one more time to be able to master it"*. When the informants first started playing the games, they were insecure and did not know how to perform the different activities and exercises. They completed the activities, but without the feeling of mastering it. This was the case with "Aging with grace", where the movements where quite fast. In addition, some of the movements were for many difficult to perform correctly. The informants also experienced similar problems with the tennis game. The ball came quickly, and it was difficult to coordinate the hand fast enough. However, the informants did not see it as a problem that they did not manage it the first time, as they believed they would get better after playing several times. *"Nothing of this is difficult. It is just a matter of training"*, I3 said. I5 replied to this with *"Sure, but it is possible to make it less confusing"*.

It seemed important for the informants to see a progress in the game, and to feel that they are learning something. *"I believe in games that have the characteristic of play, where you also can see that you get better"*, I2 said. This will provide the players with something useful, which will make them want to play again.

While observing the informants interact with the technology, play the games, and walking through some of the menus, we saw that the informants mastered the different challenges better and better. They learned how to connect with the sensor and they responded faster to feedback and information. This was both our observations and the informants own perception. When we asked them if they felt it became easier as they played, the majority of the informants answered *"Yes"*. One informant stated that when playing tennis she felt she was helped a lot by the game to hit the ball, but that this made the feeling of mastery come fast, and was therefore positive for the gaming experience. Some of the informants stated that they learned how they were supposed to play the game by looking at the other informants play, and that it therefore might have become easier for them to play.

As a part of mastery, it was also mentioned that we need to consider all the different groups of elderly to make suitable tasks for everyone to master. One of the informants mentioned different groups to keep in mind: "the people who already have decided to keep their body in shape", "people who wants to know if they are doing the exercises right", and "the people who are already inactive". For the latter group she mentioned the importance of getting help, e.g. from grandchildren. Another group mentioned was the people who cannot stand or walk, who might be sitting in a wheelchair.

9.4 Immersion and Engagement

The informants showed a lot of engagement and different feelings during the gaming session. In most of the games they used body movements eagerly. They also burst out with various comments like *"yes yes yes yes"*, *"noooooo"* and *"ooh, I wanted that pineapple!"*, while playing. In addition, the informants laughed a lot during game play. A few of the informants only used monotonous movements, like just waving their arms up and down with not that much engagement in "Fruit Ninja".

Not all the games created feelings of immersion and engagement. "Aging with Grace" was a game that the informants "just did", without showing any particular emotions. There were not many comments during game play, and there were no laughter or engagement. We only observed concentrated faces. However, the informants tried their best, and most of them went through the exercises with controlled and powerful movements, in tempo with good rhythm. In "Fruit Ninja" the informants had a lot of questions, and some of them just "waved their hands", without understanding what they were supposed to do. This got in the way for the feeling of immersion. They seemed most immersed into the skiing game. However, in the second match of skiing the players switched tracks. The informants had troubles understanding which track that was their track and had comments like *"Eh.. I do not understand"* and *"Are we going in the same lane?"*. I5 was confused while playing, *"First red and then blue and then blue and* *then.. [...] This does not work"*. The fun and enjoyment we observed the first round of skiing were the second round replaced with frustration. Tennis was one of the games the informants expressed they liked the most. However, we did not observe this enjoyment. They did not immerse into the game, as they talked a lot while playing.

The informants expressed, especially in the tennis and skiing game, that there was a lot going on at the same time. We asked them if they felt it was easy to focus on the challenges, exercises and activities, although there was a lot of hustle. The informants agreed on that, while playing, they were totally focused. I7 said *"When you are in the game, then you do not see the outside world, then you are concentrated"*. The informants felt that they lived into the character of the avatar. They did not feel that the avatar was a person separate from themselves. *"I felt like the avatar itself"*, I3 said.

9.5 Instructions and Feedback

The first time playing the informants seemed confused and unknowing. One informant started pointing on the screen and asked *"How do I point?"*, meaning how she could press the buttons. When playing "Aging with Grace" I1 asked *"Press the button? Is there any button here?"*. It was clear that it was not obvious what was meant by pressing a non-physical button. None of the informants had ever played games like these, and did not understand how the game could be controlled by their body movements, even though we had explained this. They desired an introduction with instructions on how to interact with the game.

It was a general opinion that the different games should spend more time on instructions and explanations regarding the different exercises. *"It needs to be a softer and more instructive introduction into the game's rules"*, I5 said. Especially in "Aging with Grace", this was the case. I1 compared this to the way they did it in an aerobics class she used to attend in her younger days. She explained that they practised the exercises slowly before they could do it fast. "Aging with Grace" started up quickly, with no room for practice or warm up, and it held a high tempo. The informants did not know how to do the required movements, since it was not given sufficient information. Most of them got the movements after a few steps, as they recognised the exercises from aerobic classes at their training centres. After playing, most of them agreed that the exercises were OK and that it was only a question of learning. It was also lack of instructions in "Fruit Ninja", which caused confusion. While playing, I7 had troubles understanding how she could see if she hit the fruit. It also seemed that I1 did not understand what actions did cut the fruit in half; she just waved her arms while she looked quite confused. *"It is just to wave your arms. There is no system"*, I3 said, indicating that the game did not require anything from them. In addition, they did not see the relationship between what they did and what they achieved. *"I did not get any feedback on my movements"*, I2 said. We observed that insufficient instruction and feedback in the games resulted in the players not understanding what was required from them. This lead to the informants just "doing something", like in "Fruit Ninja".

All the informants agreed that there were some positive health effects from playing the games; however, they did not exactly know what they were exercising. They urged that the games should include information about which body parts that are being exercised when different tasks are done. Another general opinion was that they wanted to know if they were doing the exercises right or not when they were playing. They were also eager to receive feedback on their progress. *"I think it is very nice to see how far I have walked, and how fast I have walked, and how much downhill and uphill and things like that"*, I1 said, referring to a mobile application she was using to give her information about her progress when cross-country skiing.

In the tennis and skiing games there were introduction videos in the beginning of the game. However, not all informants understood that this was instructions and not the game itself. This became clear to us as most of the informants tried to do what the avatars did in the video, and seemed confused when nothing happened. *"Should I try to hit the ball? What am I supposed to do now?"*, I1 asked during the instruction video. It appeared that the second instruction video, which was shown between two matches in tennis, was more obvious, and that they all learned from it. When the game was finished, some of the informants did not understand that the game was over. This did especially apply in the tennis game, where most of the informants ended up just looking at the screen.

There were various perceptions of the information and feedback given during game play. Some of the informants were not affected by the information given, and at times they did not even recognise its presence. *"I did not react to the text at all. If you had asked me, I would not know it had been text"*. I5, on the other hand, felt that there was too much information at the same time, which made it hard to concentrate. *"I think you should limit the total amount of information"*. I2 said she had seen the text but it disappeared too fast, so she did not have the time to read it all. She suggested that it should be a way to confirm that you have read the information before it disappears. The instructions in both the tennis and skiing game, like "raise hand above head to play" or "move closer to the sensor" were well understood by the majority of the informants. However, we had to assist some of the informants a couple of times by reading the message given on the screen.

9.6 Complicated Menus

A general agreement was that the games had too complicated menus. Moreover, the avatar hand that was navigating on the screen was too sensitive, and it was hard to keep the hand still long enough to actually "press the button". In the sports game, buttons were pressed by holding the hand over them for a certain amount of time. This required time seemed to be too long. *"This is worse than working with the mouse on the computer"*, I6 said. In "Aging with Grace" the avatar hand was, in addition to being too sensitive, obscure and at times almost invisible. It did not really look like a hand. This seemed to cause problems because not all informants understood that the object on the screen was their hand. Two informants suggested that an arrow-marker like the one used on most computers would be more intuitive and easy to use.

"The menu was extremely difficult", was one comment about the menu in "Aging with Grace". The menu was big, complex and sensitive, which made it difficult to know where to go, as well as to push the right buttons. There was a great amount of information on the screen, which made it difficult to choose the right alternative. Three informants [1] were challenged to go through the whole menu, and they, especially, struggled a lot. To navigate between the pages in the menu, there were arrows on the sides that should be pressed. These arrows were hard to see, and they were very sensitive. When telling the informants to scroll through the menu by pressing the right arrow, I1 said *"Which arrow?"*. In addition, this menu had a huge, sensitive "back"-button that the informants pressed several times without intention.

Also in "Fruit Ninja" the informants had problems with the menu. The menu was crowded with elements, which made it hard to hit the correct buttons. In addition, the menu made it difficult for the informants to distinguish between the menu and the actual game. This came clear from observing informants waving their arms like if they were playing the game when they were in the menu.

9.7 Graphics and Sound

We asked the informants about their opinions about the music in the games, and I1 answered *"I think everything about that was too much"*. I2 replied with *"I like Mozart better"*. They did not want ordinary pop music and

[1] The reason for why we did not test this on the rest of the informants, was because we experienced this to be very difficult and time-consuming, making it a bad experience for the informant.

suggested music with swing rhythms to be more appropriate. All the informants agreed that music is important to keep the rhythm when exercising, but that they would prefer the music not being too noisy. It was also a general opinion that the music was inappropriate. I7 said *"You get sensitive to sounds. You do not want it. You want it quiet. You want to be active, but without too much background noise"*. I4 added *"I would prefer walking out in the nature. Then you can listen to the birds"*.

It was a general opinion that there were too much elements on the screen during game play. I7 stated this by saying *"It is too much elements on the screen. Where should you look?"*. Some of the informants also felt it was too much going on at the same time during game play, and that it is in general hard to do several things at the same time. I5 suggested that there could be different levels of things that happen in the game. *"Eventually, when you get better and manage to keep track of things, you can add more elements to the game. A lot of what happens in these games is not relevant"*.

On the question about what they thought about the avatars and the picture in general, I5 answered *"I think it was very confusing to see myself. Especially, seeing myself and the trainer together"*. In addition, most informants agreed that the avatar of themselves in "Aging with Grace" made them look fat, which they did not like. About the other avatars, I2 said it was OK because it was just like in the cartoons, but no further comments were made on this.

We observed that at least one informant spent some time reading the text in the menus in "Aging with Grace" and in the tennis game. At one point the informant had to move closer to the TV-screen to read the text. This might be an indication of too small text, or poor readability, in these menus.

9.8 Delay Between the Player and the Avatar

"It bothered me that I did not see the correlation or the relationship between my own body movements and what was happening on the screen", I2 said

about the gaming experience. All of the informants complained about the delay that was present in the games. This applied to all the games except from "Fruit Ninja", and it was mentioned as a problem several times. The delay made it hard to move correctly and in time. Several of the informants had problems passing through the gates and to perform a perfect jump in the skiing game because of the delay. *"Missed the jump? I jumped so quickly. That is just nonsenses"*. The delay in the games made it difficult to get points and achieve high scores, which again gave the informants the feeling of not mastering the movements.

The technical aspects of the games became a source of confusion for most of the informants. *"There was some small technical details that were problematic. [...] I could not see in the skiing game that the avatar followed my movements. [...] And in tennis, it was something about the time aspect between when you tried to hit and when you actually hit the ball. I felt that the game helped me a lot in the beginning"*. The delay made it difficult for the informants to see when they actually hit the ball in the tennis game. Some of the informants expressed that the significant delay interfered with the gaming experience. I5 said that *"I experienced the tennis and skiing game as games with lack of technical perfection. It was not technically good enough to create a real-time experience"*.

9.9 Physical Outcome

The informants had a general opinion that all movements are good for your body, and that these games required you to move in a good way. They had comments like *"If the game is good for your body? Yes it is. All kind of movements are of the good"*, *"You get warm"*, *"I felt it was useful, in a health-related way"*, and *"It was amazing how much body you actually used on so little"*. However, it was mentioned that if the aim of the game was exercising, it should be built on the whole range of exercising, from warm-up to stretching.

In tennis and "Fruit Ninja", several of the informants mentioned that their shoulder and arm were in pain after playing. In tennis, the player only uses one arm, which results in an asymmetrical workload. We also observed that several of the informants used only one arm when playing "Fruit Ninja".

9.10 Playing Together

The informants agreed that this game could suit well in a nursing home setting, in a small group setting, or as an activity to do with grandchildren. *"I think skiing was fun. But I am thinking it would be even more fun to play with a grandchild in a suitable age"*, I1 said about the social aspects of the different games. She continued with *"I am thinking that in a nursing home we would probably like to play with someone"*. She also told about her mother in law who got inactive on her last years. She believed that the only way to encourage her to become more active by playing games would be if there were some social aspects within the game, like the possibility to play together with a grandchild. Some of the informants were clear in their opinion about whether they would play alone or with others, and I7 stated that *"I do not want to do this alone at home"*. However, I4 liked both and said *"I think both playing alone and together were OK. [...] I believe in exercising in small groups"*. It seemed that most informants liked to play together; however, two informants mentioned that they were indifferent. The informants enjoyed playing together in the games that were made for fun and entertainment, like skiing and tennis, while they felt that games meant for exercising, like "Aging with Grace", would be better to do alone.

The majority of the informants seemed to like both competing and collaborating. However, I5 had a strong preference about how to play together. She said *"If there is going to be any point in doing something together, it needs to be that you are enhancing each other. Like that you get a better result if you are cooperating"*.

Everyone agreed that meeting people and being social are important in life, but that they would do it on their own time, and not be locked to a specific group or time. I5 felt that meeting together in a group for exercise would give her a sense of pressure that she did not like. *"I have had pressure all my life. I do not want it anymore. I do not want to put myself in that situation where people come and ask "are you going to join this?""*. I7 agreed that such pressure does not motivate. *"It is like this: well-being is attractive, pressure is not attractive"*, I6 said, referring to the importance of doing things voluntarily. However, just having the opportunity to go out and meet people, like in an arranged training group, seemed to be important for all of the informants.

"You are talented", and *"You are starting to get it now"*, are comments the "audience" came with when they watched the other informants play. They encouraged each other, and provided positive and motivating messages. The informants that were playing seemed to enjoy this feedback, and it made the gaming session more social and fun.

We asked the informants if they could imagine themselves playing at home in their own living room, with friends over the Internet. They were not very positive about this, and it seemed like they did not understand what we meant. *"This is very distant for me"*, was I6's comment. *"It would probably be more motivating to just ask her if she wanted to come over and play"*, I1 said. These answers show how being social over the Internet is quite unfamiliar to the informants. To make such a game social, all the informants agreed that meeting in person would be better than playing online. On the other hand, the informant using a training mobile application seemed to like to share exercise information with friends over the Internet.

9.11 Experience and Understanding of Technology

None of the informants had used technology like Xbox Kinect before, and they all said that it was a completely new experience for them. I3 said *"I have practically never seen it before"*. In fact, the informants said that they never had used any kind of video game technology. *"Waste of time"*, I5 said, *"I could never have time for something like that"*.

The informants generally showed interest in the technology and our project during the workshop. They asked about the project, where the games were made, and how much the Xbox Kinect costs. The informants showed interest in what equipment needed for them to play at home, and wondered *"Does it connect to a TV?"*. I7 commented that it is important that the technology is easy to install. The informants were also eager to ask questions about the games, where these were related to different aspects, like: the information given, their own performance, difficulty levels and general confusion. Overall they were very positive about the project and I3 complimented our work by saying *"It is admirable that you are working with this"*.

9.12 Summary

To summarise the findings, we will repeat aspects liked and not liked about the different games. In addition we will in a more concise way present the aspects the informants stated as important for an exergame for them. This is done to highlight the improvements that should be made.

- **Kinect Sports: Season Two: Tennis:** Tennis was one of two games they liked the most. This was due to its real-life activity, and because it involves fun and entertainment. It was a small delay, and they were helped a lot when hitting the ball. This was perceived as good by some informants and bad by others. The informants managed the game well, but did not seem concentrated on the tasks. There were a lot going on in the tennis game (e.g. fans, commentators etc.). This was perceived as annoying by some and was not noticed at all by others. There were clear instructions; however, the first time playing, the instruction video was confused with the game itself by some. In addition, tennis requires only one arm in activity, which makes asymmetrical exercises. The informants would prefer playing this game together with others.

- **Your Shape Fitness Evolved 2012: Aging with Grace:** This was one of two games the informants liked the least. This was because of its distinct focus on exercising, which they could rather do at training centres. The time spend on instructions about the exercises was short and it was little time for practice. In addition, the movements were fast. We observed only concentration, but little enjoyment. The menu was in particular complex, with many buttons and obscure elements. The navigating hand was obscure and sensitive. This game was the one game they would prefer doing alone, if doing it at all. The informants did not like that the avatar was a recreation of themselves. In addition, there was a significant delay, which made the game confusing.

- **Fruit Ninja:** This was the other of the two games they liked the least. They did not understand what was required from them, and the word "stupid" was used. The menu was crowded with fruit elements, which made it hard both to distinguish between the menu and the game, and to actually "slice the button". This was the only game where they did not experience any delay.

- **Kinect Sports: Season Two: Skiing:** Skiing was one of two games they liked the most. This was because the informants felt that it actually required something from them, in addition to the real life activity. This was the game where they seemed to immerse the most. However, switching tracks was a source for confusion, as insufficient instruction on which tracks belonged to whom were given. It was also experienced delay in this game. As in tennis, there were a lot going on in the game (e.g. fans, commentators etc.), which was perceived as annoying by some and was not noticed at all by others. There were clear instructions, however, the first time playing the instruction videos were confused with the game itself by some. The game was seen as most fun to play together with others.

9.12.1 Important Aspects for the new Exergame

- Real life activities. Suggestions include: sports, wood chopping, swimming, rowing, picking apples, biathlon, interval exercises, dance, puzzle games, and a walk in the nature.
- Instructions on what is expected from the player, why the player should do the task and the training benefits from doing the tasks.
- Feedback on whether the movements are done correctly or not.
- Easier and more intuitive menus with clear objects.
- A limited amount of information and elements at the same time.
- Clear navigator.
- Avoid avatars that render the player.
- Include the whole range of exercising, from warm-up to stretching.
- Motivating factors, like clear goals that are possible to master.
- See progress and experience a learning curve.
- Different difficulty levels, where additional functionality can be added at higher levels.
- The possibility to play with others in person, like with grandchildren, or in a training group.

- Appropriate music. Examples provided include classical music, like Mozart, and music with swing rhythms.
- Avoid too much noisy feedback, like loud music, sounds and comments.
- The possibility to customise to meet different groups of elderly, like adjusting the pace in the game.
- The system should be easy to set up.
- Avoid delay between the player and the avatar.

Chapter 10

The Exergame Concept

This chapter is about the second and third activity in the cycle of user centered design, *specifying requirements* and *producing design solutions* (see Figure 8.1). Based on findings from workshop 1 and theory presented in earlier chapters, we have created system requirements and designed a concept for an exergame for elderly. The exergame concept, from now on referred to as "the exergame" or the "game", focuses on including movement and exercise in real-life and well-known activities. This will be provided in an entertaining and motivating way. We will present the requirements this exergame is built upon, before we describe the exergame in more detail. This will include games and challenges, goals, obstacles, and how to achieve points. In addition to the exergame, we have also designed a menu. This is based on a course in human-computer interaction (HCI) at NTNU and guidelines for developing interfaces for elderly.

The exergame presented is based on theory of how to design video games, as discussed in Chapter 6, and can serve as a part of a design document, according to what is described in Section 6.1. We acknowledge that not all the elements that should be included in a design document are present in this chapter.

The figures presented in this chapter are prototypes which present scenarios from the exergame. These were made with the intention of presenting the idea and design for the exergame for a group of elderly in a second workshop. The focus has therefore been on making prototypes that give the users a realistic impression of the final result. The details of our choice of prototypes are provided in Section 8.8. The prototypes presented in this chapter will be in English, to be in accordance with the language this report is written in. The original prototypes are in Norwegian and can be found in Appendix C and D. The sources for where we found the pictures used as background and as elements in our prototypes, will also be presented here.

We will start by presenting the system requirements in Section 10.1, before we continue with describing our exergame with its story and included elements. Various scenarios will be presented with the use of medium-fidelity prototypes in Section 10.2. Functional design, presented in Section 10.3, will give a concrete representation of one possible level of each of the proposed games. Design and description of the menu for the exergame are presented in Section 10.4. This chapter can serve as a part of a design document that can be used by developers to understand and design this exergame.

10.1 System Requirements

We have created a list of system requirements for the exergame, which specifies what the system shall do, and which constraints the system shall hold. The requirements have been developed with foundation in all theory presented in the earlier chapters, as well as findings from workshop 1. We have written requirements according to the definition of requirement specification, presented in Section 7.1, and they are therefore divided into functional and non-functional requirements. In the exergame we have mostly focused on the functional requirements, and interface requirements, which is a subsection of non-functional requirements.

We will support our requirement specification by referring to relevant references, findings from workshop 1 (referred to as fw1), motivational factors from Section 3.3.1 (referred to as m.x), and guidelines listed in Section 5.2 and 7.4.1 (referred to as g.x or e.x respectively). In addition, we will draw references to the GameFlow model [71] (referred to as gf), which holds important elements included in our exergame. These will be listed in the rightmost column. It is important to acknowledge that the requirements also are based upon our own ideas, thoughts and opinions.

10.1.1 Functional Requirements

The functional requirements in Tables 10.1, 10.2 and 10.3 present the services and functionality the exergame shall offer. These requirements will be used as a foundation for the exergame, and they will serve as input to the functional design presented in Section 10.3. Requirement 1.33 - 35 focus on the physiotherapists' view of the system. As mentioned, we will only emphasise interface design for the end users which are elderly people. However, these three requirements should be included in future work on the exergame. This is because we in [8] evaluated physiotherapists to be the proper customer for the game. We believe that in today's market the game will not experience success going straight to the end users [8].

No.	Requirement	Ref.
1.1	The system shall be an exergame that emphasises exercise and physical movement.	[8]
1.2	The system shall have a fun and entertaining story with focus on game play.	[8] [29]
1.3	Exercise shall be subordinate to the story.	[29]
1.4	The system shall meet the diversity in people.	[8], g.1, g.10, e.2, m.11, fw1
1.5	The system shall provide natural and familiar surroundings and elements.	g.11, fw1
1.6	The system shall provide natural and familiar activities, challenges, and exercises.	g.11, fw1
1.7	The system shall provide both physical and cognitive challenges.	m.8, fw1
1.8	The system shall allow for decision making before and during the game.	[30], m.9
1.9	The system shall provide players with clear instructions on how to use and interact with the game.	g.6, e.8, fw1
1.10	The system shall provide players with clear instructions on how to perform various activities, challenges, and exercises.	[8], g.6, g.8, e.8, m.2, gf, fw1
1.11	Instructions shall include information about the health benefits gained from playing.	m.3, fw1
1.12	Instructions shall be given during game play when appropriate. This shall be done to avoid the need to memorise information.	g.6, g.9, e.8, gf

Table 10.1: Functional requirements [a]

[a] g - guidelines from Chapter 5, e - guidelines from the Eight Golden Rules, m - motivators for exercising, gf - elements from the GameFlow model, fw1 - findings from workshop 1

No.	Requirement	Ref.
1.13	The system shall give players the time they need to read instructions.	g.46, m.9, fw1
1.14	The system shall allow players to skip instructions.	e.7, m.9, gf, fw1
1.15	Players shall be given feedback on their actions.	e.3, gf, fw1
1.16	Feedback given shall be positive and motivating.	[8], g.7, gf
1.17	Feedback shall only be given when appropriate. Interruptive feedback shall be avoided during game play.	g.9, gf, fw1
1.18	The system shall be a progression game.	[30], g.17, gf
1.19	The system shall have small subtasks with clear goals.	g.17, m.6, gf, fw1
1.20	Players shall be informed about progression and results.	g.18, e.3, m.7, gf, fw1
1.21	The system shall allow multi-play.	g.12, m.9-11, fw1
1.22	Multi-play shall have the possibility to be performed both as collaboration and competition.	gf, fw1
1.23	Players shall be given the possibility to choose preferred difficulty level.	g.17, g.19, m.9, m.11, gf, fw1
1.24	The system shall allow for players to choose individual difficult levels.	g.19, m.9, m.11, gf, fw1
1.25	The system shall be able to adjust difficulty level after players' progression.	gf, fw1

Table 10.2: Functional requirements [a]

[a] g - guidelines from Chapter 5, e - guidelines from the Eight Golden Rules, m - motivators for exercising, gf - elements from the GameFlow model, fw1 - findings from workshop 1

No.	Requirement	Ref.
1.26	Activities provided by the system shall include exercises for all muscle groups.	[15]
1.27	Exercises used shall be proved to be good for training for elderly.	[8], g.21
1.28	Activities shall be possible to perform both sitting and standing.	g.20, m.9, m.11
1.29	The system shall give the players the possibility to choose gender on their character.	g.10, g.14, m.9, m.11
1.30	The system shall always provide players with the possibility to reverse their actions.	g.48, e.6, m.9
1.31	The system shall create a user profile where players' progression and results can be saved.	[8], g.23
1.32	The system shall provide players the possibility to share their profile, or part of their profile, with friends.	gf
1.33	The system shall be able to be used as a tool for physiotherapists.	[8], g.22
1.34	The system shall give physiotherapists the possibility to set parameters to customise the exergame for each individual patient.	[8], g.1, g.39
1.35	The system shall give physiotherapists access to players'/patients' profiles.	[8], g.23

Table 10.3: Functional requirements [a]

[a] g - guidelines from Chapter 5, e - guidelines from the Eight Golden Rules, m - motivators for exercising, gf - elements from the GameFlow model, fw1 - findings from workshop 1

10.1.2 Non-Functional Requirements

The non-functional requirements presented in Tables 10.4 and 10.5 describe constraints to follow for the exergame to ensure good usability in terms of interface design.

No.	Requirement	Ref.
2.1	The system shall provide good graphics in 3D, which makes the game world look real.	[30], g.15
2.2	The system shall use characters to portray the players.	[30], g.15
2.3	The system shall provide sound and music appropriate for the user group.	g.10, m.13, fw1
2.4	The system shall provide sound and music appropriate for the game theme and the intensity in the current activity.	[52], m.13, fw1
2.5	The system shall have a menu, which is used by players to make choices about game play.	g.5
2.6	The menu shall be clear, simple, and intuitive.	g.4, g.31, e.8, gf, fw1
2.7	The menu shall be consistent.	g.32, e.1
2.8	Menu buttons shall not be too sensitive.	fw1
2.9	Menu buttons require ”push” to perform any action.	fw1
2.10	The navigator shall not be too sensitive.	fw1
2.11	The navigator shall be clear.	fw1
2.12	Information shall be easy to see, and understand.	g.47, e.8

Table 10.4: Non-functional requirements, interface requirements [a]

[a] g - guidelines from Chapter 5, e - guidelines from the Eight Golden Rules, m - motivators for exercising, gf - elements from the GameFlow model, fw1 - findings from workshop 1

2.13	Information shall be written in a familiar language with everyday words.	g.30
2.14	Information shall be written with an easy-to-read font in an appropriate size.	g.2, g.24-28
2.15	There shall be clear contrast between background colour and text colour.	g.37-43
2.16	Elements that are essential to the game shall stand out.	g.31, g.43
2.17	The system shall avoid using elements that are unnecessary for current situation.	gf, fw1

Table 10.5: Non-functional requirements, interface requirements [a]

[a] g - guidelines from Chapter 5, e - guidelines from the Eight Golden Rules, m - motivators for exercising, gf - elements from the GameFlow model, fw1 - findings from workshop 1

10.2 The Overall Story Line

We will now present the story line of the exergame. This will be based on the requirements provided in the tables above. We will refer to the relevant requirement with [req. no] throughout the presentation.

"Out in the Nature" ("Ut i naturen" in Norwegian) is the title of our exergame. This is a game based on a forest theme and it consists of real-life activities that are familiar to most people [req. 1.5]. The different activities are natural to find and do in the forest or in the nature, hence the game name. The goal is to experience beautiful nature while playing, and at the same time exercise and achieve physical activity [req. 1.3-4]. Bringing the beautiful nature "to life" is achieved by presenting the game with 3-dimensional graphics [req. 2.1]. The exergame consists of five individual games, one longer, compounded game that will engage the whole body, and four, shorter single games with various challenges and exercises, both for the mind and body [req. 1.7, 1.26].

We have used familiar elements that can be found in the forest, i.e. rocks, creeks, and logs. When we have chosen to use other elements, these are well-known, and easy to relate to for elderly people [req. 1.5]. One example is hearts and their relation to health. In addition, our intention has been to avoid unnecessary details that can lead to confusion and distraction [req. 2.17], in accordance with simplistic design, discussed in Section 7.3.2. Music and sound effects in the game will be natural when possible [req. 2.4], like birds twittering and the wind in the trees. The informants mentioned that classical music, e.g. Mozart, would be more suitable than the computer-made pop music that was used in the commercial games we presented for them. An idea is therefore to use classical music that will fit a walk in the beautiful nature a warm summer day [req. 2.3]. When there are challenges and activities that require intensity, the idea is to use music with a rhythm, without being noisy [req. 2.4]. We will not present any specific music examples suitable for this exergame, since that is outside our area of competence.

The player will be presented in the game as a character with "real-life" features [req. 2.2]. As described in Section 6.2.3, the player character can be described by three different categories: avatars, actors and roleplaying. From the definition, the player character here will be an actor. However, in commercial Kinect games the player character is called an avatar, and we will therefore do the same. They do not have a distinct personality except from being "a normal human being", but they are well integrated into the story. We will use two different male and female avatars [req. 1.3, 1.29], to meet with the requirement of having two simultaneously players [req. 1.21]. All characters are dressed in training outfits; females in training leggings and t-shirt, and males in long pants and t-shirt. The different characters will have different colours on their t-shirts to make it easy for the players to distinguish between them. The male avatars have either blue or green t-shirts, while the female avatars have either yellow or pink t-shirts. The males have short hair, and the females have half-long hair. For convenience, the characters will have international names, like Anne, Eva, Charles and

David. The avatars will be seen in a third-person perspective. This is because it is important for the player to see the avatar of herself to see if she is doing the exercises correctly.

"Out in the Nature" is meant to be an exergame for elderly, but it is important to not just focus on the exercise. This exergame has an entertaining and motivating story, which is the main focus in the game. The exercises are only subordinate to the story [req. 1.1-3]. However, we will include the opportunity for the player to choose which part of their body they want to exercise. In the first step in the menu, the player is given the choice of how she wants to play, see Figure 10.1. The player can choose to play the compounded game, choose to play based on exercising a preferred muscle group, or the player can choose among the four single games [req. 1.8]. Our choice of including this in the exergame is based upon feedback from workshop 1, where the informants stated that it was important to make own decisions on how, and when, they would like to work out.

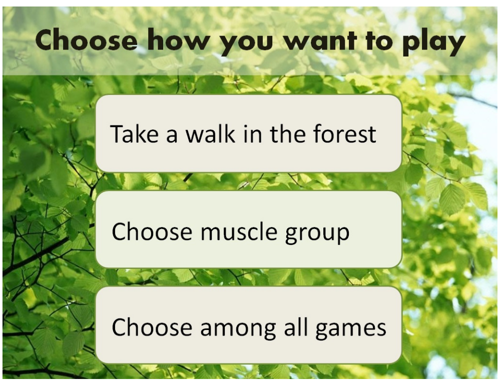


Figure 10.1: In the first menu step, the player is given the opportunity to choose how they would like to play. The can go for the compounded game, play according to a chosen muscle group, or they can choose among the four single games.

10.2.1 Exercises

The activities we have selected for the exergame are based upon findings from workshop 1, and our own ideas. However, the main reason for using these activities is because they involve exercises that have been proved to be good for elderly [req. 1.27]. In Section 5.2, stepping, balance and strengthening exercises are proposed as suitable for elderly. These were also suggested as appropriate exercises by The Norwegian Directorate of Health [15]. In addition, we have used ”Øvelsesbanken” [21], which is presented in Section 3.1, as a guide to find exercises to use in the exergame. We have picked out 18 exercises from ”Øvelsesbanken” that we argue are a good foundation for the exergame. Some exercises chosen are ”picking apples” (see Figure 10.2), ”walking”, and ”rowing”. All the chosen exercises are presented in Appendix B. Most of the exercises have the possibility to be performed both sitting and standing, to make the exergame available for those who are not able to stand or walk. We got copyright clearance from ”Øvelsesbanken” to use their exercises.

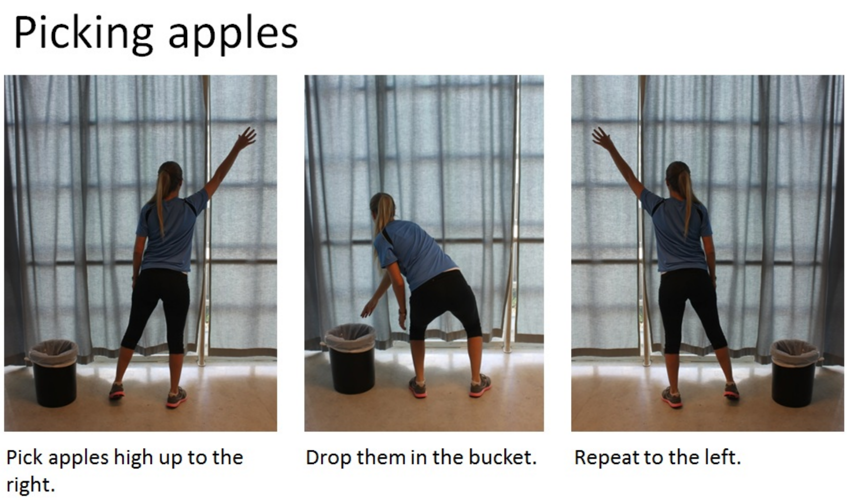


Figure 10.2: The ”Picking apples” exercise from ”Øvelsesbanken”.

In workshop 1 it was mentioned that the whole range of exercising, from warm-up to stretching, should be included. We have not looked any further into this, as this should be up to professionals, like physiotherapists, to decide. However, it should be easy to implement these requirements in this exergame.

10.2.2 Instruction and Feedback

In this exergame, the player will be given instruction about the technology, how to play, and how to perform various activities and exercises [req. 1.9-10]. When first starting the exergame, the player will be informed on how to interact with the Kinect sensor and the game. The player will be told that she has to use her body to engage game play, that she has to use her hand to navigate through the menu, and that she can make a choice by "pressing a button".

In each of the five games there will be instructions informing about the goal of the game, the purpose of the various elements, and how the player should move to perform the activities in the game [req. 1.10]. There will also be provided information of the health benefits gained from performing the various activities [req. 1.11]. When the game starts, the overall purpose is explained for the player to know what is expected from her [req. 1.9-11]. Specific information about the various challenges will not be given all at once, as this will require a lot of memorisation. Therefore, these types of instructions will be given during game play, when there occur situations that makes it appropriate to provide the player with new information [req. 1.12]. This will be when the player meets new elements, obstacles or challenges. Every instruction comes with a button that the player has to push to continue playing. In this way the player is in the control of the game, and can decide for herself when she is finished reading the instruction [req. 1.13]. Figure 10.3 shows an example of an instruction. The player will always be given the possibility to skip the instructions, so experienced players do not have to watch the same instructions each time she plays [req. 1.14].

During game play, the player will be given appropriate feedback on her actions [req. 1.15-16]. This will be given when she has completed a particular task or activity, to not interrupt the player from performing ongoing tasks [req. 1.17]. Examples will be motivating comments, such as "Congratulations, you did a great job", when the player has accomplished balancing over a log, or "Lift your legs higher to walk faster". While playing, feedback should be given orally by a calm lady voice [req. 2.3]. Textual feedback during game play is avoided to not interfere with immersion and disturb the gaming experience [req. 1.17]. However, text can be chosen instead of voice if it is preferred [req. 1.4].

Figure 10.3: This figure shows an instruction in the exergame. There is a button up in the right corner that will be used to continue with the game when the player is done reading the information.

10.2.3 Nature Trail

The main activity in "Out in the Nature" is what we have called "Nature Trail". This involves a walk in the forest with quizzes along the way. The goal for the game is to complete the trail as fast as possible, while answering questions, and avoiding obstacles on the way [req. 1.7]. Points will be given according to correct answers on the quiz, which will be shown up in the right corner together with an icon showing a sheet of paper. Because the Kinect sensor can track movements, points will also be given according to how well the player performs the required movements. These points will not be shown as numbers, as movements will be difficult to measure and "grade". Therefore, gain from correct and well-performed movements is shown in a "health-bar" on top of the screen [req. 1.20]. Showing this visually is done to avoid too much detailed information, as suggested by Brox et al. [1]. A red heart is shown together with the bar to represent health. Points for correct answers on the quiz are separated from points achieved from movements, because the quiz does not have anything to do with physical skills. The time used to complete the nature trail will affect the final result of the "health-bar", as this also reflects how well the player has moved during game play. Figure 10.4 presents a scenario from the exergame, which includes the described elements in the top-bar. "Nature Trail" supports the possibility to choose number of players, as multi-player mode enhances social interaction while playing [req. 1.8, 1.21].

Progress in the game requires movement, like walking. When walking, the avatar portraying the player will walk into the forest. The bigger movements the player uses, e.g. the higher the player lifts her feet while walking, the higher pace, and "better health" she will achieve. Figure 10.4 shows the avatar in the forest, surrounded by hearts, where the avatar does a wide stretch trying to reach a heart. The hearts will be positioned in a way that will require the player to move to reach for them. Therefore, if the player gathers these hearts, her health will improve due to physical activity [req. 1.3]. Gain from gathering hearts will also be shown in the "health-bar".

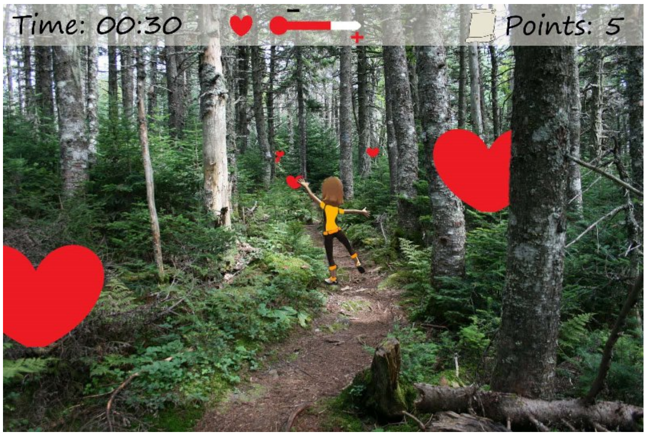


Figure 10.4: This figure presents a scene from the "Nature Trail" game. We see the avatar in the forest, doing a wide stretch trying to reach a heart. This will result in improved health, shown in the "health-bar".

The quiz will be shown along the trail as sheets of paper "hanging" on different spots in the forest. The player has to reach for them to get access to the questions. When picking a question, it will pop up and fill the screen (see Figure 10.5). Four alternatives will be shown, and the player will have to use her hand to navigate to what she believes is the right answer. Questions will be chosen randomly, so the player does not get the same questions each time she plays. The difficulty will also increase in line with number of correct answers [req. 1.25]. The player does not have to answer the quiz to complete the "Nature Trail" game [req. 1.8], but it will affect the total score at the end.

Figure 10.5: The quiz in the "Nature Trail" game will be shown as a piece of paper "hanging" on different spots in the forest. Questions will pop up and fill the screen. Here, the player is asked about where to find the Norwegian mountain "Glittertind".

Along the way in the nature trail there will be various, natural obstacles that will force the player to move her body in certain ways to be avoided. The game is supposed to exercise the whole body. Therefore, the different obstacles are chosen such that movements required to avoid them will include all muscle groups [req. 1.1, 1.3]. Examples of these obstacles are a river or creek that the player has to cross, or logs or rocks lying on the path that the player has to step over. To cross a river or creek the player has to balance on logs or step on rocks. This requires movements as toe-to-heel stepping, and step touch or skaters. When meeting a log, the player is required to take a big step, or a lunge, to get past it. Rocks in the path are avoided by performing sideways steps, or step-touch. There will also be obstacles in head height, like branches, which require the player to go into deep squats to be avoided. The Kinect sensor will track the player's body, and increase or decrease the "health-bar" according to how well the player performs the required movements. If the player hits some of the obstacles, they will get a flash of red, indicating that the player failed to avoid them. This is shown in Figure 10.6 (f). As a result, the red colour in the "health-bar" will decrease [req. 1.20].

Parts of the story are organised with the use of "branching", which is about having the possibility to choose between multiple paths [req. 1.8]. An example is choosing between walking the "regular" trail and rowing a boat over a lake. To cross the lake, and continue the nature trail, the player has to take a side step into the boat. To move forward, rowing movements are needed. There will be water lilies in the lake, which the player has to avoid. This is done by leaning the upper body over to the sides. This, and all the other described obstacles, are shown in Figure 10.6. All the tasks the player has to do throughout the game will be described in the functional design, in Section 10.3. The reader is referred to Appendix B for detailed instructions on how to perform the various exercises.

One of the requirements for this exergame is that the game has to show progress [req. 1.20]. In workshop 1, the informants told us that it is important to see that they are learning something, and that they feel that they get better. They also expressed it as important to get the possibility to choose difficult levels themselves. We have solved this by having a step in the menu where the player can choose the preferred difficulty for the game (see Figure 10.7). To include the desire to experience progress and learning outcome, the game will be adjusted according to the player's current skills, where higher difficult levels will be accessible only when the player is "good enough".

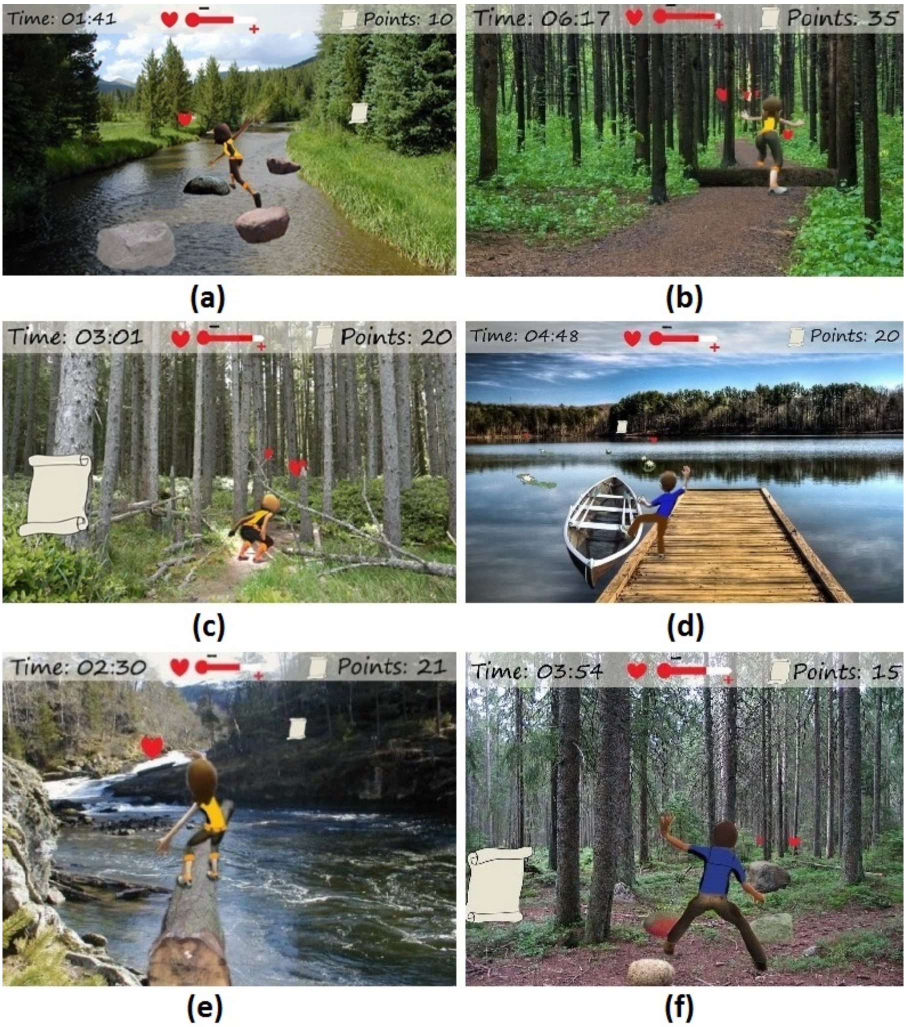


Figure 10.6: This figure presents various obstacles to be found in the nature trail. (a) jump from rock to rock to get over the river, (b) walk over the log lying across the path, (c) duck under the branch hanging over the path, (d) get over the lake by rowing the boat, (e) balance on the log to get over the river, (f) walk pass the rocks lying on the path.

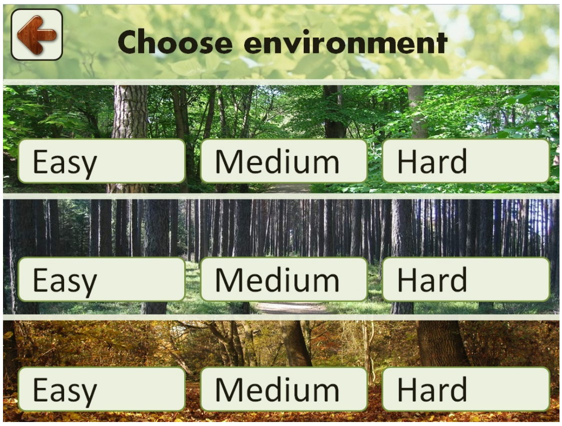


Figure 10.7: The players will get the possibility to choose environment and difficulty level. The environments to choose from are pine wood, deciduous wood summer, and deciduous wood autumn; within each environment there are three difficulty levels.

The "Nature Trail" game offers three different forest environments to walk in: a pine wood, and two deciduous woods, showing both summer and autumn. Each of the environments presents initially different difficulty levels, and within each environment, there are three difficulty levels: easy, medium, and hard [req. 1.8, 1.23]. First time playing, only the easy level will be available. The higher levels will be unlocked when the player has managed the easy level [req. 1.25]. A higher difficulty level will require more from the player, both mentally and physically. Obstacles will occur more frequently, which will require concentration, and the movements and exercises will be harder to perform, and therefore require control of the body. Within one environment, the obstacles from the easy level will follow to the next levels. This is done to include some familiar elements in the higher levels, in addition to new obstacles that will be added. To support variation between the environments, new and different obstacles will be used in each of the three environments.

The required movements in the "Nature Trail" game are supposed to exercise the whole body. This involves endurance, balance, and exercise of several muscle groups. This game, with the quiz and movements combined, will be good for both cognitive skills and physical health.

10.2.4 The Four Single Games

In addition to the "Nature Trail" game, "Out in the Nature" consists of four shorter games with focus on completing one single familiar activity or challenge. The activities we have chosen for this exergame are wood chopping, paddling down a river, swimming in a lake, and picking apples [req. 1.4, 1.6]. Within each game the player has the possibility to choose number of players and difficulty level [req. 1.8, 1.21, 1.23]. In multi-player mode, players can choose if they want to collaborate or compete against each other [req. 1.22]. When competing, the players will have the possibility to select difficulty level individually. This is to allow for players with different experience to play together, like a grandmother and her grandchild [req. 1.24]. Figure 10.8 shows how these single games will be presented in a menu. Below, we will describe one of these four games in more detail.

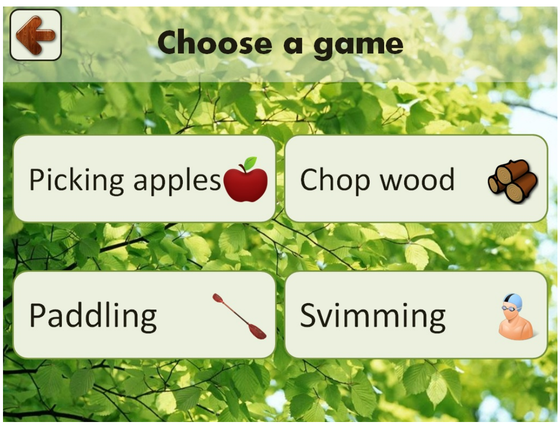


Figure 10.8: In addition to the "Nature Trail" game the players can choose between four single games: "Picking Apples", "Chopping Wood", "Paddling", and "Swimming".

Picking Apples

"Picking Apples" is a game that requires squats and stretching exercises, which will strengthen balance and muscles in thighs and the gluteal area. The goal for this game is to pick as many red, ripe apples as possible in a given amount of time, and put them in baskets on the ground [req. 1.6]. This is shown in Figure 10.9 and 10.10. The movements this game requires fit well with one of the chosen exercises from "Øvelsesbanken" (see Figure 10.2). When apples first appear on the tree they will be green, indicating that they are not ready to be picked. If ripe apples are left hanging on the tree for too long, they will rot and fall to the ground. Rotten apples will have a brown colour.

Points will be given according to how many apples the player has picked (see Figure 10.11). 3 points will be given for each ripe apple that is picked and put in a basket. The player will lose points if green apples are picked, or if apples have been given the time to rot. Picking a green apple will result in -1 point, and if the apple gets rotten this will result in -2 points. If the player does not perform squats when putting apples in a basket, there is a great possibility that the apple will miss the basket and fall to the ground. This will give the same loss of points as a rotten apple, i.e. -2 points.

Apples will appear on the tree and grow in a certain tempo according to the chosen difficulty level. A higher difficulty level will result in more apples on the tree at the same time, and a faster ripening rate. An additional challenge in a higher difficulty level is to have requirements to the two baskets, such as where the newly picked apple should be put. This is to train cognitive skills and to include more variation in movements and exercises [req. 1.24]. As mentioned, this game allows for multi-player mode where the players can collaborate on picking apples, or compete on who can pick the most apples (see Figure 10.12) [req. 1.22].

Figure 10.9: The player stretches up to pick a red, ripe apple. We observe that there are, in addition to red apples, three green apples on the tree, and two rotten on the ground.

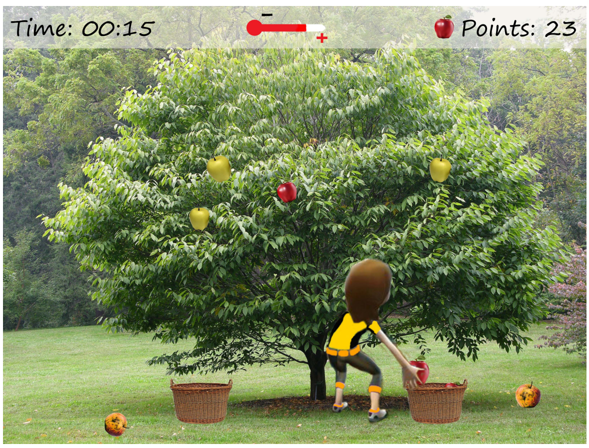


Figure 10.10: The player has picked a red apple and is about to put it in the basket. The player uses deep squats to perform this action.

Figure 10.11: This figure presents a final scene in the "Picking Apples" game. A text, together with the number of apples picked, is shown.

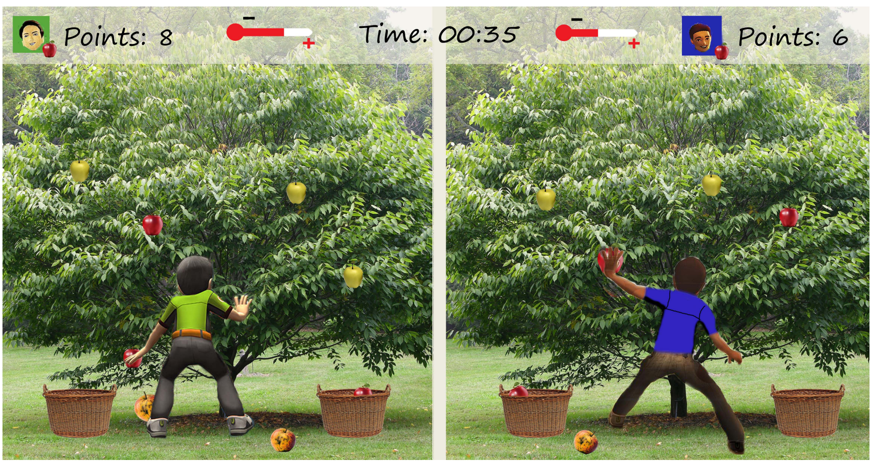


Figure 10.12: In this figure we observe two players playing together in competitive mode.

10.3 Functional Design

The functional design for this game will be described according to system requirements presented in Section 10.1, and to video game theory discussed in Chapter 6. The functional design will provide a more concrete representation of the exergame, than what have been presented earlier in this chapter. To get the overall picture of the game, Section 10.2 should be read before reading this section. Here, all the elements the game should contain will be presented shortly. Functional design will vary according to the chosen difficulty level; however, in this thesis we will only focus on presenting functional design for one difficulty level for each game. This will, as mentioned, be described according to video game theory, and more specifically to the game's story and aesthetics.

10.3.1 Nature Trail

The Fictional World

Location/setting	In the pine forest
Structural objects	Trees, the trail, heaven, rocks, log, lake, puddle, creek, river.
Interactive objects	The player character, row boat with oars, rocks lying in the middle of the trail, rocks in the river, logs over a creek, red hearts in the field, branches, question sheets, log lying across the trail.
Scripting objects	Quiz points: Shown as an icon similar to a sheet of paper, with the text "points" after it. Increments with 5 points as the player answer the right question.
	"Health-bar": Increases as the player performs right movements. Decreases as the player does not manage the right movements. Increases when the player gathers hearts. Increases based on time spend in game world compared to previous sessions.
	Time: Increases as a normal clock
Characters	An avatar (from how Kinect defines a character) seen in third-person perspective, described by its name.

Table 10.6: Different types of objects

Quest	Exercise required
Walk on the trail to get forward in the forest	Walking, lift legs high
Gather hearts and "get better health"	Stretching
Walk past rocks lying in the middle of the trail	Side steps or step touch
Duck under branches hanging over the trail	Squats
Balance over the log to get to the other side of the creek	Toe-to-heel stepping with arms out
Walk over the log lying across the trail	Lunges
Jump from rock to rock to get over the creek	Step touch or skaters
Row boat over to the other side of the lake	Rowing
Row past the water lilies	Lean upper body from side to side
Find and get question sheets	Stretching
Answer one of the four alternatives	
Solve puzzle	

Table 10.7: Quests

Mechanics

The game is a progression game, where a story should be completed. Each level will be completed by doing a certain sequence of quests or solving puzzles. The player has to finish different quests within a level to proceed to the next level, and the levels build on each other. It is common to have a climax at the end of each chapter in these type of games [30]. However, this is not included here, as this will interfere with the natural environment and the gaming experience for this type of users. Table 10.7 presents different quests in the "Nature Trail" game. Branching are shown in Figure 10.13.

Branching

The two flow charts shown in Figure 10.13 show how the story can be organised with "branching". In Figure 10.13 (a), the player can choose to walk trail 1 without obstacles and hearts. This trail can be done just by walking. In trail 2, on the other hand, there are obstacles that need to be avoided, and hearts to gather. This trail will take some more time, but at the same time, exercise more of the body, which might result in a better score. In Figure 10.13 (b) the player can choose to walk the trail without obstacles and hearts, or choose to row a boat over to the other side of a lake. The latter is shorter, but has water lilies that need to be avoided, and hearts to be gathered. There is a great chance for a total better score, by choosing to row the boat, as more of the body gets exercised. After finishing the chosen trail, the player will end up on the same trail again.

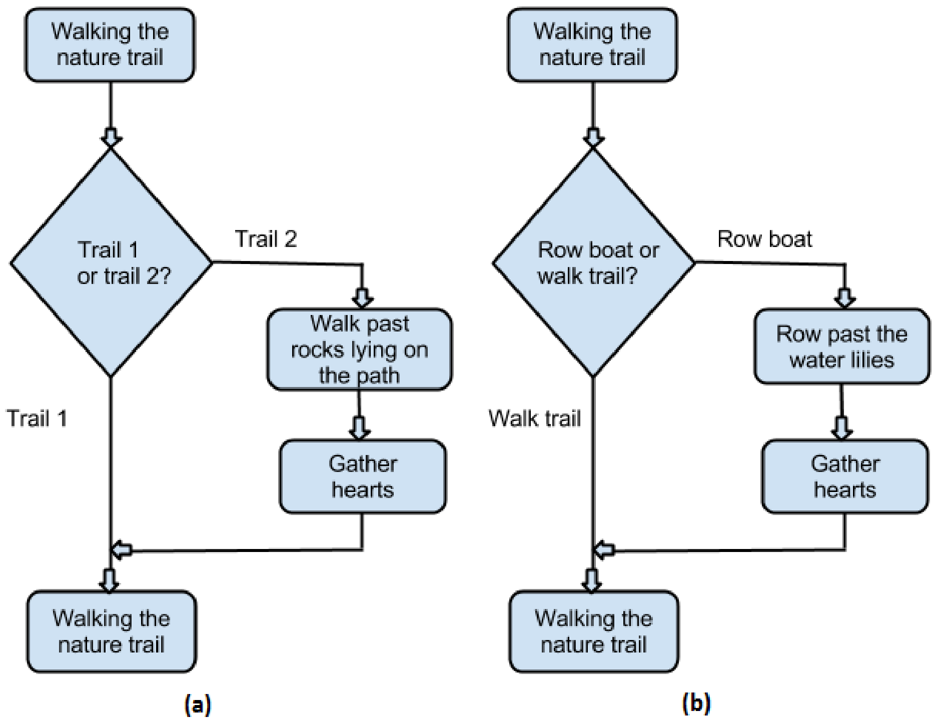


Figure 10.13: Flow charts of two ways of "branching" in the game. (a) The player can choose between two different trails (b) The player can choose between walking the trail or rowing a boat over to the other side of a lake.

Rules

Tables 10.8 and 10.9 show the rules in the game.

Interplay rules	**1. The player character:** Will move to the movements received as player input.
	2. Red hearts: When touched by the avatar it disappears.
	3. Rocks lying in the middle of the trail: If hit, the rocks will flash red.
	4. Branch: If hit, it will flash red
	5. Log over creek: If the avatar falls off, the log will flash red.
	6. Log across the trail: If hit, the log will flash red.
	7. Rocks in the river: If the avatar falls of a rock, the rock will flash red.
	8. Rowboat with oars: Will move forward as the player uses her arms with the oars.
	9. Water lilies: If hit, the water lily will flash red
	10. Question sheets: When touched by the avatar it disappears from the game environment and fills the screen with a question or puzzle.
Evaluation rules	**if 1**: Player gets forward in the game, and the health-bar fills with red colour.
	if 2: The health-bar fills with red colour.
	if 3: Player gets slowed down, and red colour in the health-bar reduces.
	if 4: Player gets slowed down, and red colour in the health-bar reduces.

Table 10.8: Rules

Evaluation rules	**if 5:** Player gets slowed down, and red colour in the health-bar reduces.
	if 6: Player gets slowed down, and red colour in the health-bar reduces
	if 7: Player gets slowed down, and red colour in the health-bar reduces
	if 8: Player gets forward in the game, and the health-bar fills with red colour.
	if 9: Player gets slowed down, and red colour in the health-bar reduces
	if 10: If player answers right she gets +5 points. If player answers wrong she gets 0 points.

Table 10.9: Rules continues

Number of Players

The game supports two simultaneous players. The players can either compete or collaborate.

Geography and Representation

Table 10.10 shows the different types of sound in the game and Table 10.11 describes how the game is presented graphically.

Music	Calm, classical music that changes to the speed of the game and to certain happenings.
Vocalization	The avatar will not have its own voice.
Sound effects	When hearts are gathered there is a cheerful "pling" sound.
	When taking the question sheet there is a "click" sound.
	When the avatar is walking there is the sound of steps on the ground. Different sounds for different surface, i.e. walking on the rocks, soil or logs.
	The sound of shoved water when rowing.
Ambient effects	Birdsong.
	Wind.
	Water flowing in the river.
	Waves from the lake.
Feedback	Calm lady voice.

Table 10.10: Different types of sound

Perspective	Third-person.
Dimension	3-dimensional and isometric.
Exploration	Desired pace.
Saving	The game will be able to save current state, progress and results.
Graphical representation	The environment will be presented as close to photorealism as possible. However, there will be some unrealistic elements present in the game environment, i.e. hearts

Table 10.11: Graphical game characteristics

10.3.2 Picking Apples

The Fictional World

Location/setting	The player stands on a lawn with an apple tree in front of her.
Structural objects	Tree, grass, heaven.
Interactive objects	The player character, apples on the tree, two baskets, one on each side of the player.
Scripting objects	Points: Shown as an apple icon with the text "points" after it. Increments with 3 points as ripe apples are picked and decrements with -1 point if an unripe apple is picked, and -2 points if an apple gets rotten
	"Health-bar": Increases as player performs right movements. Decreases as player does not manage the right movements.
	Time: Decreases from 2 minutes
Characters	An avatar (from how Kinect defines a character) seen in third-person perspective, described by its name.

Table 10.12: Different type of objects

Mechanics

This is a progression game where different levels of the game gets finished by solving the apple-picking task. The player has to finish different levels to proceed to the next level. The levels build on each other and the difficulty level gets higher as the player proceeds through the game. Table 10.13 shows the different quests in the game.

Quests	**Exercise required**
Pick apples when they get red and ripe	Stretching
Put ripe apples in baskets	Squats with downward arm movement

Table 10.13: Quests

Rules

Table 10.14 shows the rules in the game.

Interplay rules	**1. The player character:** Will move to the movements received as player input.
	2. Apples on the tree: Will appear on the tree with a green colour showing they are not yet ripe. After a while they will start to get red, and if the apples does not get picked while they are red, they will become brown and fall to the grown.
	3. Baskets: The baskets will get filled with apples.
Evaluation rules	**if 1:** Player proceeds through the game, and the health-bar fills with red colour.
	if 2: If the player picks a ripe apple she gets +3 points. If an apple becomes rotten the player gets -2 points. If the player picks an unripe apple she gets -1 point.
	if 3: If the player puts ripe apple in the basket she keeps the 3 points. If the player miss the basket, she loses 2 points.

Table 10.14: Rules

Geography and Representation

Table 10.15 shows the different sounds used in the game and Table 10.16 describes how the game will be presented graphically.

Music	Calm, classical music that changes to the speed of the game and to certain happenings.
Vocalization	The character will not have its own voice.
Sound effects	Apples making a "pling" sound when getting picked.
	Apples hitting the ground when falling from the tree.
Ambient effects	Birdsong.
	Wind.
Feedback	Calm lady voice.

Table 10.15: Different types of sound

Perspective	Third-person
Dimension	3-dimensional and isometric
Exploration	A mix between forced and desired pace. The pace is forced because the apples appear at random times. At the same time the pace is desired because the player can choose when she wants to stretch to gather the apple. However, this can also mean that the player chooses to lose an apple. Ripening pace will depend on current difficulty level.
Saving	The game will be able to save current state, progress and results.
Graphical representation	The environment will be presented as close to photorealism as possible.

Table 10.16: Graphical game characteristics

Number of Players

The game supports two simultaneous players. The players can either compete or collaborate.

10.4 The Menu

One of the main challenges we observed during workshop 1 was related to handling the menus in the different games. The general perception from workshop 1 was that the menus were complex, difficult to follow, demanding to navigate through, and too sensitive. This was also our own experience from playing. Therefore, we have made a prototype of a menu.

The design of our menu proposal is based upon the interface requirements, listed in Table 10.4 and 13.1. Simple design, distinct elements, and easy to read information are emphasised to make it user-friendly for elderly that might suffer from declined vision [req. 2.6, 2.14, 2.16]. It has also been a focus not to have too much information in each menu step. We have chosen to make a menu consisting of more steps to achieve the mentioned goal. By having a bit longer menu, we avoid filling few menu steps with lots of information and choices [req. 2.12].

The menu starts with the choice of how the player wants to play [req. 1.8]. The player can choose between a walk in the forest, to exercise a preferred muscle group, or between the four single games. If the player wants to play according to training a specific muscle group, she will be given the choice of which muscle group to exercise. Independent of how the player chooses how to play, she will be given the opportunity to choose difficulty level and number of players for the game [req. 1.21, 1.23]. Figures 10.14 and 10.15 go through the menu, from start, through choosing muscle group, to ending up playing "Picking Apples". As seen from what we have presented this far, the menu includes a lot of choices. This is based on the informants' feedback in workshop 1, where they said that they wanted the possibility to make their own choices. They did not want the game to control them.

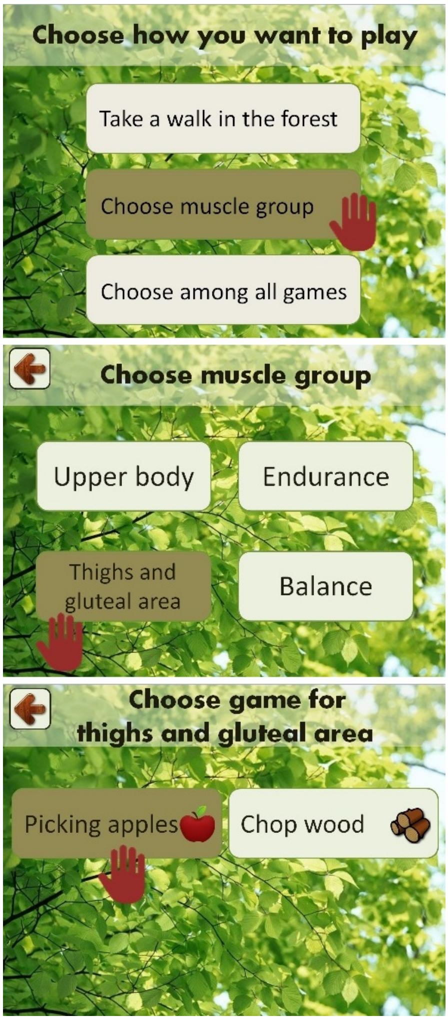


Figure 10.14: This figure shows the menu step by step, from the beginning to playing a single game, here "Picking Apples". The selection of single games is a result of the chosen muscle group.

Figure 10.15: This figure shows the menu step by step, from the beginning to playing a single game, here "Picking Apples". Single player game and the easy difficulty level are chosen.

In the menu, we have used a range of green colours, and a picture of green leaves as background, to create a theme related to forest and nature. Menu buttons are arranged as list elements or in a square, depending on what is most appropriate. This is decided by the number of elements in each step; for an odd number of elements, list view is used, while square arrangement is used for an even number of elements. The size of the elements is chosen with usability in mind; there should be room for a proper font size, and it should be easy to push the right button [req. 2.12]. The buttons have a light green, almost white, background colour, with a darker green outline. The text is written in black with an easy-to-read, sans serif font [req. 2.14]. The choice of background and text colour is to create maximum contrast [req. 2.15]. It is important to take the element's surroundings into account when choosing colours if you want to make the element stand out. With e.g. green vegetation as surroundings, white background colour, with black, dark green, or dark blue text should be chosen to create maximum contrast [req. 2.16].

Figure 10.16: In this figure an avatar hand is shown. The avatar hand will react according to the player's movements. We see that when the player moves her arm over an element, it will change colour.

The title on each step is written in a bold, black, easy to read font, on a semi-transparent light-coloured background. The title is stating what choice to be made at the current step [req. 2.6]. We know from the previous chapters that it is important to have an interface with visible information, and that users always should be given feedback on their actions. Also, the informants in workshop 1 expressed that, it was general desire to see a more clear response on their actions. We have included this in our exergame by highlighting elements that are "in action" [req. 1.15] (see Figure 10.16). The player's hand movements are portrayed on the screen as an avatar hand. The avatar hand has been given a clear colour and a solid fill [req. 2.11]. This has been done to avoid having the same diffuse avatar hand as in "Your Shape Fitness Evolved 2012".

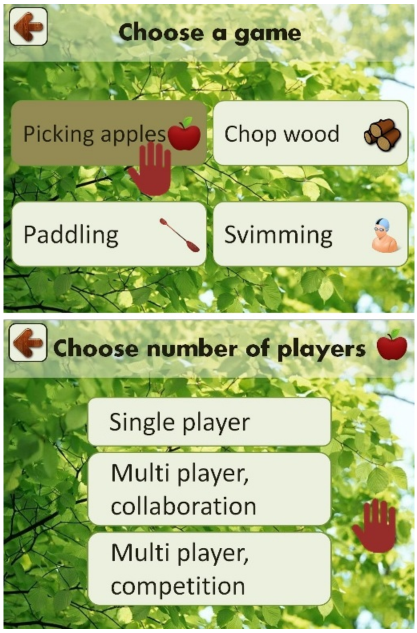


Figure 10.17: In this figure we see that icons from the menu buttons will follow through the menu. Here we see that the apple icon will follow into the menu step where number of players are to be chosen.

In the menu step where the player can choose between the four single games, we have used icons in addition to text on each button, see Figure 10.8. The icons represent the challenges in each game, and they are meant to make it easier for the player to understand the game behind the button [req. 2.6]. When choosing a game, e.g. "Picking Apples", the icon will follow up in the right corner, to inform the player where she is headed, and to reduce memory load [req. 1.12]. This is shown in Figure 10.17.

Up in the left corner there is a back button, which will make it possible for users to always regret their action [req. 1.30]. The back button is shaped and coloured similar to the other menu buttons to maintain consistency and intuitiveness [req. 2.6-7]. The choice of placement is based on the natural way to read and observe information, which is from top to bottom, from left to right. The navigation should therefore be on top [req. 2.12]. We avoided placing the back button in the bottom left corner to not mix it with the cancel/pause feature included in the Kinect software (holding your left hand straight 45 degrees from your body). The back button is marked with a wooden arrow, a familiar and intuitive icon related to navigation. The choice of using a wooden arrow is based on its relation to the forest theme.

10.5 A Video Game Series

"Out in the Nature" is part of an exergame series called "Kinect Experiences". This series consist of four individual games with the same structure as the game we have already presented. This means, one compounded game and four single games. The difference between the exergames is the main themes. In addition to "Out in the Nature", the "Kinect Experience" series consist of the exergames "Farm Life", "On Vacation" and "In the Mountains". The five games within each exergame will consist of activities that are connected to the main theme of the exergame. Examples of single games can be gathering eggs, and stacking hay bales in "Farm Life", and a walk on the beach, or catching gold fish with a hoof in "On Vacation". The idea behind this video game series is to offer a wide range of games, activities and exercises that fits the various interests the user group have [req. 1.2, 1.4-5]. What this video game series would look like is shown in Figure 10.18.

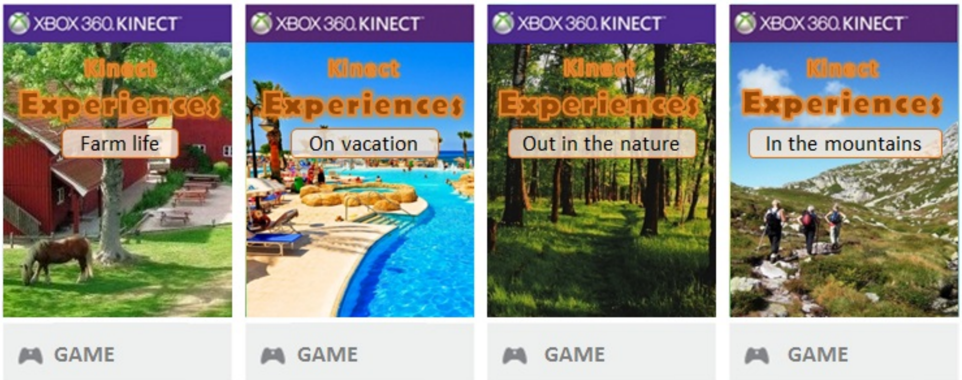


Figure 10.18: A presentation of our video game series "Kinect Experiences" (modified from [93]).

Chapter 11

Findings from Workshop 2

According to the fourth activity in the cycle of user centered design (depicted in Figure 8.1), we wanted to conduct a second workshop to evaluate the designed exergame against the requirements. A description of the execution of this workshop can be found in Section 8.9.

In this chapter we will present the findings from workshop 2. The presented findings are based upon feedback from the informants, and our perception of their reactions to the presentation. The five informants are referred to by using I1 to I5, and are randomised so there is no relation to the references in workshop 1. Due to requirements to anonymity we have decided to not distinguish between male and female. Therefore, we refer to all the informants as females. Quotes are translated from Norwegian to English to preserve the meaning.

11.1 General Perception Regarding the Game's Story and Elements

11.1.1 Nature Trail

When we presented the "Nature Trail" game it took some time before the informants had any comments. It appeared that it was not clear to them from the pictures how this game really would work. *"It is impossible for me to say anything about what I think about this game. This is because I do not have any sense of how it works"*, I4 said. She continued by asking, *"This girl on the screen, if I do certain movements, will she do the same?"*. After we confirmed this, it seemed that the informants understood more about how the game would work, and more comments appeared. I3 said, *"I think this was a good idea because the environment you are in is familiar to me"*. The other informants agreed. Several times during the discussion, I1 complemented our concept. *This was very nice"*, she said, while I4 followed with *"fun development"*.

About having quizzes in the "Nature Trail" game, I1 was very sceptical. She was afraid that it would draw attention away from the physical tasks. I3 agreed and said *"Answering the questions in the quiz will become some kind of test on how good you are, and that is not how I have understood the point of these games"*. I1 meant strongly that we should separate the quizzes from the rest of the game. She said *"I think this is very nice. [...] However, you should think very thoroughly through the cognitive aspects of linking the questions with the physical tasks. You need to have a purpose about it, a goal on what you want to achieve"*.

It was not clear for all the informants when the quizzes would appear in the nature trail. They all seemed to believe that they would appear at the same time as they were doing something else, like while balancing over a log. To be able to focus on both the physical challenges and the quiz, I4 suggested that the questions should appear somewhere where it was natural to take a break, and that the player should be able to sit down while answering them. I4 also proposed that the player could get to see the questions before the game started, and then answer them after a while. Her experience was that if she was thinking about something, the answer usually came up eventually.

From the discussion we understood that there was confusion about the link between the cognitive and physical challenges. This was not only about the goal of having a quiz, but also the quiz's purpose in the game. *"The points shown in the top-bar, do you get them just by answering the questions? It does not have anything to do with the physical skills?"*, I2 asked. Several of the informants also wondered about how the question allocation would work. *"When I'm doing the game time number three, will it still be the same assignments that appears?"*, I3 asked. I4 asked if the player could choose category for the questions.

The informants were mostly concerned about doing two things at the same time, like answering questions at the same time as doing an exercise. Another challenge they commented on was the one where they were supposed to balance over a log. *"This will exercise your balance, right, so it is easy to fall yourself, if you get dizzy"*, I1 said, referring to the possibility of falling not only in the game, but also in real life. There were also some technical questions about this challenge. *"If I am balancing on the log, and I fall down, would I feel that? If I did not manage to keep the balance, and fell in the water?"*, I4 asked.

Most of the elements in the game environment were familiar to the informants. However, the hearts were not that obvious. *"I did not quite understand. The heart floating there on the screen, is the idea that you should take it?"*, I4 asked. I2 followed with *"If you get the heart, does it disappear?"*. Further the informants wondered where the number of gathered hearts was shown on the screen. We explained that to limit the information on the screen the hearts will only fill the "health bar", as an indication of good health. They understood, and agreed that it would be hard to count the number of hearts on the screen, and that the "health bar" was a good idea. Not all of the informants were positive about the hearts. *"But* *hearts.. It is a little feminine"*, said I1, and suggested that maybe hunting butterflies would be better, especially for men because it could trigger the hunting instinct. I3 joked *"A bottle of beer?"*, while I4 added *"Let's see.. A feather? Flying by?"*.

At first the informants did not understand how the different difficulty levels would work. I1 said that she did not want to get forced into something she did not want to do, and that she wanted to be able to choose which difficulty level to play in. *"I am thinking that I do not want to get forced into something that is hard, that I do not master. Because then I get mad"*, she said. We explained how the game will remember the players progress and adjust difficulty level accordingly, and that there also will be initial difficulty levels that the player can choose between. She agreed that this was a nice way to do it, as long as she had the possibility to choose herself. I4 also agreed on the way we had organised the different levels. *"I think it is an advantage that everyone starts at the easy level, and the more confident you get, the harder it gets. I think that is a good way to be controlled"*.

11.1.2 Picking Apples

The informants all seemed to like the "Picking Apples" game. *"I think this was nice"* I3 said. However, there were some concerns related to how the apples would appear on the tree, and how they could plan the apple picking. I4 said *"I feel that two apples is fast to gather. If the tree was full of apples I would be more eager to play. [...] It might be weird if they should pop up all the time"*. We explained that the apples appear randomly to cover both the cognitive and physical exercise. They all agreed that this was a nice solution.

11.2 Information, and the Menu

More information was stated as important in workshop 1, and we had therefore tried to include this in the exergame. The informants seemed satisfied with the way we had presented this, and they also seemed to recognise the included instructions inspired by the sports game, like "raise hand above head to play". We asked if they noticed the arrow in the upper left corner, and I5 immediately said *"back"*. Everyone agreed that it was clear that the arrow indicated a back-button. About the combination of colours and how the pictures looked in general, I1 said *"beautiful!"*. I3 mentioned that it would be better with more shadow around the buttons, to indicate that it actually is a button. On the question on whether there were too many steps in the menu before the game started, the only comment was from I1, who said *"When you have used the menu, then you want to have shortcuts"*.

When we presented the possibility to choose game play based on muscle groups, there arose many questions on what we meant about the term "muscle group". It became clear that we had been inconsistent with this categorisation. I5 said *"When you use the term muscle group, then I think that endurance do not fit under this term"*.

All of the informants had problems understanding the different difficulty levels in the games. *"My immediate reaction when I saw these three different forests with different difficulty levels, was that it took me some time to understand that the different environments represent different difficulty levels"*, I3 said. The other informants agreed. Further I3 suggested *"Easy forest, medium forest, hard forest, or what you would call it"*. About the different difficulty levels, some of the informants wondered if the same challenges would appear in all levels, just more frequently. This was the way we have thought the game to be, in addition to adding new obstacles in the higher levels.

11.3 Music and Atmosphere

The informants were curious about the music and sounds in the games. I4 asked *"I am wondering about the atmosphere and environment. When I am balancing on the log, will I hear the sound of water?"*. We explained that we wanted to include sounds that are natural to the environment. I2 said *"Not noisy, like last time"*, referring to the music in the games played in workshop 1. We told them that we want to use peaceful music, like classical music. I1 suggested *"You should think about rhythmic music. Maybe it is just as easy to pick apples to a rhythm, instead of picking as many as possible? [...] Then, when the apples ripen, it will be according to the rhythm"*.

11.4 Other Aspects Concerning the Games

Some of the informants were concerned about getting tired of the game after playing it several times. One informant asked if it would be possible to exchange the game if it got boring. We presented our idea for a video game series, where each game could be downloaded from the Internet for a small amount of money, in this case 99 NOK (about 18 USD). They agreed that this was an affordable price. The informants showed interest and curiosity about how they could get the game. I1 asked *"Do you think you could get it on prescription?"*, and I4 continued by asking if it would be possible to rent such a game from the library. When discussing the possibility to exchange games if they got bored, I3 expressed that she did not think this would be a problem. *"I would think that when I have completed the game I have exercised, and that would be satisfactory for me. And then I could easily do it over again"*. After I3 had put it that way, the other informants seemed to agree.

One of the informants remembered the technical aspects related to the delay from the last workshop. She said *"this is a technical question which* *is about the capacity in the computing system. It is not straightforward to solve technically. [...] Do you have any thoughts about this?"*. We informed them that we will recommend the delay issue for further work.

All of the informants were eager to hear more about the development of the exergame, and they wanted to get information about when the game would appear on the market. I4 said *"It would have been fun to know when it comes. I have faith in this project"*. *"Include us in the customer list!"*, I1 laughed.

11.5 Summary

We will summarise important findings from workshop 2 below:

- Informants liked the familiar environment, both in the "Nature Trail" game and in the "Picking Apples" game.
- Informants were sceptical to including quizzes in the "Nature Trail" game, and suggested to separate the quizzes from the physical tasks.
- Informants stated that the balance task could be challenging.
- Technical details should be included, i.e. what happens if the avatar falls of the log.
- The purpose of the hearts was not obvious. In addition, the hearts were considered as feminine.
- Informants suggested that clearer instructions on the different difficulty levels should be included.
- Informants were curious about music and sounds.
- Informants proposed to use music in rhythm with the rate of apples appearing on the tree.

- Informants suggested more shadow around buttons to highlight them even more.
- Informants expressed lack of consistency related to what goes under the term ”muscle group”.

Chapter 12

Discussion

In this chapter we will provide a discussion of the findings done in the two workshops we have conducted, and on the concept we have created. The findings and results will be discussed up against theory and previous studies, as well as with our own opinions.

In Section 12.1 we will discuss the findings from workshop 1 together with the theory discussed in previous chapters. This will be related to our choice of system requirements and exergame concept. In this way, the reasons for the choices made should become evident to the reader. In Section 12.2 we will discuss the findings from workshop 2, and based on this, provide a list of recommended improvements and adjustments for the game. During our study, we became aware that there was a problem with delay in some of the commercial games. This was an issue that was discussed and commented on several times by the informants. Therefore, we will, in Section 12.3, provide a brief discussion of this issue, and direct the interested researcher to relevant references on this topic. At last in this chapter, we will discuss the quality of the research. This can be found in Section 12.4.

12.1 Discussion of Gathered Data and its Relation to the Exergame Concept

In Section 7.3 we discussed the importance of usability which is about how easy a system is to use, learn and understand. Workshop 1 was performed to see how a set of relevant users interacted with commercial exergames, and to identify which aspects of these games that do or do not work for this user group. Three relevant elements that are used to measure a system's usability are: *effectiveness*, *efficiency* and *satisfaction*. These were aspects among others which we tried to measure in this workshop. We also tried to answer the exergame's *context of use*. We were seeking to discover the needs of the intended users, the need for functionality, and the environment for the game. Where and in which circumstances the game can be used were discussed in our previous project assignment [8]. This is not the main focus in this thesis, but it will briefly be discussed, as it was commented by the informants.

In this section, we will discuss findings from workshop 1, and relate these findings to the literature provided in previous chapters. From this we will emphasise what we have considered in our exergame concept. With the findings from workshop 1 and the literature study conducted we want to answer these two research questions:

RQ1: Are existing commercial Xbox Kinect games suitable for exercising purpose for elderly people?

RQ2: What are the design challenges when developing an exergame for elderly people, and what aspects need to be considered in this game?

We will start with a general discussion, before we at the end of this section provide a summary to more precisely answer these two research questions.

12.1.1 Control of Character, Clear Goals and Feeling of Mastery

The GameFlow model [71], discussed in Section 7.5, describes eight core elements that should be present to experience enjoyment in games. One of these elements is control. The informants expressed that they did not feel they had control over their character. This was due to the significant delay that was present in the games. In addition, it came clear from the observation that it was not always easy to understand when the game started and ended, as well as what was an instruction video and what was the actual game. Clear goals did also seem to lack in the commercial games, and it was expressed by one informant that there was a need for more instructions on the rules of the game, and on what was expected from them. In Section 4.2, we discussed how video games can function as a pedagogical tool and it was shown that important factors to focus on include motivation, effectiveness and intuitiveness. These aspects were also mentioned by the informants. They expressed that the system needs to be easy to understand, and that it is important to see a learning curve, and experience a feeling of mastery. In Section 3.3, self-efficacy is described as an important determinant for exercise behaviour. Elements that are relevant to sustain this exercise behaviour are the feeling of pleasure and satisfaction, and self-regulatory skills. This was also discussed in workshop 1 as important aspects, and the informants mentioned goal setting, the possibility for socialising, and the possibility to decide for themselves what to do, as important. The feeling of mastery was seen as significant, and the informants were clear that if they did not get the feeling of mastery, they would not play these games. This relates to the elements discussed in the GameFlow model [71], which states that games should include challenges matching the player's skills, different levels of challenges, and clear goals, to ensure player enjoyment.

In our exergame we have emphasised the inclusion of different difficulty levels. This has been done in two ways: Different initial difficulty levels the player can choose between, and different difficulty levels within the initial levels, where the next level depends on the previous. In addition, clear goals, with appropriate challenges where the player will be rewarded with points, are aspects that are highly considered in the exergame.

Clear instructions are included in our exergame to let the player know what is expected from her, and for her to know when the game starts and stops. In this way the player should feel she is in control of the game. We are not in control over the technical details, like delay and response time. However, this should be improved for the player to feel control over their character.

12.1.2 Immersion and Concentration

As presented in the GameFlow model [71], immersion and concentration are important aspects of the gaming experience. It was hard to evaluate from observing and interviewing the informants if they were immersed into the game and concentrated on the tasks. However, comments from the informants during game play, like *"I felt like the avatar itself"*, and *"I wanted that pineapple"*, suggest that the informants immersed into the game. If we are to evaluate, we would say that all the games required concentration to perform the tasks right. However, it did not always seem like the informants were that concentrated. A few times, we had to assist the informants in reading messages appearing on the screen, like "raise hand above head to play", while they at other times read the same type of messages by themselves. We believe that the text should have been clear enough, and that the reason for them not reading the text, was because they did not concentrate enough on the game.

Concentration and immersion are considered in our exergame. For the player to see obstacles on the trail, as well as to see when apples ripen, they need to concentrate. We have provided an intuitive interface with simplistic design, which makes it easy to concentrate on important elements and tasks. The activities in the exergame are provided in a real-life environment well known for elderly, and are based upon activities suggested as interesting for them. In addition, the exergame is presented with 3-dimensional graphics.

This has been done to enhance the players immersion into the game, and hence increase the gaming experience.

12.1.3 The Possibility to Customise

We have learned from guidelines presented in Section 5.2, and from the informants, that there is a need to customise an exergame aimed for elderly users. This is to be able to meet various limitations and disabilities they might have. Our previous project [8] supports this need for customisation. There we evaluated the game to fit as a tool for physiotherapists to use as an alternative exercise method. What this game should offer was therefore described as: *"A tool with the ability to customize an exercise program, and to offer an alternative, fun and motivating training method, while at the same time ease the workload of the physiotherapist"* [8]. The possibility to customise the exergame can be a feature in the physiotherapists' interface, where they can put together different exercises within the game story, which fits their patient's needs. They could also set parameters to adjust difficulty levels according to progress, set the pace in the game to ensure mastery, and also change font and background to preferred size and colour to ensure readability. Another example is for the user herself to have an interface where she can put together her own program and set her own parameters. We have made requirements for this; however we have limited our thesis to not design an interface with the possibility to customise. These requirements are represented as 1.33, 1.34, and 1.35 in Table 10.3. Requirements 1.31 and 1.32 say that the system should have user profiles where players' progression and results can be saved. This profile should be possible to share with others. This will be especially important in a clinical setting, for the physiotherapist to monitor the patients' progress. We have not included this user profile in our concept either. The development of a user-interface seen from the physiotherapists, as well as the user profile, will be left for future work.

As discussed in our previous project, the game should, in the future, be used for home based training [8], handed out by the physiotherapist. This can overcome some challenges when it comes to motivating elderly to exercise. First, as discussed in Section 3.2, one challenge about getting elderly to exercise, is if the person lives far away from training facilities. This was also mentioned by one informant. Second, another informant mentioned that she did not want to be controlled by time and appointments. An exergame implemented at home would make exercising convenient and more available. If physiotherapists use this game as a home training program, different prompts, as suggested in Section 3.3, should be used as follow-up.

12.1.4 Social Aspects

The GameFlow model says that games should support social interaction to meet player enjoyment. Also in Section 4.3 the importance of social interaction in exergames are discussed, and in [34] it is stated that as much as 62 percent of all gamers say they play with others, either together in the same room or online. Guidelines presented in Section 5.2 also suggest inclusion of social factors in a game for elderly. Offering social interaction, is especially important for elderly who experience loneliness in their everyday life, due to inactivity [1]. It was interesting to learn that social interaction also was seen as important by the informants. The majority of the informants would rather play together than alone. They mentioned playing together in a group setting, and especially, playing together with grandchildren. However, none of the informants could see themselves playing together with others over the Internet. This relates to findings done in [43], where it was shown that elderly enjoyed playing together in the same room more than playing online. We believe that one of the reasons why the informants stated this was because they did not understand the concept of "playing over the Internet", as a result of their inexperience with this technology. This assumption is supported by one of the characteristics in Section 5.2.1. This might indicate that the market is too immature for this. However, having this way of gaming introduced by grandchildren may remove some barriers related to playing over the Internet. Especially, if they get to understand that online gaming could mean more contact with their family. Presenting a picture of the co-player in a corner of the screen might help the elderly draw relations and increase the feeling of socialisation. We did not include this in our exergame. However, this should be looked into in future work.

Two informants meant it was more motivating to collaborate than to compete. This was also found in [43], where they, based on results from their study and from studies conducted by others, conclude that the focus should be on collaborative play rather than competition for this group of people. However, the other informants seemed to like both to collaborate and to compete. In our exergame, we have provided both the possibility to compete and collaborate, because of two reasons: First, several of the informants wanted the possibility to play together with grandchildren. The findings done in [43] shows that elderly prefer to collaborate and help each other, rather than to compete. This is in contrast to what they found in previous studies about young people, which is that young people prefer competition. And second, the majority of the informants seemed to want the possibility to choose.

12.1.5 Appropriate and Simple Feedback and Information

The informants included in our research were relatively physically and mentally fit. However, we found some informants to meet some of the typical characteristics of elderly, listed in Section 5.2. We experienced that one of the informants had problems reading the text in some of the menus. Because it was only one informant that had problems with this, we assume that this informant might have had impaired vision. However, as discussed in Sections 5.2 and 5.3, impaired vision is a common problem for the older population, and should be considered in a game designed for this group. This has been taken into account in our menu proposal. The group of informants had interest in technology and used a wide range of devices.

However, none of the informants had any experience with video games. In the beginning of the workshop we experienced that the informants were insecure, and had problems understanding what they were supposed to do. It took some time for most of them to understand that they had to use their body to play. Therefore, we see the need for clearer instructions both before and during game play. This includes an introduction to how the system works, how to interact with the sensor, and information about what is expected from the player in the game. Clearer instructions have been defined as a requirement for our exergame. The final characteristic that we experienced was that some of the informants expressed that it was hard to do more than one thing at the same time. Therefore, the information given, and the tasks to be done, should be limited, and adjustable. The possibility to add more functionality after the existing functionalities are managed was suggested by one informant. This is also stated in the guidelines from Section 5.2, and suits well with the requirements of simplicity discussed in Section 7.3.2. We have solved this by offering different difficulty levels.

We learned from workshop 1 that the feedback presented in the commercial games did not satisfy the informants. Feedback is one important element from the GameFlow model, and are also stated as guidelines in Section 7.4.1 and 5.2. These guidelines suggest that informative feedback should be given in a motivating form at appropriate times. The informants desired more feedback on their actions, and they especially wanted to know whether they did the exercises right or wrong. They did not feel that they got this feedback in the games played in the workshop, which made them both confused and frustrated. Some of the games had a lot of different features that were supposed to be motivating. However, this was perceived as rather annoying. In addition, the amount of the information given, both with text and voice, was experienced as too much. At the same time, some of the informants stated that they did not recognise these types of messages at all. In Section 7.3.2, we discussed minimalistic design which is about bringing the most important elements into focus, and avoiding elements that can distract the user. Microsoft presents it as "Simple Can

Be Powerful", which means that simplistic design not necessarily needs to mean lack of functionality. From this we concluded that we should avoid too much features in our exergame. We have chosen to keep it simple, and to focus on a few motivating aspects, such as to see progress in the healthbar. One informant desired more time to read information and instructions, and suggested that there should be a way to tell the system when you are finished reading. This is supported by guidelines in Section 5.3, and has been taken into consideration in our exergame. The feedback is given at appropriate time when the player manages to do a task, and instructions on the task will be given as the task appears. In addition, the player can spend all the time she wants watching the instructions.

12.1.6 Cultural and Lifestyle Diversity

Guidelines from Section 5.2 and 7.4.1 are about the importance of matching cultural and lifestyle diversity in games. This was also expressed by the informants, and they suggested different type of themes for a possible game concept, like dance, swimming, apple picking etc. If they were to play a game like this they stated that it would need to include sports or activities related to real life. They also mentioned the importance of appropriate music. They did not like the music in the commercial games because it did not relate to the music they used to listen to. In Section 3.3 appropriate music is proposed to be a motivator for exercising, and in [20] it is discussed that music can be a way to divert from physical pain. This strengthens upon the importance of including music. The majority of the informants agreed that music was important, especially to keep the rhythm. However, they stated that they wanted it quiet, and they wanted music more related to their generation. This indicates that choosing the right music is an important requirement for the exergame. The informants' opinions did not differ much according to gender on what they liked and did not like in the games we tested. However, as discussed in Section 3.3, different people's needs and expectations, as well as aspects such as gender and ethnicity should be considered.

We have met cultural and lifestyle diversity by designing an exergame with a series of games that covers a variety of interests. In addition, the requirements specify that the player should be given the possibility to choose a male or female character. Race might also be considered, but it is difficult to cover all races. Chao et al. [22] discuss that to meet diversity requirements, it is important to be in contact with the relevant people. Even though we clearly have not covered the total group of elderly people, we have included a small group to understand some needs and expectations. Finding the appropriate music will be left for professionals, like music therapists.

Observations made during workshop 1 identified some requirements that are not included in our exergame. This is related to the functionality and the hardware of the system. Elderly are, as mentioned, inexperienced with technology, and it is important for acceptance of an exergame, that the hardware is not too extensive and complicated. In addition, the load of introducing something new for this user group should be minimised. In this matter, they should be able to use the equipment they already have as much as possible. All of the informants had their own computers, and what would be most convenient would be to use these to play. This is possible, as the Kinect technology can be experienced with both the Xbox console and Windows computers, as we learned from Section 4.4. This is discussed since it is important aspects of introducing an exergame for this user group. This, and additional non-functional requirements will be listed in Appendix J.

12.1.7 Summary

We will now provide a summary of what we have discussed in this section, this to in a more precise way answer research questions 1 and 2.

When reviewing related literature, presented in Section 5.1, it was discussed that existing commercial games are not aimed for the older user group. Based on this, different characteristics of elderly were discussed, and guidelines were suggested. That existing games are not suitable was also seen in our previous project [8], where studies found them to be too rapid and complicated for elderly. We wanted to explore this, by testing different commercial Xbox Kinect games to understand good and bad aspects within these games. Findings from this together with the previous research will answer research question 1:

RQ1: Are existing commercial Xbox Kinect games suitable for exercising purpose for elderly people?

As mentioned initially, *effectiveness*, *efficiency* and *satisfaction* are relevant measurements when evaluating the usability of systems. Based on findings from workshop 1, we can conclude the following about the commercial games tested:

- The commercial games tested on a group of elderly do only to a degree meet the requirements of effectiveness. The functionality needed to play the game are present, however, the games do not spend enough time on instructions and information, and do not give sufficient feedback on whether the players' actions are done correctly. Because of the lack of instructions in "Fruit Ninja" it became clear that the informants did not understand what was required from them, and they just waved their hands uncontrollably. In addition, the delay problem weakens the functionality. The menus in "Aging with Grace" and "Fruit Ninja" do not need the requirement of effectiveness, as they are too complicated and there are too many elements present at the same time. The buttons are too sensitive, and it is not intuitive how to press them. The majority of the informants understood what was expected from them in the tennis game, and played through this game without problems. The skiing game was also well understood, until the second match where the two players that played together switched tracks. All of the informants had problems relating to their player after switching tracks. This also relates to the lack of instructions.
- It is hard to evaluate the efficiency in a game, because it requires us to measure how much time used to accomplish a task. In these

games, the players were forced to follow the pace in the game. All informants managed to complete the games, however, with various results. The efficiency of the two menus tested can be measured, as we can look at the overall time spend getting through them. The menus in "Aging with Grace" and "Fruit Ninja" do not meet the requirements of efficiency. We had to assist the informants through the menus, and because of too much information and too sensitive buttons, the informants spent unnecessary time on getting through the menus. In addition, the issue with the delay reduces the degree of efficiency.

- Two of the four games played in workshop 1 meet the requirement of satisfaction. All of the informants liked playing the tennis and skiing game and they had fun while playing. "Fruit Ninja", they did not like that much, which relates to their wish for playing games with a meaningful content that they could relate to real life. The informants were not satisfied with "Aging with Grace" either, because this focused on "just" regular training, which they would rather do without the game. This supports Zyda's statement on that the main focus in serious games should be on fun and entertainment [29].

It is important to remember that this was the first time the informants played games like these, and initially they did only play the games once [1], which do not enable us to say anything about the informants learning curve. However, we did see that they understood more what was expected from them, and that they got more confident after a while. If we had continued with several rounds with the same games, we might have seen improvements. This was also mentioned by the informants.

To describe what is important to focus on when developing an exergame for elderly people, we will answer research question 2:

[1] Three of the informants got to play the skiing game a second time because they specifically asked for it. We did not observe anything new in this second session, and have because of this, and because the rest of the informants did not try a second time, not included this in our analysis

RQ2: What are the design challenges when developing an exergame for elderly people, and what aspects need to be considered in this game?

Understanding the game's *context of use* is important when specifying requirements. From the different characteristics discussed in Chapter 5, and from meeting a group of relevant users, we have learned more about elderly as a group. The characteristics identified (see Section 5.2.1) need to be acknowledged to make a suitable game. One of the main challenges when developing an exergame for this user group is that they are a group with diversity, both when it comes to interests and different types of disabilities. The informants desired a game with a story that appeals and relates to real life, as well as appropriate music to their age. Different themes for a possible game were mentioned, showing the diversity of needs. Guidelines proposed in Chapters 3 and 5, as well as the Eight Golden Rules and the GameFlow model have many relevant elements that are found to be important. Several of the findings done in workshop 1 relate to these guidelines. From this we have made functional and interface requirements, which should be followed making an exergame for this user group. It was urged for more instructions on how to interact with the game, as well as what was expected from the players, the goals, and the rewards. The menus in the commercial games were seen as challenging because of the amount of information and the sensitive buttons. In a game for this user group this needs to be improved, taking physical disabilities in arms and visual decline into consideration. The majority of the informants would only play these types of games together with others. Social aspects are discussed as important in Section 5.2, in the GameFlow model and by the informants. Therefore, this is included in our game. The delay in the games was seen as a great issue, and should be acknowledged. We believe that if this game is to be used for exercising, both at home and in clinical settings, technical precision has to be present. The last part of specifying the context of use, is to find out where and in which circumstances the users would like to use the game. In a previous study [8] we evaluated the game to fit well as a part of physiotherapy or in a group training setting. This was supported by the informants. Most of them preferred playing with others, and could see this as an activity done together in a group. They also wanted to play the game with grandchildren.

It is important to acknowledge the difficulties about engaging a user group into a setting they are completely unfamiliar with. Most elderly are inexperienced with video game technology, and it could therefore be challenging to include them in a development process for an exergame. Not only is the technology completely new for them, but they have not yet acknowledged that this is something they are in the need for. We experienced some of these challenges in our workshop. The informants were involved with a new technology, and they were discussing an unfamiliar topic. This resulted in them at times being ambiguous in their feedback and comments. First, they said that they wanted to buy such a game, and few moments later they said that video games are a waste of time. We have tried to bring out the informants overall opinions during the workshop.

12.2 Evaluation of the Exergame

In Section 8.1 we presented the importance of user involvement during system development, as the end-users are the ones who will use the final product, and are the only ones who know what they want. After creating an exergame based on specified requirements, we invited a group of elderly to a second workshop to get feedback on our ideas and design proposals. We presented prototypes of the exergame, and we opened up for questions and discussions. Figure 8.1 shows the cycle for user-centered design, where workshop 2 is about the fourth activity, which is to evaluate system design. As presented in Section 8.1, ISO 9241-210, states that feedback from users will help designers not only evaluate design, but also improve them according to the users' needs. Involving the end user in the design process will increase the possibility of making a user-friendly interface for the intended user group, which is, as stated in Section 7.3, crucial for making a successful system.

In this section the evaluation of the exergame will be discussed. Based on theory and findings from workshop 2 we will present important aspects to be included in future work of designing this exergame for elderly. These aspects will be discussed, but we will not make any changes to our current exergame. This is out of the scope of this thesis and is left for future work. At the end, we will review what has been presented in this section, and use this to evaluate the exergame by answering research question 3:

RQ3: What would be suitable system requirements, and appropriate design, for an exergame for elderly people?

12.2.1 Few Comments and Moderate Response

Generally there were few comments, but several questions, during the workshop. When we presented the various prototypes, the informants responded with silent nodding or just looking mutely at the screen. There could be several reasons for this. One reason could be because the informants were inexperienced with video game technology, which could have made it difficult for them to comment on the exergame, as they did not know what to look for and respond to. One informant stated that it was impossible for her to comment on the exergame, as she did not know anything about how the game would work. The moderate response could also be related to the informants' health conditions, and the fact that elderly see is at challenging to comprehend and process too much information at the same time. However, we found our informants to be both physically and mentally fit.

Another reason for the lack of comments could be related to how we presented the prototypes. Our exergame is based on highly interactive video game technology, and it is, as presented in Section 8.1.1, very difficult to make good prototypes for this. In addition, the Kinect technology do not use any sort of controllers that we could have made prototypes for. We made prototypes with the purpose of showing various scenarios from the game, and did not make them in a way where it was possible for the informants to interact with them. We presented the prototypes with the "Wizard of Oz" method, meaning that one of us controlled the interactive system, and the other one took the role as the user. This was to try to give the informants a feeling of interaction. However, the lack of interaction between the informants and the prototype could have been a reason for the informants' poor understanding of how the game would work.

Another reason could be that we did not present the information good enough. A question from one informant during the presentation supports this assumption. Even though she had played games like this before, she asked if the avatar in the prototype would respond to her movements. After we explained the relationship between the avatar and the player, it seemed that the informants understood quickly. This increased understanding lead to more questions and feedback. Also, it appeared that it was not clear how the quizzes would appear. I4 thought the quizzes had to be answered at the same time as doing other tasks, which was not the way we had though it to be. This misunderstanding was a result of us not presenting the scenarios clear enough.

The final reason could be that the informants wanted to be polite. The fact that we presented our own concept may have led to them not wanting to be honest with us, in case it would hurt our feelings.

12.2.2 Challenge, Concentration and Difficulty Levels

The GameFlow model with its concentration element emphasises the importance of not distracting players from tasks they want or need to concentrate on. In addition, players should not be bothered with tasks they do not see as important. Related to this concentration element, the informants had some concerns and uncertainties about integrating quizzes in the trail. The informants expressed that they felt that having quizzes together with physical tasks would draw attention away from one of them. They did not like the idea of doing two things as the same time. *"I would like to focus on the task I am supposed to do"*, one of the informants said. It is important to take the element of concentration into consideration when developing an exergame for elderly. This is supported by the characteristics listed in Section 5.2, which states that elderly people often have difficulties doing more than one thing at the same time. We suggest that one solution for future work should be to let the player choose, when starting up the game, whether she wants to include the cognitive challenges or not.

One informant suggested that the quizzes should provide different categories, to meet different interests and knowledge areas. In our exergame proposal, we have not focused on what kind of questions that will appear. What we presented was only an example question. Further work should include finding an appropriate way to engage cognitive skills and to find suitable questions and tasks for this.

From the challenge element in the GameFlow model we know that games should offer difficulty levels that match the player's skills. This, combined with the concentration element, has led to the idea of adjusting frequency of the appearance of obstacles, and number of simultaneous tasks, according to the various difficulty levels. The difficulty of required exercises and movements should also be controlled by the player's current difficulty level. This is important for elderly who might suffer from various physical challenges. One informant stated that balancing over a log looked challenging, as she thought she would feel dizzy, and that she was afraid of falling in real life. This challenge was also reviewed by a physiotherapist. She stated that it was a difficult exercise to perform, and it therefore should be included in higher levels in the game. This support the importance of providing the possibility for players to choose difficulty levels themselves, as stated in one of the guidelines in Section 5.2. However, the GameFlow model suggests that the game also should support adjustment of difficulty level in accordance to the player's skills and progress. By offering both these opportunities in this exergame, we meet the feedback from the informants, as they want to be able to master the various tasks, and not be forced into something they would not master. They wanted to choose themselves and at the same time feel that they learned something and got better.

12.2.3 Graphics, Sounds and Interface

In general, the informants liked the exergame we presented for them. They expressed that the nature trail was a good idea because they were familiar with the environment. This supports findings from previous studies, like in [9], where the participants appreciated the use of a real-life environment. The GameFlow model states that immersion is important for the player to effortlessly be involved in the game [71], and we believe that the use of a natural and real-life environment can be helpful for achieving this.

Gudelines from Section 5.2 emphasise that an interface should be simple and not too complex, and that important elements should be brought into focus. The informants seemed to like and understand the menu interface we presented for them. Their general perception of the interface was that it was *"beautiful"*. The back-button and the purpose of it was observed and understood immediately. A comment was to highlight the buttons even more, making them stand out more with a hint of shadow around them. In the first workshop, the informants commented that they did not like the navigator hand as it was both difficult to see and too sensitive. They said they would rather prefer the familiar arrow navigator from regular computers. However, in the menu we have designed we chose to use an avatar hand. This avatar hand is designed with a solid fill and a distinct colour. We did not receive any comment about the avatar hand, and conclude that we presented a good solution.

In Section 5.3 we discussed the importance of using a one-coloured background, as well as not having text on pictures, to ensure readability. Both in our menu, and in the scenarios, we have chosen to use transparent boxes when presenting text, as instructions and information. We chose this to not interrupt with the picture of the game environment and the overall design. Having the box filled with colours hides too much of the picture, and it does not look very nice. In this case, we chose design over usability. Guidelines discussed in the same section, say that the text should be put where there are light areas in the picture, which we have met by putting black text over a white transparent box. We did not get any feedback on this aspect, and conclude that it, in this case, worked to choose design over usability.

SilverPromenade, presented in Section 5.1, had success with an intuitive and user-friendly interface, which quickly and easily guided the users to game play. However, as mentioned in Section 10.4, we have chosen to have a longer menu to include the possibility to choose actions, and at the same time avoid too much information at each step. The informants said the menu was OK, but they wanted to use shortcuts when they had got familiar with the game. Inclusion of shortcuts for the experienced user is mentioned as an important feature by the guidelines presented in Section 7.4.1, and should therefore be included in future work for this exergame.

There were some questions related to the various elements in the prototypes. Most of these questions were related to the heart element and were about what the hearts meant, what they represented, and what would happen if the player touched them. That the hearts were observed quickly is positive, as these are important elements of the game. This means that they stand out, which we have learned from Sections 5.2, 5.3 and 7.3.2 to be important. However, from the guidelines in Section 7.4.1, we know that intuitive interfaces also are important. What is not so positive with all the questions is that it shows that our interfaces are not that intuitive as we had imagined them to be. This has to be taken into consideration for future work. Three informants also had comments about the choice of symbol. They did not like the use of hearts, as some of them felt it was too feminine. It will be left for future work to discuss if this feedback is relevant for the gaming experience, and if so, find elements appropriate for both genders. In addition to questions about the elements, we got comments and feedback that indicated that there were too many elements in the picture. In the prototypes we have shown obstacles, hearts and quizzes all in the same picture, and we presented it this way to show how elements will appear along the way in the nature trail. However, the informants did not see the depth in the picture, and believed that they were supposed to do everything at the same time. This made the prototypes appear quite distracting, as the informants did not know what to focus on. This interferes with the concentration element from the GameFlow model. Therefore, presentation of elements has to be considered in future work.

Two different steps in the menu were source to a lot of discussion due to lack of intuitiveness and consistency. One of these was where the player was to choose environment and difficulty level. This especially yielded the understanding of the increased difficulty level between the three environments. It came clear to us that it was not very intuitive that the three different forest environments were meant as three different difficulty levels. Future work should be to focus on including textual information to make this part more intuitive. Instructions on what the different difficulty levels imply should also be included. The other menu step was where the player had to choose to play according to a specific muscle group. The informants did not see consistency between the term "muscle group" and what we presented in the menu. I1 said *"The term muscle group, it does not fit with what you show here [...]"*. This is not positive for our interface, as one of the Eight Golden Rules says that designers have to strive for consistency to achieve good system design. We acknowledge that we did not think through this step thoroughly. However, what we presented was just an example, and we conclude it to be the work of professionals, like physiotherapists, to find appropriate muscle groups to include in the exergame.

A motivator for exercising, discussed in Section 3.3, is sound and music, and from 6.2.1 we also know that this is important for the players' enjoyment and gaming experience. We did not present any music or soundtrack for the informants, as this is, as mentioned, out of our competence area. However, we told the informants that we wanted to use calm and peaceful music, to meet their feedback from workshop 1, where they expressed that it was too much noise. We also presented the informants for ambient effects, like birdsong and sound of running water, as this are sounds related to the environment of the game, and sound effects like a "ping" when collecting a heart. They seemed OK with this music and sound, but they wanted music with more rhythm to easily immerse into the game and exercise. Future work should therefore be to find appropriate music for the different games, based on the exercise and pace in each game.

One of the informants had a question about what would happen if she fell down from the log and into the river. Technical issues similar to this question could include the possibility to walk outside the path and into the forest. We did not present how these kinds of happenings would be handled, because we simply did not think about it. Because we are familiar with computer and video games it is obvious for us that there are limitations to avoid the player from "walking out of the game world". However, this is not necessarily obvious for this user group. Regardless of the user group, these are important technical limitations that need to be integrated into the system requirements.

12.2.4 Summary

A summary of the discussion just provided will be given in order to more precisely answer research question 3. From the evaluation of the game we will give recommendation for future work on this exergame.

RQ3: What would be suitable system requirements, and appropriate design, for an exergame for elderly people?

Our overall observation and understanding during this evaluation activity were that the informants liked the idea and design we presented for them. They were mostly positive, especially to the use of real-life environments and well-known activities. The use of real-life activities has also shown promise in a previous study [9]. From what we have learned, we see our system requirements as appropriate for an exergame for elderly. However, some adjustments to our exergame proposal have to be made both when it comes to design and functionality. These various aspects are listed below as a recommendation for further development of this exergame. If these recommendations are taken into consideration, and changes are to be made, we believe this together with our specified requirements and design proposal will provide an exergame suitable for elderly people.

Recommendations for How to Further Develop this Exergame

- Future work should include working on how to present the difficulty levels for the users. There should be focus on including instructions and information about how difficulty levels are chosen and controlled. In addition, textual information should be included in the menu step where the player is to choose environment, to indicate that each environment holds initial different difficulty levels.

- Our prototypes showed obstacles, hearts and quiz icons all in the same picture, which made the prototypes distracting. Future work should include studying the presentation of elements. A suggestion is to not show the elements from a long distance, but let them appear as the player comes closer to them. Future work should also look into the choice of elements, and validate that they are appropriate for the game and the user group.

- The exergame should hold the possibility to separate the quiz from the nature trail. This should be done to let the player more easily focus on one task at the time. It might be more natural to include the quiz when the player has gotten more familiar with the game.

- Future work should focus on the quizzes' role in the game, and how and when they will appear. Future work could also include looking into presenting the "quiz icons" in a different way, to not take focus away from the other current tasks.

- The buttons in the menu should be highlighted to let them stand more out. This can be done by adding some shadow around the buttons.

- Appropriate shortcuts should be included in the menu. These should not interfere with the functionality already provided by the Kinect technology, like pausing by holding the left arm out from the body.

- It should be the future work for professionals, like music therapists, to find appropriate music to the game. This yields ambient effects that fit the environment, sound effects to give users feedback on actions, and music suitable for the intensity in the game.

- The purpose of all important elements should be presented in the instruction video. The idea is that the purpose of the hearts, and all the other elements, shall be presented in an instruction, but this was not included in our presentation. We observed how the lack of instruction created confusion, and we therefore see the importance of having these instructions.

- It should be the future work for professionals, like physiotherapists, to find out what muscle groups to present as choices when the player wants to play according to a specific muscle group. Our lack of knowledge in this area shone through when we presented this part, as the informants quickly commented the lack of consistency between the term "muscle group" and what we had presented as muscle groups to choose from.

- Technical limitations should be explored and integrated into the system requirements.

12.3 The Delay Problem

In workshop 1 a lot of time was spent discussing and commenting technical aspects related to the delay between the player and the avatar on the screen. Also in workshop 2 this issue was brought up. This problem was a source to much confusion and frustration, and it did not give the informants a real-time experience. The informants stated that they felt that the delay ruined the overall gaming experience. Obviously, it is crucial to take this into consideration when developing an exergame. The control element in the GameFlow model [71] is about the player being in control of their actions, characters and movements. Feedback from the two workshops was that the informants did not felt this control, due to the delay. *"There was no relation between our own movements and actions on the screen"*. For an exergame to be accepted as a tool for exercising, especially in a clinical setting, the delay issue has to be handled. In this section we will briefly discuss the delay problem. Because this was an issue that appeared during our study, we have not provided any background study on this topic in previous chapters. Therefore, we will introduce some new and relevant references in this section.

When searching Google for "Kinect" together with "delay" or "lag", we got a lot of results, both articles, and forum questions and discussion. This can indicate that we are not the only ones who have experienced problems with Kinect's real-time representation. We wanted to play some games over again to see if the delay was still there, or if it was just a one-time coincident. We started by playing "Aging with Grace", the same game as the informants played. A picture of this is shown in Figure 12.1 (a). Observing this figure, we clearly see that there is a significant delay between the player's movements and the avatar on the screen. The avatar to the left is the trainer, while the other avatar portrays the player. What we can see here is that the player is following the trainer's movement, having the arms down, while the avatar portraying the player is behind, having the arms straight out to the sides. We also played "Fruit Ninja" over again, and observed that the significant delay we observed in "Aging with Grace" was not present in this game. Figure 12.1 (b) shows the gaming session with "Fruit Ninja", and we see that the shadow avatar follows the player's movements.

We noticed that a clear difference between "Aging with Grace" and "Fruit Ninja" is the amount of information being processed. In "Aging with Grace", the player's movements are tracked and compared to the required movements, and based on that, precision and various variables, like calories burned, are calculated. These calculations are not present in "Fruit Ninja". As these calculations are both process and time consuming, we believe that this can be the source to the experienced delay. Our assumptions are supported by Andrew Oliver from Blitz Games, which states that fitness games that uses skeletal systems require more time to calculate than other games, and that these games normally experience delay [94].

From a review done on some of the forums found when searching Google, it seems like the degree of delay varies within different games. It is clear that people have different opinions about Kinect and the delay problem. Some people do not notice the delay at all, while others feel that Kinect is not nearly as good as its reputation, due to the delay [95] [96]. [94] may support the assumption about delay depending on the game played. Here, Andrew Oliver states that software could be the source to the delay, and that the delay can be eliminated if developers choose the right software to build their game upon. Shotton et al. [97] have written a paper where they present a method for giving quick and accurate prediction of 3D positions for Kinect. By learning the Kinect software how to predict human movement and behaviour patterns, process speed can be increased while delay is decreased [97] [98]. This paper gives a detailed presentation on how this could be done, and we refer the interested reader to [97].

As mentioned, accuracy and real-time operations are crucial for developing an exergame appropriate for elderly, and especially if it should be accepted and used as a tool at physiotherapy clinics. What we have noticed is that the issue already have got a lot of attention, and that there have been done studies both to acknowledge the problem [99], and to try to come up with a solution [97]. At the department of Telematics at NTNU, there are done a lot of research on delay and optimisation of real-time operations. In addition, there exist separate majors a NTNU that are specialised at teaching Quality of Service (QoS). This involves learning about reliability in terms of performance and real-time requirements, user requirements, and optimisation of costs. All this indicates that there in the future will exist motion sensor technology with minimal or no delay.

(a)

(b)

Figure 12.1: Figure (a) shows that there is a clear delay between the players movements and the avatar on the screen, while in figure (b) this delay is not present.

12.4 Quality of the Gathered Information

In Section 8.5 the importance of evaluating quality of the research is discussed. This can be done by looking into the three criteria; *reliability*, *validity* and *generalizability*.

12.4.1 Reliability

Writing this report, we have distinguished between our own findings, and findings from theory and previous studies conducted by others. Our findings are presented in chapters separate from theory and literature, see Chapter 9 and 11. In these chapters, neither our own opinions nor theory are included. These chapters only present feedback and opinions from the informants, as well as our observations. Citation is used were appropriate to strengthen our findings. Findings from the two workshops are related to relevant theory in Chapter 10, where the exergame concept is presented, and earlier in this discussion chapter. This separation of information will strengthen the reliability of the information gathered.

The sample of informants chosen for our qualitative research might have affected the quality of our study. The informants are all members of "Seniornett", and are therefore very committed to learning about technology. All of them already use a wide range of technology devices. We evaluate them to be more experienced with technology than most people in the same age group. Most of the informants have a high education, and they are relatively active in their everyday life. Five out of seven informants stated that they are active in the means of exercise, while the two others mentioned that they are active due to everyday tasks. Based on this, we evaluate them as fit older people. The informants average age in workshop 1 was 70.6 years (with a standard deviation of 7,9 years), and 74,5 years (with a standard deviation of 7,5 years) in workshop 2. The informants are representative for our qualitative research based on their age span; however, they do not meet all the characteristics that are common for the older group. The exergame should also suit frail elderly people with different disabilities. This group of people might have experienced reduction in functionality, which makes it difficult to perform regular exercise and everyday tasks.

Our relationship with the informants is an important aspects when discussing reliability. With the exception of one informant, we had never met the informants before. In addition, none of the informants knew each other. The fact that we were unknown for the informants could have resulted in the informants not wanting to say what they actually meant and felt. In addition, they might have experienced it as intimidating to talk to us. However, when first meeting the informants, we welcomed them and talked about familiar everyday topics, just making conversation. We felt this helped establish sort of a comfort. Our observation during the workshop, showed no sort of discomfort. They talked, laughed and joked a lot, both with us and each other, and we felt that the atmosphere was good.

Our role in this workshop might have affected the reliability of our findings. What is preferred is for our participation to be neutral, but that was not the case. We participated in the workshop by informing about the technology, showing how the different games would work, we guided the informants when needed, and we partly participated in the discussion. This might have influenced the feedback from the informants. In addition, as we already have discussed, the fact that we presented our own concept, might have constrained the feedback.

12.4.2 Validity

In the discussion we have related findings from the qualitative research with theory and previous studies within the same subject. What we see is that our results support what is found in related theory and findings. We did not experience much deviation in our findings from findings in previous studies. In addition, the outcome of our study forms a thorough basis for answering the research questions. We will therefore state that our findings are valid and of relevance to the purpose of the study.

We had some difficulties placing our study within a specific research method, because what we have been studying is something completely new. By reading Chapter 8 it should be clear for the reader which strategies and methods we have chosen to use, and why. We feel that this strengthen the validity of the information gathered.

12.4.3 Generalizability

The system requirements proposed in this thesis are based on thorough research with the use of a wide range of sources and data gathering methods. This makes the result so general, that it could be used as guidelines for others who want to develop similar games for the same user group. Many of the requirements can be used for the development of different types of user-interfaces for elderly people as well. Conceptual generalizability, which is the goal with the SDI analysing method [84], can therefore be seen as relevant for this study.

12.4.4 Other Quality Aspects

During this thesis we have given a detailed presentation of the theory used, the work we have done and the choices we have made. We have summarised theory to provide an accessible overview of the information for the reader, we have written in a familiar and easy-to-read language, and we have along the way discussed and justified all the theory we have used and choices we have made. As our report is written in a way that makes it easy for the reader to get insight into our work, it ensures transparency.

In our qualitative interviews we have used focus groups as setting. In Section 8.3.3 it is discussed that a preferred size for a focus group is 6-12 informants, but that mini-focus group interviews with 3-4 informants are accepted if the informants are experts on the discussed subject. Totally, we had seven informants for workshop 1, but these were divided into two days, with three and four informants each day. Theoretically, this means that we conducted mini-focus group interviews. The problem with this is that the informants are far from being experts on the subject, as they in fact never before had seen the technology we presented for them. However, what was a bit different with this first workshop was that we, in beforehand of the focus group interview, had introduced the informants for the Xbox Kinect technology. We asked about their perceived gaming experience in the interview, and felt that we received good, detailed and descriptive answers.

One of the informants in the second workshop did not participate in workshop 1. This means that she attended workshop 2 with no previous experience with the Xbox Kinect technology, except from what we presented during our first meeting with "Seniornett". This made it difficult for her to relate to and understand what we presented during workshop 2, and she was therefore not able to provide us with much feedback. This is negative for the quality of the information gathered in workshop 2, as the number of involved informants already was less than what is preferred.

In 8.5.4 we present *elite bias*, which is a pitfall that might have affected our results. Including only one group of people in qualitative research can give incomplete and under-representative data, and as a result, it could be hard to understand the broader situation. Because of the overall time limit for this master thesis, and other practical reasons, we only included this one group of people, even though they have the same interests for learning technology. Our findings would probably have been different if we had gathered a group of "random" people, because they would have more diversity in backgrounds and interests.

Another pitfall, presented in 8.5.4, that we might have experienced is the *Hawthorn effect*. This is about the risk of people behaving differently because they know they are being observed. This may have been an issue in our qualitative research, since the Hawthorn effect may have an even bigger impact with the use of video recording. However, we tried to make a comfortable setting, and to "hide" the video recording equipment as much as possible. The informants seemed calm and unaffected by the video recording, and we therefore conclude that the Hawthorn effect did not affect the quality of our work.

User involvement is about involving users from the start to the end of the system development process. We only included the informants two times in the development process, to discover their needs and opinions, and to evaluate our design. Basically, in line with user-centered design, the informants should have been more involved. However, this was not done due to time constraints in this master thesis, and because the informants were inexperience with the technology.

Workshop 1 was held over two days, but it was not executed exactly equally the two days. One day the informants got a little more instruction and guidance than the next day, some informants got to play longer than others, and not all the same questions were asked during the discussion. All this can have affected the findings from this workshop.

Since we performed focus group interviews, the informants were influenced by each other's statements and opinions. They discussed an unfamiliar subject, and it seemed easy to just "mean the same" as the informant stating something. As we had two groups of informants, the informants within each group formed similar opinions, that not necessary was the same in the two groups.

The choice of games for workshop 1 was not a coincidence. Each game was chosen for a reason (see Section 8.7.2) and we wanted to trig different reactions. This could have affected the outcome of our research. Choosing different games might have changed the findings from our research.

In this chapter, the findings and the results are discussed. The discussion justifies the choice of concept, and it recommends future work to be done. In addition, we provide a thorough discussion on the quality of our research. This should help the reader of this report understand how he or she can rely on our findings and results.

Chapter 13

Conclusion

This thesis concludes with presenting a design of an exergame for elderly, together with recommendations for future work. The game is meant to be compatible with the motion sensor technology provided by Microsoft Kinect. The work have been done by studying and analysing related theory and literature, which includes studying elderly people and their attitude towards exercising, research done on elderly and exergames, and theory about video game design, usability and system design in general. One iteration of the cycle of user-centered design was conducted, all from gathering information about the users' needs and expectations, to specifying requirements and designing solutions, which were evaluated together with the users. This has been done by conducting two workshops with a group of elderly people from the organisation "Seniornett". The motivation for the thesis is built upon the work presented in our project assignment [8]. However, in that assignment we focused on the exergame's potential in the market, with physiotherapists as customers. In the present thesis, the focus has been on the exergame's context of use, seen from the end users.

Results from the first workshop clearly showed that existing commercial games are not developed with elderly as the intended user group. These games were at times too fast, they had too complex menus, and the games contained elements and features, which were disturbing to the informants. In addition, there was lack of instructions and feedback, which made the informants feel that they did not master the challenges. This furthermore made it difficult to know if what they did was done correctly. However, the commercial games held features that captivated the elderly. Well-known activities in a real-life environment enhanced the gaming experienced, and they seemed to enjoy playing.

Based on theory, literature, and findings from the first workshop, requirements have been specified and an exergame concept has been designed. The exergame contains challenges, activities and environments that are familiar to the elderly users. The story for the game is a walk in the nature, with additional, well-known activities like picking apples, swimming, paddling and wood chopping. Exercises that are shown to be good for elderly are built into the story of the game, where the game will take the player through a full body workout. The inclusion of clear instructions is emphasised, and motivational factors, like the possibility to achieve goals, are included. The exergame also contains challenges besides physical tasks, like quizzes to answer along the walk in the nature. To enhance the gaming experience, the user interface is simple and not too extensive.

The evaluation of the exergame concept in the second workshop showed that the group of elderly liked the idea of the familiar forest environment. What they were concerned about was the inclusion of quizzes while walking or performing other challenges, as they did not like the idea of doing more than one task at the same time. They were also confused about how the different levels were presented. About the menu in the game, they had no negative comments. The general evaluation of the exergame was that the group liked the concept presented to them. The results from the evaluation have been listed as recommendations for future work.

The results from the workshops presented in this thesis are based upon feedback from the chosen group of informants. This is a group of fit elderly, which exercise regularly. They all have technology experience, but not with video games. Knowing elderly as a group, we evaluate the informants to be a homogeneous group based on their interests, and physical and psychological challenges. The choice of representative users is important in the work of gathering reliable information. We acknowledge that the inclusion of a homogeneous group might not have provided us with information representative for elderly people as a group.

Use of exergames for exercise and rehabilitation is a popular topic, and a large amount of research has been done. To make an exergame for the elderly users, it is crucial to take characteristics of elderly, as diversity in needs and interests, and the wide range of various physical and psychological challenges, into consideration. We believe the exergame concept presented in the present thesis, together with the recommendations provided for future work, is a good foundation for a future exergame for elderly people. The provided guidelines and requirements can help developers create user-friendly exergames that meet the needs and characteristics of elderly.

13.1 Future Work

Future work can head in different directions.

One direction can be to continue working on the exergame concept presented in the thesis. This will imply inclusion of the aspects for future work listed in Section 12.2.4. This should be taken into a new iteration of the cycle of user-centered design. Next time design is to be prototyped, there should be focus on developing more interactive prototypes to increase the users understanding of the game. Professionals, like music therapists and physiotherapists, should be included in this work to find appropriate music and exercises, respectively. There should also be put focus on how to make a user-profile and how this can be used to save the players' progression and results. How this user profile can be used for social interaction should be studied. Finding an appropriate way to present how social interactions can be realised over the Internet should be found, as this user group can benefit from this.

Another direction can be to look into, study and validate our summarised guidelines, findings, and specified requirements. The research done in the present study has been thorough; however, it is acknowledged that further research can provide new insights. In this regard, one approach can be to conduct new workshops, with a wider selection of informants. This implies recruiting a higher number of informants than we did, but also including elderly with more diversity in technology experience, interests, education, physical health, and life-style. A more diverse group of elderly will provide the study with more reliable information.

A place for this exergame to be used is at physiotherapy clinics as an assistant tool in the physiotherapists work [8]. Future work should be to investigate an exergame from the physiotherapists' point of view, to understand and specify their wants and needs. This includes wanted functionality and requirements to a user interface. Future work should also include looking into other possibilities for how and where the exergame could be used.

Technical aspects, such as the delay problem should be addressed in future work. The goal should be to eliminate this issue. This can be grounded in choice of software.

Bibliography

[1] E. Brox, L.F. Luque, G.J. Evertsen, and J.E.G. Hernández. Exergames for elderly: Social exergames to persuade seniors to increase physical activity. In *Pervasive Computing Technologies for Healthcare (PervasiveHealth), 2011 5th International Conference on*, pages 546–549. IEEE, 2011.

[2] Kathrin Maria Gerling, Jonas Schild, and Maic Masuch. Exergame design for elderly users: the case study of silverbalance. In *Proceedings of the 7th International Conference on Advances in Computer Entertainment Technology*, ACE '10, pages 66–69, New York, NY, USA, 2010. ACM.

[3] J.A. GARCIA, N.K. Felix, D. Schoene, S.T. Smith, and Y. Pisan. Exergames for the elderly: Towards an embedded kinect-based clinical test of falls risk. In *Health Informatics: Building a Healthcare Future Through Trusted Information-Selected Papers from the 20th Australian National Health Informatics Conference (Hic 2012)*, pages 51–57. Ios PressInc, 2012.

[4] Anna Dickinson, John Arnott, and Suzanne Prior. Methods for human–computer interaction research with older people. *Behaviour & Information Technology*, 26(4):343–352, 2007.

[5] A John Campell and M Clare Robertson. *Otago Exercise Programme to Prevent Falls in Older Adults*. University of Otago, March 2003.

[6] Folkehelseinstituttet. Fakta og statistikk om fysisk aktivitet. `http://www.fhi.no/artikler/?id=56857`. visited: 27/05/13, (In Norwegian).

[7] Helsedirektoratet. Velferdsteknologi. fagrapport om implementering av velferdsteknologi i de kommunale helse- og omsorgstjenestene 2013-2030. `http://www.helsedirektoratet.no/publikasjoner/velferdsteknologi-fagrapport-om-implementering-av-velferdsteknologi-i-de-kommunale-helse-og-omsorgstjenestene-2013-2030/`. (In Norwegian).

[8] Kine Aa. Omholt and Mathilde Wærstad. Business opportunities and economics for an exercise game in the health sector. Project Assignment, dec 2012.

[9] Kathrin M Gerling, Frank P Schulte, and Maic Masuch. Designing and evaluating digital games for frail elderly persons. *Proc. of ACE 2011*, 2011.

[10] E.D. Bruin, D. Schoene, G. Pichierri, and S.T. Smith. Use of virtual reality technique for the training of motor control in the elderly. *Zeitschrift für Gerontologie und Geriatrie*, 43:229–234, 2010.

[11] Wijnand Ijsselsteijn, Henk Herman Nap, Yvonne de Kort, and Karolien Poels. Digital game design for elderly users. In *Proceedings of the 2007 conference on Future Play*, pages 17–22. ACM, 2007.

[12] Helse og omsorgsdepartementet. Nasjonal helse- og omsorgsplan (2011–2015). `http://www.regjeringen.no/nb/dep/hod/dok/regpubl/stmeld/2010-2011/meld-st-16-20102011/2.html?id=639796`. visited: 22/11/12. (In Norwegian).

[13] M.J.D. Taylor, D. McCormick, R. Impson, T. Shawis, and M. Griffin. Activity-promoting gaming systems in exercise and rehabilitation. *Journal of Rehabilitation Research and Development*, 48(10):1171–1186, 2011.

[14] Marie Williams, Roy Soiza, Alison Jenkinson, and Alison Stewart. Exercising with computers in later life (excell) - pilot and feasibility study of the acceptability of the nintendo(r) wiifit in community-dwelling fallers. *BMC Research Notes*, 3(1):238, 2010.

[15] Jan Lexell, Kerstin Frändin, and Jorunn L. Helbostad. Fysisk aktivitet for eldre. `http://helsedirektoratet.no/folkehelse/fysisk-aktivitet/aktivitetshandboken/generelle-kapitler/Documents/fysisk-aktivitet-for-eldre-kapittel-4.pdf`, 2008. visited: 27/05/13, (In Norwegian).

[16] U.S. Department of Health and Human Services. 2008 physical activity guidelines for americans. `http://www.health.gov/paguidelines/pdf/paguide.pdf`, 2008. visited: 11/03/13.

[17] The Federal Interagency Forum on Aging-Related Statistics(Forum). Older americans 2012 - key indicators of well-being. `http://www.agingstats.gov/agingstatsdotnet/Main_Site/Data/2012_Documents/Docs/EntireChartbook.pdf`, June 2012. visited: 11/03/13.

[18] Odd Frank Vaage. Mosjon - etter alder, kjønn og utdanning, Gammel og ung - alle er mer fysisk aktive. *Samfunnsspeilet* 3rd edition, June 2009. (In Norwegian).

[19] Kristin Tharaldsen. Funksjonsvedlikehold og gruppetrening for eldre - gjennomføring og evaluering av praksis. *Fysioterapeuten*, Nov. 2009. (In Norwegian).

[20] Karen A. Schutzer and B.Sue Graves. Barriers and motivations to exercise in older adults. *Preventive Medicine*, 39(5):1056 – 1061, 2004.

[21] Øvelsesbank - eldretrening. `http://eldretrening.net/`. visited: 21/04/13, (In Norwegian).

[22] Dinnie Chao, Capri G Foy, and Deborah Farmer. Exercise adherence among older adults: Challenges and strategies. *Controlled Clinical Trials*, 21(5, Supplement 1):S212 – S217, 2000.

[23] Siobhan M White, Thomas R Wójcicki, Edward McAuley, et al. Physical activity and quality of life in community dwelling older adults. *Health and Quality of Life Outcomes*, 7(10), 2009.

[24] Children's Health. Video games. `http://www.healthofchildren.com/U-Z/Video-Games.html#b`. visited: 21/11/12.

[25] Hours of playing video games can change brain for the better, research finds. `http://www.foxnews.com/health/2012/03/06/hours-playing-video-games-can-change-brain-for-better-research-finds/`. visited: 27/05/13.

[26] Essential facts about the computer and video game industry. `http://www.theesa.com/facts/pdfs/esa_ef_2012.pdf`, 2012. visited: 20/05/13.

[27] Odd Frank Vaage. Norsk mediebarometer 2012. `https://www.ssb.no/kultur-og-fritid/artikler-og-publikasjoner/_attachment/108249?_ts=13e0c464178`, 2012. visited: 20/05/13, (In Norwegian).

[28] Essential facts about the computer and video game industry. `http://www.theesa.com/facts/pdfs/ESA_EF_2011.pdf`, 2011. visited: 27/05/13.

[29] Michael Zyda. From visual simulation to virtual reality to games. *Computer*, 38(9):25–32, 2005.

[30] Simon Egenfeldt Nielsen, Jonas Heide Smith, and Susana Pajares Tosca. *Understanding Videogames - The Essential Introduction*. Routeledge, 2008.

[31] Tarja Susi, Mikael Johannesson, and Per Backlund. Serious games: An overview. 2007.

[32] Alf Inge Wang. Dataspill som datateknisk forskningsobjekt - seriøse dataspill. `http://events.idi.ntnu.no/symp11/slides/AlfInge.pdf`. visited: 14/02/13, (In Norwegian).

[33] IDATE. Serious games - a 10 billion euro market in 2015. http://www.idate.org/2009/pages/download.php?id=147&idl=21&t=f_telech_actu&fic=518_Serious_Games_VA.pdf&repertoire=news/518_Serious_Games. visited: 14/02/13.

[34] Entertainment Software Association. 2012 sales, demographic and usage data. essential facts about the computer and video game industry. http://www.theesa.com/facts/pdfs/ESA_EF_2012.pdf. visited: 18/02/13.

[35] Xbox.com. Xbox kinect. www.xbox.com/kinect. visited: 06/03/13.

[36] Stephanie Crawford. How microsoft kinect works. http://electronics.howstuffworks.com/microsoft-kinect.htm. visited: 20/02/13.

[37] Matt Matthews. Analysis: Where do kinect sales go from here? http://www.gamasutra.com/view/news/172666/Analysis_Where_do_Kinect_sales_go_from_here.php#.UTdaDKVwpBk. visited: 06/03/13.

[38] Microsoft. 'kinect effect' magic pushes beyond the living room. http://www.microsoft.com/en-us/news/features/2011/oct11/10-31kinecteffect.aspx, October 2011. visited: 07/03/13.

[39] Microsoft. Kinect for windows. http://www.microsoft.com/en-us/kinectforwindows/develop/new.aspx. visited: 06/03/13.

[40] A.S. Billis, E.I. Konstantinidis, C. Mouzakidis, M.N. Tsolaki, C. Pappas, and P.D. Bamidis. A game-like interface for training seniors' dynamic balance and coordination. In PanagiotisD. Bamidis and Nicolas Pallikarakis, editors, *XII Mediterranean Conference on Medical and Biological Engineering and Computing 2010*, volume 29 of *IFMBE Proceedings*, pages 691–694. Springer Berlin Heidelberg, 2010.

[41] Michael John, Stefan Klose, Gerd Kock, Michael Jendreck, Richard Feichtinger, Ben Hennig, Norbert Reithinger, Jörn Kiselev, Mehmet

Gövercin, Elisabeth Steinhagen-Thiessen, et al. Smartsenior's interactive trainer-development of an interactive system for a home-based fall-prevention training for elderly people. In *Ambient Assisted Living*, pages 305–316. Springer, 2012.

[42] Peter Gregor, Alan F. Newell, and Mary Zajicek. Designing for dynamic diversity: interfaces for older people. In *Proceedings of the fifth international ACM conference on Assistive technologies*, Assets '02, pages 151–156, New York, NY, USA, 2002. ACM.

[43] Brian J. Gajadhar, Henk Herman Nap, Yvonne A. W. de Kort, and Wijnand A. IJsselsteijn. Out of sight, out of mind: co-player effects on seniors' player experience. In *Proceedings of the 3rd International Conference on Fun and Games*, Fun and Games '10, pages 74–83, New York, NY, USA, 2010. ACM.

[44] Ben Shneiderman and Catherine Plaisant. *Designing the User Interface - Strategies for effective human-computer interaction.* Addison-Wesley, Boston, Massachusetts, fifth edition, 2010.

[45] Bjørn Nygård. Teksten - slik vi vil ha den. `https://www.blindeforbundet.no/nbf/publikasjoner/brosjyrer/teksthefte/Teksten.htm`. visited: 17/04/13, (In Norwegian).

[46] Making it clear. `http://www.actionforblindpeople.org.uk/assets/Uploads/downloads/making-it-clear-colour-690.pdf`. visited: 17/04/13.

[47] Web content accessibility guidelines (wcag) 2.0. `http://www.w3.org/TR/WCAG/`, 2008. visited: 17/04/13.

[48] Om oss. `https://www.blindeforbundet.no/internett/om-oss`. visited: 17/04/13, (In Norwegian).

[49] About us. `http://actionforblindpeople.org.uk/about-us/`. visited: 17/04/13.

[50] About w3c. `http://www.w3.org/Consortium/`. visited: 17/04/13.

[51] Richard Rouse. *Game Design: Theory & Practice*. Wordware Publishing, Inc, 2 edition, 2004.

[52] A. C. Siang and G.S.V Radha Krishan Rao. Designing interactivity in computer games: a uml approach. *International Journal of Intelligent Games and Simulation*, 3(2):62–69, 2004.

[53] Celia Pearce. Towards a game theory of game. *First person: New media as story, performance, and game*, 1:143–153, 2004.

[54] Ivan Beram. Levels of complexity: A level-design methodology. `http://www.gamasutra.com/features/20010716b/beram_01.htm`, 2001. visited: 11/04/13.

[55] Rolv Bræk and Øystein Haugen. Engineering real time sytems - an object oriented methodology using sdl. SINTEF DELAB, Norwegian Computing Center and Department of Computer Systems and Telematics The Norwegian Institute of Technology.

[56] Eric J Braude. *Software engineering: an object-oriented perspective*. John Wiley & Sons, Inc., 2000.

[57] Timo Jokela, Netta Iivari, Juha Matero, and Minna Karukka. The standard of user-centered design and the standard definition of usability: analyzing iso 13407 against iso 9241-11. In *Proceedings of the Latin American conference on Human-computer interaction*, pages 53–60. ACM, 2003.

[58] Martin Maguire. Context of use within usability activities. *International Journal of Human-Computer Studies*, 55(4):453–483, 2001.

[59] Nigel Bevan. Human-computer interaction standards. *Advances in Human Factors/Ergonomics*, 20:885–890, 1995.

[60] What is the kiss principle? `http://www.wisegeek.com/what-is-the-kiss-principle.htm`. visited: 21/04/13.

[61] Keep it simple stupid principle (kiss principle). `http://www.techopedia.com/definition/20262/keep-it-simple-stupid-principle-kiss-principle`. visited: 21/04/13.

[62] About.com Jackie Craven. Mies van der rohe, modern architect. `http://architecture.about.com/od/architectsaz/p/vanderrohe.htm`. visited: 20/02/13.

[63] Webdesigner Depot. Minimalist web design: When less is more. `http://www.webdesignerdepot.com/2009/12/minimalist-web-design-when-less-is-more/`. visited: 20/02/13.

[64] Microsoft Corporation Scott Berkun. The importance of simplicity. `http://msdn.microsoft.com/en-us/library/ms993297.aspx`. visited: 20/02/13.

[65] Jakob Nielsen. Ten usability heuristics. 2005.

[66] Nielsen Norman Group. Jakob nielsen. `http://www.nngroup.com/people/jakob-nielsen/`. visited: 06/03/13.

[67] Heather Desurvire, Martin Caplan, and Jozsef A. Toth. Using heuristics to evaluate the playability of games. In *CHI '04 Extended Abstracts on Human Factors in Computing Systems*, CHI EA '04, pages 1509–1512, New York, NY, USA, 2004. ACM.

[68] Thomas W. Malone. Heuristics for designing enjoyable user interfaces: Lessons from computer games. In *Proceedings of the 1982 Conference on Human Factors in Computing Systems*, CHI '82, pages 63–68, New York, NY, USA, 1982. ACM.

[69] Bruce Shelley. Guidelines for developing successful games. `http://www.gamasutra.com/features/20010815/shelley_01.htm`, August 2001. visited: 07/03/13.

[70] Melissa A. Federoff. Heuristics and usability guidelines for the creation and evaluation of fun in video games. Master's thesis, Indiana University, December 2002.

[71] Penelope Sweetser and Peta Wyeth. Gameflow: a model for evaluating player enjoyment in games. *Comput. Entertain.*, 3(3):3–3, July 2005.

[72] Mihaly Csikszentmihalyi. *Flow: The Psychology of Optimal Experience*. Harper Collins Publishers, 1990.

[73] Oxford dictionaries. `http://oxforddictionaries.com/definition/english/workshop`. visited: 18/03/13.

[74] Joseph E. McGrath. Methodology matters: doing research in the behavioral and social sciences. pages 152–169. October 1994.

[75] ISO DIS. 9241-210: 2008. ergonomics of human system interaction-part 210: Human-centred design for interactive systems (formerly known as 13407). *International Organization for Standardization (ISO). Switzerland*, 2010.

[76] Gro Bjerknes and Tone Bratteteig. User participation and democracy: A discussion of scandinavian research on system development. *Scandinavian Journal of information systems*, 7:73–73, 1995.

[77] Information and Design. Participatory design. `http://infodesign.com.au/usabilityresources/participatorydesign/`. visited: 18/03/13.

[78] Stephanie Houde and Charles Hill. What do prototypes prototype. *Handbook of human-computer interaction*, 2:367–381, 1997.

[79] Wendy E. Mackay and Michel Beaudouin-Lafon. Prototyping tools and techniques. In *The human-computer interaction handbook*, pages 1006–1031, 2002.

[80] Florian N. Egger. Lo-fi vs. hi-fi prototyping: how real does the real thing have to be? `http://www.telono.com/fr/articles/lo-fi-hi-fi-prototyping`. visited: 09/05/13.

[81] Mads Soegaard. Prototyping. `http://www.interaction-design.org/printerfriendly/encyclopedia/prototyping.html`. visited: 09/05/13.

[82] Ole Andreas Alsos. *Mobile Point-of-Care Systems in Hospitals: Designing for the Doctor-Patient Dialogue.* PhD thesis, Norwegian University of Science and Technology, November 2011.

[83] Tove Thagaard. *Systematikk og innlevelse - en innføring i kvalitativ metode.* Fagbokforlaget, 3 edition, 2011. (In Norwegian).

[84] Aksel Tjora. *Kvalitative forskningsmetoder i praksis.* Gyldendal akademisk, 2 edition, 2012. (In Norwegian).

[85] Michael D. Myers and Michael Newman. The qualitative interview in IS research: Examining the craft. *Information and Organization*, 17(1), 2007.

[86] Briony J Oates. *Researching Information Systems and Computing.* SAGE Publications Ltd, 2006.

[87] Seniornett. `http://www.seniornett.no/`. visited: 14/02/13, (In Norwegian).

[88] Xbox. Fruit ninja kinect. `http://marketplace.xbox.com/en-US/Product/Fruit-Ninja-Kinect/66acd000-77fe-1000-9115-d80258410b79`. visited: 16/05/13.

[89] Ubisoft Entertainment. Game features. `http://yourshapegame.ubi.com/fitness-evolved-2012/en-us/index.aspx`. visited: 05/04/13.

[90] Aaron Baar. Humana, ubisoft pair for fitness game. `http://www.mediapost.com/publications/article/163408/humana-ubisoft-pair-for-fitness-game.html#axzz2TSTsWD0O`. visited: 16/05/13.

[91] Xbox. Kinect sports: Season two. `http://marketplace.xbox.com/en-US/Product/Kinect-Sports-Season-Two/66acd000-77fe-1000-9115-d8024d5309d6?nosplash=1`. visited: 16/05/13.

[92] Introduction to medium-fidelity prototypes. `http://www.inovdesigns.com/prototypes.php`, 2011. visited: 20/05/13.

[93] Søkeresultater for kinect. http://www.xbox.com/nb-NO/Search?q=kinect#Games. visited: 19/04/13.

[94] Chris Pereira. Kinect lag can be eliminated, says developer. http://www.1up.com/news/kinect-lag-eliminated-developer, 2010. visited: 21/05/13.

[95] How bad is the input lag on kinect? http://www.gamespot.com/forums/topic/28842533/how-bad-is-the-input-lag-on-kinect. visited: 21/05/13.

[96] Kinect lag? http://gamerepairlive.com/topic/227-kinect-lag/. visited: 21/05/13.

[97] Jamie Shotton, Toby Sharp, Alex Kipman, Andrew Fitzgibbon, Mark Finocchio, Andrew Blake, Mat Cook, and Richard Moore. Real-time human pose recognition in parts from single depth images. *Communications of the ACM*, 56(1):116–124, 2013.

[98] Ms kinect research: lag reduced to 0.002 seconds. http://gamerepairlive.com/topic/227-kinect-lag/. visited: 21/05/13.

[99] Tommer Leyvand, Casey Meekhof, Yi-Chen Wei, Jian Sun, and Baining Guo. Kinect identity: Technology and experience. *Computer*, 44(4):94–96, 2011.

Appendix A - Development for Kinect for Windows, and The Kinect Sensor Technology

To be able to use the Kinect for Windows, a Windows Kinect sensor and a Kinect for Windows application is needed, in addition to a computer running Windows 7, Windows 8, Windows Embedded Standard 7, or Windows Embedded POSReady 7 [39]. Microsoft has also opened up the opportunity for a third party to develop Kinect for Windows applications, by releasing a Kinect for Windows SDK [39]. The first SDK was for non-commercial project, but later Microsoft also released a SDK for commercial use.

The Kinect sensor is a device that captures the movement of your body and translates it into the video game. Kinect is a oblong, black box placed a small platform, see Figure 4.1. While playing, the Kinect should be placed near the TV, connected to the Xbox through a USB-port. Game play requires some space as the optimal distance from the sensor is 1,8 meters, as well as players need room for moving around. In addition to capturing full body movement, the Kinect sensor is also able to recognise a player's face, voice, and even clothing. This makes it possible for the Kinect to automatic sign-in and recognise individual players, and to distinguish between several players [36] [99].

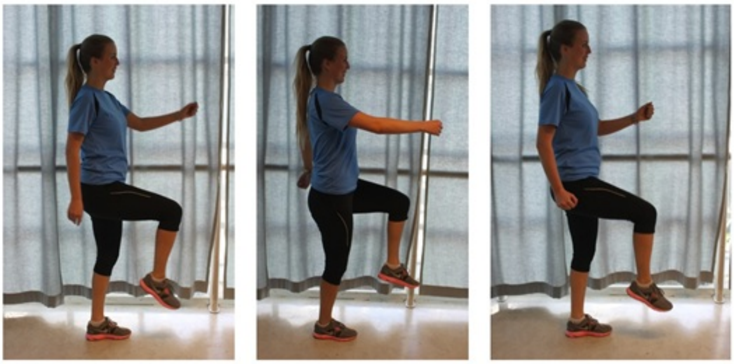
The Kinect sensor consist of a trio of hardware; a depth sensor, a RGB video camera and multi-array microphones. The depth sensor is a composition of a one-coloured sensor and an infrared projector. These two elements together make it possible to measure distance of elements and to see the room in 3D. The video camera captures the three colours red, green and blue (RGB), and it uses these colours to detect faces and other features. In the Kinect sensor there is four microphones, aligned in an array. These microphones separates voice from noise, which makes it possible to stand a certain distance from the sensor and still have the Kinect sensor recognising the player's voice [36] [99].

For Kinect to be able to capture motion it detects 48 points all over the human body. Information from these points is translated into the game, showing an avatar as a mirror of the player. With this technology, Kinect is able to be so detailed as to recognise facial details, which is used to identify players. Kinect can also view a player's avatar even if it can not detect all of the 48 points. As long as it can detect some of the body, Kinect uses the information it is given, reconstructs the rest of the body and portray a whole avatar on the screen. This feature has great advantage when playing multiplayer games, like tennis or dance games, where players happens to have parts of their bodies hidden behind each other [36] [99].

Appendix B - Exercises from ”Øvelsbanken”

The exercises presented here are modified from [21]. We have permission to use the exercises, but we could not use their pictures. Therefore, we made our own. We will present a range of exercises that, together with theory and feedback from workshop 1, have been used as a basis for our video game concept.

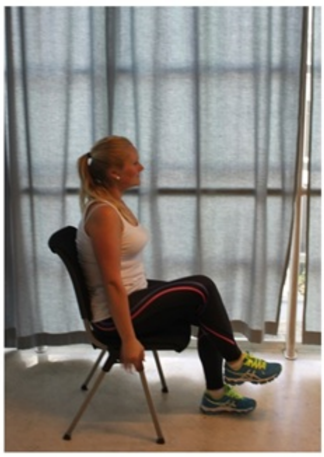
Walking



Walk on site with high knees in a slowly pace.

Walking while sitting

Sit on a chair. Hold your hands on the chair.



Lift alternately right and left foot, like walking.

Rowing

Stand with your feet slightly apart.

Bend your knees while stretching your arms forward.

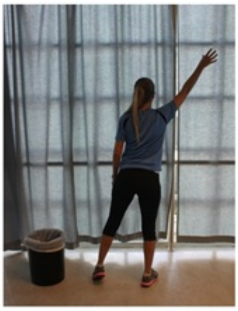
Pull your arms back and stand up again.

Rowing while sitting

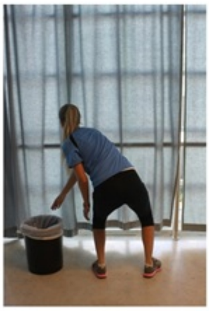
Sit on a chair. Bend forward with your back straight, while having straight arms.

Lean back while moving your elbows backward, as if your are pulling the oars.

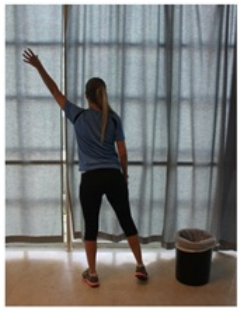
Picking apples



Pick apples high up to the right.

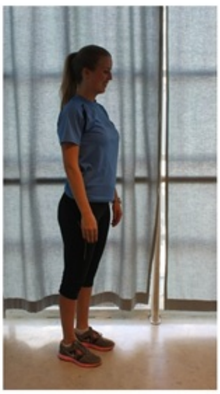


Drop them in the bucket.

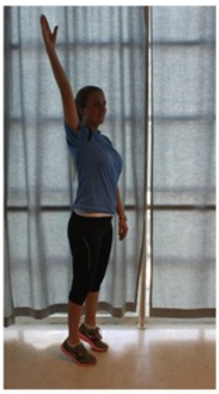


Repeat to the left.

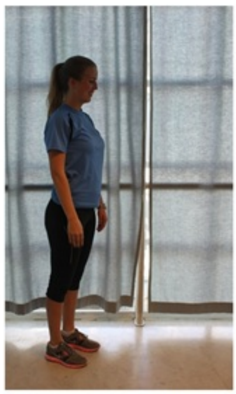
Stand on your toes, picking plums



Stand with your feet slightly apart.

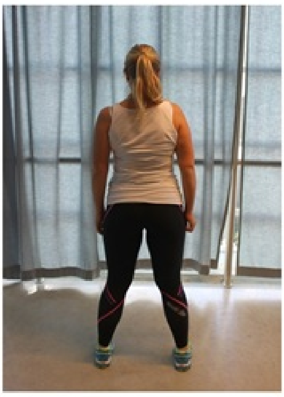


Stand on your toes without leaning forward. Hold this position for two seconds.

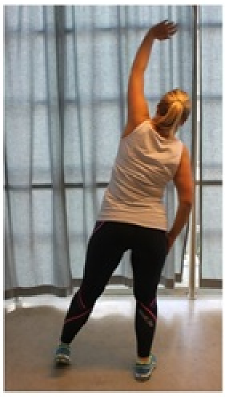


Lower your heals to the ground. Repeat the exercise. Remember to change arm.

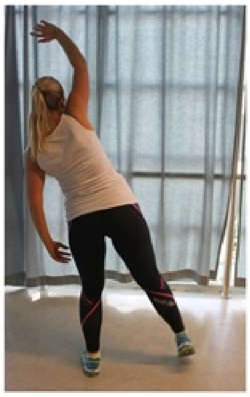
Weight shift with arm raise



Stand up with your legs wide apart. The toes are point straight forward.

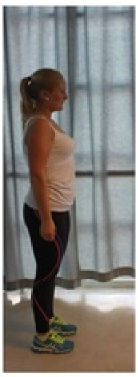


Move your body weight slowly over to your right foot. Lift your left arm and lean over to the right.

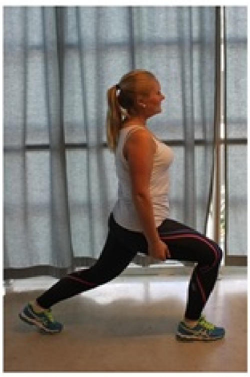


Repeat exercise on opposite side.

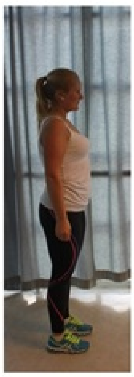
Lunges



Stand in an initial position.



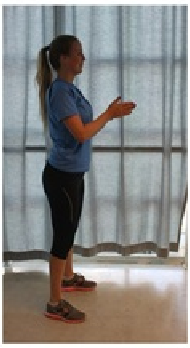
Take a wide step forward. Lean your body weight on the front foot.



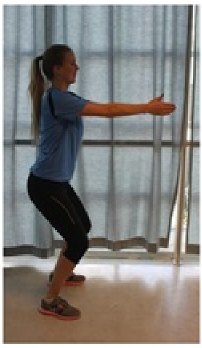
Set your foot back, and go into initial position.

Repeat exercise by alternately putting the right or left foot in front.

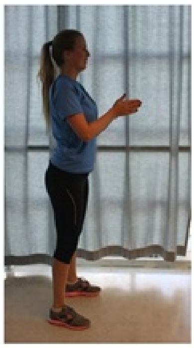
Swimming



Stand with your feet slightly apart.



Bend your knees while performing a swimming stroke.



Stand up again.

Swimming while sitting

Sit on a chair.

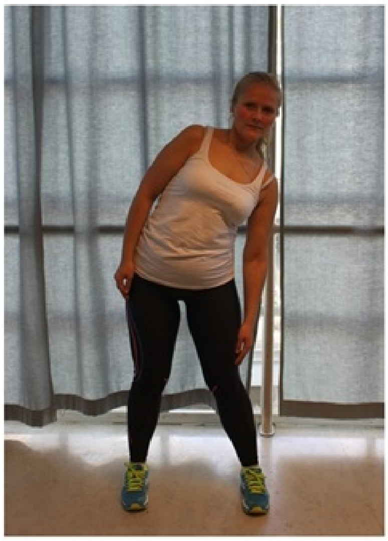
Bend forward with your back straight, while having straight arms.

Make swimming movements with your arms while moving back.

Repeat exercise.

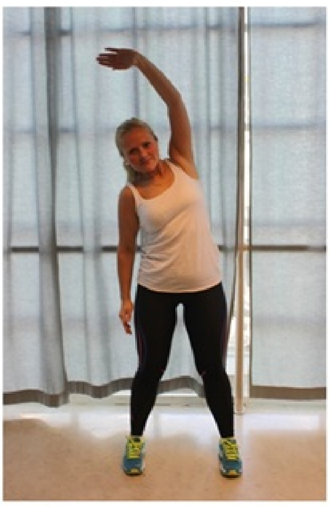
Stretching your flank

Lean over to the right side until you feel a strech in your left flank. Hold the position a few seconds.

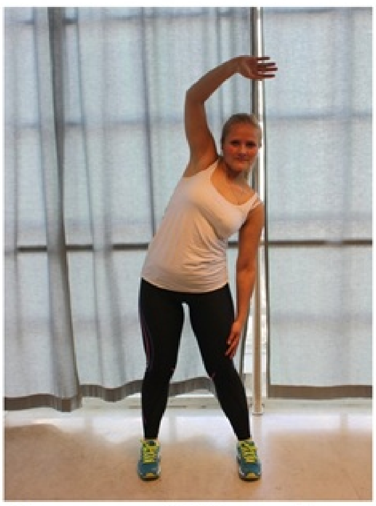


Lean over to the opposite side and repeat the exercise.

Stretching your flank, with arm lift

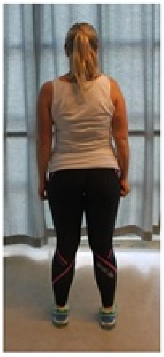


Stretch up your left arm and lean over to the opposite side. You should feel a strech in your flank. Hold the position a few seconds.

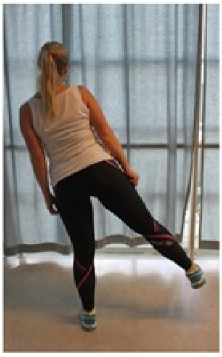


Change arm and do the exercise on the opposite side.

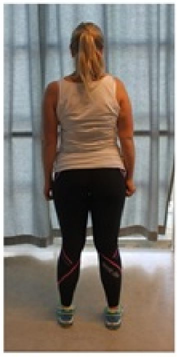
Lifting your legs



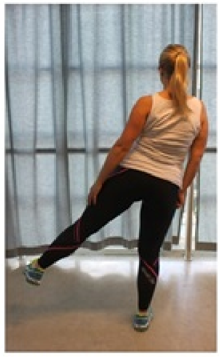
Stand up straight with your legs apart and your arms along your body.



Move your body weight slowly over to your left foot. Hold your knee streight while lifting the opposite foot. Hold this position for a few seconds.



Go back to the initial position.



Repeat the exercise by moving your body weight over to the opposite foot.

Arm stretch

Stand with your feet slightly apart.

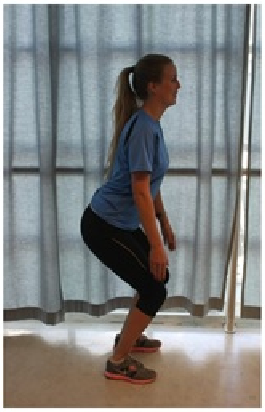
Stretch your right arm towards the ceiling. Hold the position for three seconds.

Lower your arm.

Change arm and repeat exercise.

Deep squats

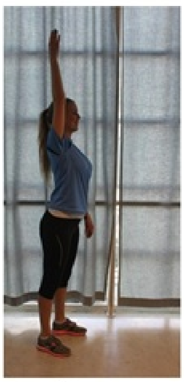
Put your legs slightly apart, have your arms along your body.



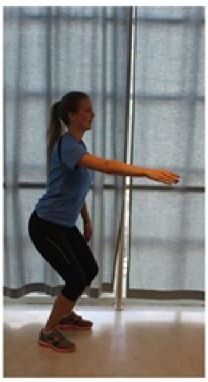
Bend your knees slowly. Hold this position for three seconds.

Stand up again.

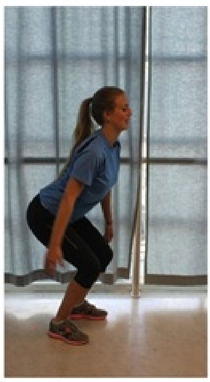
Squats with arm movement



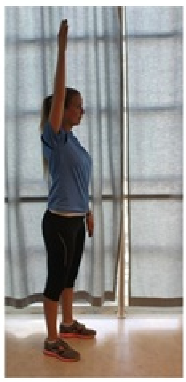
Stretch your arm.



Bend your knees while lowering your arm.



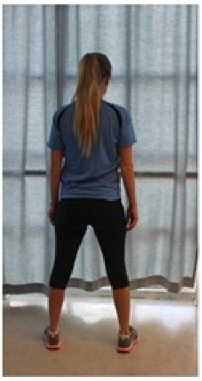
Stretch your arm towards the floor.



Stand up again and lift your arm.

Go sideways

Stand with your legs together.



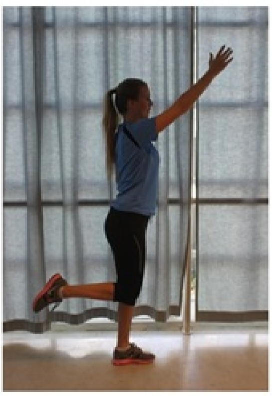
Go sideways. Be sure that your toes are pointed straight ahead.

Put you legs together.

Go sideways. When finished, change direction.

On one foot while lifting one arm

Stand in an initial position.



Move your body weight over to your left foot while bending the opposite knee. Raise the arm on the same side. Hold this position for a few seconds.

Go back to the initial position. Repeat exercise while lifting the opposite arm and knee.

Appendix C - Prototypes from the Original Norwegian Exergame Concept

The figures shown in Appendix C shows a original prototypes of the exergame. These prototypes were presented for the informants in workshop 2, and are therefore in Norwegian.

Pictures used in the prototypes are taken from these references:

http://spicebush.blogspot.no/2010/08/lend-hand.html

http://commons.wikimedia.org/wiki/File:Spruce_forest_in_Poland.jpg

http://fc02.deviantart.net/fs70/f/2013/022/e/6/tippah_lake___boat_pier____hdr_by_joewjacksonjr-d5sdwr4.jpg

http://ecology110fra.wordpress.com/2011/02/22/tragedy-of-the-commons-hits-colorado-river/

http://www.hutchings.no/nordalsfjord/norsk/fiske.html

http://whydyoueatthat.wordpress.com/tag/yule-log/

http://caquino.photoshelter.com/image/I0000xpZDS5_ktfs

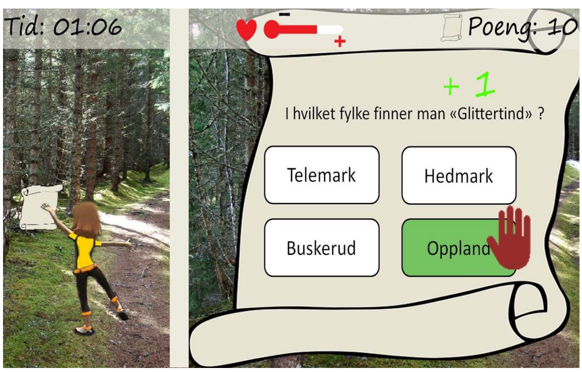
http://mrfylke.no/Morotur/Turer/Trollskogen-ved-Remmemsraaket

http://upload.wikimedia.org/wikipedia/commons/d/df/Hornbeam_Maple_Acer_carpinifolium_Tree_3264px.jpg

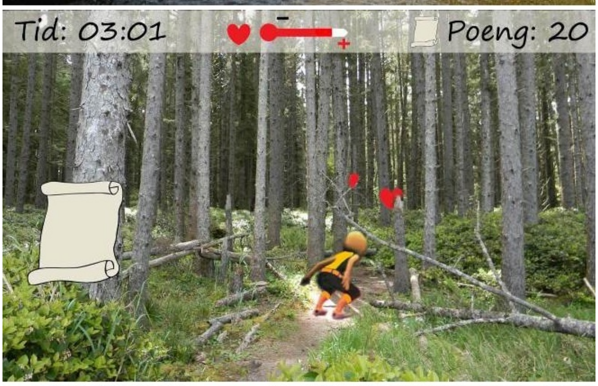
http://marketplace.xbox.com/en-US/Product/Kinect-Adventures/66acd000-77fe-1000-9115-d8024d5308ed


Tid: 00:30
SAMSUNG
Strekk deg etter de røde hjertene for å forbedre din helse


Tid: 00:30
Poeng: 5

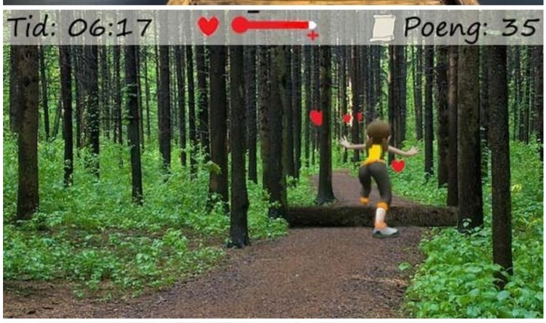

Tid: 01:06
Poeng: 10
+ 1
I hvilket fylke finner man «Glittertind» ?
Telemark
Hedmark
Buskerud
Oppland


Tid: 01:41
Poeng: 10


Tid: 03:01
Poeng: 20

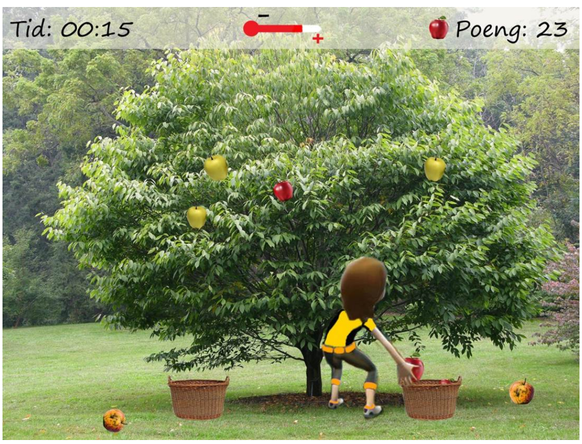

Tid: 02:30
Poeng: 21


Tid: 04:48
Poeng: 20

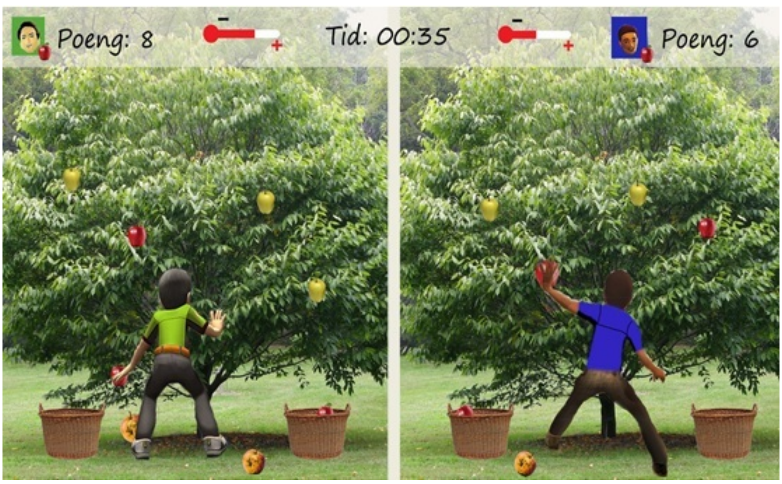

Tid: 06:17
Poeng: 35


Tid: 03:54
Poeng: 15


Tid: 00:20
Poeng: 20


Tid: 00:15
Poeng: 23


Tid: 00:00
Poeng: 27
Spillet er slutt!
Bra jobba. Du fikk 27 poeng!
= 10
= 0
= 3


Poeng: 8
Tid: 00:35
Poeng: 6

XBOX

Gratis. XBOX LIVE

Min konto | Bli medlem nå | Logg på

Xbox 360 + Kinect | Xbox LIVE | Social | Spill | Filmer | Musikk | Kundestøtte | kinect

Søkeresultater for kinect

FILTRER ETTER: ALT GENERELT **SPILL** VIDEO BRUKERSTØTTE FORUM

Spill

Xbox 360

Vis alle resultater for Xbox 360

SPILL

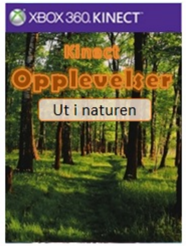
Kinect Opplevelser - Gårdsliv

kr 99,00

SPILL

Kinect Opplevelser - På ferie

kr 99,00



SPILL

Kinect Opplevelser - Ut i naturen

kr 99,00

SPILL

Kinect Opplevelser - På fjellet

kr 99,00

Appendix D - Review of the Original Norwegian Menu

The figures shown in Appendix D shows a review of the original prototypes of the menu. This menu was presented for the informants in workshop 2, and is therefore in Norwegian. The figures shows various steps from the menu, in addition to a menu sequence, from the initial step to the gaming session. This menu review starts with the choice on how to play. The player chooses to play according to a preferred muscle group. A selection of single games are shown, where the player chooses "picking apples". The menu shows a start, middle, and end scene from this game. When finished, the player chooses to change number of players from single player to multi player.


Velg omgivelser
Lett
Middels
Vanskelig
Lett
Middels
Vanskelig
Lett
Middels
Vanskelig


Velg hvordan du vil spille
Bli med ut i skogen
Velg muskelgruppe
Velg blant alle spill


Velg hvordan du vil spille
Bli med ut i naturen
Velg muskelgruppe
Velg blant alle spill


Velg spill
Plukke epler
Hogge ved
Padle
Svømme


Velg antall spillere
Én spiller
Flere spillere, samarbeid
Flere spillere, konkurranse

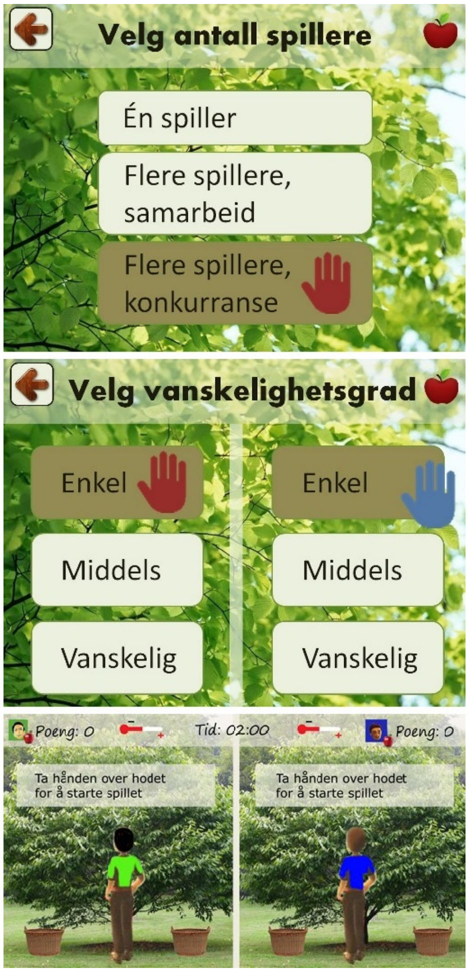

Velg hvordan du vil spille
Bli med ut i naturen
Velg muskelgruppe
Velg blant alle spill
Velg muskelgruppe
Overkropp
Utholdenhet
Sete og lår
Balanse
Velg spill for sete og lår
Plukke epler
Hogge ved


Velg antall spillere
Én spiller
Flere spillere, samarbeid
Flere spillere, konkurranse
Velg vanskelighetsgrad
Enkel
Middels
Vanskelig
Tid: 02:00
Poeng: 0
Ta hånden over hodet for å starte spillet


Tid: 00:15
Poeng: 23


Tid: 00:00
Poeng: 27
Spillet er slutt!
Bra jobba. Du fikk 27 poeng!
= 10
= 0
= 3


Spill på nytt
Gå til meny
Endre vanskelighet
Endre antall spillere


Velg antall spillere
Én spiller
Flere spillere, samarbeid
Flere spillere, konkurranse
Velg vanskelighetsgrad
Enkel
Middels
Vanskelig
Enkel
Middels
Vanskelig
Poeng: 0
Tid: 02:00
Poeng: 0
Ta hånden over hodet for å starte spillet
Ta hånden over hodet for å starte spillet

Appendix E - Response on our Application to NSD

Norsk samfunnsvitenskapelig datatjeneste AS
NORWEGIAN SOCIAL SCIENCE DATA SERVICES

NSD

Harald Hårfagres gate 29
N-5007 Bergen
Norway
Tel: +47-55 58 21 17
Fax: +47-55 58 96 50
nsd@nsd.uib.no
www.nsd.uib.no
Org.nr. 985 321 884

Lill Kristiansen
Institutt for telematikk
NTNU
7491 TRONDHEIM

Vår dato: 07.03.2013	Vår ref:33297 / 3 / MSI	Deres dato:	Deres ref:

TILBAKEMELDING PÅ MELDING OM BEHANDLING AV PERSONOPPLYSNINGER

Vi viser til melding om behandling av personopplysninger, mottatt 10.02.2013. All nødvendig informasjon om prosjektet forelå i sin helhet 07.03.2013. Meldingen gjelder prosjektet:

33297	*Treningsspill for eldre: Muligheter for samhandling*
Behandlingsansvarlig	*NTNU, ved institusjonens øverste leder*
Daglig ansvarlig	*Lill Kristiansen*

Personvernombudet har vurdert prosjektet, og finner at behandlingen av personopplysninger vil være regulert av § 7-27 i personopplysningsforskriften. Personvernombudet tilrår at prosjektet gjennomføres.

Personvernombudets tilråding forutsetter at prosjektet gjennomføres i tråd med opplysningene gitt i meldeskjemaet, korrespondanse med ombudet, eventuelle kommentarer samt personopplysningsloven og helseregisterloven med forskrifter. Behandlingen av personopplysninger kan settes i gang.

Det gjøres oppmerksom på at det skal gis ny melding dersom behandlingen endres i forhold til de opplysninger som ligger til grunn for personvernombudets vurdering. Endringsmeldinger gis via et eget skjema, http://www.nsd.uib.no/personvern/meldeplikt/skjema.html. Det skal også gis melding etter tre år dersom prosjektet fortsatt pågår. Meldinger skal skje skriftlig til ombudet.

Personvernombudet har lagt ut opplysninger om prosjektet i en offentlig database, http://pvo.nsd.no/prosjekt.

Personvernombudet vil ved prosjektets avslutning, 08.11.2016, rette en henvendelse angående status for behandlingen av personopplysninger.

Vennlig hilsen

Vigdis Namtvedt Kvalheim

Marte Sivertsen
Marte Sivertsen

Kontaktperson: Marte Sivertsen tlf: 55 58 33 48
Vedlegg: Prosjektvurdering

Prosjektvurdering - Kommentar

Prosjektnr: 33297

Forskningsprosjektet gjennomføres av masterstudentene Kine Omholt og Mathilde Wærstad. Datamaterialet vil også benyttes av forskere ved NTNU til samme formål, jf. telefonsamtale med daglig ansvarlig Lill Kristiansen 05.03.2013.

Formålet er å se nærmere på treningsspill for å forbedre eldres fysiske helse. Forskerne vil fokusere på å kartlegge kriteriene som må ligge til grunn for at spillet skal være best mulig tilpasset denne brukergruppen, samt hva som kan være motiverende for å øke treningsmengden.

Utvalget omfatter to informantgrupper, "eldre personer" (seniorer) og fysioterapeuter/fagpersoner. Seniorene skal delta på en workshop, som består av utfylling av et spørreskjema, en gruppesamtale og å spille dataspill. Deltakerne spiller dataspill alene eller i gruppe. Gruppesamtalene registreres på lydopptak, dataspillingen filmes. Fysioterapeutene og fagpersonene intervjues med lydopptak.

Personvernombudet forutsetter at taushetsplikten ikke er til hinder for den behandling av opplysninger som finner sted.

Det tas høyde for at det vil kunne bli registrert sensitive personopplysninger om helseforhold, jf. personopplysningsloven § 2 nr. 8 c), jf. telefonsamtale 07.03.2013.

Ifølge prosjektmeldingen skal det innhentes skriftlig samtykke basert på skriftlig informasjon om prosjektet og behandling av personopplysninger. Personvernombudet finner informasjonsskrivene tilfredsstillende utformet i henhold til personopplysningslovens vilkår.

Personvernombudet legger til grunn at veileder, forskere og studenter setter seg inn i og etterfølger NTNU sine interne rutiner for datasikkerhet, spesielt med tanke på bruk av privat pc til oppbevaring av personidentifiserende data.

Bruk av datamaterialet i presentasjoner vil være helt anonymt, jf. telefonsamtale 05.03.2013. Ingen enkeltpersoner vil gjenkjennes i publikasjoner med mindre det er innhentet eksplisitt samtykke til dette.

Dato for prosjektslutt er 08.11.2013. Datamaterialet lagres ved institusjonen i 3 år etter prosjektslutt, og anonymiseres senest innen 08.11.2016. Anonymisering innebærer at direkte personidentifiserende opplysninger som navn/evt. koblingsnøkkel slettes, og at indirekte personidentifiserende opplysninger (sammenstilling av bakgrunnsopplysninger som f.eks. yrke, stilling, bosted, alder, kjønn) fjernes eller grovkategoriseres slik at ingen enkeltpersoner kan gjenkjennes i materialet. Personidentifiserende opplysninger i video- og lydopptak må slettes/sladdes/fjernes.

Personvernombudet forutsetter at datamaterialet ikke utleveres til andre enn forskere ved institusjonen. Eventuelle oppfølgingsstudier og forskning på datamaterialet til andre formål enn innmeldt må det gis egen melding om til personvernombudet.

Appendix F - Informed Consent

Informasjonsskriv til deltakere i forskningsprosjekt om dataspill som trening for eldre (til seniorene)

Formål med studien

En spesifikk spillsjanger er treningsspill, som er en kombinasjon av fysisk aktivitet og videospill. I dette forskningsprosjektet (vår masteroppgave) skal vi se nærmere på treningsspill for å forbedre eldres fysiske helse. Det finnes mange kommersielle spill med fysisk bevegelse i dag, men problemet med disse spillene er at de går for fort og ofte inneholder bevegelser som ikke er tilpasset den eldre generasjon.

Vi vil fokusere på å kartlegge kriteriene som må ligge til grunn for at spillet skal være best mulig tilpasset brukergruppen eldre/seniorer.

Metode

Studien vil foregå i to deler etter det innledende informasjonsmøtet. Man kan delta på en eller begge delene.

Del1: En workshop (samling) som består av et enkelt spørreskjema, en gruppesamtale der vi og snakker om deres tanker både om data, dataspill, fysisk aktivitet og deres generelle velferd. Denne delen vil vi ta opp på lydbånd. Videre ønsker vi at dere enkeltvis - eller flere sammen - kan prøve å spille noen av de spillene som er på markedet i dag. Denne delen vil vi filme. Man kan delta på gruppesamtalen og samtidig reservere seg mot å bli filmet.

Del2: Basert på erfaringer og deres tilbakemeldinger i del1, vil det bli utarbeidet noen skisser til et eller flere dataspill. Del2 vil være å delta i en uttesting av disse skissene.

Deltakelse og reservering

Deltakelse i forskningsprosjektet er frivillig. Du kan når som helst trekke deg uten å oppgi noen begrunnelse. Alle innsamlede opplysninger vedrørende deg vil da bli fullstendig anonymisert og lydfilene vil bli slettet. Bruk i så fall kontaktinfo som står nedenfor.

Opplysninger som vil bli brukt

Innhentede data makuleres 3 år etter prosjektslutt (prosjektslutt er 8. november 2013). Dataene vil kunne brukes i relaterte forskningsprosjekter i denne perioden.

De innsamlede dataene (som videofilmene og lydfilene) vil bli behandlet konfidensielt. Vi vil ikke registrere navn eller fødselsdato. Alt materiale fra datainnsamlingen vil bli oppbevart forsvarlig slik at kun studentene, deres faglærer og andre forskere på ntnu har tilgang. Som deltaker i studien har du full innsynsrett i dataene.

Dataene vil benyttes som grunnlag for vitenskapelig publisering i relevante fora. Hvis vi benytter bilder eller sitater i vitenskaplige publikasjoner vil dere være fullstendig anonymisert.

Den første publikasjonen vil være vår masteroppgave, og resultatene fra denne vil være åpent tilgjengelig for interesserte forskere, spillutviklere og andre interesserte (som Trondheim kommune). Masteroppgaven vil også bli formidlet tilbake til seniornett, Trondheim

Prosjektet er meldt til personvernombudet for forskning (NSD).

Med vennlig hilsen

Kine Omholt og Mathilde Wærstad
masterstudenter i kommunikasjonsteknologi ved ntnu

Kontaktperson og ansvarlig for studien er

Professor Lill Kristiansen
Institutt for telematikk, NTNU
Mobiltelefon: 97 72 72 27 / epost: lillk@item.ntnu.no

Samtykke til deltakelse i studien

◊ Jeg er villig til å delta i hele studien (inkl. filming)

◊ Jeg er villig til å delta i del1 med gruppesamtale (med lydopptak). Jeg ønsker ikke å bli filmet

◊ Jeg er villig til å delta i del2 med gruppesamtale (med lydopptak). Jeg ønsker ikke å bli filmet

◊ Jeg ønsker å motta informasjon på epost om prosjektet når masteroppgaven er ferdig (frivillig)

(Signert av deltaker, dato)

Navn (TRYKKBOKSTAVER): ________________________________
Kontaktinformasjon (for avtale om tidspunkt, og evt. informasjon om prosjektet):

Telefon/mobiltelefon: ________________________________

Epost (oppgis kun om den leses regelmessig): ______________________________

Jeg bekrefter å ha gitt informasjon om studien

(Signert, student , dato)

Appendix G - Questionnaire

Introduksjonsspørsmål til Workshop

Dette er en spørreundersøkelse for å kartlegge kort hvem dere er, og hva slags erfaringer og holdninger dere har til teknologi, trening og spill. All informasjon vi får fra denne undersøkelsen vil anonymiseres. Kryss av de alternativene som passer deg best.

1. Kjønn:
   - ☐ Mann
   - ☐ Kvinne

2. Alder: ☐

3. Antall personer i din husstand;
   - Under 50 år: ☐
   - Over 50 år: ☐

4. Hva bruker du av forskjellig teknologi?
   - ☐ a. TV
   - ☐ b. Datamaskin
   - ☐ c. Dataspill
   - ☐ d. Videospill
   - ☐ e. Håndholdte spillkonsoller (for eksempel GameBoy)
   - ☐ f. Mobil
   - ☐ g. Nettbrett
   - ☐ h. DVD-spiller
   - ☐ i. Musikk (kasett, CD)
   - ☐ j. Digital musik (mp3-spiller, iTunes, Spotify)

   Annen teknologi som ikke er nevnt:

   ☐

5. Hvor mye erfaring har du med datamaskiner?

- ☐ a. Ingen
- ☐ b. Bruker det ikke selv, men har sett andre bruke det
- ☐ c. Bruker av og til andres datamaskin
- ☐ d. Eier egen datamaskin, men bruker den aldri
- ☐ e. Eier egen datamaskin, men bruker den sjeldent (mindre enn 1 gang i måneden)
- ☐ f. Eier egen datamaskin og bruker den noe (mindre enn 1 gang i uken)
- ☐ g. Eier egen datamaskin og bruker den mye (flere ganger i uken)

6. Hvis bruk av datamaskin, hva bruker du den til?

- ☐ a. E-post
- ☐ b. Lese nyheter på internett
- ☐ c. Nettbank
- ☐ d. Dataspill
- ☐ e. Sosiale medier (for eksempel Facebook, Twitter, Google+ eller andre)
- ☐ f. Nett-TV
- ☐ g. YouTube
- ☐ h. Skype
- ☐ i. Chat/nettprat (for eksempel MSN)

Annet som ikke er nevnt:

7. Hvis du bruker dataspill, hva slags dataspill bruker du?

8. Hvor viktig er sosiale aktiviteter for deg?

- ☐ a. Ikke viktig
- ☐ b. Lite viktig
- ☐ c. Noe viktig
- ☐ d. Viktig
- ☐ e. Veldig viktig

9. Hva synes du om å dele informasjon om hendelser i livet ditt med andre? For eksempel dele et bilde fra en skitur, en ferietur, eller bilder av familie gjennom sosiale medier, som Facebook.

- ☐ a. Det ville jeg ikke gjort
- ☐ b. Dette har jeg ingen mening om
- ☐ c. Jeg liker å følge med på hva andre kjente gjør, men ville ikke lagt ut noe om meg selv
- ☐ d. Jeg liker å dele hendelser i livet mitt med andre, men bare familie, venner og bekjente
- ☐ e. Jeg liker å dele hendelser i livet mitt med andre (både kjente og ukjente)

Andre kommentarer til dette temaet:

10. Hvor aktiv er du en vanlig dag?

- ☐ a. Ikke noe aktiv
- ☐ b. Beveger meg i sammenheng med nødvendige hverdagslige gjøremål (for eksempel som å gå på butikken, vaske hus)
- ☐ c. Er i noe aktivitet (for eksempel gå en tur med hensikt trim)
- ☐ d. Er aktiv (for eksempel deltar i treningsgrupper, drar i svømmehallen, går i fjellet, går på ski)

Andre kommentarer:

11. Hva slags aktiviteter driver du med i hverdagen? (Tenk på hele året)

12. Drev du med en aktivitet før, som du ikke driver med lenger? Hva slags aktivitet? Hvorfor sluttet du?

13. Hva er motivasjonen din for å holde deg aktiv?

- [ ] a. Liker generelt å holde meg i aktivitet
- [ ] b. Å holde meg i aktivitet gir meg godt humør
- [ ] c. Vil holde meg frisk
- [ ] d. Ønsker å bli fysisk sterkere
- [ ] e. Ønsker å gå ned noen kilo
- [ ] f. Det er sosialt

Andre grunner:

14. Hva anser du som trening?

15. Pleier du å spille spill (inkludert brett- og kortspill)? I såfall hvilke?

16. Hva er motivasjonen for å spille spill?

- ☐ a. Tidsfordriv
- ☐ b. Jeg syns det er gøy
- ☐ c. Det får oppmerksomheten min bort fra andre ting
- ☐ d. Jeg gjør det for å være sosial
- ☐ e. Det er "hjernetrim"

Andre grunner:

17. Hvis du skulle spilt sammen med noen, hva slags samspill ville du ønsket?

- ☐ a. Samarbeid
- ☐ b. Konkurranse
- ☐ c. Begge

Tusen takk for hjelpen!

Appendix H - Interview Guide for the Focus Group Interview in Workshop 1

Oversikt over workshop og intervjuguide seniorer

Workshopen (omtalt som del1 i infoskriv) vil være delt i tre:

Del a: En enkel spørreundersøkelse

Del b: Videofilming av seniorer som spiller videospill

Del c: Gruppesamtale. Dette vil ha kvalitativ intervjuform. (Vil bli tatt lydopptak av dette)

Utkast til intervjuguide (seniorer)

- Er dette første gang dere har spilt/brukt en teknologi som dette?
    - Hvis ja, hva har dere brukt før?
    - I hvilken sammenheng?
- Hva følte dere under spillingen?
- Følte dere at dere fikk noe fysisk utbytte av spillingen?
- Hva sitter dere igjen med etter å ha fått spilt disse spillene?
    - Likte dere spillene?
    - Hva likte dere/likte dere ikke?
- Hvor vanskelig var det å forstå hvordan man skulle bruke teknologien?
- Syntes dere det var greit å finne ut hvordan dere skulle starte spillene?
    - Var menyen forståelig?
- Hvor vanskelig var det å forstå hva dere skulle gjøre i spillene?
    - Var det ganger dere "bare gjorde noe" for å komme seg videre, uten egentlig å skjønne hva man gjorde?
- Var det greit å konsentrere seg om oppgavene i spillet eller ble dere distrahert av omgivelsene? Eksempler på dette?
- Var det noen øvelser/bevegelser dere måtte utføre hvor dere følte dere ikke hadde kontroll?
- Hvordan var informasjonen dere fikk underveis i spillet? Var den informativ, unødvendig, plagsom/i veien?
- Hva syntes dere om musikken og de andre lydene i spillet?
- Hva syns dere om grafikken? Fremstillingen av figurene, farger osv?
- Hvordan syns dere det var å spille to og to? Hva var forskjellene ved å spille alene og det å spille to og to?
- Hvor tror dere et slikt spill best hadde egnet seg? Kunne dere tenkt dere til å spille det alene hjemme i egen stue, eller i en sosial setting med flere deltakere, eller begge?
- Dersom det fantes spill som dette, med spesielt tilpassede øvelser dere visste var gode for å forbedre deres fysiske helse, ville dere brukt det?
- Hva trenger slike spill for at det skal være morsomt og underholdende for deg?
- Har dere noen tanker om hva som kunne vært passende tema for et slikt treningsspill?
- Har dere noen andre tanker rundt et slikt spill?

Appendix I - Interview Guide for the Focus Group Interview in Workshop 2

Spørsmålsrunde 1:

- Hva syns dere om ideen?
- Hva syns dere om bildene/detgrafiske?
- Er det noen øvelser dere tror kan bli vanskelige å gjennomføre?
  - Hvilke?
- Hvilken øvelse likte dere best?
  - Hvorfor?
- Virker det realistisk?
- Er dette noe dere kunne/ville brukt?
  - Hvorfor/hvorfor ikke?
- Legger dere merke til, og forstår dere all informasjonen på "skjermen"?
  - Hva er forsåelig/ikke forståelig
- Kom informasjon, tekst og elementer godt fram?
  - Ser dere hva denne knappen betyr (peker på tilbakeknapp)
- Dere nevnt at det var viktig "å bruke hodet" (Det kognitive). Vi har derfor prøvd å inkludere dette med naturstispørsmål. Hva synes dere om dette?
- Det med å velge omgivelser og vanskelighetsgrad, innbyr det til læringseffekt og variasjon?

Spørsmålsrunde 2:

- Hva syns dere om ideen?
- Hva tenker dere om de fire forskjellige enkeltspillene?
- Hva syns dere om bildene/det grafiske?
- Virker det realistisk?
- Legger dere merke til, og forstår dere all informasjonen på "skjermen"?
  - Hva er forsåelig/ikke forståelig
- Kom informasjon, tekst og elementer godt fram?
  - Ser dere for eksempel klokken og poeng?
- Er det motiverende nok? Kunne dere tenkt dere til å spille dette?

Spørsmålsrunde 3:

- Er menyen forståelig?
  - Hvorfor/hvorfor ikke?
- Hva syns dere om fargene og bakgrunnen?
- Hvordan syns dere teksten og informasjon kommer frem?
- Hva syns dere om mengden informasjon i hvert bilde/steg?
- Hva syns dere om lengden på menyen?

Appendix J - Non-Functional Requirement not Included in the Exergame

Appendix J shows a table with non-functional requirements. This have been specified based on theory and feedback from workshop 1, in addition to our own knowledge, opinions and ideas. These have not been included or mentioned in our concept, but they are important aspects to consider when developing an exergame for elderly.

3.1	The system shall be able to run on both PC and Xbox.
3.2	The system shall be easy to set up (physically).
3.3	The system shall include Kinect functionality, like pausing a game by holding one arm out from the body.
3.4	The system shall load within few seconds.
3.5	The system shall be small in size and do not require too much space.
3.6	The system shall not require too much capacity. It shall be able to run on a regular PC.
3.7	The system shall not require too much power.
3.8	The system shall avoid delay between the player's movement and action on the screen.
3.9	The system shall ensure secure storage and sharing of profiles.