

Enhancing usability for elderly people
Bachelor thesis Information Sciences

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Abstract

Using a computer is commonly experienced as a problem amongst elderly people. This thesis aims to find a way to enhance computer usability for elderly users.

Firstly, an elaborate description of the user group and the problem is given. The user group and problem have been researched by studying literature, observing the user group at work and interviewing a usability expert.

Based on these results, experimentation platforms have been designed implementing suggested improvements for the found problems. These features have been tested and evaluated by conducting experiments and interviews with potential users.

Finally, the found solutions to enhancing usability for the elderly are summarized.

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Chapter 1

Introduction

In our modern society, technology is becoming more and more integrated with daily life. This can be seen in simple things such as going to an ATM to get cash or going to a bank to make a payment and having the assistant telling you to learn e-banking. This affects all of society, but for elderly people this poses a problem: it forces them to learn how to work with a computer.

Elderly people commonly experience problems when working with a computer. It is known that they can have trouble reading and are slower to understand and learn new things. Besides that, using unfamiliar devices such as a mouse can be an obstacle which requires lots of time and trouble to overcome, if it is overcome at all.

Computing literature and courses specially adapted for the elderly therefore focus on the constant revision of the course material to make it learnable.

Elderly users tend to view computers as complex machines that are fast, not transparent and hard to understand. They have a natural tendency to distrust computers, and a certain reluctance to begin working with them.

However, when they start familiarizing with the concept, they often find that a computer is also an exciting machine with unlimited possibilities.

Making computer interfaces usable for elderly people allows them to cope with the rapid changes occurring in our modern society. But most of all it is of vital importance that they experience these developments as being enjoyable and fun. Presenting technology to them in the right way can greatly contribute to this process.

Currently, there is an increasing amount of information becoming available on the web, and people are often instructed to consult 'the website' instead of being given oral explanations. Moreover, tasks such as banking and shopping are increasingly taking place online.

Newspapers often mention that we live in an ageing society. Therefore, elderly people may not be forgotten when designing computerized applications which affect all of society.

For elderly people, it would be a great improvement if computerized tasks were made easier, so that they do not have to experience the consequences of having outdated knowledge. Their integration in modern society will be a much smoother process.

There has been a lot of research on usability of computer and web interfaces. However, these projects only focus on a single aspect of the elders' needs and fail to recognize the diversity in the target user group.

In my thesis I aim to define the greatest problems elderly users experience when working with a computer. I will suggest possible solutions for these problems, test them and finally produce an advice for future interface design for the elderly.

My main question will therefore be: how can usability be enhanced for elderly users?

In the following chapter, I will characterize my user group, find out their typical traits, focus on the analysis of the current problems, how severe they are and where they occur.

I will also describe the preliminary research I have conducted. I have been present at several computing classes for elderly people, where I both observed them working with computers and helped them when they experienced difficulties to find out where the problems occurred and what their typical way of working was.

Chapter 3 analyzes the structure of current software and evaluates its usability as far as the needs of elderly are concerned.

The fourth chapter describes the structure and methods of experimentation I will use to test the hypotheses I have formulated based on my observation and interview results.

Finally I will discuss the results from the experiments, possibilities for future research and suggest a potential solution for the problems I have found.

The appendices contain reports of the interviews I have done and a listing of the source code of the experimentation platforms used to conduct my experiments.

Chapter 2

Special users: the elderly

2.1 Understanding elderly users

Think of a typical computer application. When it was being designed, what user group did the developer have in mind? Probably the so-called "typical user". This user can be male or female, is between 20 and 40 years old, is well-educated and computer literate, has all physical capabilities intact and is familiar with the way most computer applications work.

Unfortunately, this profile does not hold for older people. They are different, and most developers fail to recognize just how different and diverse elderly users are. This is problematic, because before starting any attempt to design an adapted interface, we first need a thorough understanding of the capabilities and limitations of the targeted user group.

Gregor and Newell [6] use a very rough characterization of older people by dividing them into three groups:

1. **Fit older people**

These are people who show no visible signs of disability, nor would they consider themselves disabled, but who inevitably no longer have the cognitive and physical capabilities they used to have when they were younger.

2. **Frail older people**

This group can be considered to have certain disabilities (from illness or age) which can be severe. Moreover, they have the same age-related general reduction in their other functionality as the first group.

3. **Disabled older people**

These are people with long-term disabilities which have affected the ageing process. Their functioning abilities may be highly dependent on their other abilities, which will also be declining with age.

This taxonomy shows that there is a complete range of capability levels to be distinguished in the user group. Capability and disability cannot be seen as

plain opposites. Software developers and researchers alike fail to recognize this, and develop products labeled "for the disabled" or "for the elderly". Yet a "disability" such as lack of speed in fingers for mouse-clicking will only be regarded as a disability when using a computer.

Users can also suffer from multiple disabilities which may interact to pose trouble at the computer greater than the effect of each single disability. Therefore research focusing on solving problems for a single handicap may not always provide sufficient solutions. This stresses the fact that software cannot be designed for one group of elderly, because in this group, every user has special needs.

2.1.1 Diversity in the user group

As age increases, the individual variability of physical, sensory and cognitive functionality will increase as well. The rate of decline in functionality can increase significantly as people get older. However, this rate will also vary in each individual.

Older people can also have completely different needs and desires depending on which stage of their lives they have reached. Their living environments can be of influence, for instance whether living independantly or in an elderly residential home. The same goes for their living conditions, such as the need for a walking cane, disability to stand for long periods or a need to wear warm gloves [6].

2.2 Problems at the interface

Research and development on interface design for elderly people taking place today is extensive. It mostly focuses on the development of special, simplified systems with very limited capabilities. An example is Secure Internet Machines' and KPN's *SimPC*, a Linux-based computer with highly limited functionality aimed at people who have never worked with a computer before.

This initiative has never become a great success. One of the major flaws is that it assumes users' needs are static and do not change over time. This means functionality cannot be manually controlled and adapted. However, this assumption cannot be made, because even elderly people have the ability to learn, slow as the process may be. The SimPC will eventually become too limited and relatively expensive.

The amount of information presented by our current operating system interfaces is overwhelming for the elderly user group. The problem is that there are too many options, and the actions to take appear to be very complex. Elderly people, whose cognitive capabilities decline with age and who find it difficult to logically structure their thoughts and perform analytical thinking, simply do not know what to do at that point.

Moreover, they cannot see what happens when an icon is clicked, only the result of the action is displayed to them. Computers therefore appear closed and mysterious. This results in a tendency to distrust modern technology, raising

in them a fear of, for instance, breaking something when clicking a certain button. Another example is the fear of losing their money while attempting to do e-banking.

Improving accessibility has also been a major object of study. As mental and physical capabilities decline, accessibility becomes an increasing problem for elderly users.

A study by Virginia Ogozalek [14] suggests that interfaces become more accessible if the amount of reading necessary is reduced. This seems a logical theory, since it has been shown that elderly people can have trouble reading small fonts and are slower to learn new things [16].

However, she states that elderly men seem intrigued by a text-based interface, because it represents the "machine-ness" of the computer.

Women generally do not like a text-based interface, and she suggests that interfaces which are more friendly and less machine-like will be more accessible for women.

2.2.1 Preliminary research

I have done my own observations and conducted several interviews with members of my targeted user group. I have been present at computing classes for elderly people, both at beginners' and advanced level, and during the lesson I observed them when they were working with the computer, taking notes on the most commonly occurring problems and difficulties, and also actively helped them when they experienced trouble. This provided live interaction with course participants and allowed me the opportunity of getting immediate comments on difficulties.

I also interviewed both course participants and teachers to find out their opinion on the current problems experienced when elderly people start working with computers.

These observations and interviews have proven to be very valuable in providing information on the most pressing, commonly recurring problems. They have shown that elderly people experience most trouble when handling unknown devices, the mouse in particular. This is mostly due to a decline in motor skills, such as unsteady hands while navigating and not being able to click fast enough to perform a double-click. Recalling when to double-click and when to single-click is also a point of difficulty.

The second most pressing problem is to remember the sequence of actions that has to be performed in order to accomplish a certain task. The elderly course participants I observed were completely lost when confronted with a "Save as" dialogue in which they had to perform three actions (specifying a file name, a location and pressing the 'Save' button).

Cognitive capabilities decline with age, and this becomes apparent in such situations. They all realized that there was a logical structure underlying the machine, they just didn't understand it yet.

Observation results

I let my observations be guided by several key points. From my observations I have been able to draw the following conclusions:

1. *How do the course participants handle input devices such as mouse and keyboard?*

The elderly seem to have a lot of trouble handling the mouse. It is a foreign way of working for them, not comparable to anything they have ever worked with before. They largely complain of unsteady hands, which too often results in clicking a wrong button or clicking next to the button. Double-clicking is especially hard, because beside the unsteadiness the two clicks have to follow each other rapidly in order for the computer to interpret it as a double click. Also, distinguishing when a double-click has to be used and when a single-click suffices is a difficult task.

Some people indicate that when they try to click on the left mouse button with their index finger, the middle finger goes down as well and ends up clicking the right mouse button. Therefore both buttons are pressed and undesired menus appear. This is especially true for the few people I spoke to who suffered from degenerative diseases such as rheumatoid arthritis and MS.

Navigating the Windows Start menu was really difficult for them. Going in a vertical direction to find the right menu-item was a slow process, but it worked. However, navigating horizontally across the screen proved to be a true frustration, since the mouse could not be moved steadily across the screen and the pop-up menu had often disappeared before it was even reached. Several attempts were required to get to the menu.

The keyboard does not seem to pose a problem. The only difficulty is finding the correct button to press in the seemingly infinite set of buttons offered by the keyboard.

2. *How do they receive monitor output?*

All participants appeared to do quite well receiving output from the monitor. None of them had any trouble reading the menus, and they did not mind having a lot of options to choose from in the interface.

They mentioned the problem was not so much that they were overwhelmed with too much information, but that too much of the unfamiliar was presented. They indicated that it needed only time and practise to turn the unfamiliar into something familiar.

3. *In what way is the course material presented and how do teachers handle this?*

The course material is presented to the elderly in a very simplistic way. They use a book which explains operations as a sequence of steps. Each step is elaborately explained in words, and screenshots are printed to illustrate the instruction. This provides a constant feedback mechanism for the course participants. It has an easing effect if they can see that the

output on their monitor corresponds to what is displayed in their book.

The teachers do not hesitate to take a lot of time for elaborate explanations. Especially for the true beginners a lot of emphasis is put on the use of analogies and metaphors to make the material appear more familiar.

Elderly people who have never before worked with computers or related mechanisms miss the ability to do analytical, logical and rational thinking. Therefore they tend to experience difficulties understanding the logical structure underlying Windows. A metaphor helps them translate the abstract idea of the directory structure into something that appears real to them.

The filing cabinet metaphor was used to explain the directory structure in Windows. Letters represented individual files and hanging files represented directories in which files are stored.

Even when the instructions were being put into practise, constant reference had to be made by the instructors to the drawer in which letters were neatly organized.

Constant revision and presenting operations as logical sequences of simple steps are of great importance when explaining to the elderly. Moreover, being consistent is also vital. When two different ways to achieve the same result are explained, participants lose track of it.

Each step the teacher took in explaining how to create a directory had to be elaborately narrated and was carefully observed by participants. Each explanation was done at least twice.

Elderly people can only handle one step at a time. Whereas creating a directory might seem a single operation to most of us, to the elderly it appears as a "dazzling set of complicated steps".

4. *Do people show signs of wanting to act on their own, or do they ask for continuous confirmations before acting?*

All the people I observed that lesson were not the least bit afraid to act on their own. In fact, all the interface icons presented an adventure to them, and they appeared extremely curious about what would happen when an icon was clicked. Especially when working with MS Paint, the different options were happily explored.

They did constantly ask if they were doing the right thing, but most of the time had to be stopped from clicking the wrong thing.

5. *Does their way of working show that some interface attributes or interaction patterns appear more logical than others?*

I could not determine whether some interface attributes or patterns of interaction were considered easier or more useful than others. This is mainly because nothing on the interface and no operation seemed easy or logical to the participants.

They tend to have a very chaotic way of working, and do not understand the logical sequence of an operation at all. They cannot remember the order of steps to be taken, and therefore an operation seems nothing more than an unstructured maze of steps.

6. *Are they motivated during the lesson?*

The course participants did seem highly motivated to work with computers. There is a particular drive to master the basics, and most of all they like working with a computer. They are inspired by the innumerable possibilities presented by the computer.

There are continuous complaints about how hard it is, and how things don't work out as thought, but as soon as the teacher comes to solve the problem the frustrations disappear.

However, the participants do indicate that they are more frustrated when things fail when they practise on their own, with no one to come and correct them. Some people tend to become anxious when they make mistakes, but this varies greatly between participants.

7. *Are any alternative input or output devices being used?*

Participants are encouraged to take their own laptops, if they have them, so that the problem of switching between computers can be minimized.

There was a lady who had a laptop with her, and she mentioned that she disliked working with the trackpad.

Otherwise, no alternative input/output modalities are used.

For people with visual handicaps, text in the monitor is enlarged and the standard magnifying glass in Windows is activated. If the handicap is too severe, people are discouraged to follow the computing course.

2.2.2 Difficulties and design paradigms

It is clear that there are many problems elderly people encounter when trying to work with a modern computer interface. However, there are several difficulties to these problems.

Firstly, problems tend to appear at different points in the interface. Therefore the analysis of user behaviour has to consider different aspects of the interface and take into account the differing reactions to these triggers.

Secondly, no two users are the same and have the same needs. Users, especially elderly users, are highly diverse as far as abilities are concerned. Moreover, these abilities are dynamic over time.

However, while cognitive functionality may further decline over time, we also have to realise that elderly people are still able to learn. The process may be a lot slower than it used to be, but learning still occurs.

Therefore interfaces are required to be flexible and configurable to specific users' needs and states of mind.

Current software is typically static and has limited means of adapting to specific users' needs. New design paradigms are continuously being suggested to

improve usability for the elderly.

User Centred Design

The *User Centred* or *Human Centred Design* paradigm is such a paradigm, focusing on specific users' wishes.

Sharon Oviatt describes it as follows:

"Human centred design advocates that a more promising and enduring approach is to model user's natural behaviour to begin with, including any constraints on their ability to attend, learn, and perform, so that interfaces can be designed that are more intuitive, easier to learn and freer of performance errors" (Oviatt 2006) [15].

The essence of this paradigm is that the design minimizes the user's *cognitive load* by providing an interface which enhances performance while eliminating any distracting features.

Cognitive load is defined as the mental resources a person has available for solving problems or completing certain tasks at a given time.

However, this design paradigm still focuses on a specific type of user's demands, making use of user groups with homogeneous needs. Therefore it still provides static artefacts [11] [9].

Design for Dynamic Diversity

A new paradigm that meets the above mentioned requirements is *Design for Dynamic Diversity* (D3 or DDD). A supporting methodology is suggested by Gregor and Newell [6]: *User Sensitive Inclusive Design*. This methodology employs the ideas of User Centred Design, but for a very diverse group of users. The emphasis is especially on diversity of functionality, and ethical issues related to the elderly group of users.

The following modification of UCD-principles is suggested:

- There is a much greater variety of user characteristics and functionality. Therefore a need exists to specify these characteristics and functionality in detail.
- Finding and recruiting representative users is a hard task. Frail, possibly disabled people with medical conditions may not be in shape to participate in experiments.
- Conflicts of interest between user groups has to be dealt with.
- Personalisable and adaptive interfaces have to be created.
- Accessibility has to be enhanced using additional components, both in hardware and software.

The word *Sensitive* has been specifically chosen to reflect the facts that a truly representative user group is not available, communication with users will be dif-

difficult, ethical issues may form obstacles and that the designer needs to embrace a different attitude of mind.

2.3 Learning in elderly people

People have a tendency to relate new things to what is familiar to them. Therefore the concept of *interface metaphors* seemed a great idea [16].

An interface metaphor is a concept that is already familiar to the intended user group and is applied to represent a computer operation at the interface.

Interface metaphors are currently widely employed in interfaces. Examples are the icons used for the trash can, the archive hierarchy representing My Documents and the Desktop metaphor. While these may work fine for groups of younger users, elderly users cannot relate these to familiar ideas.

Current interface metaphors are clearly not sufficient for this group of users [9]. Moreover, they are not suitable for use in the DDD paradigm because they do not address the dynamic nature of diversity [6].

Current approaches to teaching elderly is to employ constant revision of course material so that they will remember in the end. However, it pays to find out how short-term memory in elders functions.

For younger people, experimental psychologist George Miller has found that "The magic number 7, plus or minus 2" describes the maximum quantity of ideas or facts that people can actively attend to at a single moment. This *Rule of 7* has become well-known in interface design.

The question is whether the Rule of 7 also holds for elderly users. If not, it will be worthwhile to present elderly with smaller amounts of information on a given screen, to avoid providing them with an overwhelming cognitive load at a single moment.

While it is of great importance to make computers seem more appealing to elderly users, the most important questions we have to keep in mind are:

- What functionality do elderly users expect from a computer?
Do they want to use it primarily for Internet and e-mail, do they want to make use of more advanced software, do they want to learn incrementally?
- People who can handle computers at present, will they still be able to do so in a certain number of years from now?
Again the flexibility and configurability of the interface will play a vital role.
- How do elders learn and think? How do they view a computer?
It is important to consider that most elderly people still have the ability to learn, even though the process does not happen as fast as in younger users. Teaching elders to handle a computer and designing interfaces that support this way of thinking requires insight in the learning process in elderly users. Modelling users' natural behaviour is a good way to achieve this.

Chapter 3

Measuring usability

Elderly users come to a computing class with a goal in mind. The most commonly heard motivations are the desire to e-mail with (grand)children, to learn how to use the Internet for banking, to have a distraction from being alone all the time, or just being sent by their children.

On being asked what they considered to be the greatest difficulties, they all pointed to mouse navigation as being a dreadful way to navigate. The cursor appeared to be all over the screen, and double-clicking was often replaced by a single click and then pressing the 'Enter' button.

Secondly, they mentioned that remembering what to do at a certain point in a task was very hard. Tasks were so complex, and they had to think of so many things that they completely lost track of it all, even when performing the same task several times. The task they were performing during the course was the saving and retrieving of a document. They tried to remember a certain sequence in the separate actions, without truly understanding the concept of directory hierarchies in the file system. This makes it much harder to perform such a task, since remembering how to do a trick has to be stored in and retrieved from long-term memory, which is an expensive operation when compared to understanding and applying knowledge [4].

Elderly people find it difficult to think about the computer structure in abstract terms, and see every task as a linear process. They are more likely to get lost while navigating a menu or website due to a decline in spatial and working memory. Therefore the hierarchy in tasks has to be minimized as much as possible, and consistency in the working process is extremely important [17].

3.1 Usability goals

Usability of an application can be measured by observing users working with it in a controlled experimental setting, by asking them about their experiences and by measuring certain variables, such as time to task completion, accuracy and tracking mouse movements.

De Haan et al. [7] have specified four usability criteria which can be used to evaluate an interface:

1. Easy-to-use
2. Easy-to-learn
3. Efficient
4. Fun-to-use

If users can perform and complete tasks and operations easily using the application and input modality intended for that application (such as mouse and keyboard), then the application can be classified as *easy-to-use*.

When users have no problems finding out how to work the application and given input modalities without being given any explanations other than the task instructions, the *easy-to-learn* criterium is fulfilled.

Users also have to be able to complete tasks within a reasonable amount of time (*efficient*). This time interval, which is largely dependant on the users in question, will be somewhat longer for elderly users.

Most of all, users have to enjoy working with the application. The *fun-to-use* criterium may seem obvious, but, as Donald Norman has described:

"Affect changes the operating parameters of cognition: positive affect enhances creative, breadth-first thinking whereas negative affect focuses cognition, enhancing depth-first processing and minimizing distractions. Therefore, it is essential that products designed for use under stress follow good human-centered design, for stress makes people less able to cope with difficulties and less flexible in their approach to problem solving."

Donald Norman, Attractive things work better [13].

Interfaces must thus be designed to induce as little stress as possible, since negative affect can lead to greater difficulty in accomplishing tasks. Positive affect has just the opposite effect.

Elderly people are more prone to react stressfully to an interface than people from younger user groups. Elderly people are in most cases largely unfamiliar with the way a computer works. Moreover, they experience a decline in cognitive functioning, mostly in spatial insight, motor skills and learning ability. These factors cause the elderly to react more warily to a computer interface than younger people.

Therefore attractive, friendly-looking, fun-to-use interface design is especially important for this user group.

During the interview with Charles van der Mast he mentioned that assisting interfaces work well in situations of stress. Having a directive interface which leads the user through the application tasks minimizes the hierarchical structure of tasks, the cognitive load of the operation and can promote a better

understanding of the task as a linear process without having to remember this process.

3.2 Current software structure

Most current software prompts a user to specify certain options and settings by offering a pop-up window in which these settings can be specified. It has a certain measure of directiveness in that self-explanatory names and sometimes short descriptions are given in this window, but typically several things have to be stated in one screen.

This is the point where elderly users get confused. They do not know what to do first, simply forget to specify some of the options or not interpret the names as being self-explanatory at all.

For instance, when trying to save a document, they may forget to specify the correct location or provide the document with a meaningful name. In that case, the default location and/or name are used. This creates complete chaos in the directory and document structure and makes file retrieval a difficult task.

The most common options and tasks (saving, opening, closing etc.) are rightfully placed in the first level of the menu hierarchy. However, there is a lot of functionality which elderly may also like to make use of which is hidden far deeper in the menu hierarchy.

Without help, elderly users will never find this functionality and thus never get to know about it.

Toolbars can be of help to bring the functionality more directly into the interface, but the small, similar-looking buttons do not immediately look meaningful to elderly users.

Therefore this structure will have to be altered to make it seem more accessible to elderly people.

Firstly, however, the structure of common software tasks and the way users view the task have to be modelled and analyzed.

As an example for a task I will take the burning of an audio cd.

Firstly I will analyze how this task is composed in hierarchical terms, and then I will construct and compare two different mental models of this task. One will be based on an average user's way of thinking, the other for an elderly user.

It should be noted that all models are slightly simplified, since the aim is to provide an overview of the main actions users have to do to accomplish the task, and not to design a new burning application.

Therefore only the burning process has been modelled, and 'distracting' operations such as saving and the possibility to end halfway during the process have not been taken into consideration.

3.2.1 Hierarchical task analysis

In this task model there are two levels of abstraction to be distinguished. The level describing the name of the operation, such as 'Open application', and the level stating explicitly which actions have to be performed in order to complete the operation.

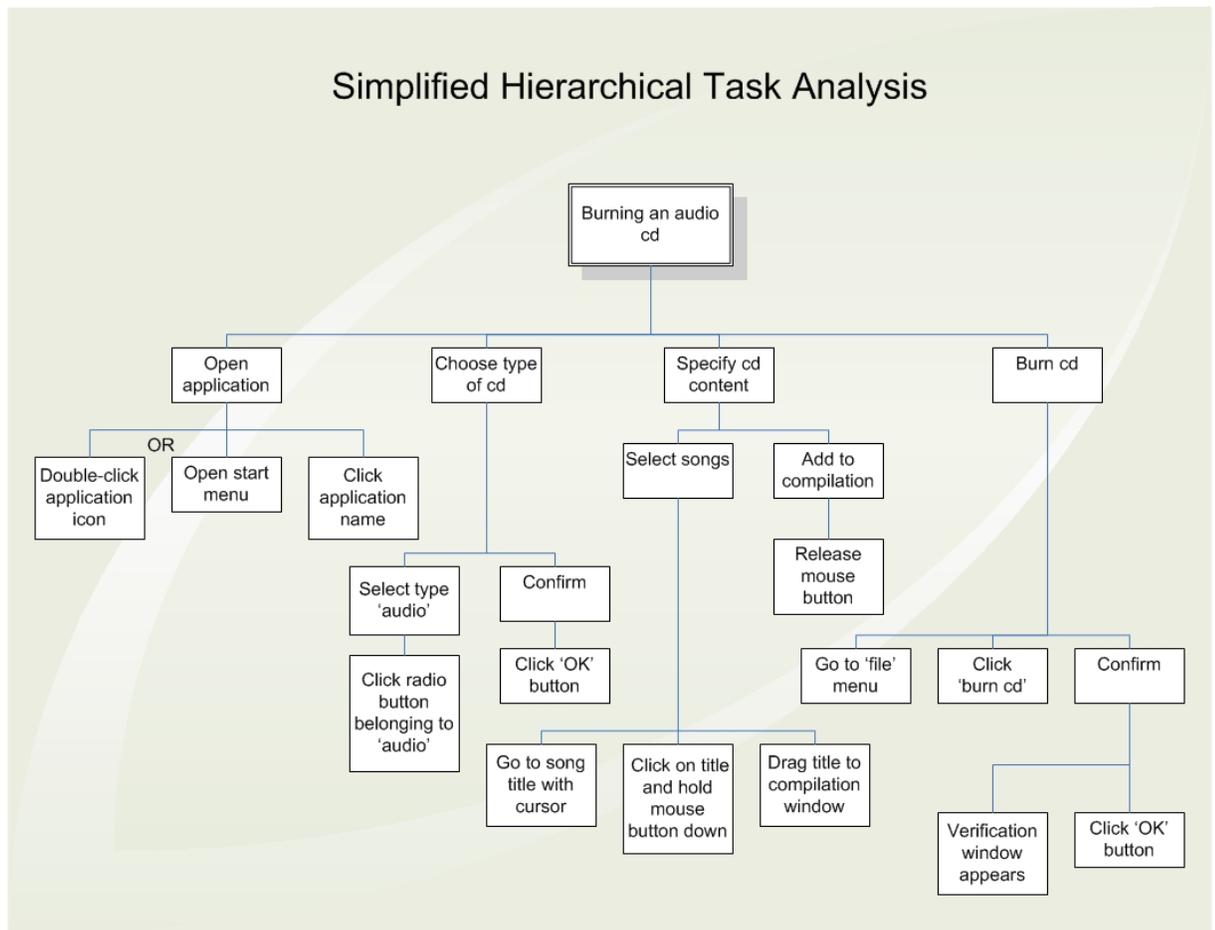


Figure 3.1: Task analysis for burning an audio cd

3.2.2 Mental models

Mental models are the cognitive models users have formed in their minds of how an application works. Mental models are usually partial, since there are few individuals who fully understand how an application works. This is especially true for elderly users. Therefore I want the mental models the interface induces to be as simple as possible.

As can be seen in these mental models, the difference between an average user and an elderly user is the level of abstraction applied for thinking about a task. For an average user, an operation such as 'Select content from files' appears a single action, which happens automatically and requires no further thought. For an elderly user, however, this operation is like a whole sequence of actions, all which have to take place in a certain order. This was clearly shown during the observations in the computing classes, where they were voicing their thought in terms of "And now I have to go here, and after that I have to...".

It should be noted, though, that mental models are not permanent and may change over time. As elderly users get more experienced, the mental model may become more merged with the average user's mental model, as could be seen in the advanced computing class, where, for instance, starting an application required no more trouble.

However, for every new action an elderly user faces, and for each elderly user who is new to computers, this mental model applies.

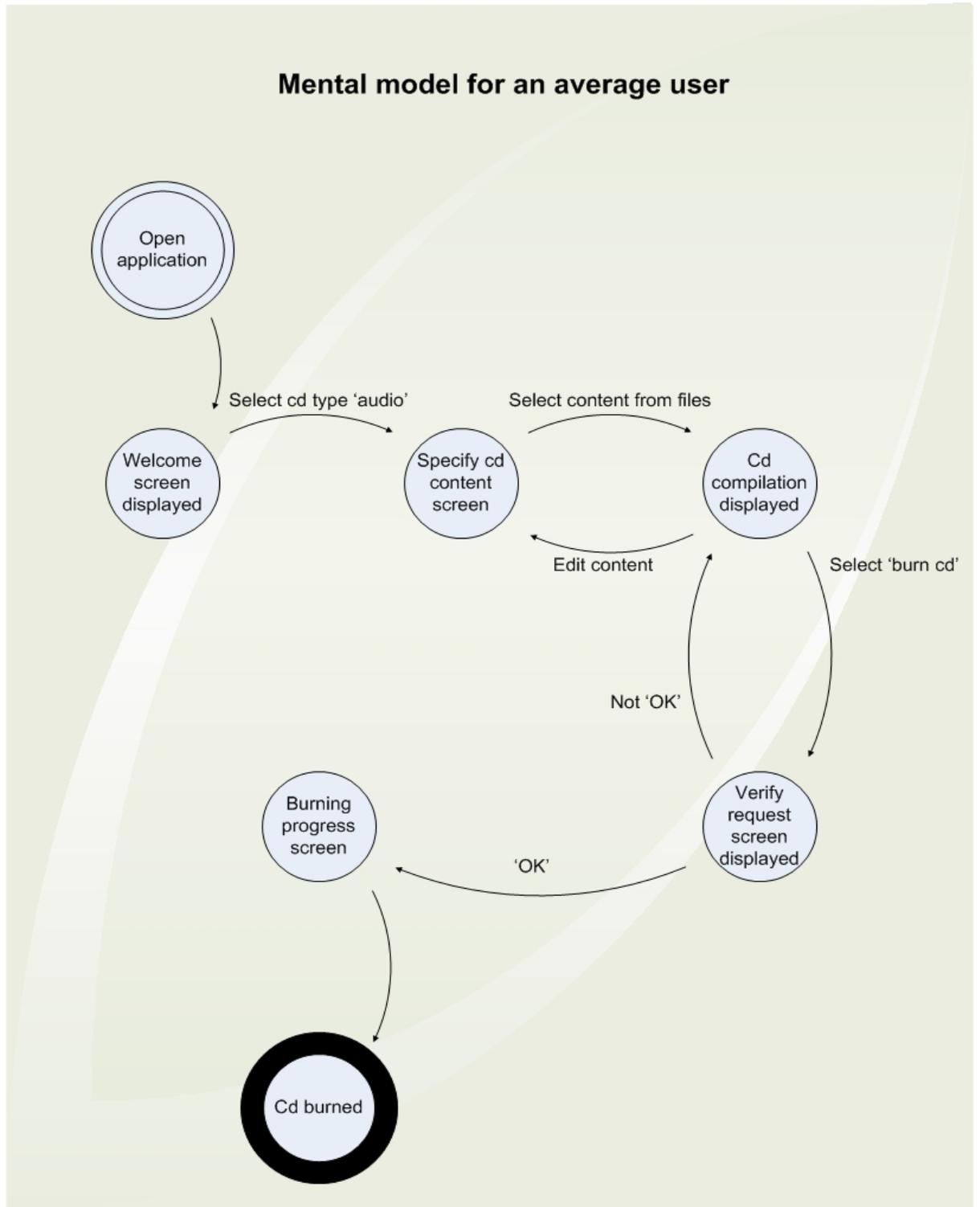


Figure 3.2: Mental model for an average computer user

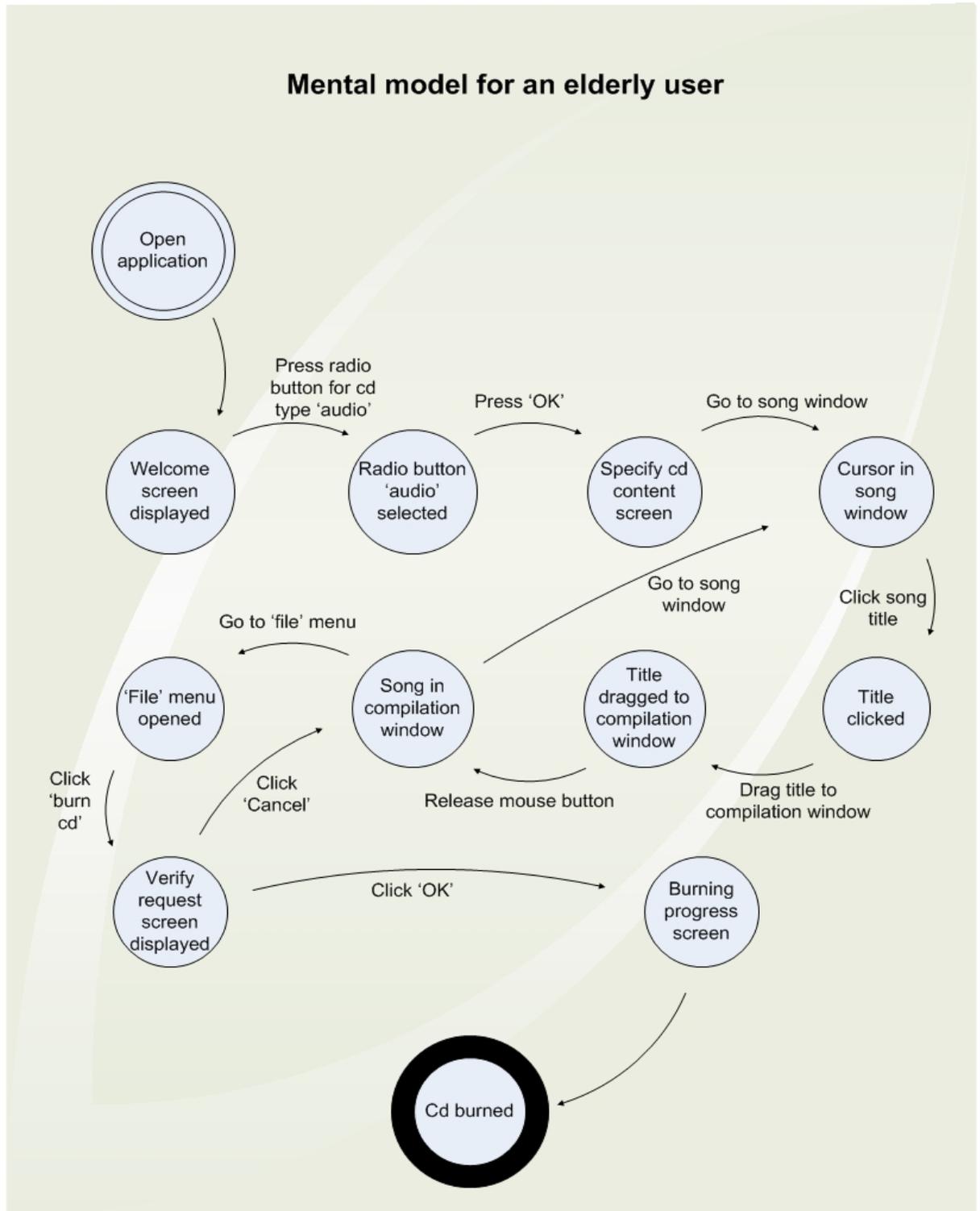


Figure 3.3: Mental model for an elderly computer user

Chapter 4

Methods of experimentation

Firstly I will present a total overview of the research activities I have conducted for clarity.

4.1 Overview of research activities

1. Characterizing user group
 - (a) Preliminary observations and interviews to discover problem areas
 - (b) Literature study to find out typical traits and properties
2. Exploring current software structure
 - (a) Interview with usability expert
 - (b) Hierarchical task analysis for typical computerized task
 - (c) Creation and comparison of mental models for typical and special users
3. Experimental design
 - (a) Design experimental platforms based on results from previous two phases
 - (b) Create experimental platforms in Java
 - (c) Operationalization on how to measure results
 - (d) Finding participants
4. Conducting the experiments
 - (a) Having participants perform experiments while observing

- (b) Question participants on their experiences afterwards
 - (c) Recording everything on video
5. Analysing the results
- (a) Transforming participant answers into measurable numbers
 - (b) Describe observation results from experiments

4.2 Experimental design

I will be conducting several experiments in order to test my hypotheses. I will use the evaluation method of *User Testing* to test the usability of my suggested solutions. User Testing lets participants who are representative of the target audience work with the software and encounter possible problems as they perform tasks. An observer watches them work and reports on the uncovered problems and suggests recommendations based on the findings.

This is a very convincing way to validate a theory. If certain problems appear at the same point in the task, this will be a subject for further study.

Getting immediate feedback from participants is very valuable, because it provides lots of information about their opinions, which are likely to be shared by many people in the same user group.

4.2.1 Selecting participants

There will be a total of six participants for the experiments. They will be divided over three groups. One group will be selected from the members of the beginners' computing class in Nijmegen. They are all 60 years and older. This group will consist of two participants.

The other two groups will be selected from a residential elderly home in Zwolle. They are all over 55 years of age. One group of two will have no experience with computers whatsoever, and another group of two will have some experience from work-related tasks. None of these participants have followed any computer courses.

This is to test whether the experimental results will follow the same trends in all groups, or whether the suggested interface adaptations will only work for users with some experience, or vice versa.

Experiments are within subjects. Learning effects will be minimized by presenting each participant the trials for the navigation experiment in a randomized order. For the open/directive interface experiment this is unfortunately not possible, since the directive interface may not be presented before the open interface.

4.2.2 Locations

The observations will take place at two locations. The first set of experiments will take place at the Faculty of NWI, where the participants from Nijmegen

will be brought to a room in the study landscape. The equipment will be placed in this room. The evaluation will take place in the canteen afterwards.

The second set of experiments will take place in the public living room of the residential elderly home in Zwolle. All participants will be asked to come to this living room, where the equipment will be placed and the questionnaires will be taken.

The equipment consists of a laptop on which the experimental software is running, a mouse for navigation so that the trackpad need not be used, and a camera for data registration. Present in the room at the time of an experiment will be the cameraman, the participant and the experimenter.

4.2.3 Evaluation methods

Variables

There are several variables that will be measured in the experiments. All answer categories are organized such that the negative answers will correspond to the lowest scores.

- Total time to task completion
In milliseconds from start of task to end of task, done by software.
- Usability
For each usability criterium mentioned in chapter 3 (easy-to-use, easy-to-learn, efficient, fun-to-use) the following categorial organization will apply:
 - *very bad (score 1)*
 - *bad (score 2)*
 - *neutral (score 3)*
 - *good (score 4)*
 - *very good (score 5)*

The results come from participant evaluation.

- Appreciation of interface
This takes into consideration the layout, structure and look of the interface. The participants will be asked to rate the interface on a scale of 1 - 10. The ratings will be mapped to the following answer categories: {very bad (1), bad (2), neutral (3), good (4), very good (5)}. Rating {1,2} will be mapped to {very bad} up to rating {9, 10} being mapped to {very good}.

Observations and interviews

Apart from measuring variables, one of the best ways to evaluate an elderly user group is to perform real-time observations and interview them after they have

completed the experiment.

The observation will be formally unstructured, because I have defined the variables I want to measure and will describe the points of attention to focus on during the observation. Moreover, I will ask them to follow a think-aloud protocol by voicing their thoughts while completing the tasks, to find out more about their way of thinking and possibly reactions to the interface. This will be subjective information, but very valuable when it comes to evaluating usability.

Points of attention

1. How do the participants initially react when presented with the interface?
{*stressful reaction (1), no visible reaction (2), relaxed reaction (3)*}
2. What behaviour do they show while completing the tasks?
{*negative affect (1), no affect (2), positive affect (3)*}
3. Are there specific, continuously recurring problems to be observed?
Open answer, depends on participants.
4. How do reactions vary between participants, taking their backgrounds into consideration? *Open answer, depends on participants.*
5. How do they handle mouse and keyboard? {*with difficulty (1), with a little difficulty (2), with ease (3)*}
6. How well are they able to understand the supposed intuitiveness presented by the interface? {*don't understand it (1), understand after being told (2), understand by themselves (3)*}.

After all experiments have been completed, the participants will be asked to conduct a short interview, to give their opinions about the experimental situations and evaluate the underlying ideas. They will also be asked about their backgrounds, so it can be considered during data analysis.

The interviews will be largely non-directive and open. I will ask certain questions about the tasks, but the interview will be guided by the participant's input.

Interview questions

1. What are your educational background and work experience?
2. Did you have trouble completing the tasks?
3. During the navigation experiment, can you describe which situation you preferred and why?
4. Do you find deep hierarchies in menu structures a problem?
5. If you find keyboard navigation easier, are you willing to learn a few basic keyboard combinations to facilitate navigation?

6. For the instructive interface experiment, did you find the presented instructions helpful for completing the task?
7. Do you think instructions will help you learn work with a computer or do you think they will mask the true structure of the computer's functioning?
8. Did you mind doing the tasks?

Note: The last question has specifically been formulated that way, because when asking participants whether they liked doing a task, or even working with computers in general, they are unable to formulate a clear answer. Computer tasks and liking do not match from their point of view.

Getting a no-response on the last question indicates that the tasks did not induce a stressful reaction, which satisfies the positive affect issue.

4.2.4 The experimentation platforms

I have learned that the most pressing problems occur with mouse navigation and performing seemingly complex tasks. My first priority is to develop test platforms that can test my hypotheses on these two problem areas.

However, there are also problems with readability and representation of choices in the interface. Therefore I also describe platforms to test my hypotheses on those problems, but they will only be implemented if time allows.

Enhancing usability of menu navigation

Hypothesis:

Menu navigation for elderly people is currently a difficult task. Submenus often disappear before the elderly have even reached them. I expect this task to become easier for them if the way menu navigation currently happens is slightly altered.

The main problem for them is navigating in a horizontal direction, so that particular operation has to be minimized.

I suggest a menu in which the desired item can be selected by navigating towards it in the vertical direction, and then selecting it by clicking it once. This results in the appearance of a submenu, which stays there until a menu-item on the submenu is selected, or a random spot beside the submenu is clicked.

For people who have trouble clicking the mouse, the *response time* of the submenu can be increased. Response time can be defined as the time it takes for the system to react to a certain input.

The consequence of this is that the submenu will stay visible for a longer period of time, independent of where the cursor moves when navigating to the submenu.

The only trouble I foresee is that when an incorrect menu is indeed selected, waiting for it to disappear will take a long time. Whether this will pose a problem will have to be determined from the experiment.

I expect this to make menu navigation easier because it is not necessary to

navigate in a strictly horizontal line across the menu. The desired item can be selected using as much time as the elder may need.

Many elderly complain when using a mouse, but none of them complain about the use of the keyboard. Therefore I also want to test whether navigating a menu using a keyboard is perceived as being easier, or whether they find it harder because they have to remember which key to press to make the menu appear.

Set-up:

A small Java experimentation platform will be used for this experiment.

A distinction can be made between the following four experimental situations:

1. Clickable menu navigation, using mouse for navigation
2. Increased response time, using mouse for navigation
3. Standard menu navigation, using keyboard for navigation
4. Standard menu navigation, using mouse for navigation

The first three are hypothetical situations which have to be tested and evaluated. Response time in the second situation is increased to 1000 ms. The fourth situation is the normal, current situation, which also has to be performed in order to check whether the hypothetical situations really lead to improvements in usability.

The task:

Participants will be asked to select several menu-items using each of the above mentioned methods of navigation. Participants will be asked to perform this task four times, with a different hierarchical depth each time. Each method of navigation will be used, they will be presented in a random order, resulting in a total number of 16 trials.

This is necessary to minimize the possible influences of learning effects on variable measurements. These effects can occur between first and further attempts, and between different methods of navigation. Learning effects might lead to an incorrect interpretation of the data, because participants may already be familiar with a certain method of navigation, and therefore may be slightly more adept at it.

The results from the trials will be compared, both for the same method as for the different methods.

From this the conclusion will have to be drawn whether the modified methods of navigation provide improved usability.

Experiment walkthrough

This set of screenshots shows an impression of the experiment for standard

mouse navigation. The tasks and settings are the same for all situations, only the instructions differ slightly where input modalities are indicated. The complete source code can be found in Appendix C.

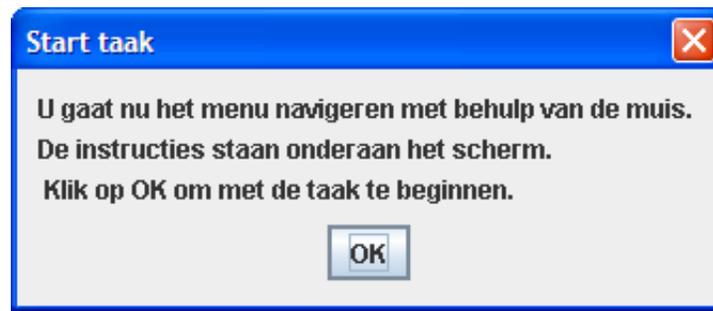


Figure 4.1: Initial instruction screen for standard mouse navigation

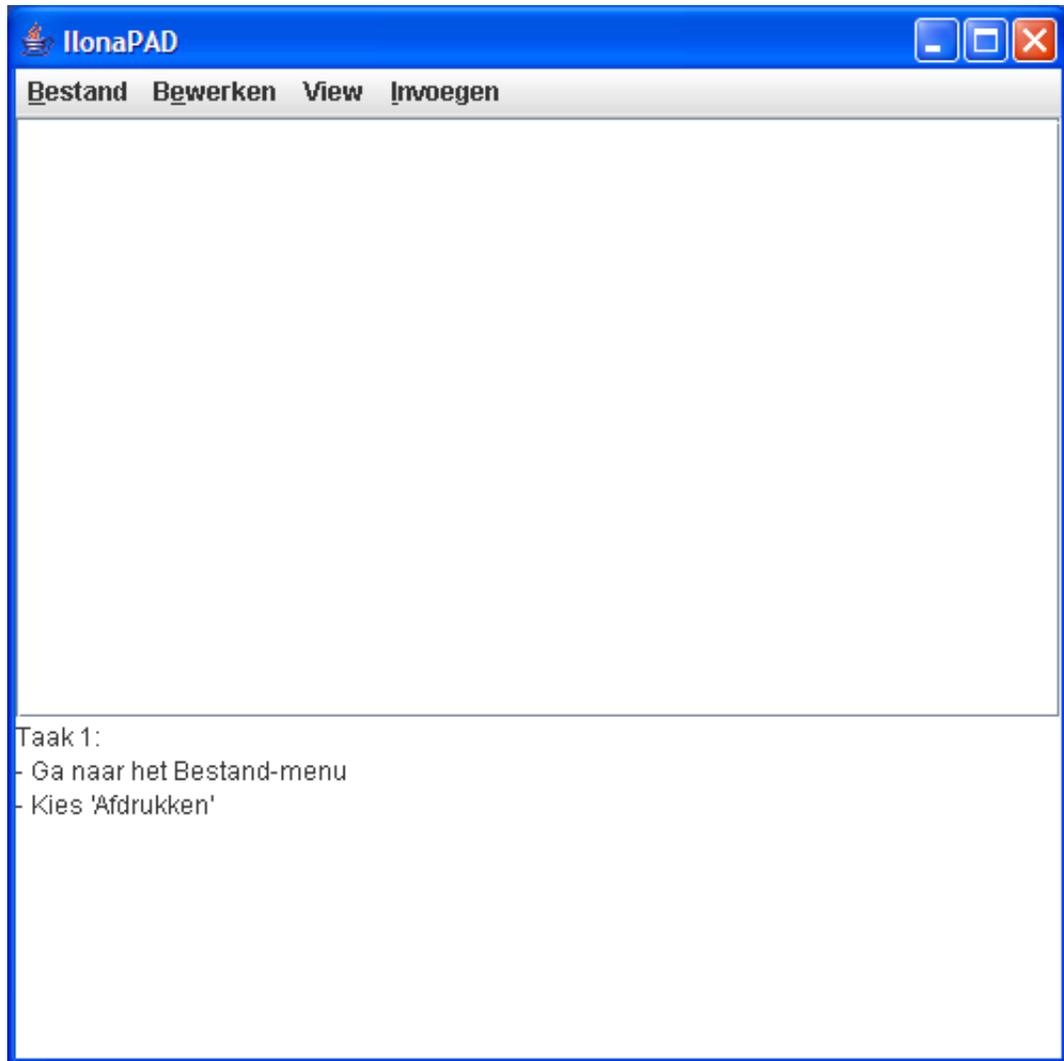


Figure 4.2: Instruction for first task with level 1 hierarchy depth

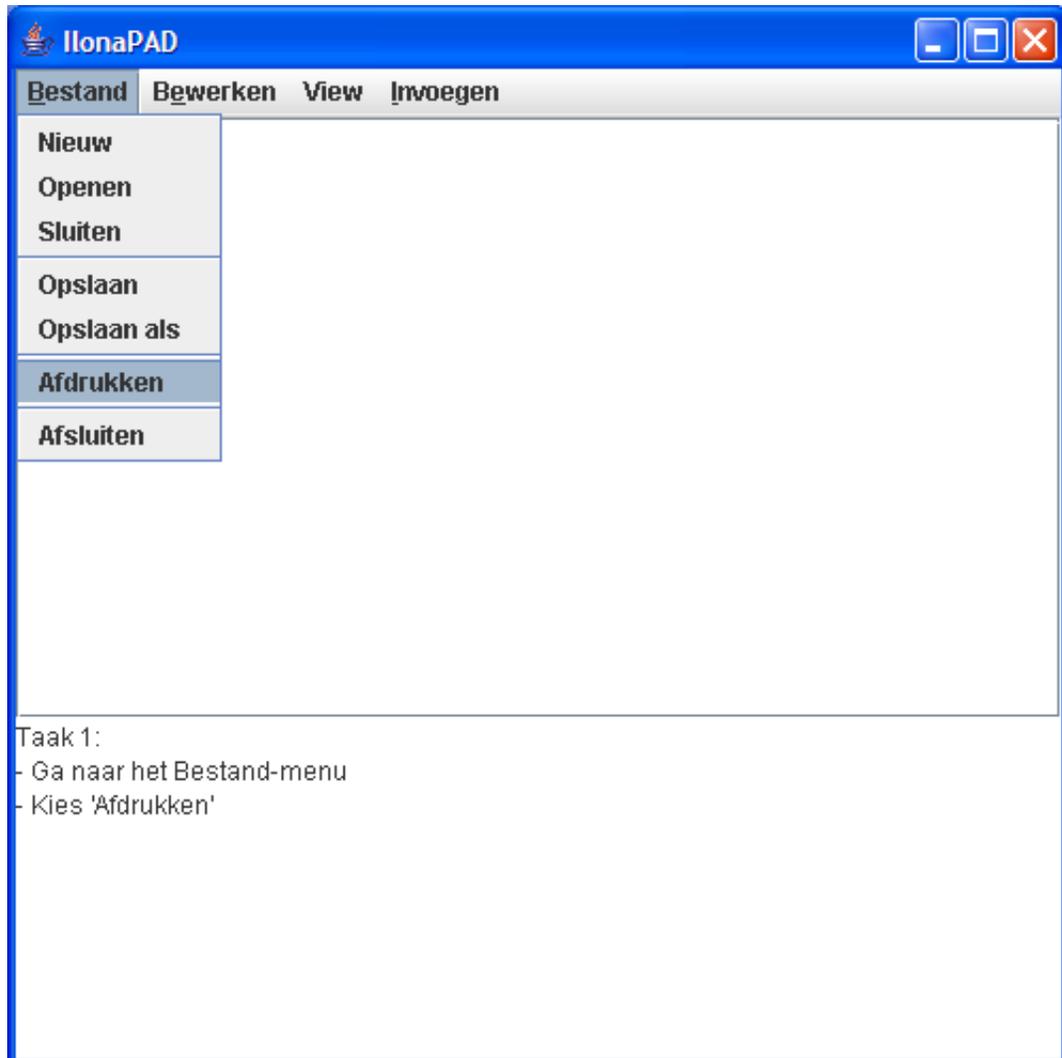


Figure 4.3: Performance of first task

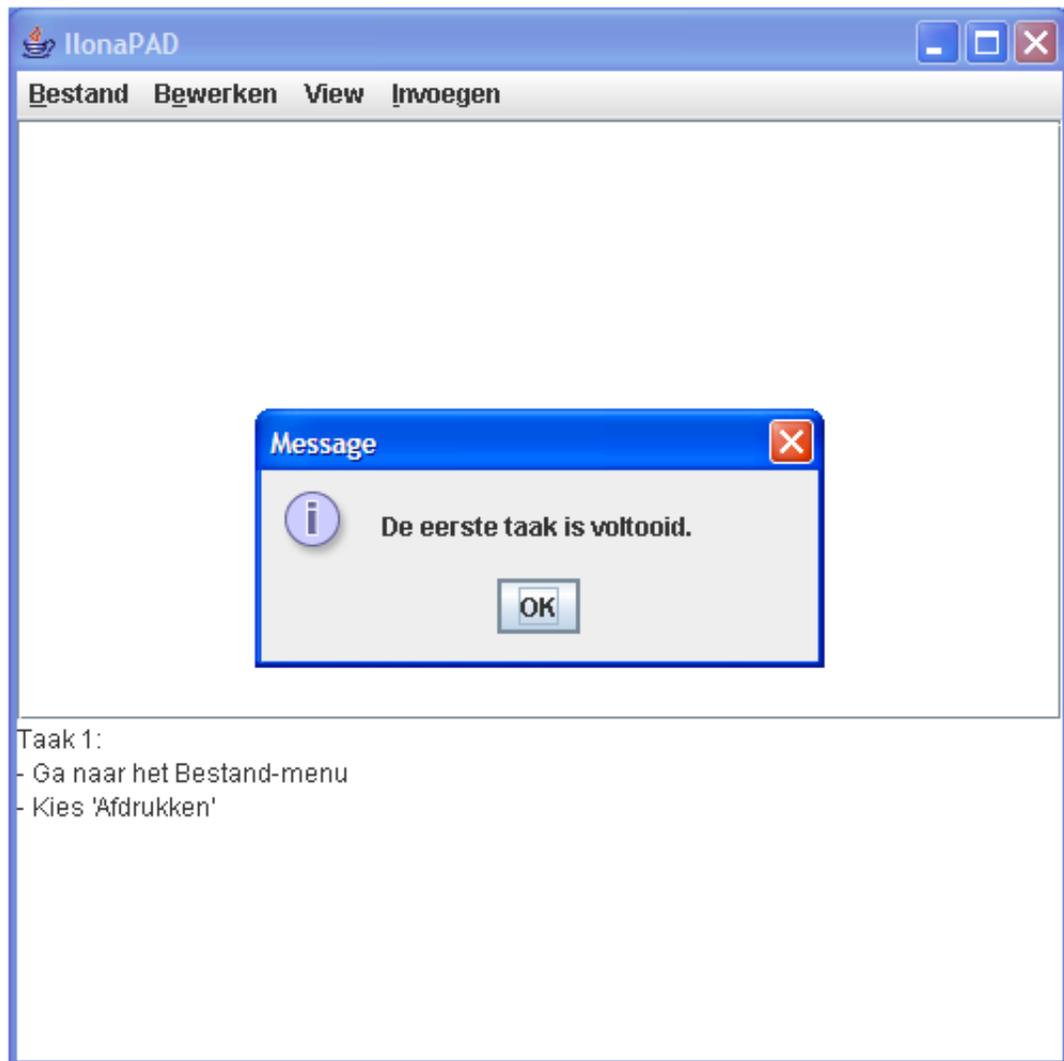


Figure 4.4: Completion of first task

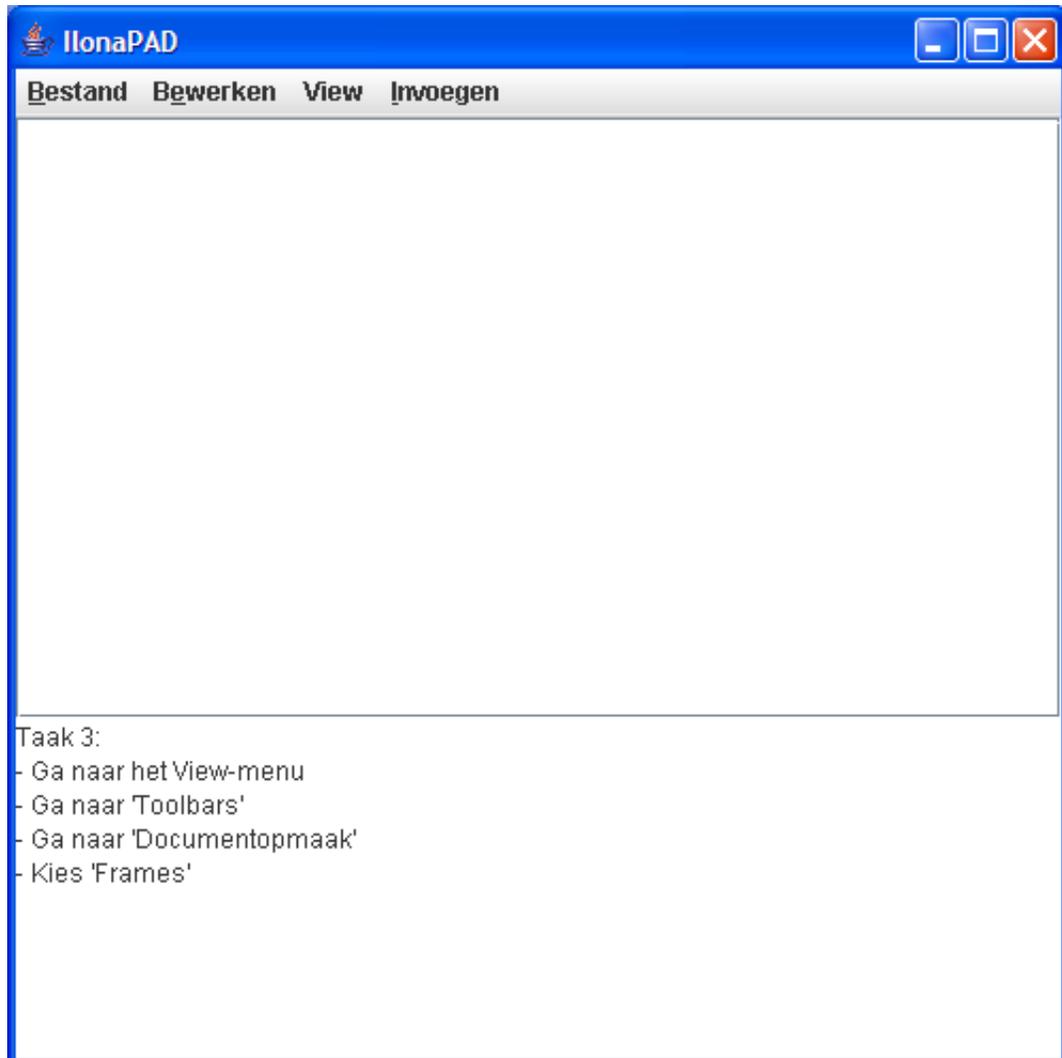


Figure 4.5: Instruction for third task with level 3 hierarchy depth

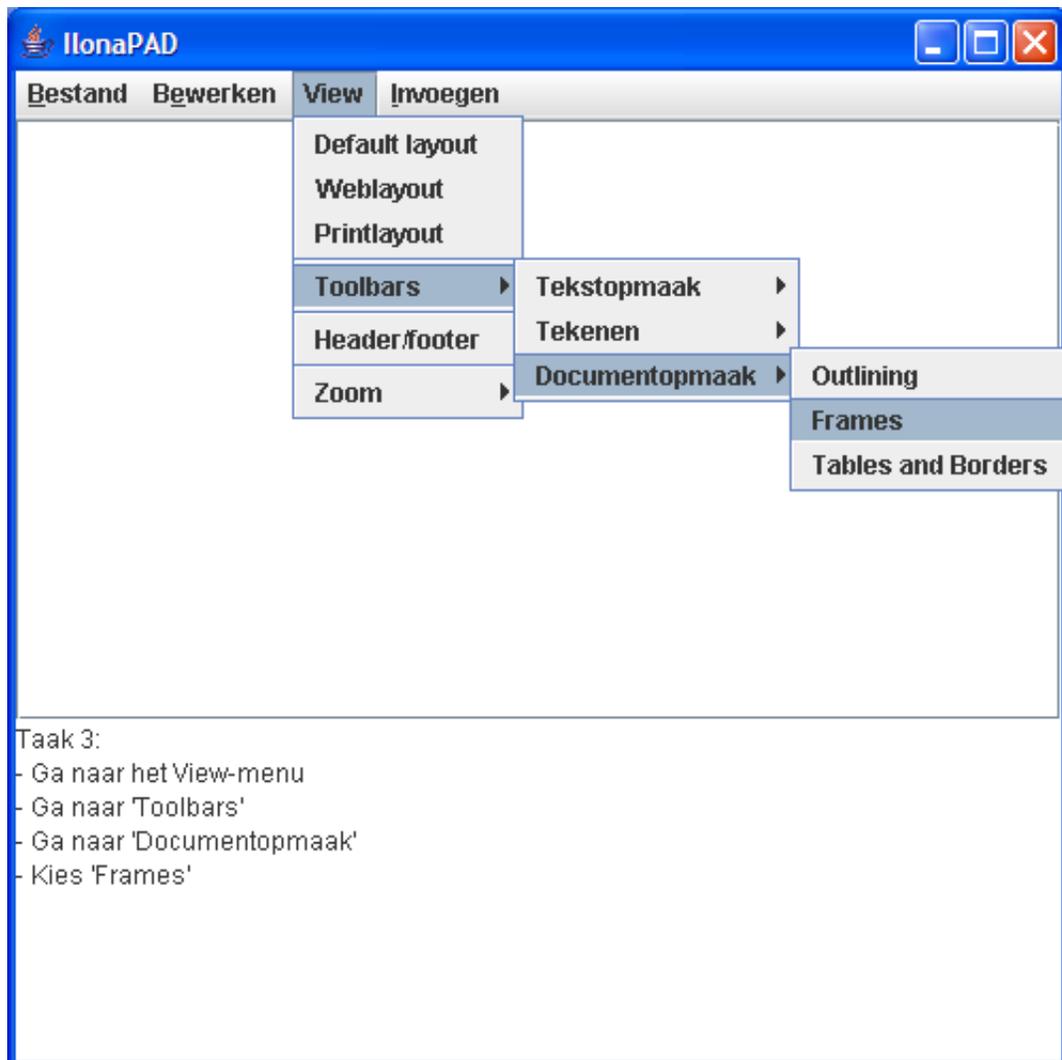


Figure 4.6: Performance of third task

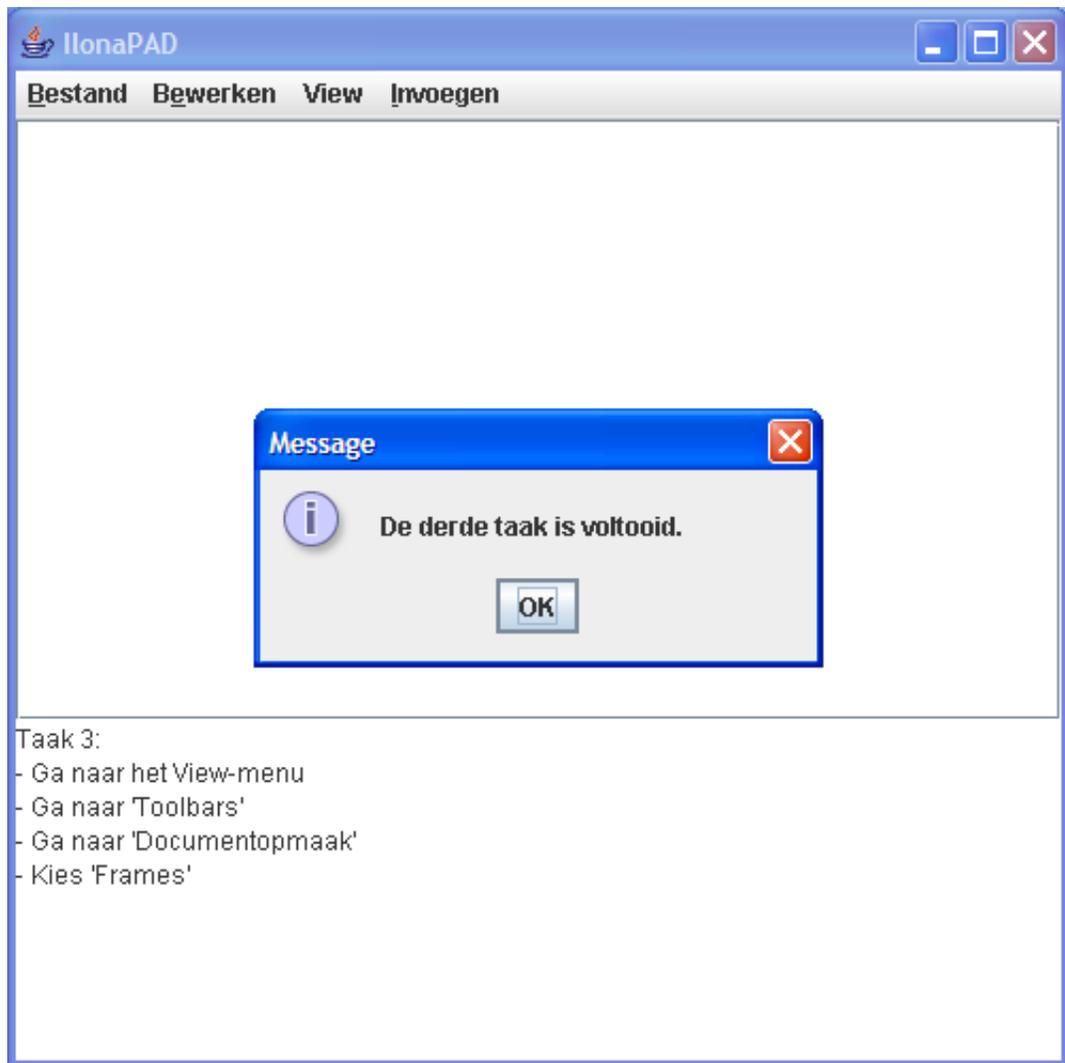


Figure 4.7: Completion of third task

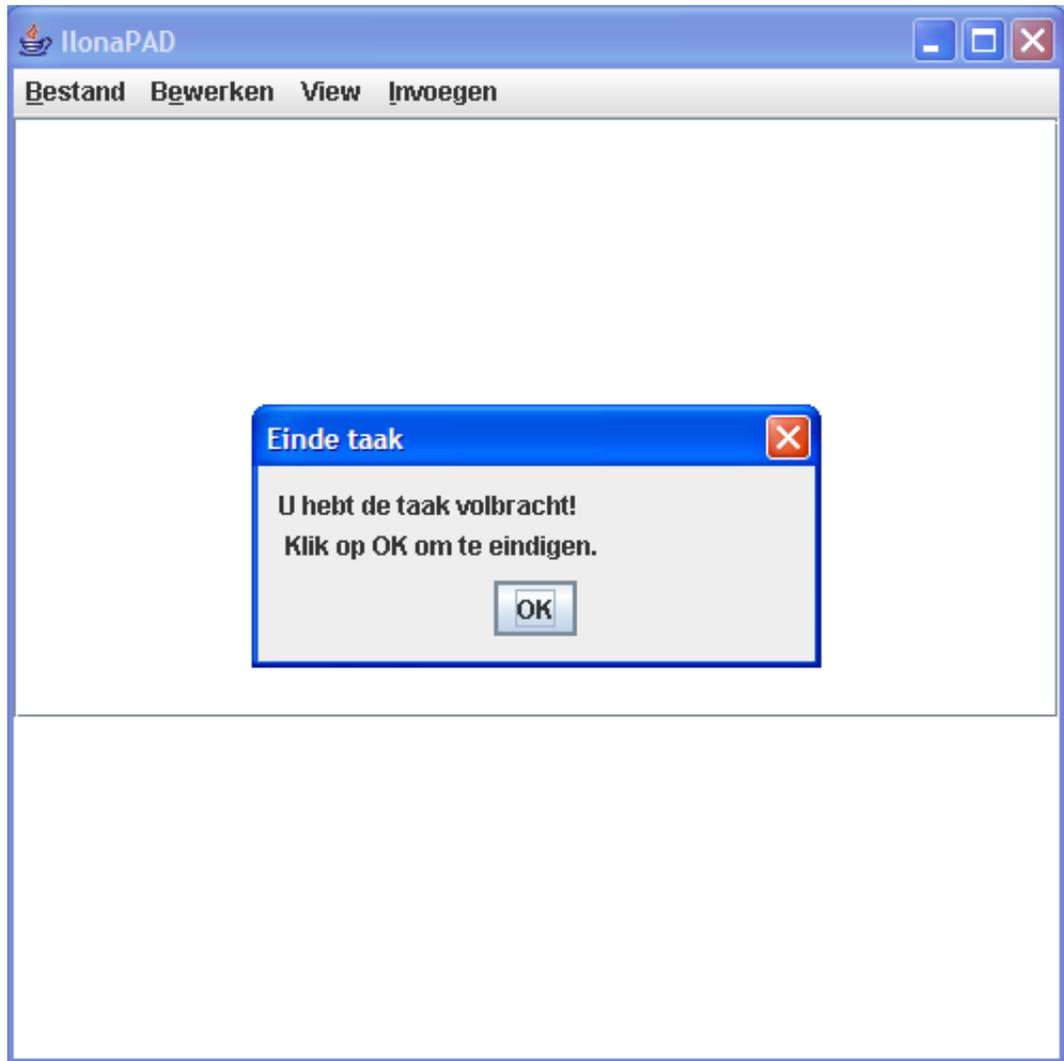


Figure 4.8: Completion of experiment

Directive instructions vs. Open dialogue

Hypothesis:

When elderly are confronted with an open dialogue in a situation such as when having to save a document, they have to perform several operations in a single screen. Firstly, they have to specify the location where they want their file to be saved, then they have to provide a name for their file and finally have to click the 'Save' button to complete the process.

From my interviews I have concluded that elderly have problems thinking of all those operations at a given moment. They have great difficulty remembering the sequence of operations that have to be performed, resulting in panicky and confused user behaviour. This usually means they end up forgetting to specify a location, and consequently can no longer retrieve their files. Moreover, their hard drives will become a great mess with files stored in all sorts of directories without any structure behind it.

However, my interviewees mentioned that they do see that there is a logical structure behind the operating system, the trouble is that they have difficulty learning to understand it. I suspect that a directive interface, in which a screen is displayed containing instructions only for a single step in the operation, can help them understand this structure. This way they will easily be able to complete every single instruction, without the possibility of making errors. Eliminating this factor may decrease some of the extraneous cognitive load caused by the fear of making errors and crashing the computer that most elderly experience. The only type of errors they can make is, for instance, entering an incorrect location to store a file. But this is a problem that will always remain. After all, they can also make the mistake of putting a letter in a wrong desk drawer.

Set-up:

A Java-based platform will be used for this experiment, in which the participants will be asked to perform certain operations both with the use of a directive interface and the use of an open dialogue.

The operation will be new to the participants: simulating the burning of a cd.

The task:

Participants will be presented with a task they have probably not done before. They will be asked to burn a cd.

This task is complex for them, which will provide ultimate proof whether the directive interface works better than the open dialogue. First of all, they will have to specify their task. Then, they have to select a set of songs they want on their cd. To complete the task, they have to give the command to start burning the cd. This task will have to be performed firstly with the open dialogue, and afterwards guided by the directive interface.

The reason that the open dialogue situation is presented before the directive interface situation in all tasks is that this prevents them from learning about the structure of the task through the directive interface. This most closely simulates a real-life situation, where they will be presented with the open dialogue

at a first attempt as well.

Experiment walkthrough

This set of screenshots shows an impression of the directive/open interface experiment.

The complete source code can be found in Appendix C.

Open interface



Figure 4.9: Initial instruction screen for open interface

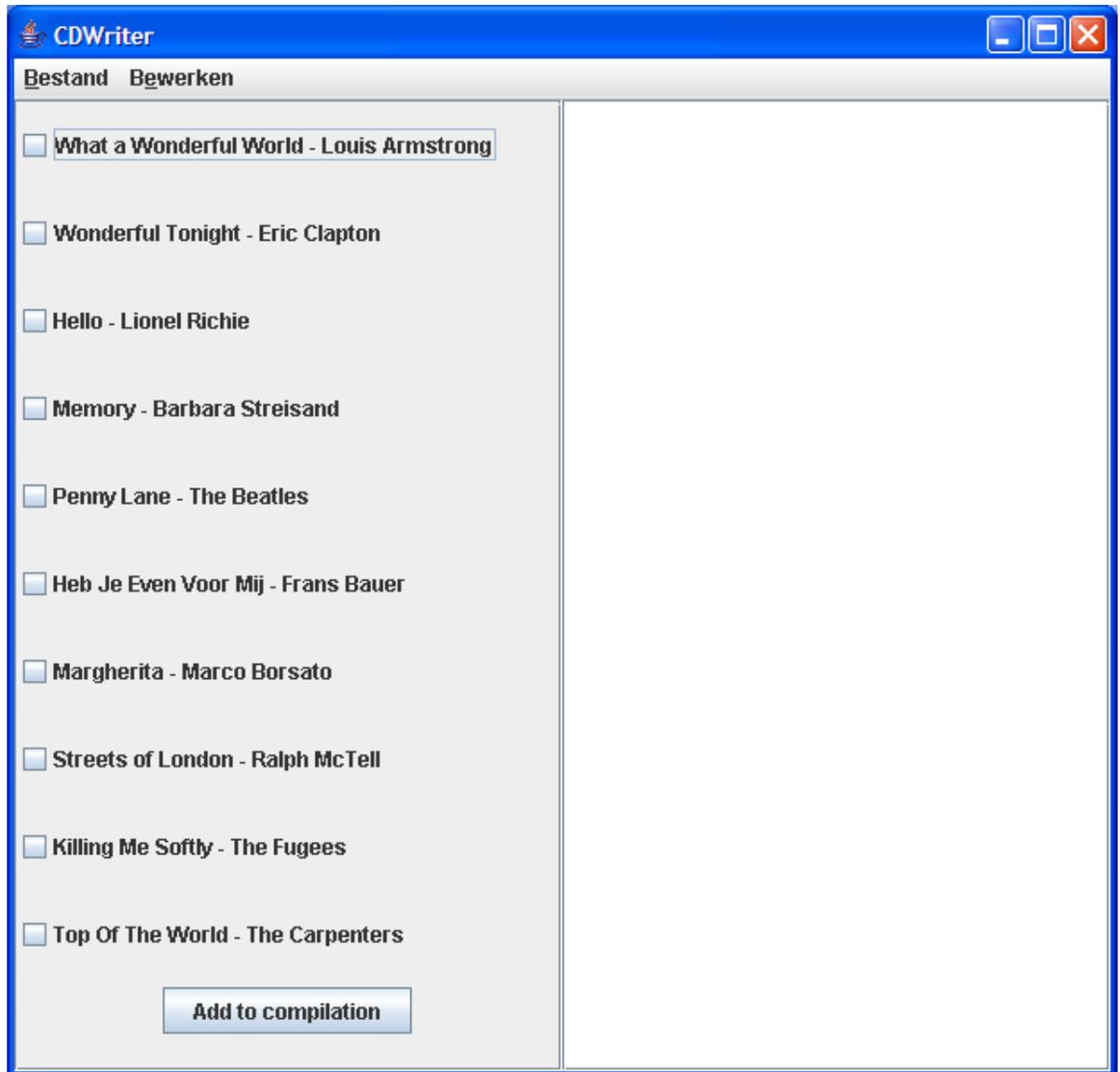


Figure 4.10: Open interface workbench

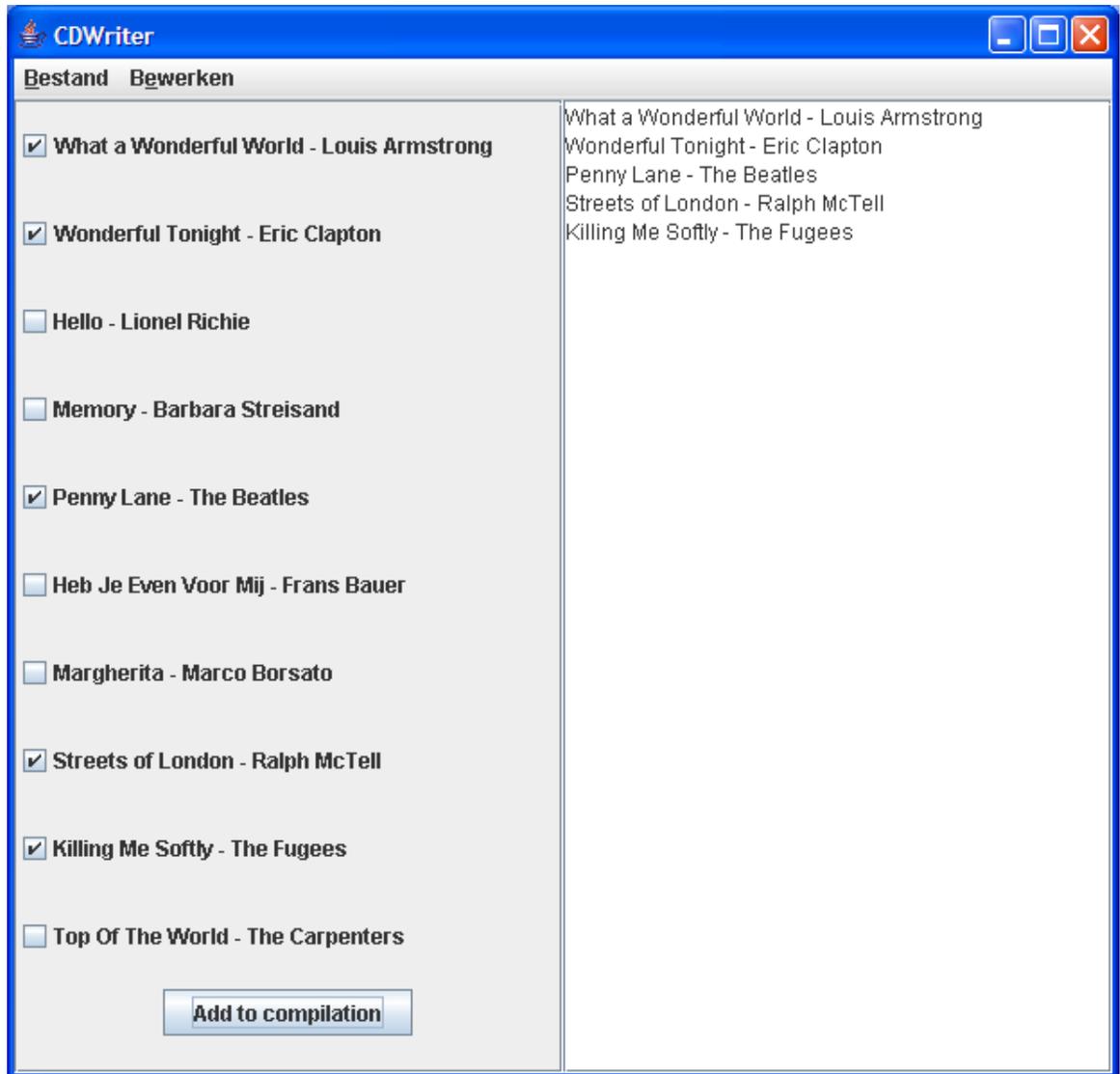


Figure 4.11: Workbench after song selection has been made and 'Add to compilation' has been clicked

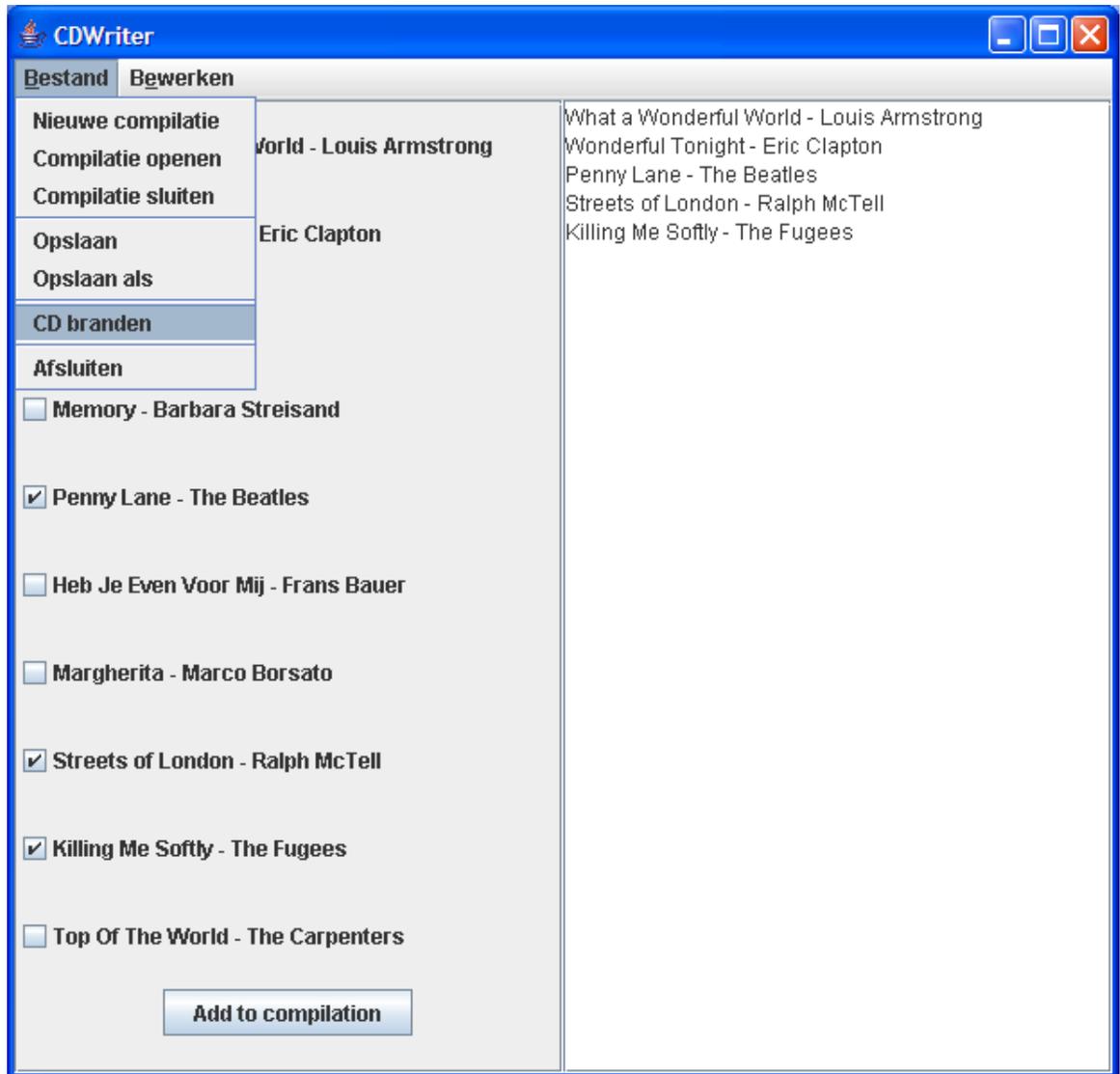


Figure 4.12: Giving the 'Burn cd' command

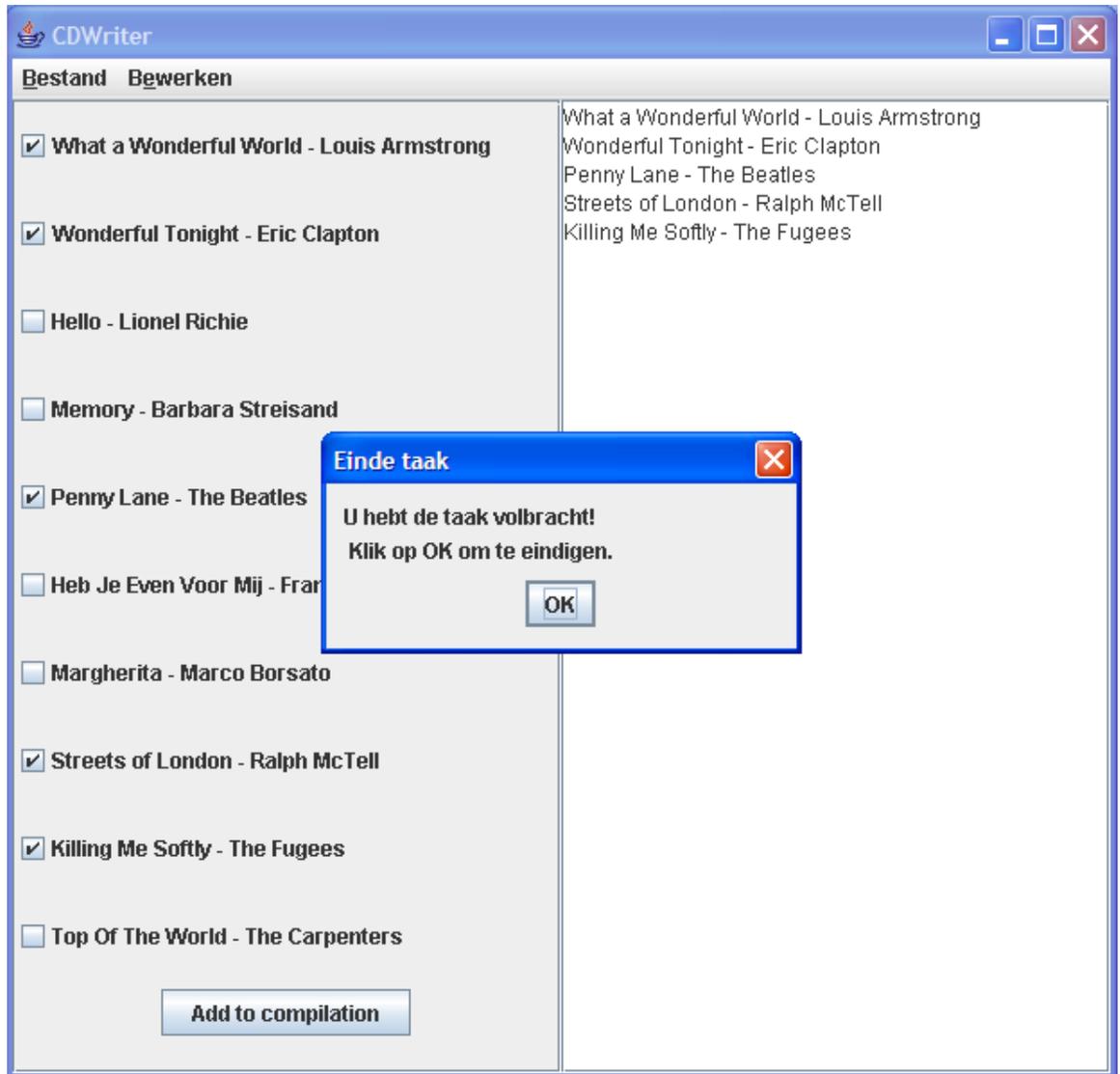


Figure 4.13: Completion of experiment

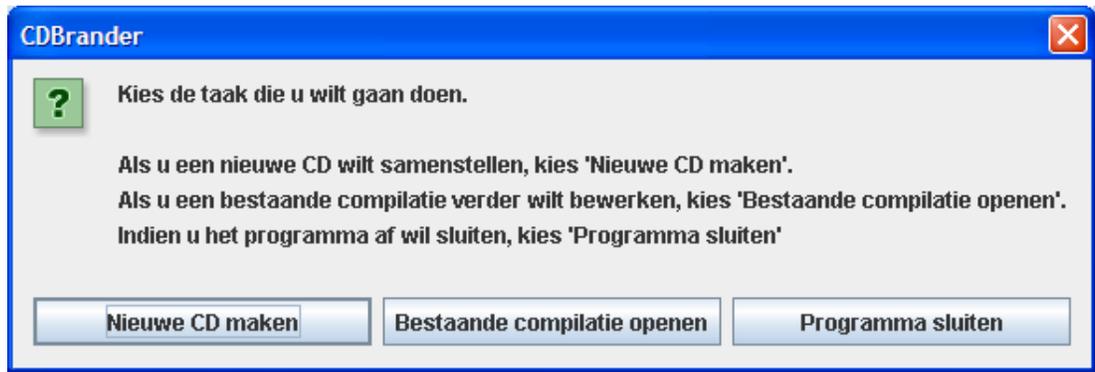
Directive interface

Figure 4.14: Initial instruction screen for directive interface

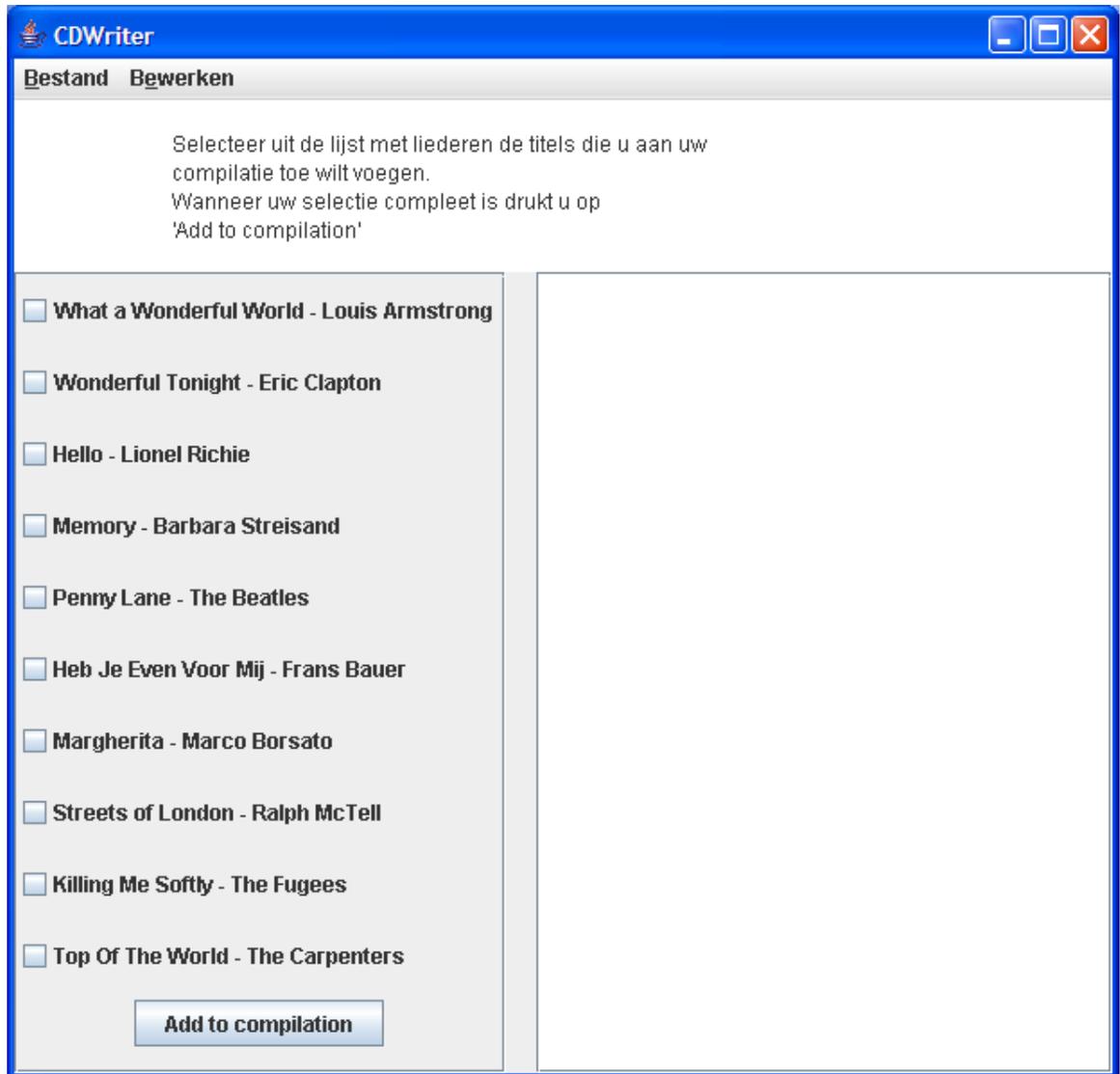


Figure 4.15: Workbench with instructions for directive interface

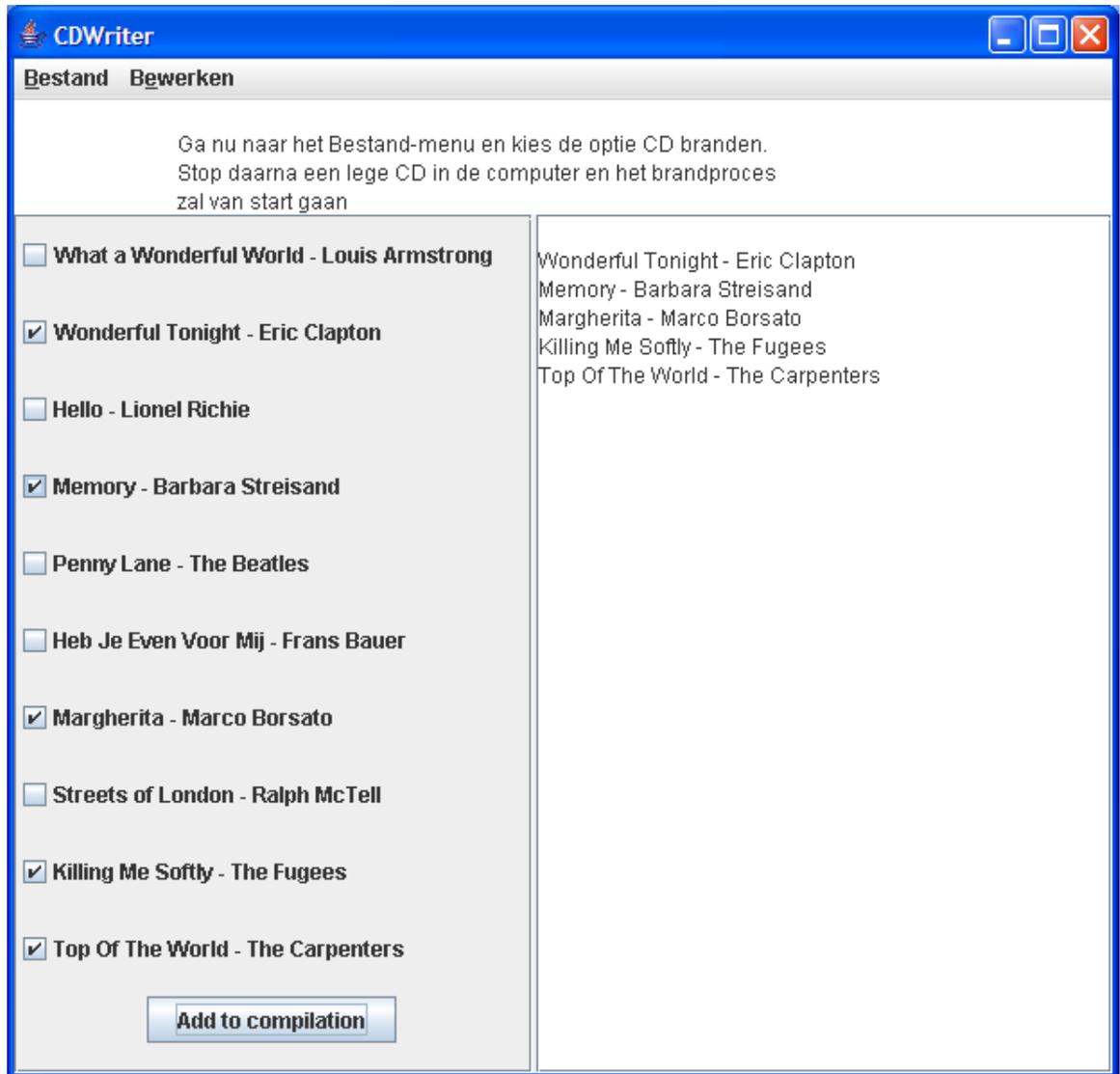


Figure 4.16: Workbench after song selection has been made and 'Add to compilation' has been clicked

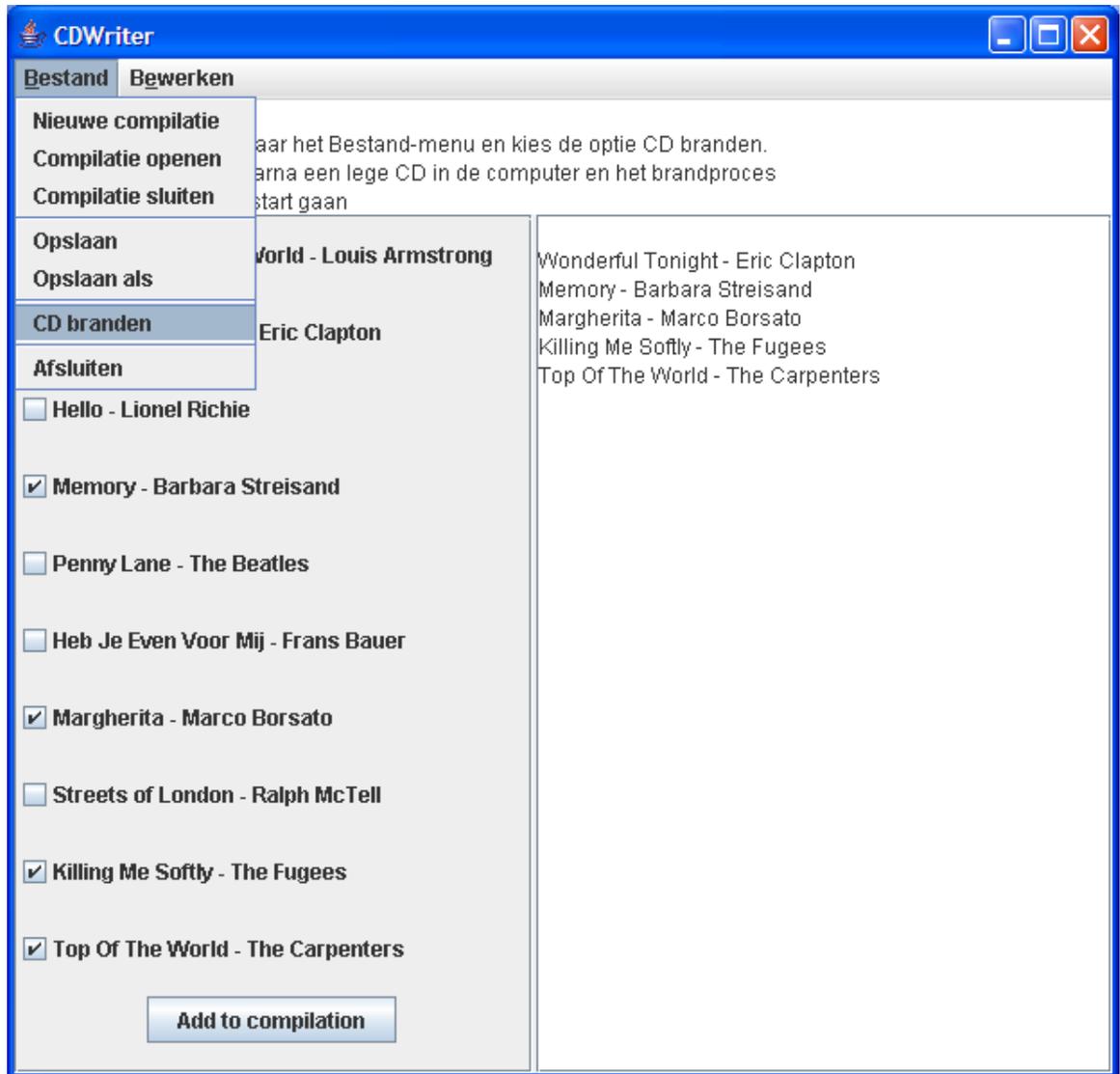


Figure 4.17: Giving the 'Burn cd' command

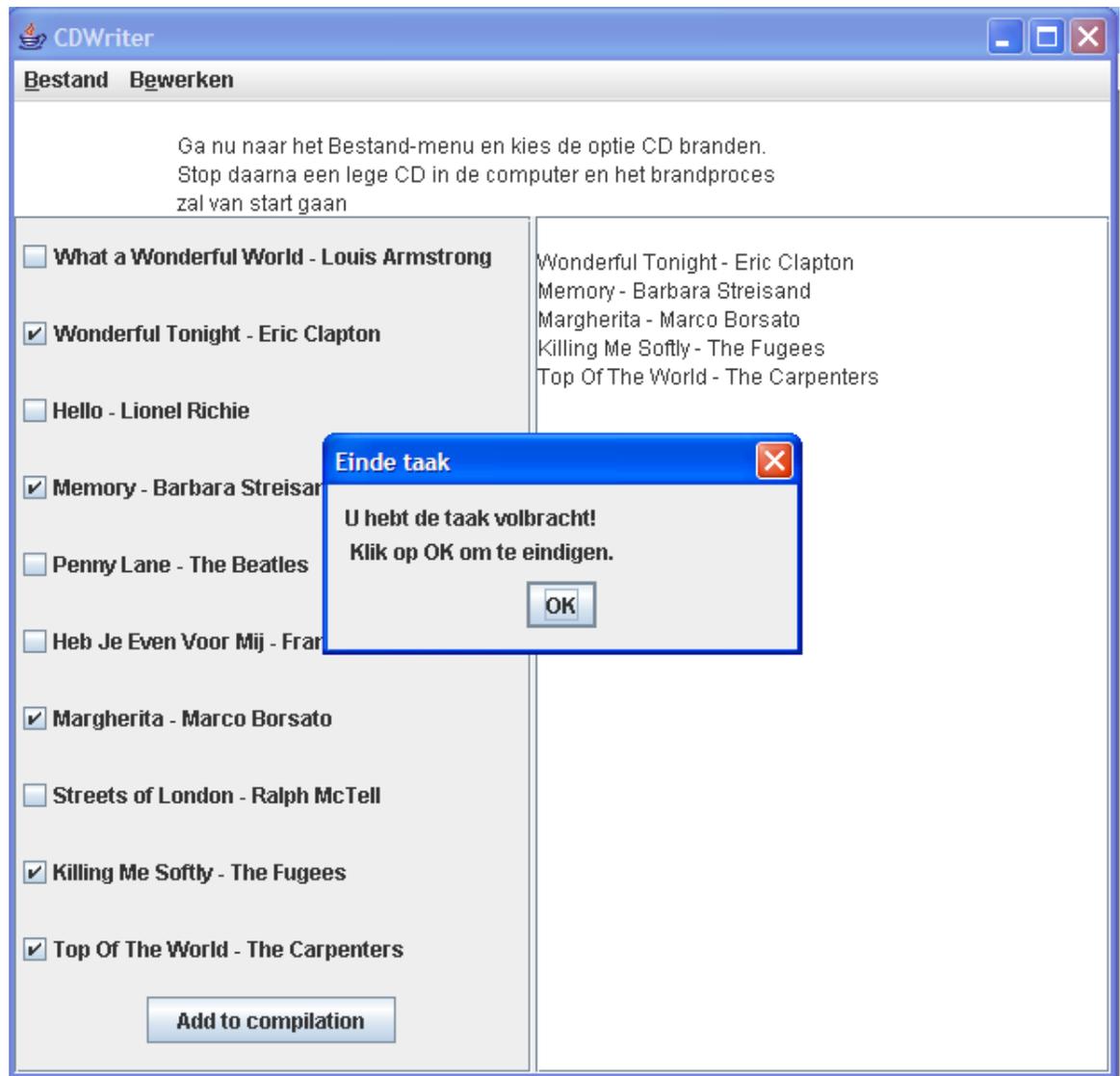


Figure 4.18: Completion of experiment

Representation of menu-items

Hypothesis:

Elderly people do not like being overwhelmed by too many menu options to choose from. An excessive number of choices only leads to increased extraneous cognitive load and distracts the elders from the task they are trying to accomplish.

I expect to diminish the extraneous cognitive load by displaying only those icons the elders themselves consider necessary for their daily computer tasks. By having only a selected subset of options to choose from, menus will become smaller, resulting in easier, faster and more accurate navigation.

This can be accomplished by creating a highly flexible, configurable interface in which parameters such as which menu-items to display can be set the moment the computer is set up (or edited when desired).

It will be too much to ask the elderly to configure their own interface. Therefore configuring will have to be done by a more knowledgeable assistant. Configuring, however, will have to be such an easy task that even healthcare workers could help with this task.

This experiment provides an ideal setting for testing elderly users' short term memory capabilities. Menus with a different number of items, adhering to the Rule of Seven, can be given and evaluated.

Set-up:

A Java-based experimentation platform, using standard mouse navigation techniques, will be used. Two situations can be distinguished in this experiment:

1. Menus containing only those options necessary for task completion, ranging from 7 items to 4 items
2. Menus containing all current options

The first situation is the hypothetically ideal situation, the second is the current standard situation. The limit of 4 has been chosen because it will be hard to present all useful options in less than 4 items. A comparison will have to be made which of the two situation results in best performance.

The task:

The participants will be opening a certain program through the menu. They will be presented with a standard operating system interface, from which they can open the menu to start the task. The task ends as soon as the correct option has been selected.

There will be ten trials per participant: eight using the menu containing only the subset of items with each amount of items, two with the complete menu.

The choice for two trials per situation is to check whether both trial results are alike and thus to ensure that there are no coincidental factors at work.

Afterwards the participants will be asked which number of menu-items they found most workable.

Increasing readability and learnability

Hypothesis:

During my observations I have seen the course participants staring intently at the computer screen, and even setting the font size to 20 when working with Wordpad, in order to increase readability.

The standard option currently is to employ the magnifying glass. However, this is displayed in a small window on top of the screen, and constantly moves as the mouse cursor moves. Since the elderly already experience problems keeping the mouse steady, this magnifying glass completely ruins the overview of the interface that is so vital to them.

The other problem is that elderly often spent several seconds searching for the desired desktop icon they want to select. Font size may have a role in this, but the large number of formal-looking available icons may be a bigger problem.

My hypothesis is that elderly will be better off with an interface that has the magnifying glass 'built in'. Menu-items and desktop icons will be displayed in a larger font size. The problem that might come up in this situation is that the menu-items might not fit into the standard menu anymore. However, this can be solved by displaying only the most desired functionality in the menu. Larger fields for the menu-items may also result in easier mouse navigation.

Besides that, I expect that desktop icon selection will be easier if icons are more distinguishable from each other. Therefore I will employ the use of cartoon icons for this. In a cartoon, the cartoonist has often given some thought to the problem of how to capture the essence of the object in the cartoon. This means the elderly will not have to do this thinking for themselves anymore, which may result in a further decrease in cognitive load.

Set-up:

A Java-based platform will be used for this experiment, in which participants will be asked to work with a desktop and menu using normal font size, and a desktop and menu using increased font size.

Then they will be asked which situation has their preference.

The task:

The first task will consist of navigating a menu using standard mouse navigation, only with the increased font size interface (this is because the other relevant situation has already been tested during the *Enhancing navigation* experiment). Participants will be asked to select five menu-items.

Each trial starts as soon as the menu is opened, and ends as soon as the correct item has been selected.

For the second task they will be asked to visit five desktop locations using the standard Windows desktop icons, and the cartoon-based, increased font size desktop icons.

Each trial will consist of one single visit, and results will be measured for each individual trial. Because an initiating action is lacking in this task, the task will be started by presenting a dialogue saying: "Press OK to start the task". As

soon as this is confirmed, the task starts.

***Note:** Due to time constraints I have not been able to implement and conduct the last two experiments.*

Neither have I been able to implement the clickable menu navigation situation. This was due to a lack in programming skills. I asked several Java experts for help, but not even then did we manage to implement the desired situation.

Chapter 5

Results

In this chapter I will describe my experimental results, firstly from the observations and the interviews, and finally the results from the measurements will be analyzed.

The graphs I refer to in my quantitative analysis are included in this chapter. The exact numerical results, as well as the transcriptions of the interviews, can be found in appendix D.

A photographic impression of the experiments is also given in appendix D.

5.1 Qualitative analysis

5.1.1 Observation results

The first thing that became clear during the experiments was the importance of proper guidance. Even though the comments the participants made while performing the experiments showed that they had a general idea of how to follow the instructions, many remarks took the form of "Do I have to do ... now?". Even though they instinctively know what to do, they need constant confirmation that they are doing the right thing.

The questioning format shows a general trend of insecurity among elderly people when being confronted with new situations, and having proper assistance is a first step in the right direction of learning to handle this new situation.

The participants all shared an initial fear of not being skilled enough to do the experiments. They mentioned that they weren't sure if they could do it, and were afraid of messing up the results.

This attitude induced a slight reluctance to participate in some participants, but they all allowed themselves to be convinced otherwise.

After all experiments were completed, not one of them said they disliked doing them, and many even said it had been fun. They also mentioned that computers would probably not be as hard as they seem once some experience is gained.

However, there seems to be some sort of natural intuition involved as well that has little to do with age.

The eldest participant, who had no previous computer experience, showed a rather sharp understanding of the way the interface worked and did not ask that much help. She intuitively found her way around the different menu's, and often successfully predicted what her next task would be. She said that it was due to good assistance that she was doing well, but me sitting beside her had more of a symbolic, mental support function than physically helping her complete the tasks.

This in contrast to a younger participant with no experience, who required considerably more help to complete tasks.

Time efficiency is the least important usability criterium for elderly people. In their think-aloud remarks, all participants expressed that they found it most desirable that the application was easy-to-use and easy-to-learn.

They were mostly able to complete the tasks on their own, with the guidance of the instructions provided in the interface. Their faces showed positive expressions when a task was completed, and satisfaction when they had successfully completed an experiment. They mentioned that the experimental platforms had a clear structure, and during the open interface experiment the more experienced participants were largely able to predict in advance which actions they had to take in order to 'burn the cd'.

Participants showed most positive reactions when completing a task did not require too much trouble. They were more motivated for the next task after a successful completion of the former task as well.

When the task took too long to complete, or required lots of effort, they started showing frustrations. The most common reason the tasks failed were because the menu's had disappeared before the subitems could be clicked, due to unsteady mouse navigation. Therefore the task had to be done over again, which eventually became a long process.

Another effect which was rather surprising was the fact that every single participant thought that it was necessary to click on a menu subitem to make it appear. They didn't specifically mention this in their think-aloud remarks, but during each trial involving mouse navigation the menu subitems were consistently clicked.

This suggest that clickable mouse navigation is an intuitive way of working for the elderly. This is completely in line with their distaste for submenu's which disappear almost immediately when the cursor moves away from it. Making a menu appear by clicking on a subitem, and making it disappear by either clicking on the desired subitem or clicking somewhere beside the menu allows them more control over the navigation. It gives them time to consider the offered submenu items, without having to worry about the submenu disappearing should the mouse cursor accidently move of it.

Since physical and motor capabilities decline with age, all participants showed (strongly) reduced hand coordination and steadiness. Moreover, they also showed

irritated reactions when the submenu's disappeared before they were able to click the desired submenu item.

A side effect which I had not specifically intended to test was that some participants made a remark about how they liked the readability of the task platforms. This side effect occurred because the resolution on the test laptop had not been configured properly, thereby resulting in bigger letters.

This suggests that it might be worthwhile to increase font size when designing for the elderly.

5.1.2 Interview results

All participants mentioned they were happy with the instructions, and that it helped them complete the experiments more easily. The tasks were not perceived as very hard to do, and they were even found to be fun.

The participants who feared doing them most were the ones with the least experience. They were also the ones who were most pleasantly surprised by the relative ease of the computer work.

Most participants liked the mouse best for navigation, there was only one who preferred the keyboard. Her argument was that the keyboard provided more control over the navigation mechanism, and that it prevented the menu's from flying in all directions. She also said that she'd be prepared to learn several key combinations, arguing that it would eventually become automatism as long as it is done often enough.

This was exactly the answer I had expected to hear when designing the keyboard navigation experiment.

The other participants argued that it would be too difficult to remember the key combinations and their related actions. This also turned out to be the only con-argument I had expected from the pro-mouse participants.

The participants who preferred the mouse said it was most intuitive to push the mouse into the direction they wanted the cursor to go. They didn't mind their unsteady navigation, saying it would improve if they would start practising with it.

For two of my participants the keyboard was not a good option due to medical conditions.

Of all five pro-mouse participants, there were only two who noticed a difference between the situation with increased response time and the standard situation. They were both participants who already had some prior experience with computers. Both of them also preferred the increased response time situation.

The problem I had foreseen of waiting too long for the menu to disappear again did not occur.

It seems logical that only the more experienced participants would notice a difference between both situations. They have worked with the standard situation more often and are therefore more adept at spotting the difference. When con-

fronted with a computer for the first time, there are too many other distracting factors, like how to operate the mouse, trying to find the instructions and the desired menu's, to notice any difference in response time. For more experienced participants, these distractions are not relevant since they are familiar with them already.

Therefore the two experienced participants are the only ones who can objectively say something about the increased response time situation. Since they both preferred it, arguing it provided a better overview if things did not appear and disappear so fast. The theory that elderly users will be better off when given more control over their way of navigation is again supported.

The completely inexperienced participants all considered navigating deeply into the menu hierarchy a problem. Their relatively poor navigation skills caused it to be a difficult task to reach deeply hidden menu's. Mostly the submenu's were gone before the desired item was reached, and the task had to be started over many times.

It may be worthwhile testing if this problem still exists if users are given more control over navigation, for instance through clickable menu navigation.

Inexperienced participants also most wholeheartedly admitted to be happy with instructions and said they would like directive interfaces for every computer task. The main argument was that it could never hurt to keep things as simple as possible.

The more experienced participants also seemed to get by with meaningful, descriptive names on buttons and menu's. However, this presents the problem that these names can get quite long for some actions. None of the participants, though, mentioned they minded doing some more reading if it would help them use the computer with greater ease.

5.2 Quantitative analysis

5.2.1 Time analysis

Menu Navigation

For P1, P2 and P6 standard navigation was presented before delayed navigation. For P3, P4 and P5, delayed navigation was presented before standard navigation.

For both P1 and P2 the standard situation took longer than the delayed situation. For all other participants, the delayed situation took the longest.

So for all participants except P6 the situation they were presented with first took the longest. These results show that in most cases a learning effect occurs, because, even though it would seem logical that the delayed situation takes longest, P1 and P2 have proven that it is possible to complete delayed naviga-

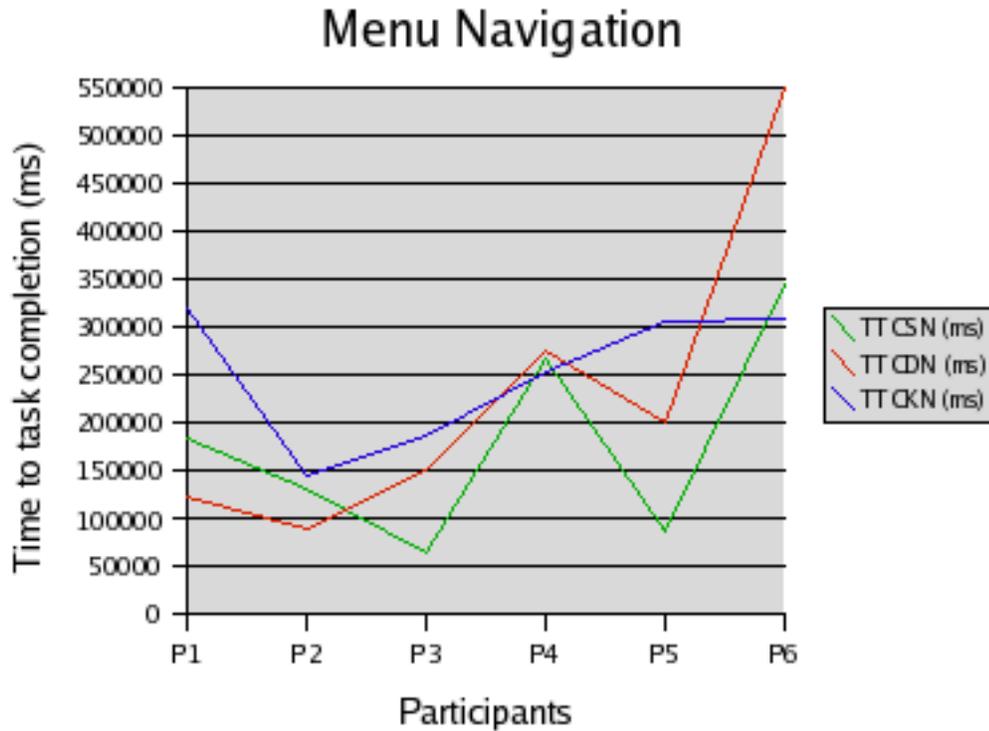


Figure 5.1: Time to task completion for menu navigation tasks

tion faster than standard navigation if you've already seen the task.

P6 is the exception in this case, who completed standard navigation faster than delayed navigation even though standard navigation was presented first. From the observations it turned out that she took the same to think as with standard navigation, only the response time for the menu's was longer.

The results clearly show that learning takes place in elderly people. It also shows that learning takes longer as age increases, because the graph shows that the youngest participants (P1, P2, P3, P5) have the greatest difference between their TTCs for both navigation situation. Their TTCs were also shorter than P4 and P6's TTCs.

Finally, for P6, the eldest participant, there is no clear learning effect visible in her results. This suggests that either she would have to complete the task several more times before a learning effect would be visible, or that she confirms the hypothesis that delayed navigation takes longer because it allows the user more time to think and navigate slowly.

However, the number of participants was too small to draw this conclusion for certain. Also, most participants mentioned they did not notice any difference between standard and delayed navigation.

This at most suggests that it is not worthwhile to increase response time in an adapted interface.

For P4, there is only a very small difference between the TTCs for standard and delayed navigation. The keyboard navigation TTC is also lower than the other two.

This supports the statement P4 made about preferring the keyboard as a navigation medium.

P6 also had the lowest TTC for keyboard navigation, but she found the mouse more intuitive. The lower TTC may have been due to the guiding instructions, which stated exactly which keys to press.

For all other participants, TTC for keyboard navigation was longer. They all mentioned they did not like keyboard navigation because it presented a cognitive load (of learning key combinations) which was far too high.

Open vs. Directive Interface

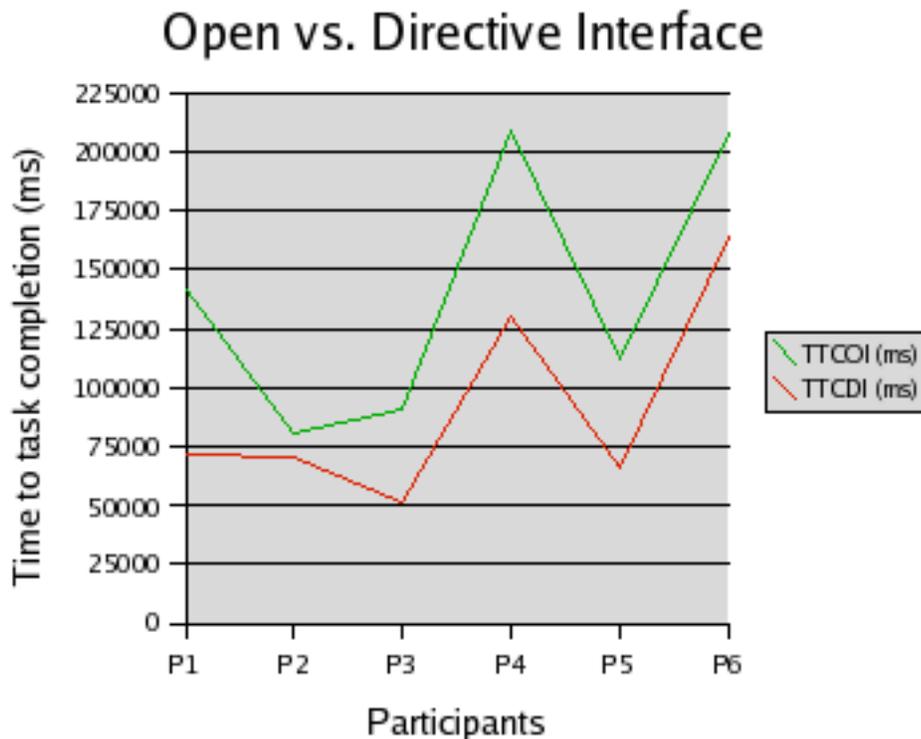


Figure 5.2: Time to task completion for open/directive interface tasks

The graph shows in all cases that the directive interface caused the task to be completed faster than with the open interface.

For P2, who had by far the most experience from work-related issues, showed the smallest gap between the two TTCs.

The shorter TTC for the directive interface could also testify of a learning effect occurring, because all participants were provided with the open interface first. However, in the interviews all participants mentioned that they preferred the directive interface which they found easier to use, so this may have contributed to the shorter TTC as well.

Again the number of participants is too small to verify this conclusion, but combined with the observations, I can say that it again shows that elderly people learn and that the directive interface is an option which will enhance usability.

5.2.2 Usability scores

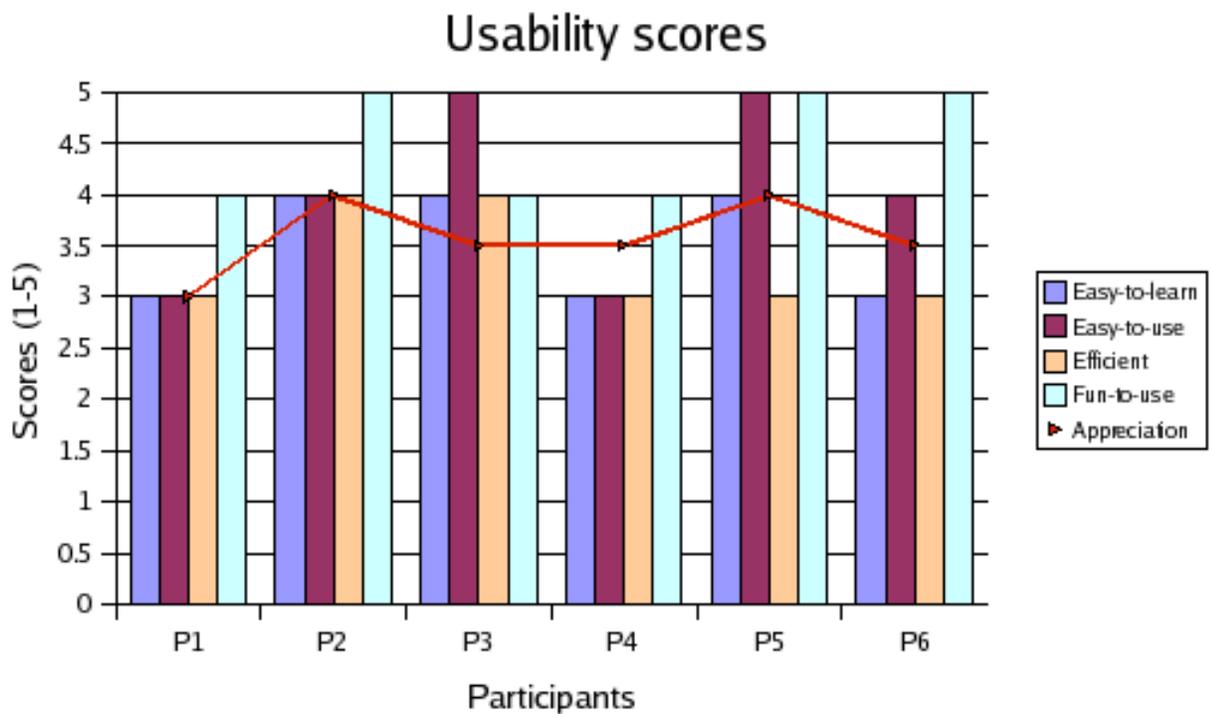


Figure 5.3: Usability scores and appreciation of interface

All participants were asked to rate the interface based on the usability criteria as defined by De Haan et al. [7]

Besides that, they were asked to give an overall appreciation mark for the in-

terface.

The graph shows that the *easy-to-use* and *fun-to-use* criteria are in all cases best rated. *Efficiency* scores lowest, on average.

This shows that elderly users emphasize mostly the ease with which they can operate the interface, and consider speed to be less important. With ease, the fun part inevitably comes into play.

The appreciation marks match perfectly with the given usability scores.

There are no scores issued below 3, so this testifies of usable, positive-affect-inducing interface features.

5.2.3 Analysis of behaviour

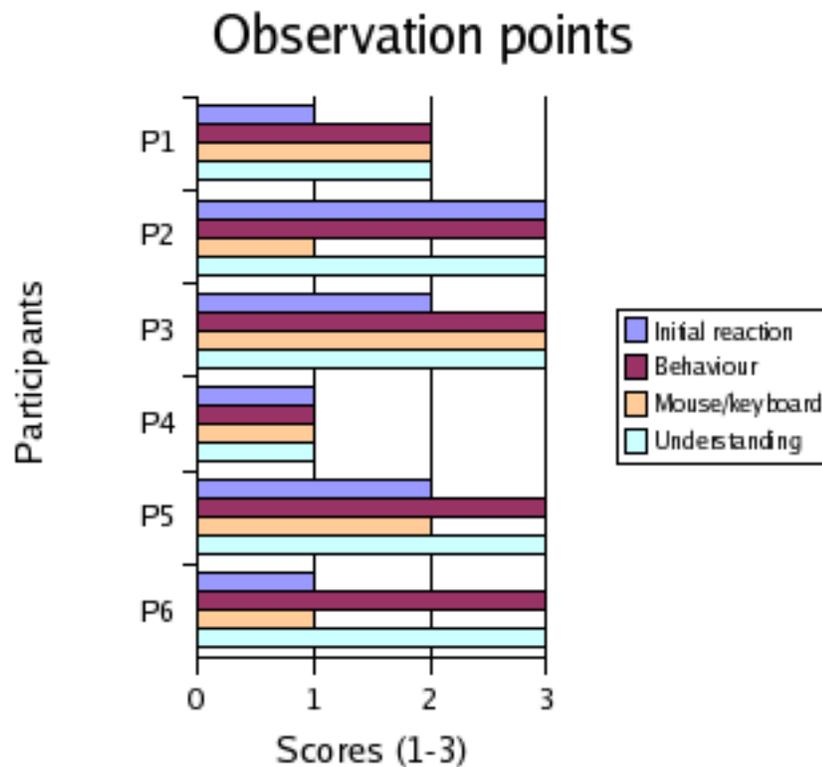


Figure 5.4: Measurement of behaviour by observation

Finally I measured the participants' behaviour by observing their reactions and giving scores to the reactions.

The points of attention with their corresponding possible score values can be found in chapter 4.

The graph shows that the participants with least experience from their work backgrounds showed the most stressful initial reaction. P2, who had most experience, also showed the most relaxed reaction.

P1, P4 and P6 all showed an initial stressful reaction, but each of their behaviour during the tasks differed. However, there was also a subtle difference to be observed in their initial reactions. P1 and P6 were both rather reluctant to do the tasks, but had a far more open attitude towards the computer. They were willing to try, but said they could not guarantee a positive outcome. Whereas P4 was truly convinced she'd be unable to do it, and was rather unwilling to try. This explains the neutral and positive affect P1 and P6 respectively showed while doing the tasks, and P4's negative affect.

P4 also scored lowest for the other attention points, which correlates with the initial reaction.

The other participants all showed positive affect during the tasks. This suggests that they liked doing them, and the way they were set up.

The mouse and the keyboard presented little trouble for those who had worked with them before, but were difficult for the inexperienced participants. The exception here is P2, but this can be explained due to his medical condition.

Most participants also showed a good understanding of the way the interface works, which proves that the interface structure supports their way of thinking.

The only continuously recurring event I observed was the tendency to follow a clickable mouse navigation protocol, which was not a problem but rather a nudge in a certain direction for what seems intuitive.

The participants' backgrounds show only that the more experience, the less stressful their initial reactions, the faster they could complete the tasks and the easier they could operate the input modalities.

However, the natural understanding of the interface also occurred in some of the inexperienced participants, so experience is not necessarily required to understand a computer.

Chapter 6

Conclusion

Computer classes, well-elaborated books and clear instructions in the interface are of vital importance when elderly are being confronted with new technology for the first time. When being gently introduced into the world of computers, they show a tendency to like it and embrace it wholeheartedly. If it becomes clear what has to be done, and this is presented in a way that does not appear to be too difficult, elderly users are more likely to learn and remember than when they are left to themselves to figure it out. Most elderly see difficulty as a reason not even to start working with computers. They all show an initial fear which has to be overcome using the right means.

Elderly people want a computer to be simple to operate and understand. They dislike it when things proceed too fast, and typically get irritated when the computer 'does not do as instructed'.

Elderly users think in linear processes, approaching a task in a 'one step at a time' fashion. They learn mostly by means of constant revision; by having something explained to them several times and performing the task several times. Therefore I can say that learning certainly occurs in elderly users, only it takes more time and effort than for an average user, especially when age increases.

Having instructions in the interface supports this way of thinking and learning, saving them the trouble of having to remember a long sequence of actions and helping them eventually understand the structure behind the computer.

In a practical situation, however, there will be too many possible options to choose from when in a particular state. Therefore the instructions may only present the most common options to avoid confusion, with a possibility of displaying more options if desired. This way the linear line of thinking will be mimicked as well as possible, but with additionally providing the flexibility of the graph-like structure of computer options.

A highly efficiently functioning menu leads to less efficient performance rates for elderly people. The menus disappear too fast for them to be able to provide an adequate reaction, a feature which they greatly dislike.

Therefore a menu which allows elderly users more control over their actions can

greatly enhance usability for them, even though it may function less efficiently for an average user.

This type of menu may be achieved by implementing clickable mouse navigation. Increasing response time and keyboard navigation did not prove to be viable options.

The fact that ease of use is more important than speed is also proven by the fact that all participants mention that they appreciate the directive interface. Even though it requires slightly more time to read the instructions, it guides them through the interface easily and saves them the time and frustration of having to search for the right actions and being stuck because of insufficient knowledge.

Moreover, speed will increase as elderly users get more experienced, and not necessarily by the efficiency of the interface, which is proven by the fact that in most test cases, the situation which was presented first, whether this was delayed or standard navigation, was performed slowest.

Using a slightly larger and clearer font size in the interface can be of help for elderly users too, especially when eyesight starts declining.

The mouse as an input modality does not seem to present such large problems as was initially suggested by the computing class teachers. Most participants saw the mouse as their preferred input modality. Therefore I do not consider it worthwhile to use multimodal input for elderly users. Having different ways of giving input would confuse them more than it would help them. Especially since they learn to work with a mouse in their computing classes.

Designing a completely different operating system for elderly does not seem a viable option either. Again, when they start learning to use a computer, they all start learning using Windows as an operating system. Therefore this environment becomes familiar to them. It is better to focus on enhancing helpful functionality in Windows than to design a new operating system.

This has also been shown by the SimPC failing to become a public success.

Teaching elderly to work with a special operating system also discourages them from ever being able to use public or any other computer.

Concluding, I can say that an interface to enhance usability for the elderly would implement the following:

- A mechanism that offers elderly control over their way of navigation,
- Clear instructions on the possible actions in the current state,
- Appear to be functioning in a linear way to avoid confusion,
- Meaningful, descriptive names on buttons and menu-items,
- Large, clear font size,
- A familiar operating system environment.

6.1 Possibilities for future research

From my observations I continuously noticed the tendency to click to make a submenu appear and to click to make it disappear again. This clickable mouse navigation therefore seems intuitive to elderly users. Research still needs to be done to see if it really is the best mechanism to offer elderly more control over navigation.

This question can be extended by asking whether deep hierarchies in menus still present a problem if elderly can control their navigation method, for instance with clickable menu navigation.

The remarks on the clear readability raise the question whether a larger font size truly increases readability, or whether it crowds the interface too much and interferes with the overview.

Furthermore, directive interfaces for standard computer applications have to be applied far more often in designs for the elderly. Research should focus less on trying to make applications more time-efficient for the elderly, but instead try to enhance usability in the currently existing, familiar environments.

During this project I didn't have time to test how well short-term memory in elderly users is preserved. While this will differ for every user due to their dynamic nature, it will be worth testing whether there is a general tendency to be discovered, a 'Rule of 7 for the elderly'. If so, menu representation can be further improved and adapted to elders' needs to create even more usable interface.

Finally, the hidden functionality deep within the menu hierarchy can be adapted. A well-known solution to getting functionality directly into the interface is the use of toolbars, but elderly users have trouble interpreting the small, unfamiliar icons. Therefore experimenting with large, cartoon-based icons which already capture the essence of an action may be a good option, not only to increase interpretability, but also to increase positive affect. A much wider audience will feel attracted to these colorful, friendly interfaces of the future.

Bibliography

- [1] Apted, T., Kay, J., Quigley, A.: Tabletop sharing of digital photographs for the elderly, *Proceedings of the SIGCHI conference on Human Factors in computing systems*, Montréal, Québec, Canada, pp. 781-790, 2006.
- [2] Becker, S. A.: A study of web usability for older adults seeking online health resources, *ACM Transactions on Computer-Human Interaction*, Vol. 11, No. 4, pp. 387-406, December 2004.
- [3] Chadwick-Dias, A., McNulty, M., Tullis, T.: Web usability and age: how design changes can improve performance, *Proceedings of the 2003 conference on Universal usability*, Vancouver, British Columbia, Canada, pp. 30-37, 2002.
- [4] Dix, A., Finlay, J., Abowd, G. D., Beale, R.: *Human-Computer Interaction*, Third Edition, Pearson Prentice Hall, 2004.
- [5] Feinberg, S., Murphy, M.: Applying cognitive load theory to the design of web-based instruction, *Proceedings of IEEE professional communication society international professional communication conference and Proceedings of the 18th annual ACM international conference on Computer documentation: technology & teamwork table of contents*, Cambridge, Massachusetts, pp. 353-360, 2000.
- [6] Gregor, P., Newell, A. F.: Designing for Dynamic Diversity: making accessible interfaces for older people, *Proceedings of the 2001 EC/NSF workshop on Universal accessibility of ubiquitous computing: providing for the elderly*, Alcácer do Sal, Portugal, pp. 90-92, 2001.
- [7] Haan, G. de, Veer, G. C. van der, Vliet, J. C. van: Formal modelling techniques in human-computer interaction, *Acta Psychologica*, Vol. 78, pp. 27-67, 1991.
- [8] Hanson, V. L.: Web access for elderly citizens, *Proceedings of the 2001 EC/NSF workshop on Universal accessibility of ubiquitous computing: providing for the elderly*, Alcácer do Sal, Portugal, pp. 14-18, 2001.
- [9] Heller, R., Jorge, J., Guedj, R.: EC/NSF workshop on universal accessibility of ubiquitous computing: providing for the elderly event report,

- Proceedings of the 2001 EC/NSF workshop on Universal accessibility of ubiquitous computing: providing for the elderly*, Alcácer do Sal, Portugal, pp. 1-10, 2001.
- [10] Kurniawan, S., Zaphiris, P.: Research-derived web design guidelines for older people, *Proceedings of the 7th international ACM SIGACCESS conference on Computers and accessibility*, Baltimore, MD, USA, pp. 129-135, 2005.
- [11] Lopes, J. B.: Designing user interfaces for severely handicapped persons, *Proceedings of the 2001 EC/NSF workshop on Universal accessibility of ubiquitous computing: providing for the elderly*, Alcácer do Sal, Portugal, pp. 100-106, 2001.
- [12] Marcus, A.: Universal, ubiquitous, user-interface design for the disabled and elderly, *Interactions*, Vol. 10, No. 2, pp. 23-27, March-April 2003.
- [13] Norman, D. A.: Emotion and design: Attractive things work better, *Interactions magazine*, Vol. 9, No. 4, pp.36-42, July 2002.
- [14] Ogozalek, V. Z.: A comparison of the use of text and multimedia interfaces to provide information to the elderly, *Proceedings of the SIGCHI conference on Human factors in computing systems: celebrating interdependence*, Boston, Massachusetts, United States, pp. 65-71, 1994.
- [15] Oviatt, S. L.: Human-centered design meets cognitive load theory: designing interfaces that help people think, *Proceedings of the 14th annual ACM international conference on Multimedia table of contents*, Santa Barbara, California, United States, pp. 871-880, 2006.
- [16] Yousef, M. K.: Assessment of metaphor efficacy in user interfaces for the elderly: a tentative model for enhancing accessibility, *Proceedings of the 2001 EC/NSF workshop on Universal accessibility of ubiquitous computing: providing for the elderly*, Alcácer do Sal, Portugal, pp. 120-124, 2001.
- [17] Zhao, H.: Universal Usability Web Design Guidelines for the Elderly (Age 65 and Older), *Universal Usability in Practice*, University of Maryland, USA, April 2001.

Appendix A

Preliminary research interviews

On Tuesday March 27, 2007 I have attended two computer lessons intended for elderly people. The first one was an introductory course taking place at Nieuw Malderborgh, a centre for senior citizens in Nijmegen. The course was organized by the SWON, Stichting Welzijnswerk voor Ouderen Nijmegen.

The content of the course was aimed solely at making participants familiar with the basics of Windows. During the course, Windows XP was used on all computers. The objectives on the day I attended were to save a document in a newly created directory, and retrieving it again.

The participants were mostly between 70 and 80 years of age, with the eldest being 81 and the youngest just over 60.

The second course was a more advanced course with the objective of familiarizing participants with Microsoft Word. The course was held at the OverBetuwe College, a school for secondary education in Elst, coordinated by Stichting Welzijn Ouderen Overbetuwe (SWOO). The topic of the lesson was using tables and spacing in Word.

It was remarkable to see that all participants were a lot younger than the ones from the introductory course. They were all between 55 and 70 years old. However, they had one thing in common: all of them had followed an introductory course (in Elst) beforehand.

A.1 Interviews with course participants

I conducted several interviews with the course participants to find out what they considered the greatest problems with computers, using the following questions:

1. Do you like working with a computer?
2. Why are you following this computer course?

3. Is it easy to learn how to operate a computer? If not, what is so difficult about learning it?
4. Do you possess knowledge that aids you in the learning process?
5. What do you think of this computer course?
6. What do you think about the mouse and the keyboard?
7. What do you think about the monitor? Can you read the output given with ease? What do you think about the way the different options are represented?
8. Would you rather receive output through other means such as spoken dialogue?

Participant 1

Male, 81

1. I do not like working with a computer, I have no affinity with these machines whatsoever.
2. My son made me, and to learn how to do Internet banking.
3. No, it's difficult for me. My memory is not what it used to be, and all the operations are new. It takes some time before they get stored, but this has only to do with age. There are so many operations.
4. I have taught English before. This creates a certain discipline and way of thinking that can be of help.
5. The course is great! Jos (teacher) really takes the time to explain everything in detail.
6. The mouse and keyboard do not pose any trouble.
7. I have a 19-inch monitor at home, I can read everything perfectly. The desktop is not frightening, there is a logical structure beneath it, and it is just a matter of understanding this structure.
8. No.

Participant 2

Female, 72

1. It's fun to have a computer, especially now that I'm alone. It keeps me busy, gives me something to do.
2. I've long been intending to do this, I've just been putting it off for ages. Now that she (points to her friend sitting next to her) decided to follow the course and asked me to come along, I've finally done it.

3. It's very hard indeed, there's so much coming at you in one lesson. I usually open the book, but it's always explained in just a slightly different fashion than here. This is why practising is so important, otherwise you forget everything you've just learned.
4. I've worked at a till before, but it only helps in making typing a little bit easier.
5. Wonderful. It's so good to have everything explained from scratch.
6. The keyboard is okay, but the mouse is difficult to control. I cannot keep it steady, and when I scroll, it often goes off the table. But it's usable.
7. The monitor is like a maze, it's difficult to find everything you need. I can read it okay, but there's so much to read.
8. That could be easy.

Participant 3

Female, 77

1. Yes, it's fun and really interesting. It intrigues me that there are so many possibilities with that machine.
2. I want to know something about modern technology, I don't want to be outdated. When you watch television, all you hear is: "www, dot nl".
3. Yes it's hard. The order is especially difficult, you have to remember it all. Besides that, finding things is tough, so much information is offered at the same time. Especially if it's new, and most of it is.
4. I have learned typing and steno before, but that is so long ago.
5. It's certainly worth the trouble, the explanations are great, and we get lots of personal attention.
6. They're okay to work with.
7. The monitor is good. It's perfectly readable, only things are hard to find when you're seeing so much and every window seems new.
8. It could be useful if the computer offered extra support.

Participant 4

Female, 59

1. Yes, I like it, you can do so much with a computer.
2. To learn more about computers, become more familiar with them, and to learn about the Internet. I'm already quite familiar with Internet, but one can always learn more.

3. It's quite easy, I'm only following this course because I want to fill up my knowledge gap.
4. Yes, I work with computers quite a lot compared to the others, so that's not the problem.
5. Certainly worth following, clear explanations and lots of attention.
6. They're easy to work with for me.
7. No problem at all.
8. No.

Participant 5

Male, 61

1. I'm actually starting to like it.
2. Working with a computer becomes a necessity these days, and I want to know what I'm doing. I think I will become braver when I become more familiar with the computer. Currently I do fear to make mistakes. All those windows asking: "Are you sure" you want to do this and that make you insecure and unsure of yourself.
3. All the work that has to be done with the fingers.
4. I already know some things about computers, it's just this continuous change and rapid development that is hard to follow.
5. The course is wonderful. It's good to be taken by the hand and have everything explained properly and slowly.
6. Mouse and keyboard are really hard for me to operate. You see, I have a handicap (MS patient) so it's troublesome for my lame fingers to operate them.
7. The monitor is okay. It doesn't matter if there is lots of information presented to you, you only look for what you need, which you'll usually find no matter how much you see.
8. Not really.

Participant 6

Female, 64

1. Not at first, but now I'm getting at ease with it, and it's much better.
2. I have no choice, my husband passed away and I'm left on my own to do the banking and other administrative tasks.

3. Before I started this course, I had never touched a computer before. It was really difficult at first, and actually it still is. The problem is that there is so much of the unfamiliar that you have to become familiar with in such a short time. And the order is so hard to follow and remember. Everything goes so fast. It often happens that I fall behind when we have to do certain things, and the teacher always has to help me along. But I do think Windows is learnable.
4. Nothing in particular.
5. I really needed it, it's so good that they take all the time we need for us.
6. The keyboard is really a maze of letters and buttons. I don't know what half of them are for! As for the mouse, it's usable. However, menu's that pop up during navigation are often gone before I have selected the right option.
7. The monitor is quite okay. I can read everything.
8. Not necessarily.

A.2 Interviews with teachers

I interviewed both teachers using the following questions:

1. What kind of applications do elderly people most commonly use?
2. What are their main motives for following the course?
3. Do you notice certain frequently occurring problems?
4. Can you say that current interfaces are usable for elderly people? Think about ease of learning, efficiency and fun while working.
5. Could you name some of the, in your opinion, main shortcomings of current interfaces?
6. Could you describe your idea of an ideal user interface for elderly people?
7. Would you consider the use of an interface metaphor in the interface design a useful addition?
8. What do you do to help people with severe visual/physical handicaps?

Teachers introductory course

1. Usually they use Internet, e-mail applications and word processing applications.
2. All of them want to be able to mail with their children and grandchildren, wanting to be able to use the Internet is another commonly heard motive, and sometimes Internet banking is specifically named as well.

3. Certainly. The mouse is the greatest recurring problem. Especially double-clicking and leaving the mouse in one place while clicking. We let them play Solitaire to get them used to dragging and clicking with the mouse.
4. Yes, I think Windows as it is is quite learnable for elderly people. The essential part of solving the problem is that they have to learn to understand the structure on which Windows is build, and not necessarily adapting the interface. And this takes time, and constant revision.
5. Not everything is easily accessible. For instance, menu navigation in the horizontal direction is a problem all the time. But this has everything to do with the mouse difficulties again.
6. There is no ideal interface, because this would be different for every single person.
7. We only use metaphors when explaining the directory structure. Once they grasp the concept, and they usually do when the course is over, it is not needed anymore. I don't really see how interface metaphors could be useful.
8. We've never really had such severe handicaps that prevented people from following the course. When visual abilities are low, we increase the font size and activate the magnifying glass built into Windows. But I admit, it's not easy to work that way. Only once have we had a person who could not read anything on the monitor. But she had severe dyslexia. It was such a shame, because she wanted to learn so badly, but we did advise against completing the course.

Appendix B

Interview with the expert

The interview with Charles van der Mast took place on April 23, 2007 in Delft at the Faculty of Electrical Engineering, Mathematics and Computer Science. Professor Van der Mast works as an associate professor/senior lecturer in Human Computer Interaction.

Are there certain models or methods which can be used to evaluate interface usability for elderly people? I know of methods like GOMS, which tests interface efficiency, but I suspect that such a method will probably not be suitable to evaluate elderly.

GOMS is certainly not a suitable method to evaluate a target group such as elderly people. You are better off using questionnaires, counting errors and measuring time to task completion when evaluating elderly.

There have been studies by TNO Human Factors, I can't remember any names at the moment, which have proven that elderly have a limited spatial insight, which is negatively correlated with their navigation skills on the Internet. That is to say, elderly have a harder time getting around on the web than younger generations.

You also need to take into account the question of how directive the interface is. This is often applied in computerized systems for elderly which provide a sort of permanently present doctor. They use open dialogues for situations in which all goes well, but as soon as an emergency occurs, and elderly tend to panic in such situations, the interface takes over the commanding role. Screens are provided in which only one action at a time can be taken. That way, elderly cannot make mistakes and are quickly guided to the best solutions.

There is also a strong emotional factor involved.

From the elderly I have spoken to, I have heard reactions in which they are not happy with the screens asking: "Are you sure you want to ... ". They say it makes them insecure.

You could replace those type of menu's by offering several fair solutions which they can choose from. That way they will be able to make a simple and straightforward choice between options, and most importantly, they will know what they are choosing. Asking whether they want to take one action or not will not work for people who do not know what the consequence of the action is.

Interfaces are always required to be flexible. I think this is especially true for elderly people. How can this configurability be realised?

Flexibility can be found in configurable colours, button sizes and representation or hiding of functionality. It is best to do this with a human assistant. This can be someone from a home health care organization, a (more computer-literate) neighbour or family member, who can help the elderly person configure the interface. In the beginning, any disturbing functions can be hidden, and when the person becomes more acquainted with the computer, more functionality can be represented.

How can I determine what type of situation has the most acceptable cognitive load?

Cognitive load represent how easy a task is. The best way to measure this is to compare different forms of interaction. You have to look at the information that is presented to you by the interface, and the changes taking place between tasks.

Furthermore it is useful to do a hierarchical task analysis for user behaviour. For elderly people, you do not want any deep hierarchical structures, it only confuses them.

You can also make a mental model for elderly, but it will keep changing, because elderly continuously learn new things about their computer.

Is there any way to make an interface appear more accessible and friendly to the elderly users?

You could enlarge representation icons, but a nice way is to replace photographic Desktop icons with cartoon icons. Cartoons are better at capturing only the essence of a picture. This is because the cartoonist has already given the issue of how to represent the meaning of the picture lots of thought while drawing it.

Appendix C

Source Code

This appendix contains the source code, written in Java, to the experimentation platforms used to conduct the experiments.

C.1 Standard menu navigation

This section contains the code for the menu navigation experiment. The instruction given indicates standard menu navigation. However, the commands for keyboard navigation and delayed navigation are also included. For keyboard navigation, this is

```
menu.setMnemonic(KeyEvent.VK_B);
```

and for delayed navigation this is

```
subsubmenu.setDelay(1000);
```

Furthermore, only the initial instruction is slightly different, indicating which situation will be tested.

```
import javax.swing.*;
import javax.swing.event.MenuEvent;
import javax.swing.event.MenuListener;
import javax.swing.event.PopupMenuEvent;
import javax.swing.event.PopupMenuListener;
import java.awt.*;
import java.awt.event.*;
import java.io.FileOutputStream;
import java.io.PrintStream;

/**
 * Software voor experimenten bachelorscriptie
 * 'Enhancing usability for the elderly'.
```

```

* Setup om menu navigatie te testen.
* 21 mei 2007
*
* @author Ilona Wilmont
*
*/

public class StandardMenu extends JFrame implements ActionListener
{
    private JTextArea textarea;
    private JTextArea instructionarea;
    private JMenuBar menubar;
    private JMenu menu, submenu, subsubmenu, subsubsubmenu;
    private JMenuItem menuitem;
    private JScrollPane scrollpane;
    private String instruction;
    private long start, stop, elapsed;
    private boolean timestarted;
    private FileOutputStream out; // declare a file output object
    private PrintStream p; // declare a print stream object

    public StandardMenu()
    {
        super ("IlonaPAD");

        start = stop = elapsed = 0;
        timestarted = false;

        try {
            // Create a new file output stream
            // connected to "standard.txt"
            out = new FileOutputStream("standard.txt");

            // Connect print stream to the output stream
            p = new PrintStream(out);

            p.println("Test resultaten: ");

        } catch (Exception ex) {
            System.err.println("Error writing to file");
        }

        JOptionPane pane = new JOptionPane ("U gaat nu het menu navigeren " +
            "met behulp van de muis. \n" +
            "De instructies staan onderaan het scherm.\n Klik op OK om met" +

```

```
" de taak te beginnen.");

    JDialog dialog = pane.createDialog(this, "Start taak");
    dialog.setVisible(true);

    if(pane.OK_OPTION == (int)0)
    {
        timestarted = true;
        start = System.currentTimeMillis();
    }

    createGUI();
}

public void createGUI()
{
    setLayout (new BorderLayout());
    textarea = new JTextArea(15, 40);
    scrollpane = new JScrollPane (textarea);
    add(scrollpane, BorderLayout.CENTER);

    instructionarea = new JTextArea(10, 10);
    instructionarea.setText("Taak 1: \n" +
        "- Ga naar het Bestand-menu\n" +
        "- Kies 'Afdrukken'");
    instructionarea.setEditable(false);
    add(instructionarea, BorderLayout.SOUTH);

    //create menubar
    menubar = new JMenuBar();

    //create and add first menu
    menu = new JMenu("Bestand");
    menu.setMnemonic(KeyEvent.VK_B);
    menubar.add(menu);

    //several menuitems
    menuitem = new JMenuItem("Nieuw");
    menu.add(menuitem);

    menuitem = new JMenuItem("Openen");
    menu.add(menuitem);

    menuitem = new JMenuItem("Sluiten");
    menu.add(menuitem);
}
```

```
menu.addSeparator();

menuItem = new JMenuItem("Opslaan");
menu.add(menuItem);

menuItem = new JMenuItem("Opslaan als");
menu.add(menuItem);

menu.addSeparator();

menuItem = new JMenuItem("Afdrukken");
menuItem.addActionListener(this);
menu.add(menuItem);

menu.addSeparator();

menuItem = new JMenuItem("Afsluiten");
menu.add(menuItem);

// create second menu
menu = new JMenu("Bewerken");
menu.setMnemonic(KeyEvent.VK_E);
menubar.add(menu);

menuItem = new JMenuItem("Ongedaan maken");
menu.add(menuItem);

menu.addSeparator();

menuItem = new JMenuItem("Knippen");
menu.add(menuItem);
menuItem = new JMenuItem("Kopieren");
menu.add(menuItem);
menuItem = new JMenuItem("Plakken");
menu.add(menuItem);

menu.addSeparator();

submenu = new JMenu("Selecteren");
menu.add(submenu);

menuItem = new JMenuItem("Hele tekst");
menuItem.addActionListener(this);
submenu.add(menuItem);
menuItem = new JMenuItem("Huidige alinea");
```

```
submenu.add(menuitem);

menu.addSeparator();

menuitem = new JMenuItem("Zoeken");
menu.add(menuitem);

//create third menu
menu = new JMenu("View");
menubar.add(menu);

menuitem = new JMenuItem("Default layout");
menu.add(menuitem);
menuitem = new JMenuItem("Weblayout");
menu.add(menuitem);
menuitem = new JMenuItem("Printlayout");
menu.add(menuitem);

menu.addSeparator();

submenu = new JMenu("Toolbars");
menu.add(submenu);

subsubmenu = new JMenu("Tekstopmaak");
submenu.add(subsubmenu);

menuitem = new JMenuItem("Standaard");
subsubmenu.add(menuitem);
menuitem = new JMenuItem("Formatting");
subsubmenu.add(menuitem);
menuitem = new JMenuItem("WordArt");
subsubmenu.add(menuitem);
menuitem = new JMenuItem("Word Count");
subsubmenu.add(menuitem);

subsubmenu = new JMenu("Tekenen");
submenu.add(subsubmenu);

menuitem = new JMenuItem("Drawing");
subsubmenu.add(menuitem);
menuitem = new JMenuItem("Picture");
subsubmenu.add(menuitem);

subsubmenu = new JMenu("Documentopmaak");
submenu.add(subsubmenu);
```

```
menuItem = new JMenuItem("Outlining");
subsubmenu.add(menuitem);
menuItem = new JMenuItem("Frames");
menuItem.addActionListener(this);
subsubmenu.add(menuitem);
menuItem = new JMenuItem("Tables and Borders");
subsubmenu.add(menuitem);

menu.addSeparator();

menuItem = new JMenuItem("Header/footer");
menu.add(menuitem);

menu.addSeparator();

submenu = new JMenu("Zoom");
menu.add(submenu);

menuItem = new JMenuItem("25\%");
submenu.add(menuitem);
menuItem = new JMenuItem("50\%");
submenu.add(menuitem);
menuItem = new JMenuItem("75\%");
submenu.add(menuitem);
menuItem = new JMenuItem("100\%");
submenu.add(menuitem);
menuItem = new JMenuItem("125\%");
submenu.add(menuitem);
menuItem = new JMenuItem("Margin width");
submenu.add(menuitem);
menuItem = new JMenuItem("Page width");
submenu.add(menuitem);

//create fourth menu
menu = new JMenu("Invoegen");
menu.setMnemonic(KeyEvent.VK_I);
menubar.add(menu);

menuItem = new JMenuItem("Break");
menu.add(menuitem);
menuItem = new JMenuItem("Paginanummers");
menu.add(menuitem);
menuItem = new JMenuItem("Datum en tijd");
menu.add(menuitem);
```

```
submenu = new JMenu("Autotext");
submenu.setMnemonic(KeyEvent.VK_A);
menu.add(submenu);

subsubmenu = new JMenu("Aanhef");
submenu.add(subsubmenu);

menuitem = new JMenuItem("Geachte heer/mevrouw");
subsubmenu.add(menuitem);
menuitem = new JMenuItem("Lieve");
subsubmenu.add(menuitem);
menuitem = new JMenuItem("L.S.");
subsubmenu.add(menuitem);

subsubmenu = new JMenu("Afsluiting");
subsubmenu.setDelay(1000);
subsubmenu.setMnemonic(KeyEvent.VK_F);
submenu.add(subsubmenu);

subsubsubmenu = new JMenu("Formeel");
subsubsubmenu.setDelay(1000);
subsubsubmenu.setMnemonic(KeyEvent.VK_F);
subsubmenu.add(subsubsubmenu);

menuitem = new JMenuItem("Met vriendelijke groet");
subsubsubmenu.add(menuitem);
menuitem = new JMenuItem("Hoogachtend");
menuitem.addActionListener(this);
subsubsubmenu.add(menuitem);
menuitem = new JMenuItem("Met de meeste hoogachting");
subsubsubmenu.add(menuitem);
menuitem = new JMenuItem("Bij voorbaat dank");
subsubsubmenu.add(menuitem);

subsubsubmenu = new JMenu("Vriendschappelijk");
subsubsubmenu.setMnemonic(KeyEvent.VK_V);
subsubmenu.add(subsubsubmenu);

menuitem = new JMenuItem("Groetjes");
menuitem.addActionListener(this);
subsubsubmenu.add(menuitem);
menuitem = new JMenuItem("Veel liefs");
subsubsubmenu.add(menuitem);
menuitem = new JMenuItem("Tot gauw");
subsubsubmenu.add(menuitem);
menuitem = new JMenuItem("Hou je haaks");
```

```
subsubsubmenu.add(menuitem);
menuitem = new JMenuItem("Het allerbeste");
subsubsubmenu.add(menuitem);

subsubmenu = new JMenu("Attentieregel");
submenu.add(subsubmenu);

menuitem = new JMenuItem("T.a.v.");
subsubmenu.add(menuitem);
menuitem = new JMenuItem("Ter attentie van");
subsubmenu.add(menuitem);

subsubmenu = new JMenu("Onderwerpregel");
submenu.add(subsubmenu);

menuitem = new JMenuItem("Onderwerp");
subsubmenu.add(menuitem);

menu.addSeparator();

menuitem = new JMenuItem("Referenties");
menu.add(menuitem);

menu.addSeparator();

submenu = new JMenu("Plaatje");
menu.add(submenu);

menuitem = new JMenuItem("Vanuit bestand");
submenu.add(menuitem);
menuitem = new JMenuItem("ClipArt");
submenu.add(menuitem);
submenu.addSeparator();
menuitem = new JMenuItem("WordArt");
submenu.add(menuitem);
menuitem = new JMenuItem("Grafiek");
submenu.add(menuitem);

menuitem = new JMenuItem("Object");
menu.add(menuitem);
menuitem = new JMenuItem("Diagram");
menu.add(menuitem);

setJMenuBar (menubar);
}
```

```

public void actionPerformed (ActionEvent e)
{
String text = ((JMenuItem)(e.getSource ())).getText();

if (text.equals("Afdrukken"))
{
JOptionPane.showMessageDialog(this, "De eerste taak is voltooid.");
instructionarea.setText("Taak 2: \n" +
"- Ga naar het Bewerken-menu \n" +
"- Ga naar 'Selecteren' \n" +
"- Kies 'Hele tekst' ");
}
if (text.equals("Hele tekst"))
{
JOptionPane.showMessageDialog(this, "De tweede taak is voltooid.");
instructionarea.setText("Taak 3: \n" +
"- Ga naar het View-menu \n" +
"- Ga naar 'Toolbars' \n" +
"- Ga naar 'Documentopmaak' \n" +
"- Kies 'Frames' ");
}
if (text.equals("Frames"))
{
JOptionPane.showMessageDialog(this, "De derde taak is voltooid.");
instructionarea.setText("Taak 4: \n" +
"- Ga naar het Invoegen-menu \n" +
"- Ga naar 'Autotext' \n" +
"- Ga naar 'Afsluiting' \n" +
"- Ga naar 'Vriendschappelijk' " +
"- Kies 'Groetjes' ");
}
    if (text.equals("Groetjes"))
    {
        instructionarea.setText(" ");
    }

JOptionPane pane = new JOptionPane ("U hebt de taak volbracht! \n " +
"Klik op OK om te eindigen.");

JDialog dialog = pane.createDialog(this, "Einde taak");
dialog.setVisible(true);

if(pane.OK_OPTION == (int)0)
{
    timestarted = false;
    stop = System.currentTimeMillis();
}

```

```

        elapsed = stop - start;
        p.println(elapsed + "\n");
    }
}

public static void main(String [] args)
{
    StandardMenu standardMenu = new StandardMenu();
    standardMenu.setSize(500, 500);
    standardMenu.setVisible(true);
}
}

```

C.2 Open and directive interface

This section contains the code originally intended for the directive interface experiment.

However, the open interface experiment code is identical except for the instructions contained in the lines starting with

```
instructionpane.setText("...")
```

and the extra

```
private JTextArea instructionpane;
```

created to hold and display the instructions.

```

import javax.swing.*;
import java.awt.*;
import java.awt.event.*;
import java.io.FileOutputStream;
import java.io.PrintStream;

/**
 * Software voor experimenten bachelorscriptie
 * 'Enhancing usability for the elderly'.
 * Setup om directieve versus open interface te testen.
 * 21 mei 2007
 *
 * @author Ilona Wilmont
 *
 */

public class DirectiveCD extends JFrame implements ActionListener,
ItemListener

```

```

{
    private JMenuBar menubar;
    private JMenu menu, submenu, subsubmenu, subsubsubmenu;
    private JMenuItem menuitem;
    private JScrollPane listpane;
    private JCheckBox song1, song2, song3, song4, song5,
    song6, song7, song8, song9, song10;
    private JScrollPane compilationpane;
    private JTextArea compilationarea;
    private JPanel songpane;
    private JTextArea instructionpane;
    private JButton addbutton;
    private int numberSongs = 10;
    private int[] liedjes = {0,0,0,0,0,0,0,0,0,0};
    private String[] titles = new String[numberSongs];
    private long start, stop, elapsed;
    private boolean timestarted;
    private FileOutputStream out; // declare a file output object
    private PrintStream p; // declare a print stream object

    public DirectiveCD()
    {
        super ("CDWriter");

        start = stop = elapsed = 0;
        timestarted = false;

        try {
            // Create a new file output stream
            // connected to "cddirective.txt"
            out = new FileOutputStream("cddirective.txt");

            // Connect print stream to the output stream
            p = new PrintStream(out);

            p.println("Test resultaten: ");

        } catch (Exception ex) {
            System.err.println("Error writing to file");
        }

        timestarted = true;
        start = System.currentTimeMillis();
    }
}

```

```

        Object[] options = {"Nieuwe CD maken",
                            "Bestaande compilatie openen",
                            "Programma sluiten"};
        int n = JOptionPane.showOptionDialog(this,
        "Kies de taak die u wilt gaan doen. \n \n" +
        "Als u een nieuwe CD wilt samenstellen, kies " +
        "'Nieuwe CD maken'. \n" +
        "Als u een bestaande compilatie verder wilt " +
        "bewerken, kies 'Bestaande compilatie openen'. \n" +
        "Indien u het programma af wil sluiten, kies " +
        "'Programma sluiten'\n\n",
        "CDBrander",
        JOptionPane.YES_NO_CANCEL_OPTION,
        JOptionPane.QUESTION_MESSAGE,
        null,
        options,
        options[0]);

        createGUI();

    }

    public void createGUI()
    {
        setLayout (new BorderLayout());

        instructionpane = new JTextArea();

        instructionpane.setText(
        "\n\t Selecteer uit de lijst met liederen de " +
        "titels die u aan uw \n\t compilatie toe wilt voegen. \n\t" +
        "Wanneer uw selectie compleet is drukt u op \n\t'Add " +
        "to compilation'\n");

        add (instructionpane, BorderLayout.NORTH);

        createMenu();
        createSongList();
        createCompilationList();

    }

    public void createCompilationList()
    {
        compilationarea = new JTextArea();

```

```
        compilationpane = new JScrollPane(compilationarea);

        add(compilationpane, BorderLayout.EAST);
    }

    public void createSongList()
    {
        song1 = new JCheckBox ("What a Wonderful World - " +
            "Louis Armstrong");
        song1.addItemListener(this);
        song2 = new JCheckBox ("Wonderful Tonight - " +
            "Eric Clapton");
        song2.addItemListener(this);
        song3 = new JCheckBox ("Hello - Lionel Richie");
        song3.addItemListener(this);
        song4 = new JCheckBox ("Memory - Barbara Streisand");
        song4.addItemListener(this);
        song5 = new JCheckBox ("Penny Lane - The Beatles");
        song5.addItemListener(this);
        song6 = new JCheckBox ("Heb Je Even Voor Mij - " +
            "Frans Bauer");
        song6.addItemListener(this);
        song7 = new JCheckBox ("Margherita - Marco Borsato");
        song7.addItemListener(this);
        song8 = new JCheckBox ("Streets of London - Ralph McTell");
        song8.addItemListener(this);
        song9 = new JCheckBox ("Killing Me Softly - The Fugees");
        song9.addItemListener(this);
        song10 = new JCheckBox ("Top Of The World - The Carpenters");
        song10.addItemListener(this);

        songpane = new JPanel(new GridLayout(0,1));
        songpane.add(song1);
        songpane.add(song2);
        songpane.add(song3);
        songpane.add(song4);
        songpane.add(song5);
        songpane.add(song6);
        songpane.add(song7);
        songpane.add(song8);
        songpane.add(song9);
        songpane.add(song10);

        JPanel buttonpanel = new JPanel();
        addbutton = new JButton("Add to compilation");
```

```
        addbutton.addActionListener(this);
        buttonpanel.add(addbutton);
        songpane.add(buttonpanel);

        listpane = new JScrollPane(songpane);
        add(listpane, BorderLayout.WEST);

        //initialisatie titles array
        for (int i = 0; i < numberSongs; i++)
        {
            titles[i] = null;
        }
    }

    /*
     * Houdt bij welke songs er geselecteerd zijn.
     */
    public void itemStateChanged (ItemEvent e)
    {
        Object source = e.getItemSelectable();

        if(source == song1)
        {
            liedjes[0] = 1;
            titles[0] = "What a Wonderful World - " +
"Louis Armstrong";
            if (e.getStateChange() == ItemEvent.DESELECTED)
            {
                liedjes[0] = 0;
                titles[0] = null;
            }
        }
        else if (source == song2)
        {
            liedjes[1] = 2;
            titles[1] = "Wonderful Tonight - " +
"Eric Clapton";
            if (e.getStateChange() == ItemEvent.DESELECTED)
            {
                liedjes[1] = 0;
                titles[1] = null;
            }
        }
        else if(source == song3)
```

```
{
  liedjes[2] = 3;
  titles[2] = "Hello - Lionel Richie";
  if (e.getStateChange() == ItemEvent.DESELECTED)
  {
    liedjes[2] = 0;
    titles[2] = null;
  }
}
else if (source == song4)
{
  liedjes[3] = 4;
  titles[3] = "Memory - Barbara Streisand";
  if (e.getStateChange() == ItemEvent.DESELECTED)
  {
    liedjes[3] = 0;
    titles[3] = null;
  }
}
else if (source == song5)
{
  liedjes[4] = 5;
  titles[4] = "Penny Lane - The Beatles";
  if (e.getStateChange() == ItemEvent.DESELECTED)
  {
    liedjes[4] = 0;
    titles[4] = null;
  }
}
else if (source == song6)
{
  liedjes[5] = 6;
  titles[5] = "Heb Je Even Voor Mij - " +
"Frans Bauer";
  if (e.getStateChange() == ItemEvent.DESELECTED)
  {
    liedjes[5] = 0;
    titles[5] = null;
  }
}
else if (source == song7)
{
  liedjes[6] = 7;
  titles[6] = "Margherita - Marco Borsato";
}
```

```

        if (e.getStateChange() == ItemEvent.DESELECTED)
        {
            liedjes[6] = 0;
            titles[6] = null;
        }
    }
    else if (source == song8)
    {
        liedjes[7] = 8;
        titles[7] = "Streets of London - Ralph McTell";
        if (e.getStateChange() == ItemEvent.DESELECTED)
        {
            liedjes[7] = 0;
            titles[7] = null;
        }
    }
    else if (source == song9)
    {
        liedjes[8] = 9;
        titles[8] = "Killing Me Softly - The Fugees";
        if (e.getStateChange() == ItemEvent.DESELECTED)
        {
            liedjes[8] = 0;
            titles[8] = null;
        }
    }
    else if (source == song10)
    {
        liedjes[9] = 10;
        titles[9] = "Top Of The World - The Carpenters";
        if (e.getStateChange() == ItemEvent.DESELECTED)
        {
            liedjes[9] = 0;
            titles[9] = null;
        }
    }
}

public void createMenu()
{
    menubar = new JMenuBar();
    setJMenuBar(menubar);

    //create and add first menu
    menu = new JMenu("Bestand");

```

```
menu.setMnemonic(KeyEvent.VK_B);
menubar.add(menu);

//several menuitems
menuItem = new JMenuItem("Nieuwe compilatie");
menuItem.addActionListener(this);
menu.add(menuItem);

menuItem = new JMenuItem("Compilatie openen");
menu.add(menuItem);

menuItem = new JMenuItem("Compilatie sluiten");
menu.add(menuItem);

menu.addSeparator();

menuItem = new JMenuItem("Opslaan");
menu.add(menuItem);

menuItem = new JMenuItem("Opslaan als");
menu.add(menuItem);

menu.addSeparator();

menuItem = new JMenuItem("CD branden");
menuItem.addActionListener(this);
menu.add(menuItem);

menu.addSeparator();

menuItem = new JMenuItem("Afsluiten");
menu.add(menuItem);

// create second menu
menu = new JMenu("Bewerken");
menu.setMnemonic(KeyEvent.VK_E);
menubar.add(menu);

menuItem = new JMenuItem("Ongedaan maken");
menu.add(menuItem);

menu.addSeparator();

menuItem = new JMenuItem("Knippen");
menu.add(menuItem);
menuItem = new JMenuItem("Kopieren");
```

```

        menu.add(menuitem);
        menuitem = new JMenuItem("Plakken");
        menu.add(menuitem);

        menu.addSeparator();

        menuitem = new JMenuItem("Selecteren");
        menu.add(menuitem);
    }

    /*
     * Afhandelen van clickable menuitems.
     */
    public void actionPerformed (ActionEvent e)
    {
        Object source = e.getSource();
        String text = null;

        if (source instanceof JButton)
        {
            text = ((JButton)source).getText();
            if (text.equals("Add to compilation"))
            {
                for (int i = 0; i < numberSongs; i++)
                {
                    if (titles[i] != null)
                    {
                        System.out.println(titles[i]);
                        compilationarea.repaint();
                        compilationarea.append(titles[i] + " \n");
                    }
                }

                instructionpane.setText("\n \t Ga nu naar het " +
                    "Bestand-menu en kies de optie CD" +
                    " branden. \n \t Stop daarna een lege CD" +
                    " in de computer en het brandproces \n \t" +
                    " zal van start gaan");
            }
        }
        else if (source instanceof JMenuItem)
        {
            text = ((JMenuItem)source).getText();
            if (text.equals("CD branden"))
            {
                JOptionPane pane = new JOptionPane ("U hebt de taak volbracht! \n " +

```

```
"Klik op OK om te eindigen.");

    JDialog dialog = pane.createDialog(this, "Einde taak");
    dialog.setVisible(true);

    if(pane.OK_OPTION == (int)0)
    {
        timestarted = false;
        stop = System.currentTimeMillis();
        elapsed = stop - start;
        p.println(elapsed + "\n");
    }
}

}

public static void main(String [] args)
{
    DirectiveCD dir = new DirectiveCD();
    dir.setSize(620, 600);
    dir.setVisible(true);
}
}
```

Appendix D

Experimental results

D.1 Interview transcriptions

On Friday June 15th, 2007 I conducted several empirical experiments to test my hypotheses about improved computer usability for the elderly.

This appendix contains the data obtained from the software measurements and interviews as well as a photographic impression of the experiments being conducted.

The interview questions can be found in chapter 4.

Participant 1

Female, 77

Order in which trials were presented:

1. Standard menu (SM)
2. Delayed menu (DM)
3. Keyboard menu (KM)
4. Standard interface (SI)
5. Directive interface (DI)

1. I've done steno and typing before. I haven't got much experience with computers. I know I've done the beginner's course, but I spend far too little time with the machine. There are always other necessities to attend to. I just have a slight familiarity with the computer keyboard, but it's nothing much.
2. It was sort of hard, I also felt confronted with the unfamiliarity of the experimentation software. The environment was unfamiliar. It might have been easier if it had occurred within a familiar environment, I might have known better what to do.

3. I preferred working with the mouse, and then the delayed situation. My hands are not so steady, and it creates just a little bit more time and clarity when everything happens somewhat slower.
4. Yes, I generally do not like deep hierarchical structures. I do easily tend to lose my way within them.
5. Not applicable.
6. I was very happy the instructions were there. They really helped me through the experiment.
7. Oh, they can be useful. At least they'll provide some support when you're lost or don't know what to do and there's no one at hand to ask.
8. No, not at all. I don't hate working with computers.

Participant 2

Male, 61

Order in which trials were presented:

1. Standard menu (SM)
 2. Delayed menu (DM)
 3. Keyboard menu (KM)
 4. Standard interface (SI)
 5. Directive interface (DI)
-
1. I've done telephone sales before, mostly just keeping track of the stock, drawing up offers, stuff like that. It has involved working with computers, so I do have some experience that was helpful for these experiments. My most limiting factor is my MS. I cannot use my right hand at all, so I have to do everything left-handed.
 2. The tasks weren't very hard. Working with a mouse is perfectly do-able for me. I like playing games such as Solitaire.
 3. The mouse was definitely easiest for me, since I cannot use both of my hands. To tell you the truth, I noticed no difference between the standard situation and the delayed situation.
 4. I don't mind the hierarchy. All you do sitting at a computer is searching for the right instruction anyway, so a bit more searching doesn't matter. It's mostly a matter of patience and reading properly.
 5. Not applicable.

6. Not necessarily. Okay, it's always easier if something guides you straight through a task, and gives you an improved understanding of the underlying structure, but it's intuitive enough without.
7. Not for me.
8. I liked doing them.

Participant 3

Female, 58

Order in which trials were presented:

1. Delayed menu (DM)
2. Standard menu (SM)
3. Keyboard menu (KM)
4. Standard interface (SI)
5. Directive interface (DI)

1. I currently work at TNT (Dutch post office) as a data typist. I work with a computer, but only with a single, specialized program in which I have to enter numbers. It's mostly work with mouse and keyboard. However, I do realise that when I work with other computer applications I still have trouble. I don't work with those often enough, and am not used to their way of working.
2. No, they were quite easy to do.
3. I preferred the delayed mouse navigation situation. It's just slightly easier to keep track of all the activities in the interface when everything is somewhat delayed.
4. No, they're no problem.
5. Not applicable.
6. It was certainly easier with instructions, they offer mental support.
7. Certainly, when I had to install my own laptop myself for the first time, or when I had to configure my virus scanner, I was very happy to have instructions at hand. It would be useful to have them at hand all the time, in every single application you work with.
8. No, they were kind of fun.

Participant 4*Female, 74*

Order in which trials were presented:

1. Delayed menu (DM)
2. Keyboard menu (KM)
3. Standard menu (SM)
4. Standard interface (SI)
5. Directive interface (DI)

1. I've helped in my husband's shop, advising and helping customers, and of course I've worked as a housekeeper. People often forget that's real work too! But I've never touched a computer before.
2. Actually, it wasn't that bad. I think, provided that you have good assistance, computers aren't as hard as they seem when you spend some time with them.
3. The keyboard navigation was easier for me. At least the menu's weren't flying in all directions, I felt I had much more control over the menu with the keyboard. With the mouse you have to keep track of where the cursor is, it just provides you with way too many things to keep track of, especially for the first time.
4. Yes, I didn't like that. It was difficult to navigate that deeply.
5. Yes, I am. It's just like typing, and they will become automatic actions once you do it more often.
6. They certainly helped, it was much easier with instructions.
7. Especially in the beginning, you can't just start learning how to work with a computer by yourself.
8. I didn't mind, actually I was pleasantly surprised!

Participant 5*Female, 66*

Order in which trials were presented:

1. Delayed menu (DM)
2. Keyboard menu (KM)
3. Standard menu (SM)

4. Standard interface (SI)
 5. Directive interface (DI)
1. I've done nursing and social work before. I've only worked with a typewriter, although just with one finger because of my missing arm. I have some knowledge of the keyboard, but I'm no good with computers. I've tried it twice before, and also given up twice before.
 2. No, the tasks were no trouble at all.
 3. The mouse worked much easier, but that is obvious with one arm. Especially the second time was easier, but that must have been a strong learning effect. Because you presented the delayed situation before the normal situation, didn't you? Actually I didn't notice the delay that much.
 4. When you know they're coming, you can be mentally prepared and they're not such a problem. However, I must say I'm still very much pro "the easier the better". These experiments were very clearly and logically structured, though.
 5. Not applicable.
 6. Yes, I hadn't thought at first that it was really that simple. The instructions really helped me see that.
 7. Very, very definitely. They don't even need to be removed when I get more experienced, because it's never a bad idea to have support even if you don't use it. And besides, if you don't do this on a very regular basis, you forget everything within no time anyway at our age.
 8. I really loved doing these tasks.

Participant 6

Female, 82

Order in which trials were presented:

1. Standard menu (SM)
2. Keyboard menu (KM)
3. Delayed menu (DM)
4. Standard interface (SI)
5. Directive interface (DI)

1. Before I got married I used to work at a bank, only with typewriters, but I can't say that has helped me in any way with these experiments. After that time I've done the housekeeping jobs. I've never, ever worked with computers before.
2. It wasn't that hard, my initial fears proved unnecessary, you just have to keep paying attention and look very carefully at what goes on. And you have to read properly. All you need is there in the interface.
3. The mouse is more intuitive to me. I noticed no difference between the delayed and the normal situation. The mouse can just be pushed in any direction, it seems more natural than knowing which keys to press in order to open a menu.
4. Not as long as there's someone sitting beside you, helping and giving instructions.
5. Not applicable.
6. It's certainly easier with instructions, they provide sufficient support.
7. They will help make it easier, but the importance of proper assistance may not be forgotten.
8. It's fun to do, but I will have to study this material very slowly and continuously revise it!

D.2 Numerical measurement results

Participant	TTCSN (ms)	TTCDN (ms)	TTCKN (ms)	Task order
P1	182585	123591	319523	SDK
P2	130410	88466	144207	SDK
P3	64339	149548	186324	DSK
P4	265908	275943	252489	DKS
P5	86999	199334	306264	DKS
P6	344677	549660	308165	SKD

Table D.1: Time to task completion for navigation experiment

where

TTCSN = Time to Task Completion for Standard Navigation

TTCDN = Time to Task Completion for Delayed Navigation

TTCKN = Time to Task Completion for Keyboard Navigation

S = Standard navigation

D = Delayed navigation

K = Keyboard navigation

Participant	TTCOI (ms)	TTCDI (ms)
P1	141601	72131
P2	80280	70378
P3	90708	51439
P4	209060	129780
P5	112710	66048
P6	207365	163519

Table D.2: Time to task completion for open/directive interface experiment

where

TTCOI = Time to Task Completion for Open Interface

TTCDI = Time to Task Completion for Directive Interface

Participant	Easy-to-learn	Easy-to-use	Efficient	Fun-to-use
P1	3	3	3	4
P2	4	4	4	5
P3	4	5	4	4
P4	3	3	3	4
P5	4	5	3	5
P6	3	4	3	5

Table D.3: Usability scores

Participant	Rating	Score
P1	6	3
P2	8	4
P3	7	3.5
P4	7	3.5
P5	8	4
P6	7	3.5

Table D.4: Rating for appreciation of interface mapped to a score

Participant	Initial reaction	Behaviour	Mouse/keyboard	Understanding
P1	1	2	2	2
P2	3	3	1	3
P3	2	3	3	3
P4	1	1	1	1
P5	2	3	2	3
P6	1	3	1	3

Table D.5: Scores for behavioural analysis

D.3 Experiment photographs

This is a short impression of the participants performing the different tasks. They show participants from both the beginners' computing class and the residential elderly home.

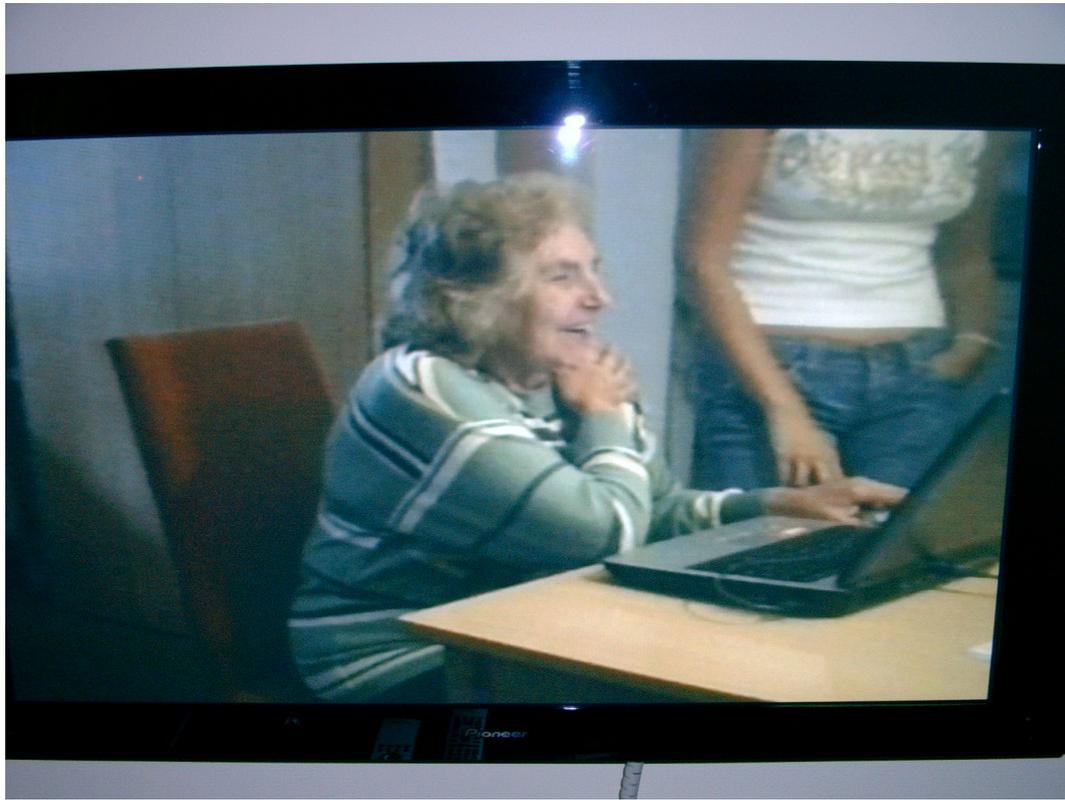


Figure D.1: Positive affect

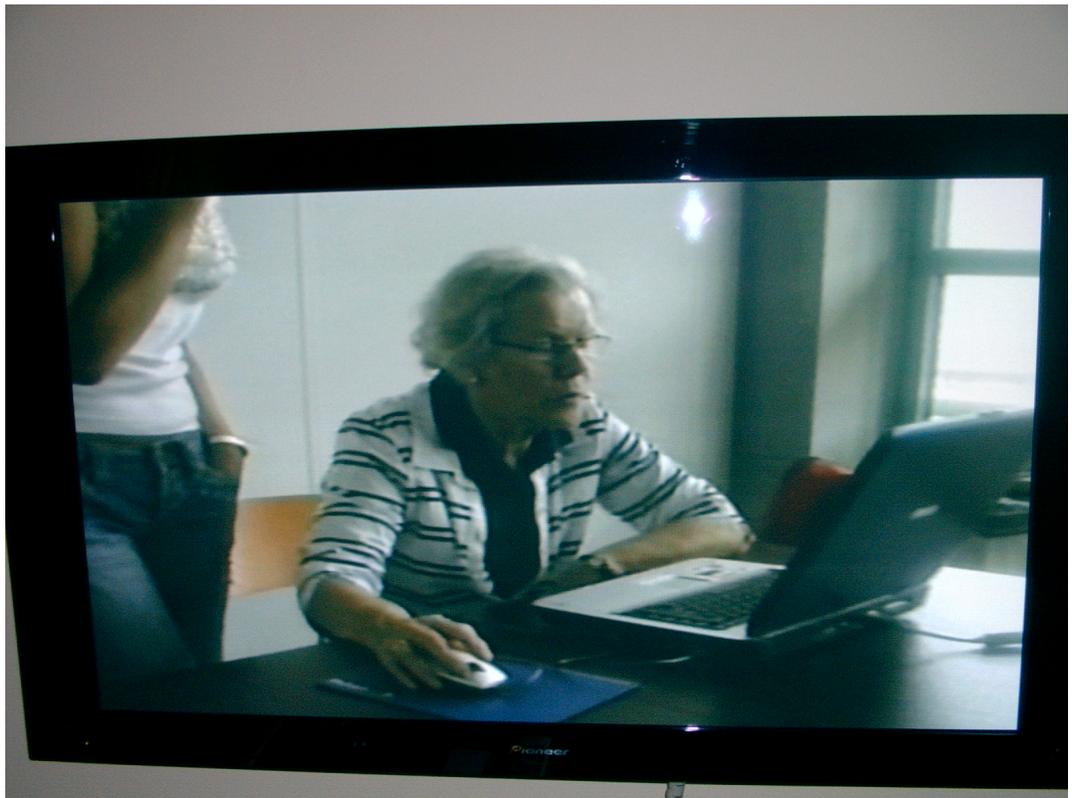


Figure D.2: Mouse navigation

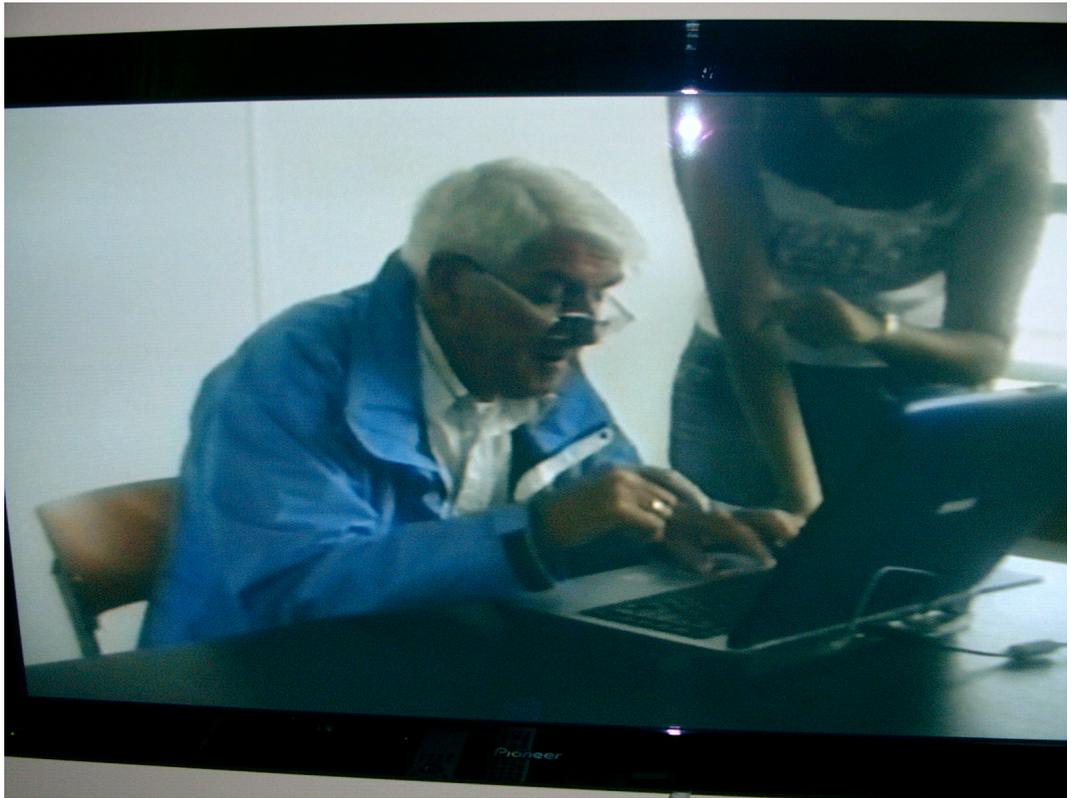


Figure D.3: Keyboard navigation