Rehabilitation Software for Aphasics

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Synopsis:

This project endeavors to create an innovative software solution within the field of aphasia rehabilitation, by combining the advantages of currently utilized applications for restoring communicative skills.

By investigating the theories and methods used in regular speech therapy, and exploring the potential of authoring systems and web based training, an online training platform for speech therapists and their clients has been developed through multiple iterations.

As a side project, the system has been examined from a business perspective, as it is the intention to launch a company around the concept.

Lastly, the product has been evaluated by speech therapists and aphasics across the country, by testing its capabilities and effect in a realistic scenario for a two month period.

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Preface

This report is written by Casper Slynge and Rene Olesen on 10^{th} semester as a master's project in Medialogy, Aalborg University and originates from the project developed by the same authors on 8^{th} semester.

The report is separated into five parts:

- Analysis
- Product Development
- Business Plan
- Evaluation
- Appendixes

The references in the report is referred to with the syntax [”reference number”, ”page number”], and can be found in the bibliography at the end of the report.

All photos, images and figures are, unless noted otherwise, produced by the authors of this report. Some screenshots and sketches presented throughout may contain Danish written text, due to the product being developed is tested on and produced for Danish people.

The terms *client* and *patient* are both interchangeably used to describe the aphasic user of SHARP, depending on its context.

It is highly recommended, that the reader watch the project videos found on the DVD in appendix C, before reading the report, as it is valuable to have a basic understanding of the resulting product, in order to better relate to the topics presented in the first part of the report. Furthermore, the reader is recommended to explore the additional material available on the DVD, such as the evaluation of the previous project, as this will provide a better understanding of the project development and evaluation.

Enjoy reading.

Aalborg University, Fall 2011 - Spring 2012

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Contents

Chapter 1

Introduction

Brain injury can affect the body in various ways, both by reducing physical proficiencies and lowering the comprehension abilities. Within this field, there exists several disorders that in some way can affect people's communicative skills. Muscles that control speech can be disturbed or development of the language can be hindered. One disorder that is quite common is aphasia, which is seen after damages to the brain, like a stroke. It is an acquired loss of the ability to speak and/or loss of language comprehension. Aphasia often occurs after damage to the left side of the brain, as this is where the speech area is positioned, which also induce that aphasics often are paralyzed in parts of the right side of the body.

Aphasia can roughly be categorized in two major subtypes. Injuries in the front will generate Wernicke's aphasia, where the expressive communicative skills are limited, while injuries in the back causes Broca's aphasia, where receptive skills are confined. Several other types of aphasia also exist, however Wernicke's and Broca's are the two most frequent. Another dynamic variable is the degree of aphasia that a person acquires, which is determined by the extent of brain damage. Small injuries can cause aphasics to have minor issues with pronouncing long words, whereas the disorder can exceed to aphasics not being able to talk at all. Due to the fact that there are so many different levels of aphasia, the rehabilitation of the disorder is a long-term process that requires many working hours from both the aphasic but also an assigned speech therapist.

Prior to any rehabilitation process, a speech therapist will assess the aphasic to clarify and determine the type and extent of the disorder. After a therapy course has been designed by the therapist, in which methods and tasks have been established, sessions will begin where the aphasic and therapist meet to complete and evaluate the given tasks. This training method is an acknowledged approach for restoring brain functions. The type of tasks that are included in a program will surely vary depending of the aphasic's state, however it may include simple written exercises like math or spelling, any kind of board game with some visual elements like memory or sound clips where pronouncement is the purpose. Even though the means may seem obsolete, it is certain that they provide a reliable and safe method for rehabilitation as they have been used for decades, however it may be questioned how efficient they are. The exercises require that the therapist and aphasic are in the same room, in order to assure that the aphasic can manage and comprehend the tasks. And even through it might be possible for the aphasic to practice some specific exercises at home, there is no way of evaluating the outcome, as the therapist can not monitor his/her performance. This point of view is not only shared by the authors, but is also assumed to be the opinion of other more technologically minded people.

Through the last 10-15 years, software applications have been developed that transfer the before mentioned means into the digital domain. This primarily involves software where prefabricated exercises have been developed, and sorted into various categories that covers the necessary areas linked with aphasia rehabilitation. This has allowed for a larger spectrum of tasks which are also more disperse in type

and has surely entailed more efficiency to the entire rehabilitation process by letting the aphasic complete prefabricated tasks at home and by letting the therapist avoid administrating all tasks herself/himself.

Even though the existing software solutions have simplified and eased the work for speech therapists and aphasics, it is presumed that they still impose some limitations. It is possible for an aphasic to practice specific types of exercises at home, however, it is still not possible for the therapist to evaluate the outcome. Moreover, even though the prefabricated tasks may be categorized in different types to fit the areas of aphasia, it can not be avoided that some of them is either too difficult or deviates too much from the requirements of the aphasic. Hence, it is presumed that rehabilitation without any supervision is still a troublesome process, even with the existing software products. Finally it is also a shared opinion among the authors, that the applications are outdated compared to the possibilities that modern computer technology provides.

This project is a continuation of previous work where a low-fi prototype of an aphasia rehabilitation system has been developed (see evaluation from previous project in appendix F). With the experience from this project in mind, which gave a thorough understanding of the aphasia disorder and the requirements and limitations that aphasics have, this project will attempt to develop a system that focus on the premises of the speech therapist. The system will include the useful elements from the previous system where aphasics were the primary consideration, but also provide the speech therapist with more freedom as opposed to existing software solutions, where the therapist has no control of the content. This is done by developing a system where the speech therapist can deliberately manage the content and presentation of each exercise to perfectly fit each individual aphasic. By doing so, it is assumed that the entire rehabilitation process can be shortened and made more efficient as the aphasic does not have to solve tasks that lies outside his/her area of relevancy. Moreover the system should be able to let the speech therapist monitor the results of the aphasics training, even when done in her/his own home.

As a side project, the system will be examined from a business point of view, as it is believed there exists a great potential within the national market, and it is the intention to launch a company around the concept once the product has been sufficiently developed. Therefore the initiating problem of this project is:

- *How is it possible to develop a software system within the field of aphasia rehabilitation that can, in practice and commercially, exceed the capabilities of existing solutions currently available?*

Part I
Analysis

This part of the report will analyze the areas that are considered to be essential, in order to answer the initiating problem.

Chapter 2

What is Aphasia

This chapter will clarify various aspects associated with aphasia and is mainly referenced by [2]. As mentioned in chapter 1, this project is a continuation of previous work. Therefore, this chapter will present the knowledge that was gained throughout the former project, while also describing the methods that are used to treat aphasia, in order to ultimately reveal a sensible solution. An anatomical approach to the disorder will describe how aphasia occurs and how it can be identified, followed by a review of the current treatment available.

2.1 Historical View of Aphasia

In the eighteenth-century the understanding of the brain was still in its early stages. At this time, the brain was only considered to manage broad concepts such as perception, intelligence and memory, in different areas. However, in 1825 Franz Joseph Gall[6] argued that the brain contains separate organs in the cerebral cortex and that each of these organs processes different mental abilities or faculties. During the following century, the arguments of Gall were debated and alternative theories were suggested, but it is generally agreed that the scientific study of the language-brain relationship initially began a few decades later with the discoveries made by Paul Broca[1][30], who was the first to demonstrate that language abilities can be affected by damages to a specific part of the brain.

During the next thirteen years after Broca's findings, two other important discoveries were made. As mentioned, Broca demonstrated that loss of articulated speech is caused by a lesion to the frontal convolution of the brain, but in 1865 Broca also discovered that language impairment is caused by damages to the left hemisphere of the brain. The last major discovery was made by Carl Wernicke[2][3], who stated that another type of an expressive disorder concerning comprehension difficulties, occurs by a lesion of the left posterior first temporal gyrus. These three revolutionary findings were contributing to the understanding and definition of aphasia as it is known today.

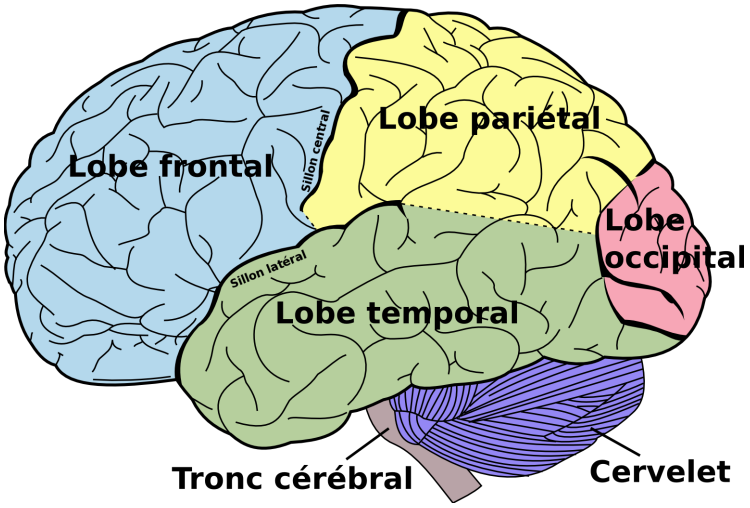
Through the nineteenth-century, the comprehension of aphasia became more complex as papers and models on the brains functionality regarding communication, language and speech were presented by neurologists and neuropsychologists. Improvements were made to the fundamental discoveries by Broca and Wernicke, leading to the understanding that currently exists.

[1] Paul Broca: French physician, anatomist and anthropologist
[2] Carl Wernicke: German neurologist

2.2 The Neuroanatomical Details

There is a common understanding to the causes of aphasia, which primarily involves brain injury that is caused by a severe impact to the head or a stroke that damages critical parts of the brain by reducing the blood flow. But how does these casualties relate to linguistic abilities? To investigate the discoveries made by both Broca and Wernicke, it is necessary to look at the brain's anatomy. Following section is referenced by [22].

The entire top part of the brain, usually referred to as the crown, is divided into four lobes, which essentially are different areas that control the sensory and cognitive functions humans possess. Although there is a considerable overlap between the functions of adjacent lobes, each lobe has its own speciality. Each lobe is assigned to perform particular tasks by processing different sensory information, motor abilities and mental functions.



[22]

Figure 2.1: *The top part of the brain (the crown) is divided into four lobes. Each of these lobes has different functions and performs particular tasks.*

Lobe frontal, the biggest of the four parts as seen in illustration 2.1, is where people focus their attention and coordinate nearly all functions of the rest of the brain. The front lobe is used to focus on desires, create ideas, make conscious decisions and manage similar attributes that give free will. The area behind the front lobe is called the parental lobe. It processes sensations, such as touch and the sense of navigation, while also coordinating some language functions. The temporal lobes are symmetrically placed on the left and right side of the brain, and handles the perception of impressions. It is largely connected to learning, language and memory. The rearmost part of the crown is called the occipital lobe and is the visual processing center of the brain. It deals with handling the data from the outside world and gives the ability to discriminate between colors and perceive motion.

In general, the motor speech area (expressive speech centre) is located in the frontal lobe, and handles the expressive features of communication such as speak, body language, writing etc. The sensory speech area (audioverbal centre) is divided across the parietal and temporal lobe, and gives the ability to understand context and comprehend the various associated input. However, it should be noted that areas associated with communication varies from person to person. For right-handed people, the speech center is most likely located in the left hemisphere, and for left-handed people, it may be in either the left or right hemisphere, even spread over both.

The complex structure of the brain complicates the neural organization of language. Our communicative

skills depend on processes that take place in various parts of the human nervous system, which means that the abilities to speak, perceive and understand language are spread between the main lobes, and it is therefore difficult to map an injury to a specific part of the brain, as neurons in all areas can have been affected. There are, however, means of estimating the lesions' location based on the patients symptoms.

2.3 Assessment of Aphasia

In general, aphasia is defined as the impairment or loss of language caused by brain damage. It is a complex disorder, however, many aphasic patients are clinically similar and fall into the same identifiable groups. Clinical exploration of aphasia, to ensure whether or not a person has aphasia and also which type, will in most cases include:

- **Spontaneous, conversational speech:** The clinicians will listen to the patient and have conversations where they ask them simple questions. They will then determine the fluency of output, effort, articulation, phrase length, etc.
- **Repetition:** The patient is asked to do repetition of single digits in the beginning and hereafter increase the difficulty of what is to be repeated.
- **Comprehension of spoken language:** In this process the clinician will try to determine the patient's ability to understand language. Depending on the amount of impaired speaking, questions, that are comprehensible for the patient, will be asked.
- **Word finding:** The patient is asked to name different objects that are in the room.
- **Reading:** To determine the patient's reading skills, she or he is asked to read from e.g. a book or magazine. If this ability is totally impaired, the aphasic can begin by reading names and single words.

2.3.1 The Boston Classification System

Throughout medical history, experts in the field have been applying different terminology and several definitions to classify the various types of symptoms seen at the patients, and nowadays, one of the more acknowledged definition methods is the Boston Classification System.

The Boston Classification System recognizes aphasia syndromes in seven different classes that each describes a lesion in a certain area of the brain. These are listed in table 2.1 with other characteristics for each class. The three major types are Broca's, Wernicke's as previously mentioned, and Global aphasia that is a mix between the two others. These are considered the major types as their lesion locations covers the two main centers of the brain. The remaining four, as listed, only relate to pathways connecting the crucial areas.

The 'type'-column lists the names of each class in the Boston Classification System. Hereafter, the lesion's physical location is described. The fluency indicates if the patient has a normal and fluent pronunciation of words and sentences. If not, the pronunciation is usually stuttered and not understandable. A good comprehension means the ability to understand new impressions and put words and objects into context. Repetition covers the patient's ability to reproduce a word or a sentence, which is, as mentioned, used to determine both his/her expressive and comprehensive difficulties.

For instance, individuals diagnosed with Wernicke's aphasia, also known as *receptive aphasia*, have a fluent speech and may speak in long sentences that neither have meaning nor contain real words. With

Type	Lesion	Fluency	Comprehension	Repetition
Brocha's	Expressive speech centre	Nonfluent	Good	Poor
Trancortical motor	Pathways connecting concept centre to the audioverbal centre	Nonfluent	Good	Good
Global	Both audioverbal and expressive speech centre	Nonfluent	Poor	Poor
Wernicke's	Audioverbal centre	Fluent	Poor	Poor
Trancortical sensory	Pathways connecting audioverbal centre to the concept centre	Fluent	Poor	Good
Anomic	Pathways connecting concept centre to the expressive speech centre	Fluent	Good	Good
Conductional	Pathways connecting audioverbal and expressive speech centre	Fluent	Good	Poor

[11]

Table 2.1: *Characteristic features of aphasia according to the Boston Classification System.*

their poor comprehension, it is both difficult to understand the speech of themselves and others and are often unaware of their mistakes. Repetition and reading aloud are also impaired, but the essential disability of Wernicke's aphasia has always been the comprehension.

Contrary, Broca's aphasics have difficulties putting together long sentences and usually speak in sentences that are very short. However, those classified as Broca's will normally be able to read a book and follow a conversation because the comprehension is not damaged. Broca's aphasia is also known as *expressive aphasia* due to the shortage of both written and verbal expressions.

In some cases, Broca's aphasics can have minor trouble comprehending as well. For instance, Broca's aphasics usually have difficulty understanding reversible sentences such as "*George is looking for John*" where the order of the words are important, and also sentences in which the grammatical subject is different than the logical subject, e.g. "*the dog was bought by Mary*" where the dog is the grammatical subject, but Mary is the one who bought it. These examples are no different whether the patients tries to comprehend it by reading or through audio.

Global aphasia is considered a mix between Broca's and Wernicke's, and is diagnosed when both of the lesion locations are affected. This type of aphasia is the most severe, as it affects both the expressive and receptive capabilities of the patient. Unfortunately, this is the most common type in the acute period affecting as many as 25-32% of aphasics, while other classic types described with the Boston Classification System are seen less frequently.[11]

Considering these three types, there obviously is a vast difference between the behavior and symptoms of each aphasia patient. Diagnosing a person who is recently afflicted can be difficult, as some of the symptoms might wear off over time, in a case where the brain is able to recover on itself (to a certain degree). Therefore, the amount and type of treatment assigned to the individual patient should be carefully considered.

2.4 Treating Aphasia

There exists multiple forms of treatment for aphasia patients and the most effective means of treating aphasia has yet to be determined. Before World War 1, the amount of treatment that was reported were at its minimum. Between World War 1 and 2, aphasia therapy still remained an uncommon process, however after World War 2 the interest of rehabilitation for aphasics grew and therapy was practiced in more and more countries, but the amount of published work from speech therapists was still low. Anna Basso describes the problem the following way:

> *"Retracing the history of aphasia rehabilitation is a difficult task. Neuropsychology lies at the intersection of many disciplines among which are neurology, psychology, linguistics, and psycholinguistics and has benefited from scientific progress and new ideas in each of these disciplines. Hence, in reporting on changes in aphasia rehabilitation, one must also comment on new ideas in these fields. Furthermore, the history of rehabilitation is closely interwoven with the history of the studies on its effectiveness, and many researchers have been more interested in demonstrating the efficacy of language rehabilitation (independently of how it was carried out) than in the rehabilitation process itself. For their part, speech therapists have not been very keen to publish the results of their experience."*[2]

Even so, within the last 20-30 years some have still tried to cover the historical work within the field of rehabilitation[8][31][23]. In 1935, Weisenburg and McBride published their book *Aphasia: A clinical and psychological study*[27], which presented some of the methods and tests that are still used today. They were the first to use standardized tests (a test where all participants receive the same test and where conditions, questions and scoring procedures are consistent) for evaluation of aphasia and presented verbal tests such as naming, repetition, spontaneous production and comprehension. Furthermore, verbal intelligence tests such as finding opposites and analogies were conducted. Moreover Weisenburg and McBride proposed that a rehabilitation program for a patient should be adapted to the individual, taking the patient's interest and type of aphasia into account.

As mentioned there exists various approaches that can be utilized in the treatment of aphasia patients. Anna Basso explains six different approaches in detail, however this project will only focus on one, *the Luria approach*, as this unifies theory and practice in a therapeutic system. Additionally, this approach is used by the speech therapists that the authors have cooperated with, and is an acknowledged technique in the field of communicative rehabilitation.

2.4.1 Luria's Approach

The Luria approach[17][1] is generally seen as a coherent therapeutic system. The fundamental aspects of the Luria approach is that a patient either has temporary loss of activity in some brain areas due to damage to brain tissue, or the brain tissue is so destroyed that the damaged functions are irreversible and can never be restored. But in both scenarios, Luria does not think that the patient should adapt to his or her defects. If the damaged functions are irreversible, the therapy must be reorganized to have the functions transferred to other parts of the brain. The defect functions must be reconstructed by creating new functional systems by using other undamaged parts of the brain. The essence is therefore to identify which areas that can used instead of the damaged ones, so the defect functions can be retrained by using another strategy. For instance, if a patient has problems visually recognizing isolated letters, a suggested strategy to overcome this problem is to have the patient trace the contour of the letters with a finger and then remember the movements that have been made. This has proven to be a successful method for the patient to recognize the letters.

Another essential aspect of the Luria approach is to change the intensity of a program as the patient is developing his or her defect functions, a process also referred to as ontogenesis. For example when a child learns to read, the reading is initially limited to letters and short phrases until she/he gradually improves until it is an automated process. The same is valid for aphasia patients. The rehabilitation of a single function such as reading or naming should initially be divided into small tasks that the patient is able to perform until she/he is able to proceed to more difficult tasks.

Finally, Luria states that it is important, always to provide feedback to the aphasic. Feedback will allow the patient to evaluate on the task that has been completed and to motivate him or her to become better or make corrections. To give a summation of the Luria approach, a research has been described by

Tsvetkova[28]. A patient with dynamic aphasia (a type of aphasia from the Luria classification) has well-preserved comprehension, naming, reading and writing but has issues when it comes to initiating speech and spontaneously generating verbal output, so the patient is unable to express himself or herself fully. The Luria program includes levels of tasks with several steps in each:

1. The patient is asked to look at a picture
2. Divide the picture into meaningful parts
3. Indicate which parts of the picture that are connected
4. Review all the preceding steps
5. Lay out a number equivalent to the meaningful parts of the picture
6. Say a sentence, associated to the parts, aloud

All the above steps must be repeated until the patient is capable of describing a simple picture with a short sentence, whereafter a more complex picture is used. When second level is initiated, a written text is used instead of a picture. By the end of the program, the patient should then be able to quickly initiate a sentence made by himself. The Luria approach can be practiced in various contexts, and while the procedures are executed correctly the choice of means are insignificant.

2.4.2 Recovery Methods

Depending on the type of patient, the type of aphasia that he or she suffers from and the defect function/activity that is being recovered, various tasks and methods can be applied in the rehabilitation process. In some cases the patient is not in need of any speech therapist because the person concerned can have a spontaneous recovery, but most often a speech therapist is assigned to a patient whereafter they meet at sessions with a variably time interval, depending on the comprehensiveness of the patient's disorder. Regardless of the patient's state, it is, however, proven that the intensity of the therapy has a great influence on the recovery of a patient.[24]

The set of tasks and activities a patient must go through, depends entirely on the therapist's assessment and diagnosis of the individual patient, but there are some general activities that are utilized to treat aphasia. The most common activities and tasks are spelling, naming, repetition, writing, reading, recognizing etc. but often it is necessary for the speech therapist to use tools that can simplify and ease the task for a patient. One tool that is often used includes picture cards of daily living and everyday objects. With these the patient can easier relate to the object, which helps him or her e.g. naming it or spelling the name. Another used tool is workbooks with CD's where the patient can practice his or her reading, spelling and other skills. Traditional games such as memory and other casual activities are also applied in the therapy to provide it with a motivational factor.

Although the type of treatment should be carefully considered for each individual patient, it can not be neglected that any type of activity that involves brain activity and encourages the patient to engage in neurally stimulating challenges is bound to result in improvements. However, it can be questioned whether there exists a more engaging solution to this stimuli, which can also heighten the speech therapist's involvement in how the challenges are configured. A goal which can be reachable, with modern technology.

Previous statements from therapists indicate that their patients usually belong to a generation that was not brought up with the computer, and therefore, they feel a sense of safety and reliability with pen and

paper exercises. If they are not used to the interactions through mouse and keyboard, they will definitely not appreciate the solutions offered by the computer after the casualty. However, the technological development is in such rapid progress that even the older generations utilize the technologies and devices that are available nowadays. Simultaneously, computer interfaces are becoming more and more intuitive and user friendly. These trends indicate that we are currently experiencing a generational shift where virtually everybody has been exposed to computer interactions at some point in their life. This gives incentive to develop a digital system that, as long as it is easy to understand and can be mediated on an intuitive platform, will be accepted by a large majority.

There exist much potential in developing a piece of software that can support, or even replace the existing tools and methods. With the dynamic nature of the computer, and the considerable possibilities of the Internet, it should be within reach to develop a system that betters the rehabilitation process but still uses the traditional approaches, such as the Luria approach. In order to innovate the current rehabilitation methods, the pros and cons of currently available software solutions should be determined. This is done in the following chapter along with a summary of the previous work made in the 8th semester.

Chapter 3

Related Work

3.1 Summary of Previous Work

Aphasia is quite common, as up to 3000 people gets it every year in Denmark alone. The rehabilitation of the disorder is done several places in Denmark and a lot of money is spent by the government on it. However, the means that are used to treat aphasics does not bear the mark of these amounts. This was discovered by the authors when a project proposal was presented back in February 2011, at the beginning of a 8th semester project. The proposal involved developing a social digital environment where aphasics could interact with each other and manage various tasks together, in order to restore their communicative skills.

After a short period of research and brainstorming it was decided to work within the area of aphasia rehabilitation, however, due to limited time and study requirements, it was with another project than the one proposed. Through research it became apparent that there exist an unexploited potential within aphasia treatment as the existing means that are used, are obsolete and does not meet the possibilities that today's technology deliver. These include written exercises, simple board games like memory and other games with pictures, words, etc. and some software solutions that either have not been updated for several years or does not exploit todays software opportunities. It was therefore chosen to develop a software solution in the effort of heightening the motivation and efficiency of aphasia therapy. A prototype was designed, by transferring the methods of traditional therapy into the digital domain. The product should be able to compete with existing means, such as the examined software solutions (further examined in section 3.5) and hopefully be able to substitute such. Several aspects were considered during the creation of this, while multiple observations were made regarding the aphasia patients' ranging capabilities. The initial research carried out gave insight in the target group's proficiencies and disadvantages, which occasioned the first iteration of the product.

3.2 Initial Prototype Test

The target group included mainly aphasia patients, since the purpose was to evaluate their requirements when utilizing a new product in a domain that may not be too familiar to them. Initiating the development of the product, a low-fi evaluation was designed prior to any implementation, in order to visualize the early ideas to the target group, and obtain their immediate reactions to these. This was done in cardboard and paper, both to lower the production time and to ensure it was presented in a relatable medium, compared to a digital prototype.

An interface was sketched out with paper clippings, prints and cardboard to represent how the final interface was intended to function and look like. This included scene backgrounds, particular graphical elements and several exercises for the patients to solve. The exercises were based on previous examples seen in regular aphasia treatment courses, and were divided into different difficulty levels to get a sense of the target group's general competence level. Another preceding considerations was to motivate the user though a reward system, by earning a diamond for every correct answer.

The test took place at Hjørring Sygehus on March 2nd, 2011, with a cooperating team, consisting of three aphasia patients, all aged above 50 years old with three to four years of rehabilitation, and a speech therapist, Pia Høgh, who supervised the entire evaluation. Each patient was asked to work out a series of exercises, which were presented to them on a flat table, yet simulating a computer interface controlled entirely by mouse clicks, performed as finger presses. After the practical experiment, each patient was interviewed towards his background, immediate thoughts and experience with the test. Pia Høgh was also asked some questions regarding her professional apprehension of the idea. The feedback from the prototype test provided the authors with knowledge on how to develop the actual product, but also knowledge about aphasics and the disorder.

3.3 Prototype Implementation

With the product design, heavily based on the results of the initial experiment, the prototype was implemented as a Javascript application in Unity. Unity offers plenty of freedom to the programmer by being very high ordered with an intuitive "drag'n'drop" interface, while allowing customization of individual objects by applying scripts to them, across multiple coding languages. It also compiles projects compatible to several platforms, both stand-alone applications for Windows, Mac OSX, iPhone, Android and also for browser integration. This gave rise to make a CD version for patients with a home computer, as well as a smartphone app and an online version to use elsewhere.

The tool itself offered features that was supposed to deliver a unique experience to the aphasic. A graphical interface (see figure 3.1) was produced to make this software stand out from the rest, and virtually everything was explained through speech, delivered by an avatar that assisted the user through each level. To heighten the motivation, the objective of the levels was to collect as many diamonds as possible. This was meant to give a feeling of achievement, and remove focus from the educational aspect, but rather present the tool as a source of entertainment and challenges.

A side study was conducted, to evaluate the difficulties aphasia patients may experience when using a computer interface, as communicating through a mouse and keyboard may be a hindrance for some patients. A setup was built to simulate a touch screen interface, by mounting a camera and a projector above a regular table, and functioning as a computer vision system that tracked the user's finger movements. This should remove the nuisances of the barrier created by a PC interface, and presumably, this would also help the patients focus more on the tool itself rather than the controls.

The main considerations, when creating the graphics and functionality of the game, were these:

- In order to broaden the difficulty level, the amount of exercises was increased compared to the initial idea. Six different task types was designed, each with five levels of difficulty, resulting in 30 exercises. Some of these difficulty steps had multiple exercises to choose randomly between, resulting in a total of around 50 unique exercises that had to be produced

- Each exercise should tell the patient his/her objective, and offer the options of repeating this, as well as restarting or skipping the current task

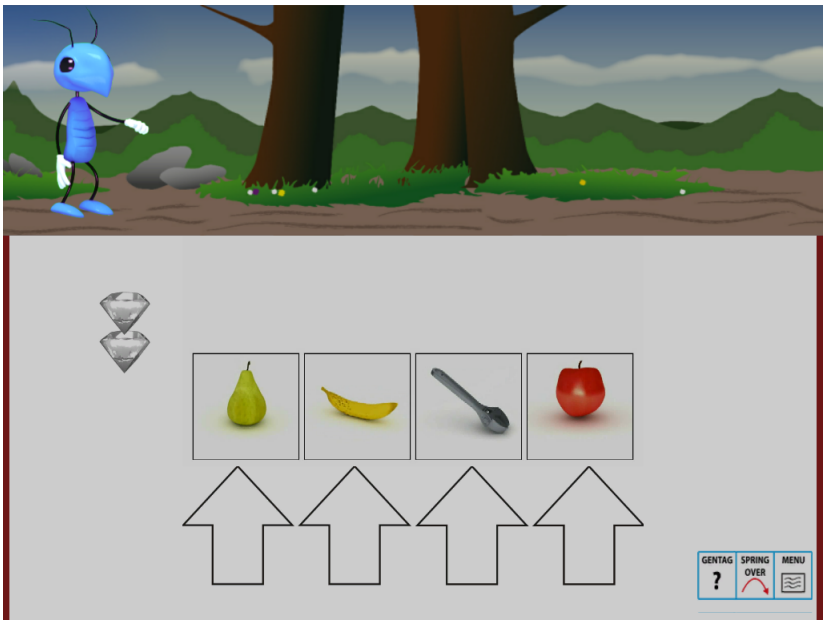


Figure 3.1: *The prototype of SHARP was designed to deliver an enjoyable and unique experience to its users. This was achieved by implementing a high amount of visual elements, such as a running avatar in a scenic environment, and animated answer choices.*

- An avatar, with the purpose of guiding the user through each level, was placed in the top of the screen where it would traverse a scenery and collect diamonds for each correct answer
- The visual style of the game should resemble the one applied in the initial concept, which was fluently created through a creative process. The lack of feedback on this aspect in the initial experiment did neither indicate any diminishment nor advantage to the experience when using the cartoonish style
- With the possibility of animating objects, it was considered beneficial to create a series of 65 3D models and make them rotate in a looping animation. This was thought to heighten the perception of the objects, as all sides of the object would be visible at one point

3.4 Prototype Evaluation

The final evaluation of the prototype was conducted at Aalborg University on May 5th, 2011, and included the same three aphasia patients and speech therapists as the first experiment (section 3.2). Each individual patient was asked to solve all 30 tasks the tool offers, which was monitored by an experimenter and supervised by Pia. Afterwards, the patients and Pia were individually interviewed with a series of questions concerning this version of the product. Their feedback gave some new input:

- One of the patients who had difficulties in the initial prototype test, experienced problems in this as well. If it was to be used by aphasics, without assistance of others, this fact could indicate that the level of guidance should be heightened even further.
- The difficulty level seemed broader to the two other patients, although they managed to solve almost all tasks with only minor assistance. But as these were on such a late state of rehabilitation,

it could be questioned whether they should denote the standard of all aphasics. Therefore, it would probably be more fitting to newly deceased.

- Regarding the interface side study, it became evident that aphasics usually use computers in their rehabilitation, with minor difficulties. This means that the interface barrier should not be a concern in further development. And even if the patient are not familiar with a computer, Unity can as mentioned compile to virtually any thinkable platform, which includes touch screen tablet devices and such.

- The visual appearance did neither seem to catch the patients' attention this time around. At most, the avatar could appear as an annoyance between the exercises, and did not exactly heighten the experience as intended. It could be argued that it was quite superfluous.

- The choice of animating each object turned out to be a bad idea, and frankly a waste of time. Although the 3D objects tended to look realistic, the degree of detail was not sufficient in some instances. This caused unnecessary confusion, and Pia advised to use traditional photographs to represent each object.

- Motivating the patients by having them collect diamonds turned out to be a successful strategy, as two of the respondents asked to try the few tasks again they failed the first time around, to reach the maximum of 30 diamonds. This indicates that, although being practically worthless, the diamonds can incite an urge for completion, even in a realistic scenario.

In conclusion, the prototype developed could function as an independent tool that would give an enjoyable experience for aphasics, however, it would probably not be successful as a stand-alone application that could be integrated in a rehabilitation course. It does not allow the therapist to monitor the patient's progress, nor does it provide any communication between the two. Furthermore, although the amount of tasks could be extended, it would still not ensure that the challenges are adapted to the user's requirements as she/he progresses through the rehabilitation process.

After the work in the 8th semester, it was obvious to the authors that the earlier mentioned unexploited potential was not yet taken advantage of. It was therefore decided to continue working within the field of aphasia rehabilitation and develop the product further on the current semester. The first natural step was to reconsider the approach by comparing this prototype to others on the market, with the new findings in mind.

3.5 Existing Products

One of the primary motivations for this project was the low amount of products designed for speech rehabilitation on the market today. Besides the paper exercises and board games, it seems as if the market lacks available alternatives. It could be claimed, that even those who have tried to develop modern solutions for speech rehabilitation do not seem to have the sufficient functionality, nor do they consider the aphasics' reduced comprehension level. Therefore, therapists tend to stick to the traditional one-on-one sessions with memory games and exercise books.

An example of a rather successful Danish piece of software is *Afasi-assistent*[5] by COGNIsoft. It is a Windows application, developed in 1997, which fully employs the technical features available at the time. The patient or institution would buy a license, and receive a CD-rom containing a series of predefined exercises with a layout that resembles the picture cards and words that are seen in the written exercises. Unfortunately, it must be acknowledged that the technology has surpassed the functionality of

this software, and it can be claimed that it is now possible to raise the patient's qualitative experience by utilizing the computer's various advantages.

Another rehabilitation utility designed for aphasics is *Aphasia Tutor*[25], developed by Bungalow Software (USA) in 2005. Overall, it is similar to Afasi-assistent, with the ambition of helping patients work independently at home. Additionally, Aphasia Tutor offers a larger range of exercises. It operates with packages, where the patient or institution buys packages containing 700 exercises each of one type ("Word retrieval", "Numbers 'n sounds" etc.). It is apparent that this piece of software was published later than Afasi-assistent, as it meets a higher technological standard, by utilizing audio and higher resolution graphics.

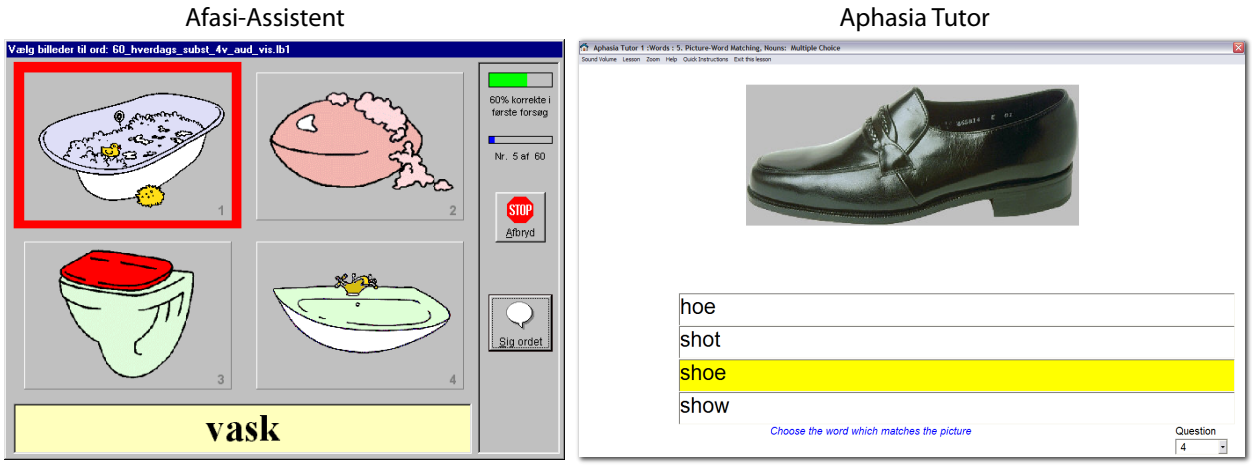


Figure 3.2: *Both Afasi-assistent (left) and Aphasia Tutor (right) exhibit a simplistic interface that strives to minimize the confusion for their users. This is achieved with large fonts, buttons and images in the main focus areas.*

When solving exercises, both of these programs are suitable for aphasics because their interfaces are easy to understand and can hardly confuse the users (see figure 3.2). This is mainly due to the setup of the various elements; the text boxes are large enough to read, even with impaired vision, and the images are represented as clear as possible without a disturbing background. It brings focus to the important areas of the screen, and decreases the amount of distracting entities. However, being restricted to the patient's or therapist's local machine, it is difficult to evaluate the progress made when the aphasic uses them by himself/herself, e.g. for home exercises.

The Danish speech therapist, Pia Høgh, who collaborated with the prototype development of SHARP, is associated with a more innovative platform for aphasics called Ansigt-til-Ansigt (Face-to-Face)[20], which started its development in 2001 and was finished late 2003. What makes it innovative is that, instead of being a standalone program, it operates as an online forum which allows speech therapists and aphasics to communicate through threads. It also features an exercise builder, giving the therapist a certain degree of creative freedom regarding the difficulty and general design of each task. The opportunity to create threads and debate topics openly, can supposedly raise the aphasics' communicative skills as it entices the patients to participate in discussions. Unfortunately, the interface of Ansigt-til-Ansigt only seem to apply to people with some computer experience, and does not exactly classify as a simple layout.

While the SHARP prototype distinguish itself from Afasi-assistent and Aphasia Tutor in its graphical presentation, compared to Ansigt-til-Ansigt, the three former can be considered similar in their execution. Out of all four tools mentioned, the authors consider Ansigt-til-Ansigt the most helpful tool for aphasics, both for its innovative choice of platform and its social approach. However, this system contains an obvious flaw, which is the unintuitive interface. It can be claimed that neither aphasics nor speech

[29]

Figure 3.3: *Ansigt-til-Ansigt offers a social experience to raise the user's communicative activity, but as this profile page shows, the interface is not created for people with limited computer experience.*

therapists can be expected to possess the technological competences required to employ this system. It is built on a framework that is not designed to be used for this purpose, and certainly not for aphasia patients. This statement is backed up by a review[19], made by *Det Digitale Nordjylland*. Although they will agree the forum has shown successful results in some instances, they write:

> *[Translated] "For some of the users it was difficult to relate to the various programs - video conference, e-mail, internet, tasks and chat."*

Ansigt-til-Ansigt is currently an integrated quote from Taleinstituttet for aphasics, however, it is apparently so difficult to comprehend for non-experienced users, that it is necessary to train speech therapists in order to use it correctly. This gives reason to produce a more intuitive interface to have the therapists approach the software with a better overview, and thereby give a more enjoyable and efficient experience.

Instead of restricting SHARP to the aphasic's machine, it could be lucrative to keep the possibilities and structure as simple as possible, like the stand-alone versions described, but maintain the networking aspect and flexibility of Ansigt-til-Ansigt. However, to avoid confusion, the networking should not consist of e-mail correspondences or chat windows, but a simple, integrated functionality to connect the therapists with each other, without being a nuisance to them.

Looking at the foreign market, a luminary product called Scientific Brain Training PRO[1], created in collaboration with Happy-neuron.com, delivers this intended functionality. It is an online platform developed for professionals that facilitates interactive games and challenges to stimulate and rebuild cognitive functions. The website presents a list of benefits, both for the patient and therapist. The patient's benefits includes ”engaging”, ”at home participation”, ”satisfaction” and ”easy to use”, which is achieved with validated exercise designs, reduced travel time (personal sessions) and minimum configuration. The first entry on the therapist's benefits list is that the program is ”patient centric”, as it allows the therapist to ”easily customize, prescribe, monitor, guide and communicate to ensure patient engagement and positive outcome”. In general, this platform is very focused on the patient's experience, and the therapist has the ability to alter and monitor the patient's rehabilitation course. It is divided into two separate portals, respectively for the client and the therapist, each possessing different structure and relevant functions. Scientific Brain Training PRO has not been designed specifically for aphasia rehabilitation, and neither allows the therapist to fully administer the contents of the rehabilitation course. Despite this, SHARP will strive to achieve a corresponding system with a similar patient-therapist connection and attempt to achieve the same advantages delivered by their platform.

Another interesting product on the foreign market is Tell Me More[2]. It is an online educational software that teaches a variety of languages through exercises. It can be accessed from any computer system, and is continually updated by the publishers. But despite being developed for teaching languages, it is used for educating aphasia patients as well, even in Denmark. This is interesting since, besides proving that Luria's approach (section 2.4.1) works in practice, it could indicate that there in fact exists a demand for a field specific software that is designed for aphasia patients.

Both of these foreign products possess the trait of freedom and convenience for the patient, as their only requirement is web access and a browser. However, the therapist's influence on the course seems to be neglected. Scientific Brian Training PRO does allow the therapist to change certain variables in the routine, but it lacks the sandbox aspect of being able to taylor the exercises accordingly to the individual patient, which is considered to be essential to a qualitative rehabilitation. The next chapter will investigate how to develop a system that covers this functionality and the possibilities it entails.

[1] Scientific Brain Training PRO: http://www.scientificbraintrainingpro.com/
[2] http://www.tellmemore.com/

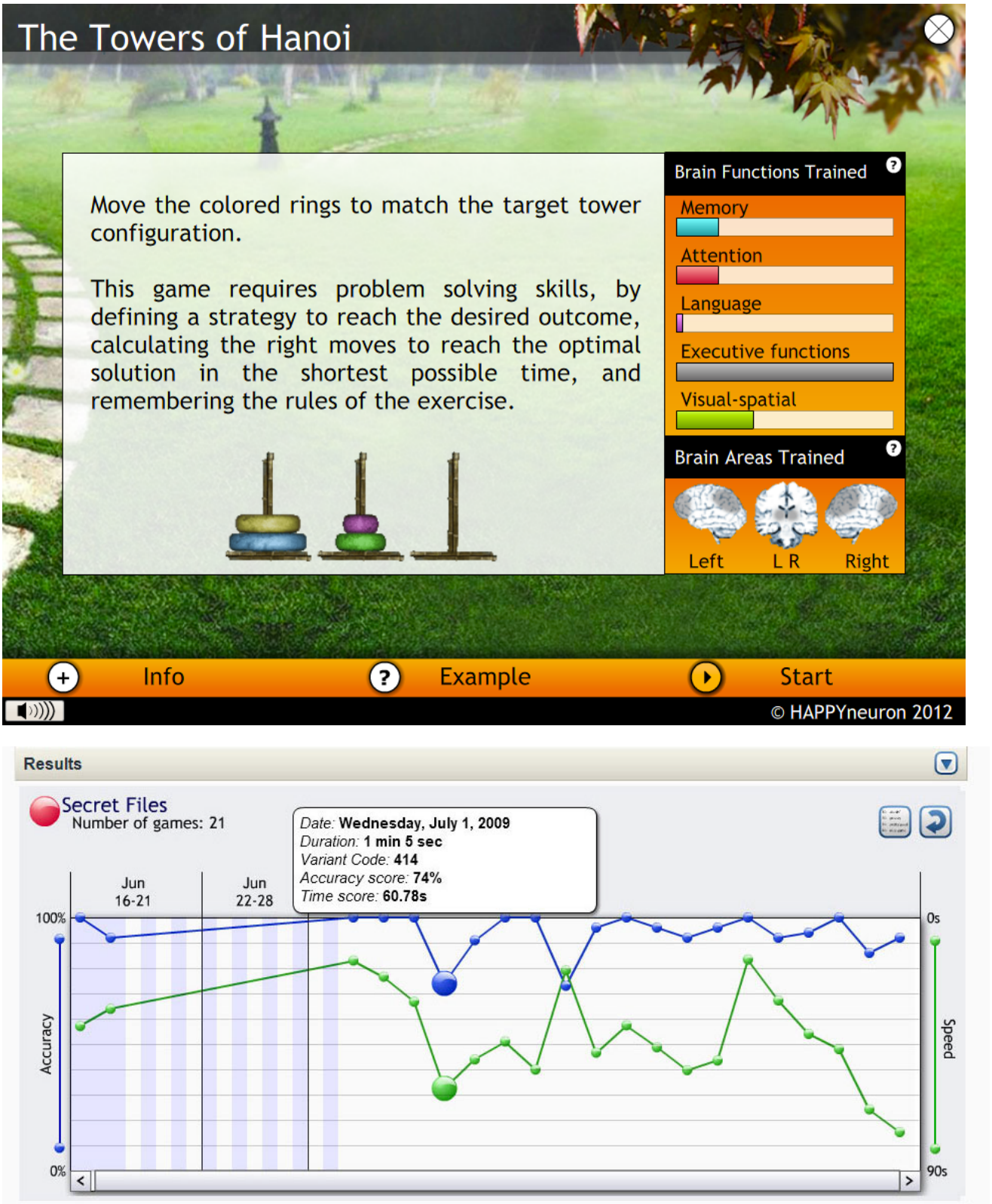


Figure 3.4: *Scientific Brain Training PRO is divided into two portals. The top image is a screenshot of the client's interface, presenting an example of a task, while the bottom image displays how the therapist can monitor the client's progression and results.*

Chapter 4

Developing an Online Educational System

As the former chapter concluded, the new version of SHARP should deliver the functionality of networking by creating a communication link between the system's users, as seen in Ansigt-til-Ansigt and Scientific Brain Training PRO. Simultaneously, it should be intuitive to use, whether it is a therapist or a patient sitting behind the screen, which the minimalistic interface of Afasi-assistent and Aphasia Tutor seem to achieve. Finally, to heighten the therapists involvement with what the client is exposed to, it is the intention to focus more on the premises of the speech therapist, as it is believed that this will make the therapy course more efficient. In order to do so, it is considered valuable to investigate the concept known as *Authoring system*, and which considerations should be taken during the development of it.

4.1 Introduction to Authoring Systems

According to Greg Kearsley's[1] definition[12], an authoring system is a system that provides the user with a small number of high level commands, which can be used to present text, process answers or specify branching logic. It is a collection of macros that translate statements into a target language and creates a user-friendly layer on top of the basic programming structure.

Kearsley describes an early example of a macro-based authoring system which involves lessons and courses shared between "the author" and a student, in a similar fashion as SHARP. He states an example of what a macro could look like:

```
IF CORRECT THEN PERFORM
  DISPLAY MESSAGE  C251
  PAUSE 10 SECONDS
  IF CORRECT > 12
    THEN GOTO LESSON 2
END
```

And follows up with:

> *"These macros eliminate the need for an author to specify details such as screen coordinates, loading of counters, screen erasure, branching labels and many other parameters typically required by author languages."*

So the purpose of an authoring system is to create an environment that conceals functions and irrelevant information, and prevents the users (authors) from dealing with unnecessary issues. Thus, it does not

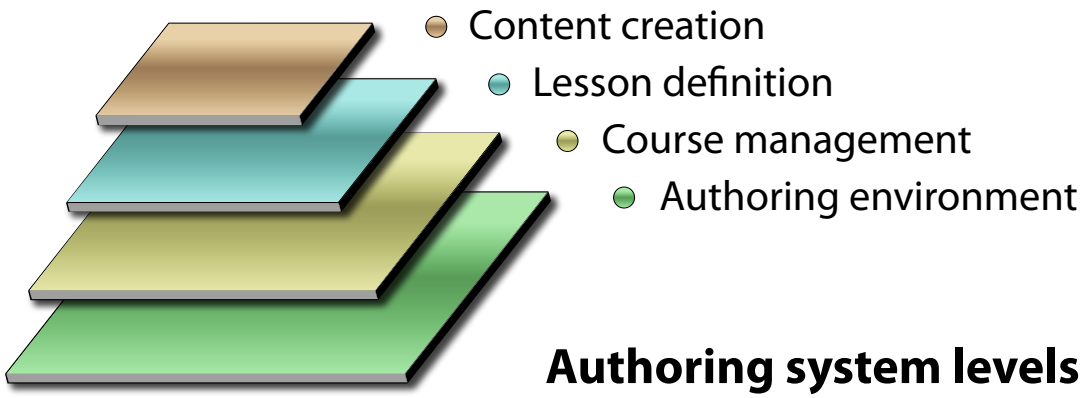
[1] Greg Kearsley: Independent consultant specializing in online education.

specifically allow its authors to create new software, but rather, as he puts it: allows programmerless creation of courseware. He believes that authoring systems have been developed to achieve three major goals:

1. To make it possible to develop computer-based curriculum without the need to learn a programming language
2. To reduce the time and cost associated with courseware development
3. To increase the transportability of courseware

4.2 Four Levels of an Authoring System

In Kearsley's article, he furthermore claims that regardless of the kind of interaction an authoring system involves, it requires a minimum amount of general features in the courseware development process. Illustration 4.1 depicts his description of the four levels an authoring system may exhibit.



[12]

Figure 4.1: *Authoring system levels. The levels are nested to illustrate that, although they are separated into four different layers, they each have an impact on the others.*

The top level, content creation, represents the minimal capability required by an authoring system, and refers to the input, formatting and modification of text, graphics, audio or any other information that will be displayed or stored in the system. It could be as simple as a text editor, or as advanced as a graphics or speech synthesis subsystem. The type of content creation possible has expanded with technology, progressing from terminal "typewriter" line-by-line input/output, to color screens with dynamic fonts and graphics that can render video, music and speech. Therefore, there is a large range of possibilities when creating a "lesson editor".

The second level, lesson definition, has to do with specifying the structure of individual lessons, and how the system is instructed to behave when a lesson is executed. These instructions could involve the presentation of the lesson or information, how the student's response should be processed and what branching sequences should be executed afterwards, like storing the result, redirecting to another lesson etc. This will of course require the author to indicate what counts as a correct and incorrect response, and possibly also which feedback should be given in either case, however, the author would not be expected to worry about formatting details as the authoring system would automatically do this.

The course management level refers to the overall functionality to change global parameters that affect all the lessons comprising a course. Kearsley specifically mentions that the course management level could allow the author to define or select:

- A particular instructional strategy (e.g. drill, quiz, tutorial etc)
- The specification of response data to be collected
- The capability to try out a lesson just created
- The control options available to the student
- The capability to document lessons and courses
- The capability to translate a course into a specified target language

Fundamentally, this level allows the author to manage the progression of a particular course.

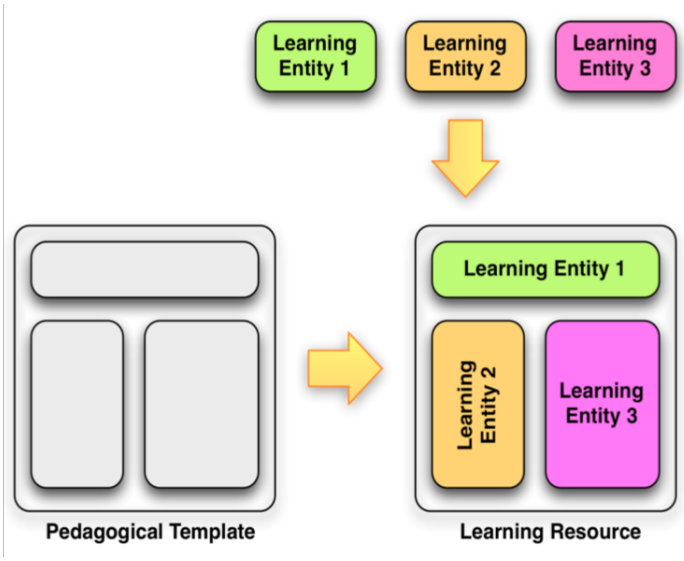
The fourth and most fundamental level describes the authoring system's environment. It is the nature of the interaction between the system and the author, and relies heavily on the target group. If the interface of the system is considered a template for various uses, it may need to be altered depending on the instructional environment and the authors' general experience. It can also include the hardware configuration of the author and the student, and which limitations each participating part has regarding CPU power and display abilities.

4.3 Modern Authoring Systems

Although Kearsley describes en early example of an authoring system, the same characteristics are still seen today. Several Web 2.0 sources utilize the same principles, like Youtube, Wikipedia and Flickr. Whether it is video, documents, articles or images it is possible to let a common Internet user create and combine multimedia and share it with others, without having to deal with the underlying programming structure. Figure 4.2 shows how all shareable multimedia can be described as *Learning Entities* in an authoring system's framework, where the authors are presented to a pedagogical template that is filled in with a combination of learning entities, however the author desires.

Youtube is an excellent example of a modern authoring system. Even though it does not directly take foundation in education, but rather content-sharing and entertainment, it still fits the definition. It is possible to upload and share a video clip with the rest of the world. If the user uploading the video wish to organize the video and manage how it is presented, Youtube offers a video editor with a huge amount of adjustable parameters to specify its exact representation. As seen on figure 4.3, which displays only the main functionality of the editor, several options are available. The author is able to change the title and description of the video, choose a thumbnail, edit the video by trimming, adding visual effects, and placing annotations as overlay on the video. The audio can also be altered, or replaced completely. Even metadata, such as search tags and location can be modified to give the video a contextual layer.

The template of a Youtube video is given by these text boxes and buttons, while the entities are the author's input, being a combination of text, video and audio. It can be questioned whether the interface is designed for skilled Internet users or for inexperienced users, because the author is presented to these options no matter how detailed she/he intends to customize the clip. When a user chooses to upload a clip, it is consequently followed by this screen. Although many people may find it easy to achieve an overview of the functions, it could also be argued that this authoring system has neglected the inexperienced user by creating a layout that may be confusing or overwhelming. This is an important matter to consider



[18]

Figure 4.2: *An authoring system learning entities.*

for this project's solution, as the target group consist of people that are not expected to have a computer related background.

While the important features of an authoring system ensures the author's experience, it may disregard the quality presented to the recipient. Another valuable aspect to examine within the development of an online education system, is *Web-based training*.

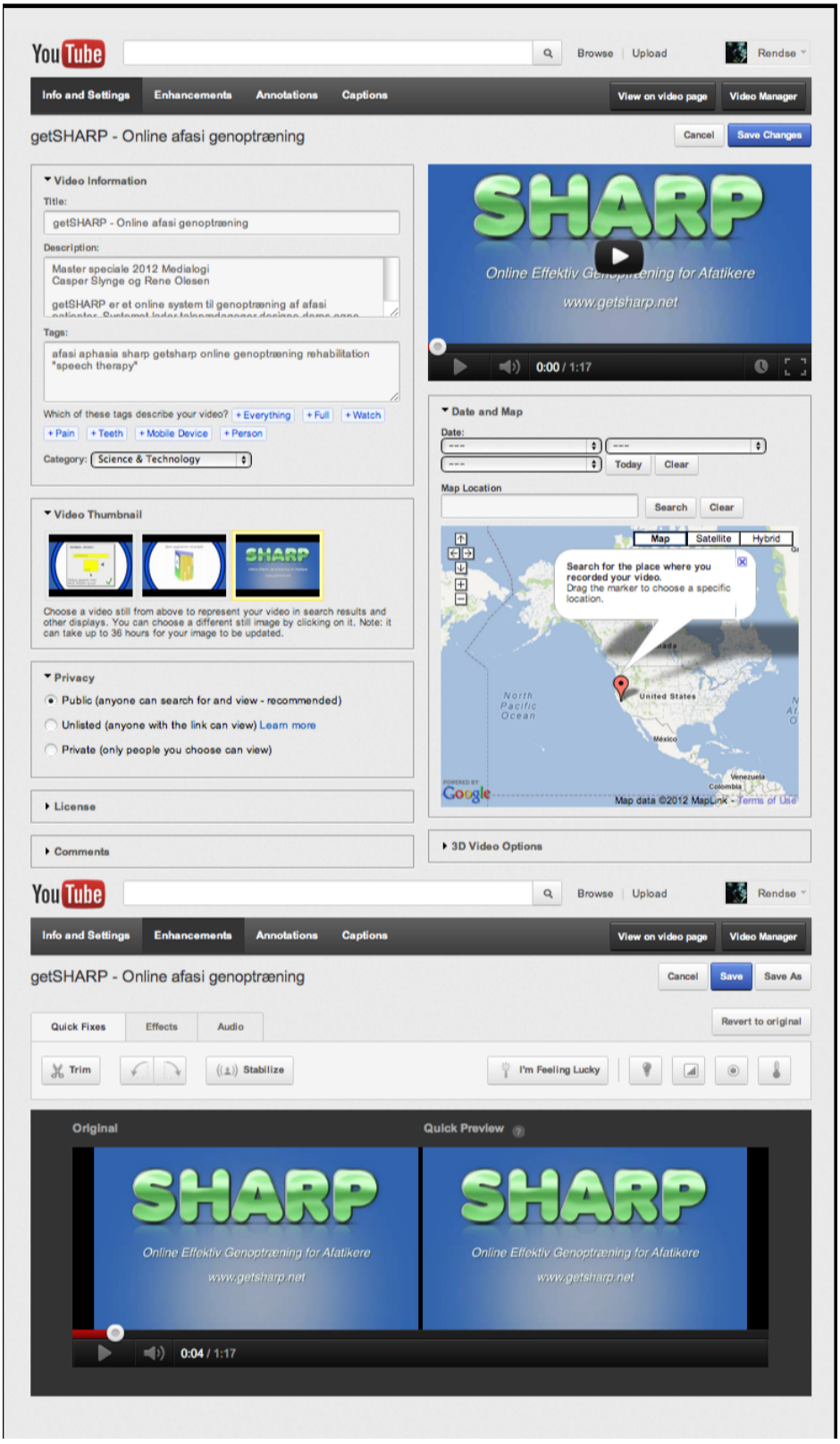


Figure 4.3: *Youtube is a modern authoring system that allows the uploader to modify virtually any detail of the media's presentation. But how clear is its interface to inexperienced users?*

4.4 Web-Based Training

As an upcoming educational authoring system, SHARP will inevitably become a source of web-based training. This concept is an innovative approach to earlier 'offline' training, that utilizes the technologies and advantages of the World Wide Web to improve distance learning. Compared to computer-based training, where the education is limited to the student's (or client's) local machine, a web-based training application can offer online content that is both dynamic and flexible. The software can be modified as necessary, in an environment that allows for independent and self-paced studying and with the rich employment of multimedia available today, it is fully capable of evaluating, instructing and adapting to the user.

According to Tim Kilby[2][16], we should expect an explosion within training offerings available over the public Internet and intranets, as the training vendors come to realize the overwhelming advantages of this delivery method. In the paper *The Direction of Web-based Training: A Practitioner's View* Kilby says the following:

> *We will likely see higher quality online courseware in the near future that meets the ever-broadening needs of learners and organizations. Predicted new technologies will dramatically alter the adult learning experience in future decades.*

He furthermore claims that there unfortunately are few examples of good web-based training design visible publicly, due to the difficulties of designing and programming user interfaces for higher levels of interaction, even though it carries many advantages.

The book *Web Based Training*[14, 16] by Badrul H. Khan presents a list of the pros and cons of having a web training site, versus earlier training methods, such as producing CD-ROMs or having a client/server-based training system. The key advantages listed are as follows:

4.4.1 Advantages

"Learn any time, any place"

By utilizing an online platform to store the content, it can be accessed from any computer with Internet connection. Instead of being restricted to a single machine, e.g. the client's home computer, the system can be used at any time and any place.

"Flexible delivery of training"

Unlike the hassle of sending CD-ROMs and installation guides to the users, web-based training can ease the process of accessing the software by simply opening their web browser and perhaps log on to the system with username and password.

"Cross platform compatibility" (Windows, Mac, UNIX, PDA, phone, other wireless devices)

It is difficult to name a commonly used communicative device which does not also possess a web browser and has access to the Internet quite literally anywhere. This brings the advantage that regardless of what platform and operative system the user employs, it is almost guaranteed that it can open and execute the courseware.

"Ease of content update"

[2]Tim Kilby: Experienced system analyst and user interface designer who coined the term *Web-based Training* in 1994 when the Web was in its infancy.

Besides avoiding the initial delivery of CD-ROMs, instructions etc., any potential update or modification to the software can be carried out on the server, instead of going through the shipment process additional times. This saves many resources on distribution and increases the developers' freedom to improve the software without aggravating the end-user.

"Requires less technical support"

One could imagine that the majority of support cases linked with 'offline' learning systems deals with installation and setup of the software. As web-based learning lets the browser handle the execution of the software, it will inflict none or very little nuisance to the user during the installation process.

"Security through registration"

A web-based training system should in most cases include a user login system that manages who has access to the product. The user ID will in this case also be associated with the person's data, such as billing address, number of accesses, date/time of access and demographic information.

The author of the book however acknowledges that the usage of web-based training carries some limitations that should not be disregarded.

4.4.2 Limitations

"No face-to-face interaction"

By physically separating the therapist and client, the rather important aspect of personal interaction is lost. This is crucial to the speech therapist, when picking up on body language and signals and getting a sense of the patient's needs. However, multiple solutions for high quality, online video communication are available to diminish this limitation.

"Limited formatting in current browsers"

Some functionality can only be executed through installed stand-alone applications, either due to a limited data stream or security restrictions in the common web browser. Although the average bandwidth has increased significantly and multimedia support in web browsers has been broadened over the last decade, it can still be an issue. For example, public networks may have rules for specific web contents and might cap the download speed.

"Limited bandwidth"

This will obviously be a problem for web learning environments that require high amounts of data streaming, or in extreme cases of low bandwidth. A solution to this is to carefully consider what type of media is employed and the volume of each element. Uncompressed images and high definition videos are integrated in the systems, although it is nearly indistinguishable from a compressed version that takes up a fraction of its original capacity.

"Costly for small numbers"

It will surely require some technical setup to create and validate a user for a client, however, as more and more web-based systems make use of online registrations/payments and the technology improves, this process approaches a state where it is practically completely automated. Furthermore, even if this will require manual tech support, it is still considered easier than having to deal with the complications of distribution.

4.5 22 Quality Measures

Quality is the most important aspect to a user's experience, but ensuring this can be difficult, since it is determined by a series of features that can be biased by subjective opinions. Tim Kilby has also developed a checklist of 22 statements about web-based training[15], that can be used as guidelines to measure the quality of a learning system, and thereby achieve a more authoritative analysis. Each of the following points should be evaluated objectively, by considering whether the training...

1. . . . meets the objectives. (Does it have a measurable effect on the clients?)
2. . . . is learner-centered.
3. . . . provides high levels of interactivity.
4. . . . is engaging.
5. . . . accommodates individual learning styles.
6. . . . uses media effectively.
7. . . . helps users apply learning productively.
8. . . . adheres to the Instructional Systems Design (ISD) or similar model.
9. . . . presents information in an organized, coherent manner while allowing user control of learning (cognitive usability).
10. . . . presents extended learning opportunities.
11. . . . has completed post-implementation evaluations and subsequent revision.
12. . . . demonstrates good usability through excellent user interface design.
13. . . . continually adapts to the user's knowledge or skills.
14. . . . validates learning at each curriculum event.
15. . . . uses group-enabling technologies (mail lists, chat, forums, multicasts) only where they are most effective.
16. . . . promotes a positive user experience with computer technology.
17. . . . records student data, such as login information, scores, usage statistics, prescriptions for learning, etc.
18. . . . will not exceed practical bandwidth limitations of the network.
19. . . . is easy to access, easy to install.
20. . . . ensures best value for training costs.
21. . . . content is accurate and timely.
22. . . . follows industry standards for interoperability

These statements will be valuable to consider, both during the design and implementation of, and when evaluating the finished version of SHARP. Although most of the development will be based on feedback from professionals, it will be advantageous to consider these points as guidelines. With the knowledge gained throughout the analysis, a conclusive solution that carries the findings, can be established.

Chapter 5

Conclusive Solution

Compared to existing products, it is obvious that the SHARP prototype needs improvements to be able to compete with them. At its current state, it does not differentiate much from Afasi-assistent or Aphasia Tutor; it contains a predefined, finite amount of exercises and it is meant for home training. Furthermore, with the experiences and findings gained from developing and testing the prototype, it has been concluded that the product at its current state does not live up to the target groups' demands. Because the product resembles existing means on the market, it is found necessary not only to expand the available functionality, but change the fundamental structure of the software as well.

As the initiating problem stated, the goal of this project is to develop a product that challenges these means, by being more desirable and compelling to the users, by offering functionality that seems indispensable during a rehabilitation course. The content of the analysis has described the fundamental theories and methods that are considered relevant for the development of the product. Three major areas have been covered:

- Methods, theories and existing means associated with aphasia therapy
- Existing products currently on the market and findings gained from the prototype evaluation
- The structure and design of an authoring system and crucial elements in web-based training

An area that has not been covered yet is the entrepreneurship, marketing and sales strategies. It is the intention to disassociate this business aspect from the product development throughout the first parts of the report. This will hopefully give the reader an unbiased insight into the considerations taken during the development process, briefly ignoring the commercial motivation, as improving the field of aphasia rehabilitation has been the genuine intention throughout. To that effect, the theoretical knowledge and actions taken regarding the business plan will be described lastly.

5.1 Starting From Scratch

The prototype developed prior to the project holds great potential for further development, as it was constructed object oriented with focus on expansion. However, it is chosen not to continue with this software. Mainly due to the recent findings that changed the course of the project radically, but also because its coding will become fundamentally different. Some of the basic concepts may be maintained, but for all intents and purposes, the new version will be developed from scratch.

5.1.1 Change of Focus

As the ”Related Work” chapter discussed (chapter 3), few solutions designed specifically for aphasia therapy are available on the market, and the most popular of these are not exactly adequate. Therefore, it was suggested that SHARP should exhibit the main advantages of the most commonly used products, and thereby combine the most favorable traits in an improved solution. Here among, Scientific Brain Training PRO's approach to make the rehabilitation process a closer and more concentrated experience between the therapist and client.

Compared to the prototype, this will entail a change of focus, as the speech therapist should also be a part of the program. So instead of designing the system solely for aphasics, the interface will also be developed on the premises of the speech therapist. This is expected to require some field research throughout the development, to gain continuous input for improvements.

5.1.2 Authoring System and Web-Based Training

In chapter 4, a definition of an authoring system was described, as well as an example of the possibilities of modern authoring systems. In the context of aphasia rehabilitation, an authoring system's main objective will be to let the authors create content for the aphasics that takes basis in accepted recovery methods, such as presenting tasks and exercises for them to solve. This will, according to Luria's approach (section 2.4.1), regenerate deteriorated functions by forcing brain activity.

Of course, it is a possibility to create a huge amount of exercises and let the speech therapists pick some that are suitable for their patients. The selected exercises could then be grouped to form a rehabilitation course, and be sent to their individual patient. This would satisfy the three goals Kearsley mentions, as it is possible to develop curriculum (series of tasks) without programming skills. It reduces the time and cost associated with courseware development, as the courseware has already been developed, and lastly, it will likely increase the transportability of courseware by making the authors able to collect and combine tasks in a flexible manner. However, this solution will not satisfy the four levels of an authoring system:

- The bottom layer (authoring environment) is satisfied, as it will become an environment for the therapists with an interface to manipulate the software
- The third layer (course management) will also be covered, with the ability to structure a rehabilitation course from beginning to end
- The second layer (lesson definition) is arguably included as well, depending on which parameters the author will have access to change for the behavior of individual exercises
- The top layer (content creation) will be absent with this solution. With all the content pre-made, the author can not modify the text, graphics, audio etc. in each exercise

A better idea is to let the therapists design their own tasks, besides the full courses, which would ensure that the lessons are tailored completely to each client's needs. The top layer will then be satisfied, while the rest of the listed requirements are maintained as well. The only apparent downside by doing so is that it will likely become more time consuming for the therapist, nevertheless, this is considered the most favorable solution, as this breeds unique tasks based on the therapist's professional considerations. Furthermore, creating unique tasks will allow the therapists to design courses specifically for the individual client, which is supported by the statement that not two aphasics are identical.

The product development will be held up against the 22 web-based training quality measures which were also presented in chapter 4. As the development is expected to involve correspondence with both speech therapists and aphasics, these quality measures will be used to support their statements and opinions.

5.2 Solution Outline

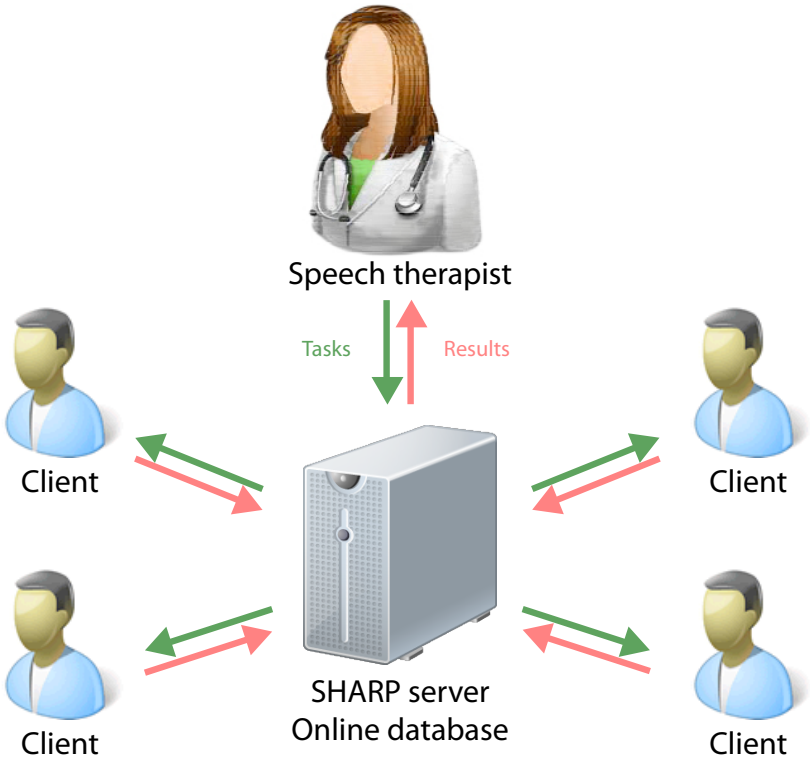


Figure 5.1: *The conceptual functionality behind SHARP.*

The solution formed in this chapter constitutes the concept behind the soon to be developed system. As figure 5.1 shows, SHARP will function as an online node in the network between the therapists and their clients. Instead of being directly connected to each other like a client/server-based system, both actors in the arrangement will have the option to log on to the system independently, either as a client or as a therapist. As mentioned in section 4.4.1, this is advantageous due to many reasons, some of them being that it will avoid any CD-ROMs or installation guides to the users, the system will be able to execute on several platforms and it is easy to update the content of the system without having to install new updates manually.

The therapist will have the ability to create a rehabilitation course, by structuring the order and appearance of individual tasks. These are adjusted to the destined client, depending on her/his dysfunctions, degree of aphasia and the therapist's professional opinion. It will feature the ability to construct a task by combining text, images and preferably audio to help aphasics who have difficulties reading. This is achieved by presenting the author to a pedagogical template, that can be filled in with custom elements (as described in section 4.3). When a task or a series of tasks have been created, it can be sent to the client through the system (green arrows), where it will wait until she/he logs on.

The client sees a new task in the inbox and can play it immediately, presenting a layout identical to the one the therapist designed. Whether the answer is right or wrong, the system will give immediate

feedback, and store the result in the database (red arrows). All results can then be reviewed by the therapist, as documentation of where the client need improvements.

All in all, this concept is expected to become more efficient and enjoyable than other products on the market, because it lets the therapist and client work independently, yet the therapist can freely alter and adapt the client's exercise course and monitor his/her progress through the results. The client side will be expected to be similar in structure to the interface of Aphasia Tutor and Afasi-assistent, while the structure of the therapist side will be an orderly authoring environment that can be used, even by inexperienced computer users.

5.3 Problem Statement

With the concept drawn out, the next phase can commence. In summary, the stated solution has to deal with the following considerations during the development process:

- How should the new authoring system be designed in order to be enjoyable and clear to the speech therapists?
- How is it possible to create a system that is simple to use, and has an effective influence on aphasics as well?
- Which innovative features could be added in order to make SHARP a more desirable solution than its competitors?

Part II
Product Development

This part of the report will describe the entire process of how the product has been designed and implemented.

Chapter 6

Preliminary Considerations

The content of this chapter will describe some of the preparatory considerations that were made before any design or implementation of the SHARP system. The product development part has been divided into three different iterations which each include a design, implementation and evaluation process. This is done in order to comply with the customer development model described in chapter 10, as it is believed that this method will reduce the risk of a failing product. Moreover, as described in section 4.5, it is essential to *demonstrate good usability through excellent user interface design*, which can be achieved by following the customer development model.

6.1 Choice of Environment

Prior to any actual design of the system, it is important to clarify the environment that is used to implement the system, as it may give some limitations to the system, or vice versa, it may give some technical advantages. Even though the system is not considered a game, the described environments are selected due to their possibilities within game development. This is because the majority of elements and the functionality of this system is very similar to what is used in video games.

Some environments fits some projects better than others, and because of that, it is important to evaluate which one of the many possibilities serves the best foundation. This section will highlight two possibilities to display how they are different, and why one fits this project better than the other. They cannot be considered the only ways of approaching software development, but are described because they are considered to be the most suitable solutions for this project.

The first possibility is often thought of as the ”hardcore approach”. It is the one involving the greatest work effort, but it is also the one that provides the greatest freedom in the process, as well as the best opportunity to create a piece of software that distance itself most from other. This possibility relies in programming just about everything from scratch, apart from some basic libraries that help with things like graphics, mathematics and perhaps a rendering engine. It is the approach, that historically is used most frequent when developing games, and the reason why games are so expensive and take so long time to produce. For non-experienced developers, there exist no shortcuts in this approach, so the learning curve is naturally very high.

Another possibility is to rely on works by others and base the development on an existing software engine. Because of the way these software engines typically work, this approach can be very valuable if the software concept is not too different from what the software engine supports. Among popular software engines for games are the *Source 3D game engine* developed by Valve for the *Half-Life* and *Counter-Strike Source* games, and the *Unreal Engine* developed by Epic Games and used for a long list

of modern games. These types of game engines provides a good basis for developing a game, but they can also be limiting if the developer wants to create something that the game engine is not designed to do, or somehow do not support.

A somewhat recent and popular software engine is the Unity game engine. It deviates from ordinary game engines in the way that it is very focused on having a flat learning curve, as well as being very time efficient to use. It does this by having a lot of settings preconfigured, as well as by delivering a more user-friendly editor (see figure 6.1) instead of relying as much on programming. It has been chosen to be used in this project, primarily because of following main advantages:

- The platform is very easy to learn to develop on because of the simple yet structured graphical editor
- Programming can be done in Javascript which makes it simple and quicker than most other environments. Furthermore, more complex programming can be done using C# which is more advanced and comprehensive, but also provides more possibilities
- Javascript is easily connected with PHP which is very beneficial, as the goal is to execute the entire system online in a browser
- Unity supports easy integration with graphical user interface elements, custom textures and audio
- Development is object-oriented and the hierarchy nature of the program helps the development stay structured
- Messages are easily sent between objects and classes which improves the interconnection between the entire system
- It is embedded with version control functionality, which makes it easy for collaboration projects
- Unity works on more than one operating system, and can compile to a browser as well as several operating systems such as Windows, MacOSX and iOS

Besides the Unity game engine, the system will also require the use of a programming language that can manage all data that needs to be stored in a database. For this task, PHP has been chosen as the scripting language that will handle all information being received from and sent to Unity, because it is simple to connect with both Unity and MySQL (open source database). PHP is designed for web development to produce dynamic web pages. It includes various conditional statements and the use of functions and variables, which makes it easy to process data from Unity or the database, as required. A domain (www.getsharp.net) and web hotel has been bought, which employs the MySQL open source database server. The task of the database is to store all necessary data when a user e.g. creates a task or answers one.

With Unity selected as the development platform, the first iteration of product development can begin, however, it is found necessary to clarify some of the precautions that should be taken when programming a complex system like SHARP.

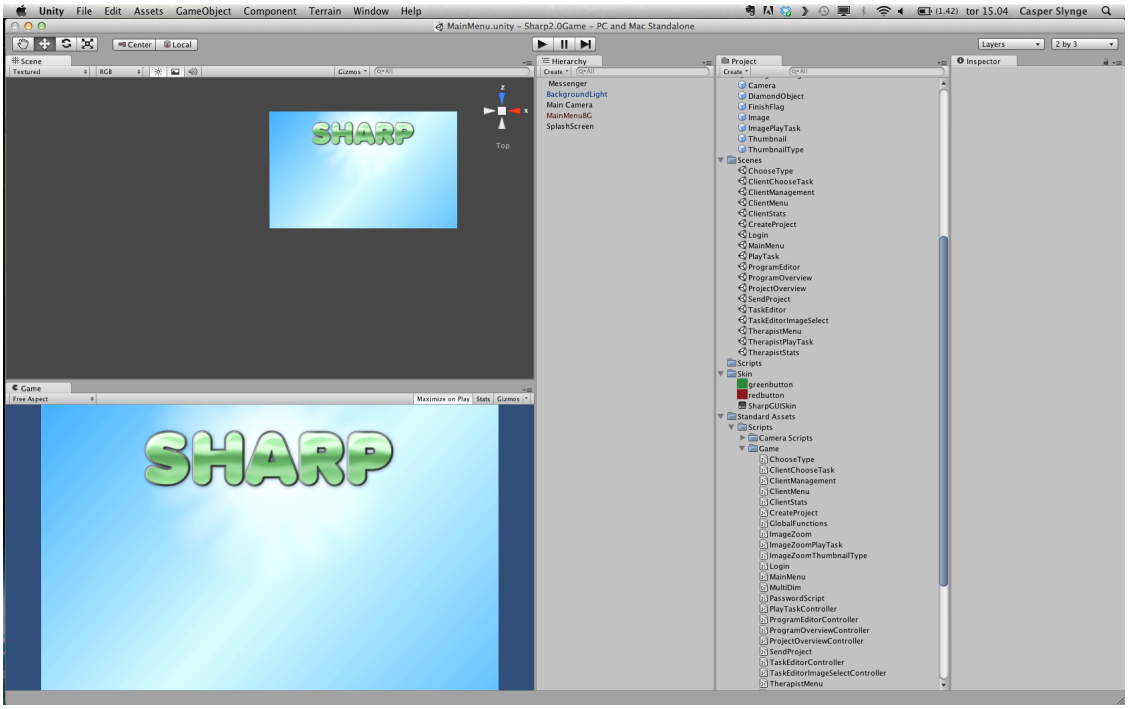


Figure 6.1: *The Unity game engine delivers a user-friendly editor which provides a well-structured division between project files, hierarchy and game scene.*

6.2 Object Oriented Programming

When developing object oriented applications, it is important to keep in mind, that just splitting a program or game up in different classes and files does not, in itself, constitute good and efficient programming practice. This section will not elaborate on the principles behind object-oriented programming, instead it will try to underline three pitfalls to keep in mind when doing so. These exist as general issues in object-oriented programming, but are especially important to be aware of when developing systems like this that is similar to a game, because games tend to have systems with lots of internal class connections and a high amount of communications.

The first point is *abstraction*. Abstraction is way of approaching complex, often inherited objects, in a more simple and ”abstract way”. An example of abstraction is when elements within a system belongs to one superior object. By doing so, the elements can have its own behavior and properties, but still share some of the same from the superior object. Besides making classes more clear and understandable, it also contributes to what is called ”DRY-code” (”Don’t Repeat Yourself”).

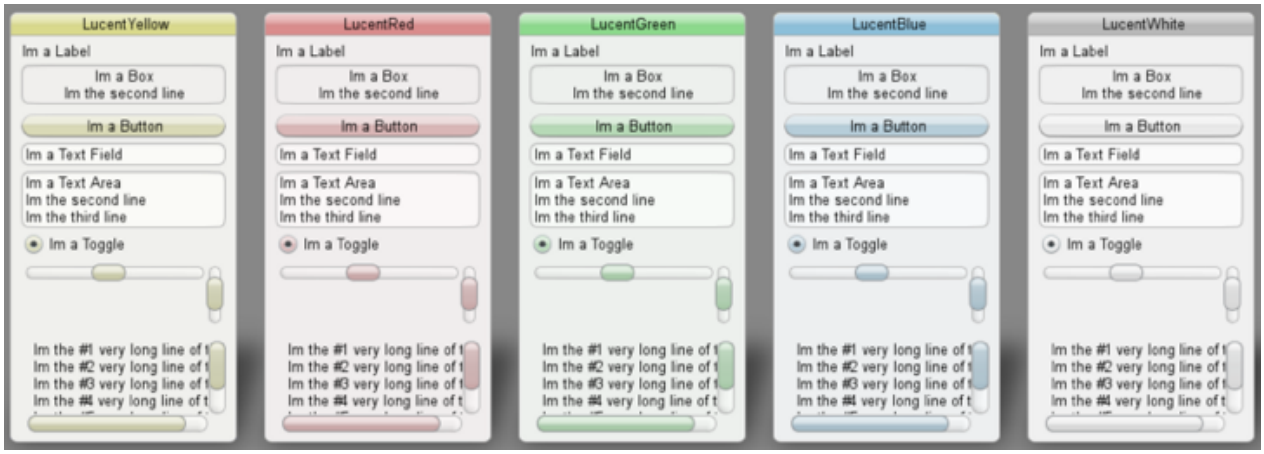
Encapsulation, as the name implies, is the concept of encapsulating some functionality or properties within one object. If this principle is followed, the programmer will be helped to make sure that objects do not get tangled.

The last concept that is considered important to highlight, is *decoupling*. Decoupling is somewhat related to encapsulation, in the way that it makes sure that objects do not get too interconnected. In a decoupling approach this is done by completely removing the dependency between two objects. A great example of this, is how Unity provides use of the internal ”messaging-system”. This works by, instead of one object communicating directly to another, it sends a message openly to the message systems, which then makes sure that every object interested in knowing about the message, is notified.

6.3 Graphical Style

During the work on 8th semester (see chapter 3), the authors discovered that aphasics can have visual difficulties as well as problems with interpreting an interface with too much information or too many elements. It is therefore essential that the graphical appearance and the interface appears as simple as possible and with a style that is calming for the eyes.

One of the many beneficial functionalities within Unity is the use of GUI (Graphical User Interface) skins. It allows developers to customize and design their own textures for all GUI elements. One skin that fulfills the above mentioned requirements is the ”Lucent GUI Skin” that provides soft-cornered, neat textures with five different mellow color schemes (see figure 6.2).



[26]

Figure 6.2: *The Lucent GUI Skin offers five different color schemes.*

Chapter 7

First Iteration

With the fundamental construction and functionality of the system established (see chapter 5), along with some layout decisions, the first iteration of product development can be conducted. Before initiating any implementation within Unity it has been decided to create some sketches of all the various screens that are required in the system. This is done in order to provide a clear overview, and to create some visual guidelines, to ensure that the graphical appearance and design will be identical if implementation is to be divided between the authors.

7.1 Design

The system should be designed according to the three major goals stated in chapter 4 by Greg Kearsley, which include designing a system that makes it possible to develop computer-based curriculum without the need to learn a programming language. This is done by presenting a simplistic user interface that allows the therapist or patient to execute complex functions by the press of a button. Moreover, the system should intend to adhere to the 22 quality measures described in section 4.5, as it hopefully will heighten the user's experience. As described in chapter 5, this system, compared to the 8th semester project, focuses more on the possibilities for the speech therapist. The system is therefore divided into two parts, one for the aphasics and one for the speech therapist. Hence, it is decided that the main menu of the system will present two buttons, where the user can either login as a patient or as a speech therapist (see figure 7.1).

Predicting the structure of the program, it is clear that the majority of the design and implementation is on the speech therapist side. The therapist must be able to create an entire rehabilitation project and design every task as she/he desires, whereas the aphasic only needs to be able to play each task and view the results. However, it is a matter of course that both portals needs a menu (see figure 7.2).

On the patient side, the user has the option of playing a project that has been sent from a speech therapist, and also see results from the tasks that have been completed. On the speech therapist side, the user can see results from his/her patients, send projects to a patient or create a new one. The idea of creating a project is a way of structuring how an entire therapy program can be designed. It can be described by looking further into the speech therapist portal. When the speech therapist creates a new project, the idea is to split a therapy course into projects, programs and tasks. Instead of creating one task after another and send each to a patient, it is found more efficient to pack tasks into a program, and programs into projects. When clicking the ”Create Project” button, the user is presented to the project editor level (see figure 7.3).

Figure 7.1: *Sketch of the Main Menu screen. The Main Menu lets the user log in as either a patient or a speech therapist.*

Figure 7.2: *The patient (left) has the opportunity of selecting one of the received projects or look at his/her results. The therapist (right) can create a new project, send project to a patient or look at the results from a patient.*

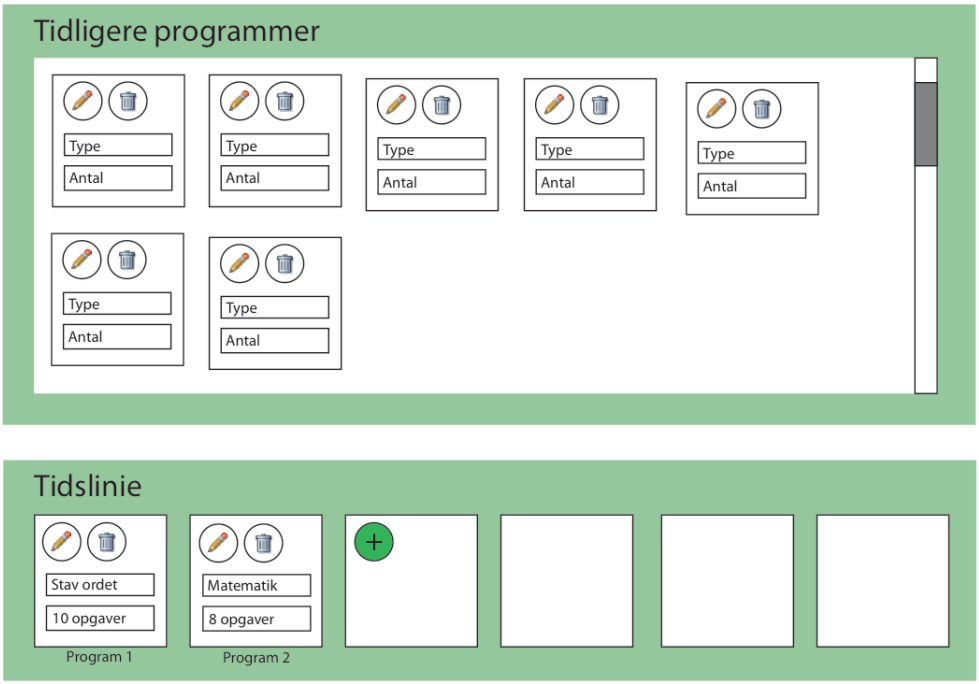


Figure 7.3: *In the Project Editor level, previous made programs are listed in the top, whereas the timeline for the given project is placed at the bottom.*

The Project Editor level lists all the programs that the user has created earlier at the top, while presenting a timeline for a project at the bottom. This allows the user to design a unique project with various programs, as he/she can add several programs to the project timeline. The programs can be of different types, e.g. one can be a mathematics program while another can be a spelling program. If creating a new program, the choose type level will be displayed.

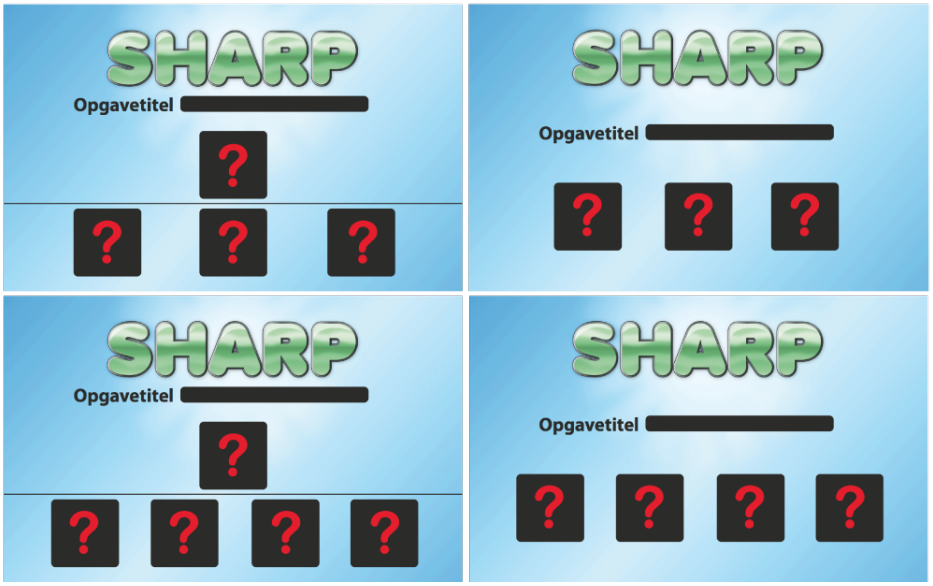


Figure 7.4: *The speech therapist can choose between four different templates for a program. This provides more freedom when designing different types of tasks.*

The idea of the templates illustrated in figure 7.4, is that there should be some preprogrammed types to provide more freedom for the speech therapist to decide which type of task he/she wants to make. The choose type level therefore presents the above templates where each template represents a type for all the tasks that is created within the given program. Four different templates are listed, and with one selected, the program editor will be presented (see figure 7.5).

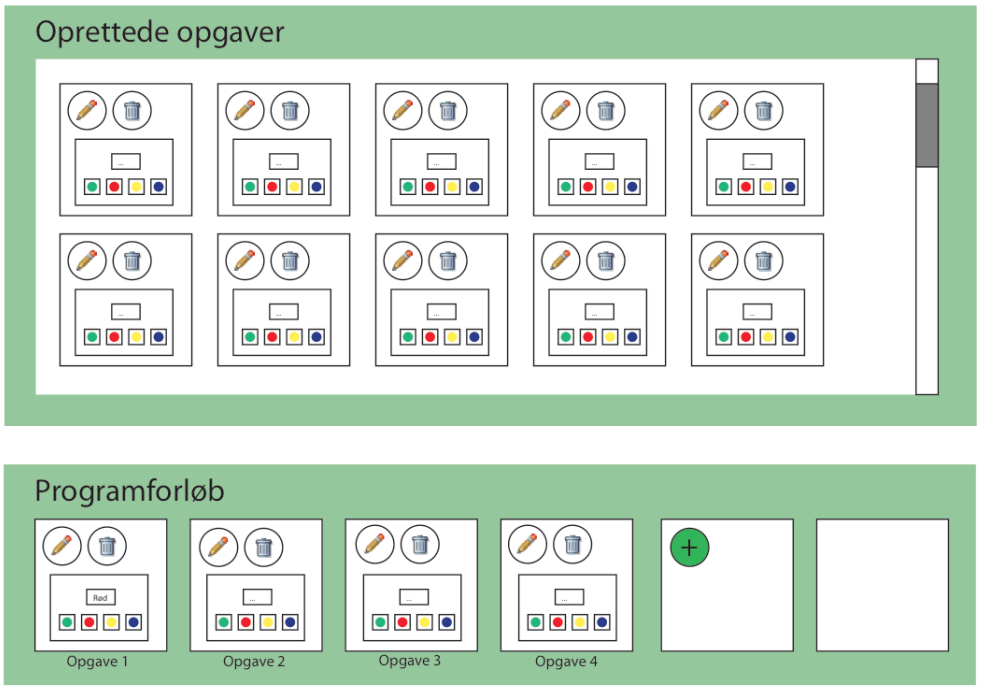


Figure 7.5: *The Program Editor is similar to the Project Editor. Previous made tasks are listed in the top window, and the program timeline is presented in the bottom of the screen.*

This editor is identical to the Project Editor, however, in this level, previous tasks are listed at the top, while a timeline for the current program is presented at the bottom. As before, the speech therapist can add tasks to the program and thereby design unique programs that fit individual patients. If creating a new task, the task editor is shown (see figure 7.6).

In the Task Editor the user can, according to the chosen template, design a unique task by adding images from a library or text to the task and option areas. The images in the library are without any copyright as they have been collected from a license-free image database[1]. Furthermore it is possible to add audio recordings to each task or utilize a prerecorded standard sound for the specific type of task.

A Results level has also been designed (see figure 7.11). The system will record data such as the results of a completed task and automatically save it in the database. By monitoring the results and showing them both to the speech therapist and patient, the system adheres to Kilby's 22 quality measures stating that a system should record student data, such as login information, scores, usage statistics, prescriptions for learning, etc. in order to enhance the user experience.

Along with a Client Management level, where the speech therapist can create and delete patients and a Project Overview level, where all created projects are listed, the above described levels constitute the

[1]License-free image database: http://www.sxc.hu/

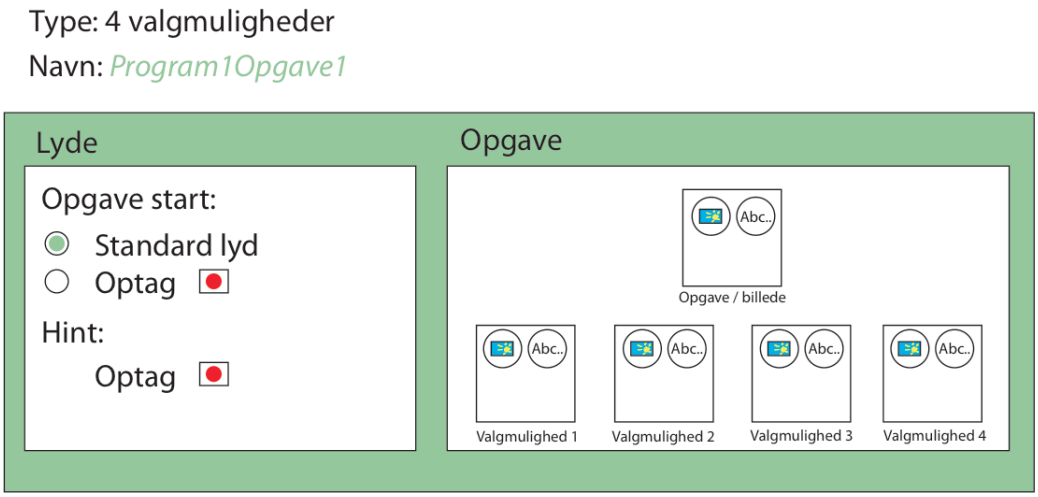


Figure 7.6: *Inside the Task Editor, the speech therapist can design unique tasks that match the type of program that has been created.*

entire speech therapist side of the system as it has been designed in the first iteration of the product development.

Looking at the other part of the system, the Client Menu allows the user to select a program that has been sent from a therapist. From this level, the patient can select specific tasks within the programs, which will launch the Play Task level. In the Play Task scene, the designed task will be presented to the aphasic and he/she can answer in different ways, depending on the type of task. When a task has been completed, the answer will be stored in a database, which can be seen by both the patient and speech therapist.

7.2 Implementation

With all the primary objects of the system sketched out, it is possible to begin implementing them. To get a clear overview of all the mandatory levels described above, figure 7.7 presents a diagram of all the levels in the system and how they interact with each other. To keep the system as structured and object oriented as possible, each level will have assigned one script controller to manage all functionality inside it. These scripts and their essential properties and methods are elaborated through UML[2] diagrams in figure 7.8.

As mentioned, each level in the system has been assigned their own programming script, which is necessary as each level require different GUI elements and different functionality. One of the many forces of Unity is the integrated library that handles GUI elements such as buttons, labels and text fields. This feature is very useful when implementing the different scenes, as each GUI element only requires one line of code in order to be created and positioned on the screen. Below is an example of how a label and a button is created:

```
GUI.Label( Rect (X-position, Y-position, Width, Height), "Label Text", "Label
    Type"); // Create a GUI label

if ( GUI.Button ( Rect (X-position, Y-position, Width, Height) , "Button Text" )
    ) // If-structure that creates a GUI button
{
```

[2]UML: Unified Modeling Language

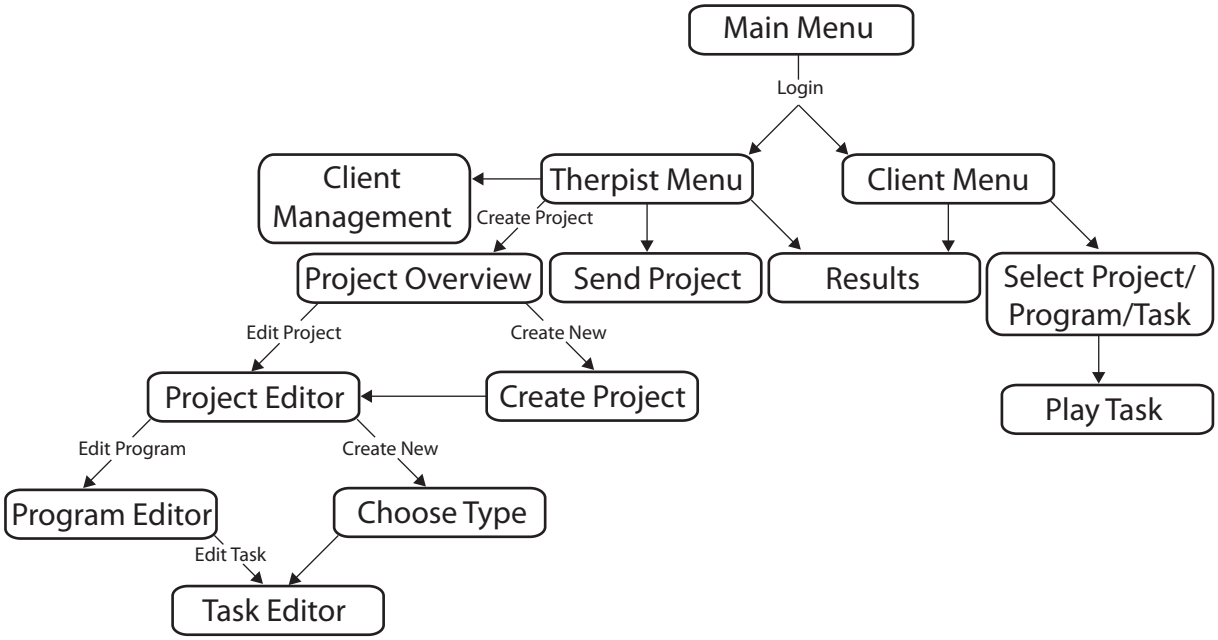


Figure 7.7: *A flow diagram provides an overview of all the designed levels from the first iteration.*

```
  // What should be done when button is pressed goes here
}
```

Another helpful function included in the GUI framework is the GUI.BeginScrollView. This is very beneficial in the levels where several lines of data needs to be listed, e.g. in the *Project Overview* level. By giving an inner and outer x-y position, width and a dynamic height, the scroll view adjusts to the amount of data that is being listed in a level. With the GUI framework the layout of the different levels have quickly been established along with the connections and navigation between them.

Another essential part of the system is the task of storing or receiving data from a database. This has been solved by making a WWWForm[3] which creates a PHP connection directly to the Javascript scripts in Unity. By doing so, it is possible execute an entire PHP file from Unity, and send and receive data by respectively sending variables or echo'ing them out in the PHP file. Below is an example of how such a connection has been made in Javascript:

```
var form = new WWWForm(); // Create instance of WWWForm
var hash = "Safety Code";
var filename = Filename of the PHP script;
var values = Array of values with the variables that are sent along;
var phpCode = A phpCode to execute specific functionality in the individual
    scripts when the data is received;
for (var i = 0; i < values.length; i += 2){
  form.AddField( "myform_"+values[i], values[i+1] ); // Add values to the form
}
var URL = "http://getsharp.net/php/"+filename; // URL to the PHP script
var w = WWW(URL, form); // Execute the form

yield w; // Wait for the script to finish

if (w.error != null) {
```

[3]WWWForm: Helper class in Unity to generate form data to post to web servers using the WWW class

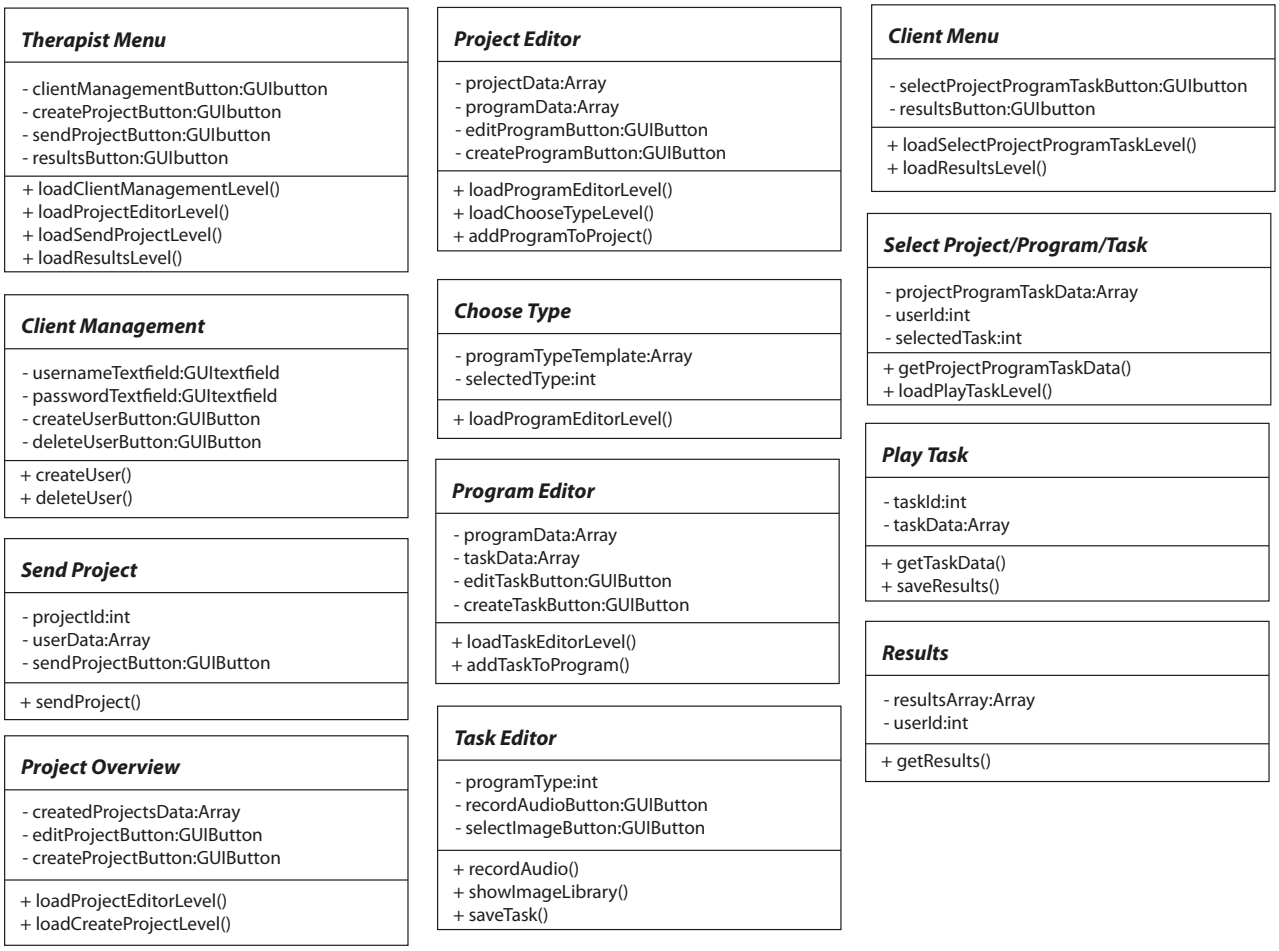


Figure 7.8: *UML diagrams describe the essential properties of a specific class. This includes some of the important variables and functions that are necessary inside the class.*

```
  formText = w.error; // If there is an error, save it in formText
} else {
  formText = w.text; // Save the data received from the PHP script
  w.Dispose(); // Clear the form
}
```

This piece of code gave the possibility of storing data from the system, e.g. when a task has been completed and the answer needs to be stored, or when data is received from the database, e.g. when getting project data for a specific speech therapist.

Another important element of the implementation is where to store various amount of data in a structured and clear way, e.g. when storing a task, the type of a program or the results. Given that there in the future will accumulate a large amount of data, it is crucial that there is a correlation in structure in the different tables, while simultaneously having a division in tables that matches the structure of the system. This will ensure that, if other programmers or developers were to continue working with the system, they would not have to use a lot of time to figure out and understand the structure of the entire system and the data. The structure of tables used in the database can be viewed in figure 7.9 and 7.10.

The two images, showing the database construction, list the structure of each table in the left side, while listing some data examples from the corresponding table in the right. The primary structure of the database consist of the tables: projects, programs and tasks. The projects table include four different types of columns, where the important columns are *admin, programs* and *public*. ”admin” stores the name of the admin that has created the project, ”programs” stores the id of the programs that have been added to the project, and ”public” tells whether the project has been shared or not. This structure is similar in the programs table, except the ”programs” column is replaced by a ”tasks” column that stores the different tasks that have been added. Furthermore a ”type” column has been added, which stores a string of numbers telling the specific type of the program. The ”tasks” table is a bit more detailed, as it has nine columns included. The table stores relevant data for each task, here among: the title of a task, a description if one is added, question and answer choices, the sound filename, etc. These columns will contain differently formatted data depending on the program type chosen.

The three remaining tables of the database stores the different users (clients) that have been created by a speech therapist, the admins (speech therapists) and finally the results from when a client has completed a task. To get a more detailed description of all the tables and fields in the database, see the digital superlative diagram which is attached on the DVD (appendix C).

If looking at the data of all tables, there are different places where the columns store a string of numbers or words, split by either a comma or a wedge symbol. This is an efficient way of storing several values in one row, as it is possible to split a string at a specific character. So when values are stored to the database, they are concatenated into one string, and when the string is used in the system again, it is split at a specific character. An example of this can be viewed in the source code below.

```
PHP:
$data = $programId_1."^".$programId_2."^".$programId_3;
$data = explode("^",$data);

Javascript:
var data : String = programId_1 + "^" + programId_2 + "^" + programId_3;
var dataArray = data.Split("^"[0]);
```

When collecting data from the database or when storing data, MySQL commands are used to read or write the specific columns, rows and fields. These commands can be written in different ways and there exists several types of commands, in order to perform the correct action in the database. Examples of different read and write commands along with a description are listed below.

Table structure for table projects

Column	Type	Null	Default
id	int(10)	No	
name	varchar(25)	No	
admin	varchar(25)	No	
programs	varchar(50)	No	
public	varchar(255)	No	

Dumping data for table projects

1	Matematik	slynge	14,1,16	true
2	Stavning	slynge	12,13,20	true
4	Kategoriser	Rendse	5,6	false
5	Sammenlign	Rendse	7	false
9	Kategorisering	slynge	18,19,45	true
7	Hvad skiller sig ud?	Rendse	11,7	false
8	Kategorisering	hammel	15	false
10	SammenhÃ¦ng	slynge	21,22	true
11	Hvad er forkert	slynge	24	true
18	SammenhÃ¦ng	Rendse	32,33	false

Table structure for table programs

Column	Type	Null	Default
id	int(10)	No	
name	varchar(25)	No	
type	varchar(10)	No	
tasks	varchar(1000)	No	
admin	varchar(30)	No	

Dumping data for table programs

1	Multiplikation	1 1 1 1 3	54,55,59,60,61	slynge
12	Korte ord	1 1 2 3 0	2,45,46,47,48	slynge
6	Kategorisering middel	1 0 2 1 3	9,8,7	Rendse
5	Kategorisering let	1 0 2 1 2	5,6	Rendse
7	Hvad hÃ¸rer sammen?	1 0 2 2 3	11,1	Rendse
11	Lette opgaver	0 0 1 2 3	43,43	Rendse
13	Mellemlange ord	1 1 2 3 0	49,50,51,52,53	slynge
14	Addition	1 1 1 1 3	62,63,64,66,67	slynge
15	Kat prog 1	1 1 2 2 3	65	hammel
16	Division	0 1 1 1 3	68,69,70,71,72	slynge
18	Mad og Dyr	1 1 2 1 2	73,74,75,76,77	slynge
19	MÃ¸bler og Instrumenter	1 1 2 1 2	78,81,82,83,84	slynge

Table structure for table tasks

Column	Type	Null	Default
id	int(10)	No	
title	varchar(255)	No	
description	varchar(200)	No	
question	varchar(255)	No	
choices	varchar(200)	No	
sound	varchar(255)	No	
answer	varchar(255)	No	
type	varchar(10)	No	
admin	varchar(30)	No	
public	varchar(5)	No	

Dumping data for table tasks

2	Korte ord opg 1	Hvad ser du pÃ¥ billedet?	koekken/ske.jpg		1328694313197.wav	ske	1 1 2 3 0	slynge	false
3	Opg1	Hvad ser du pÃ¥ billedet?	dyr/and.jpg			and	1 0 2 3 0	Rendse	true
4	Opg2	Hvad ser du pÃ¥ billedet?	dyr/hund.jpg			hund	1 0 2 3 0	Rendse	false
5	Opg1	Hvad er dette?	koekken/gaffel.jpg	Kniv^Gaffel		2	1 0 2 1 2	Rendse	true
6	Opg2	Hvad er dette?	koekken/ske.jpg	Kniv^Ske		2	1 0 2 1 2	Rendse	true
7	Delfin	VÃ¦lg den rigtige kategori	dyr/delfin.jpg	Dyr^Teknologi^Transport		1	1 0 2 1 3	Rendse	false
8	Cykel	VÃ¦lg den rigtige kategori	transport/cykel.jpg	Dyr^Teknologi^Transport		3	1 0 2 1 3	Rendse	false
9	Mobiltelefon	VÃ¦lg den rigtige kategori	teknologi/mobil.jpg	Dyr^Teknologi^Transport		2	1 0 2 1 3	Rendse	false
10	Banan	VÃ¦lg det rigtige billede	mad/banan.jpg	mad/paere.jpg^sport/cykel.jpg^transport/bus.jpg		1	1 0 2 2 3	Rendse	true
11	Fodbold	VÃ¦lg det rigtige billede	sport/fodbold.jpg	dyr/abe.jpg^dyr/hoene.jpg^sport/basketball.jpg		3	1 0 2 2 3	Rendse	true
46	Korte ord opg 3	Hvad ser du pÃ¥ billedet?	natur/blad.jpg		1328823912061.wav	blad	1 1 2 3 0	slynge	false
43	Udskil opg 1		Hvilken af disse skiller sig ud?	dyr/hund.jpg^dyr/hare.jpg^sport/basketball.jpg		3	0 0 1 2 3	Rendse	false
45	Korte ord opg 2	Hvad ser du pÃ¥ billedet?	moebler/stol2.jpg		1328823817410.wav	stol	1 1 2 3 0	slynge	false

Figure 7.9: *The projects, programs and tasks tables store all data necessary to create and manage an entire rehabilitation project for a patient.*

Table structure for table users			
Column	Type	Null	Default
id	int(10)	No	
name	varchar(50)	No	
username	varchar(30)	No	
password	varchar(100)	No	
admin	varchar(40)	No	
projectId	varchar(50)	No	

Dumping data for table users						
1	casper	casper	95cc64d28259df13ec4ad683ecf339	slynge	1,2,9,10,11	
6	Kondi Karsten	karsten	81dc9bdb52d04dc20036dbd8313ed055	Rendse	1,2,9,10,11,13	
9	ib	ib	a132c5cf175a7333c483a34f2cd2861 10b	csv	2,9,10	
8	lars	lars	c1573785b915b5e19d0eae29ed9b9972	csv	1,2,9,10,11,11,13,2,9,10,10	
11	Carsten	Carsten	614e5154688f00d1c2a6a5d23bce7e1f4	cfk	31,11,13,29	
12	Tommy	Tommy	1a8b8e54b5363a8efae84e064373f19	cfk	30,11	
13	Peter	Peter	66a95b1427af77b3d769ae9cb8533382f	cfk	29,1	

Table structure for table results			
Column	Type	Null	Default
id	int(10)	No	
clientid	varchar(40)	No	
source	varchar(20)	No	
date	datetime	No	
visible	varchar(10)	No	
answer	varchar(255)	No	

Dumping data for table results					
65	6	1,14,62,1	06/03/12 14:22	true	
64	6	1,14,63,1	06/03/12 14:20	true	
63	6	1,14,62,1	06/03/12 14:19	true	
4	1	11,24,99,1	14/02/12 23:57	false	
5	1	11,24,101,0	14/02/12 23:57	false	
6	1	11,24,101,1	14/02/12 23:57	false	
7	9	13,26,103,1	15/02/12 12:29	true	
8	9	13,26,110,1	15/02/12 12:30	true	
9	9	13,26,119,1	15/02/12 12:30	true	
10	9	13,26,120,1	15/02/12 12:30	true	

Table structure for table admins			
Column	Type	Null	Default
id	int(10)	No	
username	varchar(30)	No	
password	varchar(100)	No	

Dumping data for table admins	
1	slynge
2	Rendse
3	bent
4	matthias
5	csv
6	CFK
9	hammel

Figure 7.10: *The three remaining tables administrate all data concerning the speech therapists, users and results.*

```
//Getting all/column data from a specific table:
mysql_query("SELECT all/column FROM table");
//Example where two properties have been added:
mysql_query("SELECT * FROM projects WHERE admin='$admin' ORDER BY name"); //
    Getting all projects from a specific speech therapist

//Inserting data to a specific table by adding a new row:
mysql_query("INSERT INTO table (column1, column2, column3,...) VALUES ('value1','
    value2','value3',...)");
//Example:
mysql_query("INSERT INTO programs (id, name, type, tasks, admin) VALUES ('NULL
    ','".$programrow['name']."','".$programrow['type']."', '".$newTaskIds."', '".
    $admin."')");

//Update a field in an existing row:
mysql_query("UPDATE table SET field = 'value' WHERE another_field = '
    another_value'");
//Example:
mysql_query("UPDATE projects SET name = '$projectName' WHERE id = '$projectId'");

//Delete a specific row in a table:
mysql_query("DELETE FROM table WHERE field='value'");
//Example:
mysql_query("DELETE FROM projects WHERE id='$projectId'");
```

With the above described functions, methods and commands, the core of the system has been implemented, and a usability/interface evaluation can be conducted. Screenshots of some of the different implemented levels can be seen in figure 7.11.

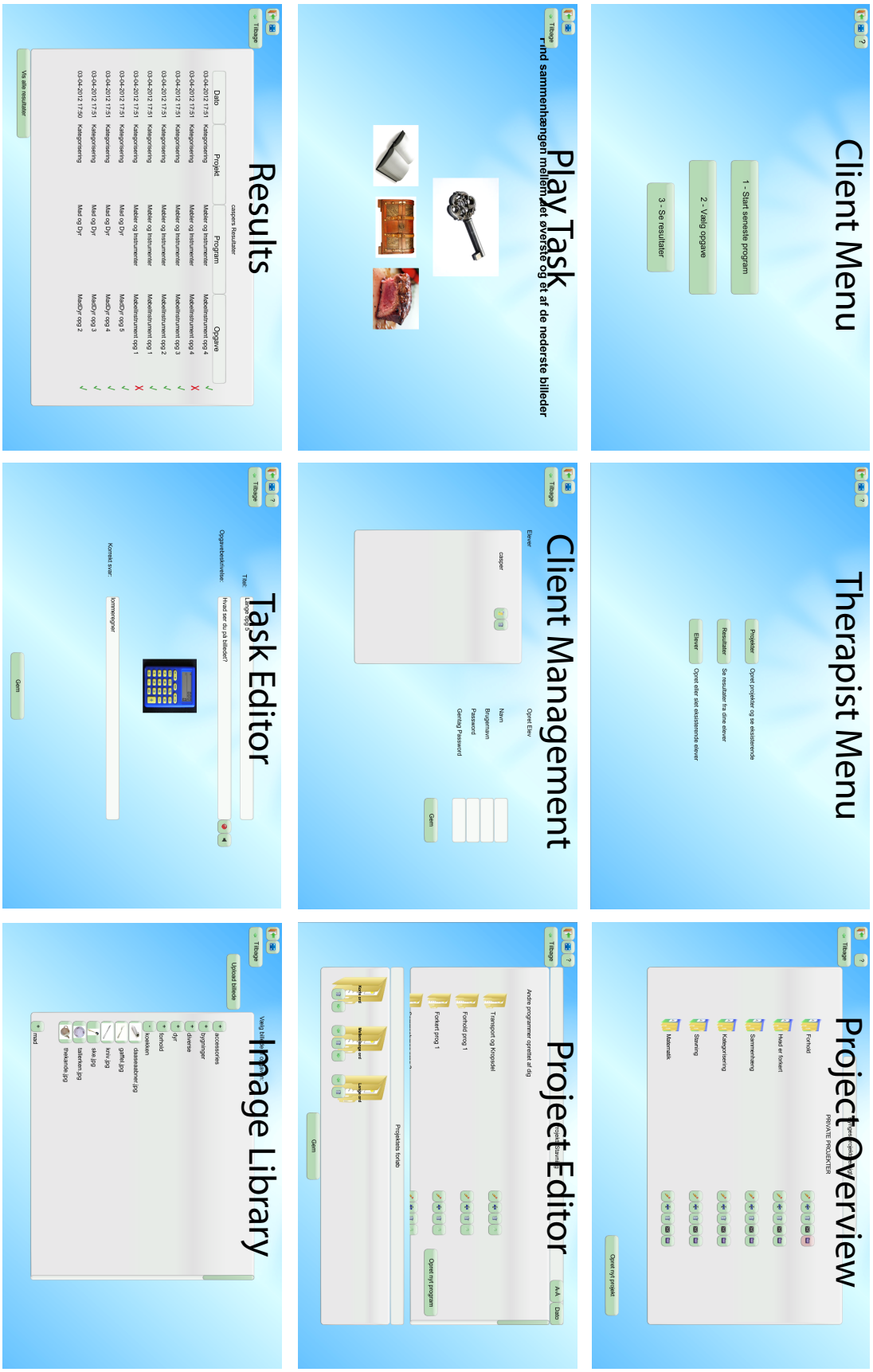


Figure 7.11: *With all the different levels from the first iteration implemented, an evaluation can be conducted.*

7.3 Evaluation of First Iteration

With the fundamental construction of the system implemented, it is found beneficial to conduct an interface evaluation, to see if the concept, structure and navigation is useful and user-friendly to the target group. Because the system focuses mainly on the opportunities and features for the speech therapist, it has been decided to consult different speech therapists to gain some feedback and to see if any changes should be made before continuing development.

Meetings with three speech therapists from respectively Hjørring, Hobro and Aalborg were arranged. The concept was presented to the therapists while giving them a quick walkthrough of the system. Simultaneously the speech therapists were asked to think out loud during the walkthrough. All three conversations were recording using a dictaphone and are attached on the DVD (see appendix C). Some of the essential constructive criticism gained from the three interviews were:

- The system should display confirm messages when a project/program/task is being deleted. Also to provide instant feedback to the user, information messages should be displayed e.g. when a task has been saved or a project has been sent to a patient.
- The images presented in the Play Task level should be larger, as some aphasics can have reduced visual acuity. Moreover it is important that the quality of the images are high, in order to avoid any disturbances for the aphasics, and that the library is expanded with more images.
- It should be possible to add auditive feedback to the tasks, in case some of the patients have issues interpreting written content.
- The process of generating project, programs and tasks should be possible, however, the amount of time it takes to create an entire project can be a disruption or nuisance to some.
- The use of the system requires that a patient is attached to a speech therapist. It should also be possible for patients to operate the system by themselves.
- A motivational factor for the aphasics should be integrated into the system, however, it may not become an aggravating element.
- The system should include more templates for program types, to provide more freedom for the speech therapist.
- Due to paralyzation in body parts, it should be possible for the aphasics to navigate through the system both with keyboard and mouse. Also it should be possible to navigate with the mouse, only with one time clicking.

With the above listed feedback, the next iteration of the implementation can be conducted. The following chapter will describe how the improvements have been implemented. In some cases, it has been found necessary to create some layout sketches first in order to get an overview of how the improvements should be implemented.

Chapter 8

Second Iteration

Unity provides a GUI feature called GUI.Windows which allows a pop-up window of a specific size to be placed on top of the scene. This feature has been used to implement a confirm message (see figure 8.1) when a project, program or task is being deleted or renamed. To handle the information messages, a label with a background is displayed for two seconds, whereafter it is removed (see figure 8.1). Furthermore, to add some more usability to the interfaces, hover labels have been implemented, so when the mouse cursor is hovering over any kind of button, the purpose of the button is described through a label with a background like the information messages. This is found very useful as some of the buttons does not include any text, but only icons.

Figure 8.1: *Top: A confirm message is used to avoid any unfortunate deletions. Bottom: An information label is used to provide instant feedback to the user.*

Images in the Play Task level has been made larger in size. More images have been added to the library, however a new feature has also been added to the system. Since Unity does not support functionality for file uploading, an image upload webpage has been programmed which allows the user to upload any type of image to his/her own private folder on the server. The webpage which utilize HTML and PHP to create the image upload, is linked to from within the system, in the Task Editor library on the speech therapist side. When the image is uploaded it is automatically scaled to a width of 300 pixels and a height dependent on the ratio, in order to preserve the proportions. The image upload webpage can be seen at the following link http://getsharp.net/imageupload.php.

Another feature that has been added to the system is the opportunity of recording sound sequences which automatically will be attached to the current task that is being edited. The sound sequences will act as auditive feedback for the aphasics if they have issues comprehending written content of a task. Unity neither supports sound recording, so this feature has been implemented by utilizing an open source Javascript and Flash application called FlashWavRecorder[1]. As with the image upload, a webpage has been created which integrates the FlashWavRecorder (http://getsharp.net/recorder.php). When a sound has been recorded, an upload button is presented, and when pressed, the sound will be uploaded to the server and the filename will be stored in the database. This filename is then added to the current task.

[1]FlashWavRecorder: http://blogupstairs.com/flashwavrecorder-javascript-flash-audio-recorder/

It has been decided to create a maximum of five audio sequences for each task, to prevent any type of spam or database overload. When a client starts a task with various audio sequences, the amount of speaker buttons corresponding to the amount of sequences will be listed at the right side of the screen. Furthermore, when the task is started, the first recorded audio sequence will be played automatically.

It was a general opinion from the interviews that the process of creating an entire project with several programs and tasks provides a great amount of freedom for the speech therapist, however, it may be a process that require too much time. This issue has been solved by adding a feature that allows a speech therapist to make his/her projects public, meaning that it will be visible to other users. The therapists can then send the projects to their own clients, and moreover they can duplicate them to their own private projects and thereby develop further on them (see figure 8.2). By adding this feature, the system provides a network where colleagues can share projects and tasks with each other, which limits the work they have to do themselves. Also, by using a group-enabling technology like this, it is assumed that it will elevate the user experience, as described in section 4.5. The function of sharing items has also been added to single tasks (see figure 8.2). Furthermore, several projects have been created by the developers and shared, so that new users of the system have a project foundation to begin with, and to get some inspiration of how projects can be designed. Having predesigned projects will also make it possible for clients to use the system without external supervision or help. The projects can be made visible to all clients making it unnecessary for a speech therapist to send any projects. However, it is the intention that all clients should be advised by a speech therapist, as they have the best insight in which type of tasks each client require.

In the 8th semester project, the product was thought of more as a game than an application. This was, among others, seen through the motivational element that was implemented, where the aphasic should collect diamonds in each task. However, through the evaluation it became apparent that the motivational element could become a nuisance to the user, which is why it has been removed in this project. It is still considered beneficial though, to include some sort of motivation for the user, as long as it does not become an irritating feature, like locking tasks until previous are completed. One of the speech therapists recommended a simple green check mark when answering correct and a red cross when answering wrong (see figure 8.3). Besides that, percentage bars have been implemented to illustrate how many percent of a given project that has been completed (see figure 8.3). These are presented both to the client when selecting a project, program or task, and in the results shown to the speech therapist. This is done in order to let the speech therapist and client evaluate the progression over time, as the date and time are also displayed together with the result. These motivational elements are assumed to make the user experience more engaging, which is an important aspect of a learning system according to the 22 quality measures (section 4.5).

One of the most important improvements during the second iteration of development is the implementation of the Choose Type Editor. Instead of utilizing templates that the speech therapist can choose between, an editor has been designed, that lets the user design his/her own program type. Figure 8.4 illustrates how the initial sketches of the editor has been designed.

As seen on the sketches, the editor provides much more freedom than the predetermined templates, to uniquely design a program type. The user can choose if the task should include a description, if it should include sound sequences, whether the task should be text or an image, and finally if the answer possibilities should be buttons with text, images or a text field. A screenshot of the implemented editor can be seen in figure 8.5.

The opportunity of navigating through menus (only for the client) with both keyboard and mouse has been implemented. The aphasic can select which task to start by using the number buttons on the keyboard. Also, all buttons can be pressed by using single clicks with the mouse.

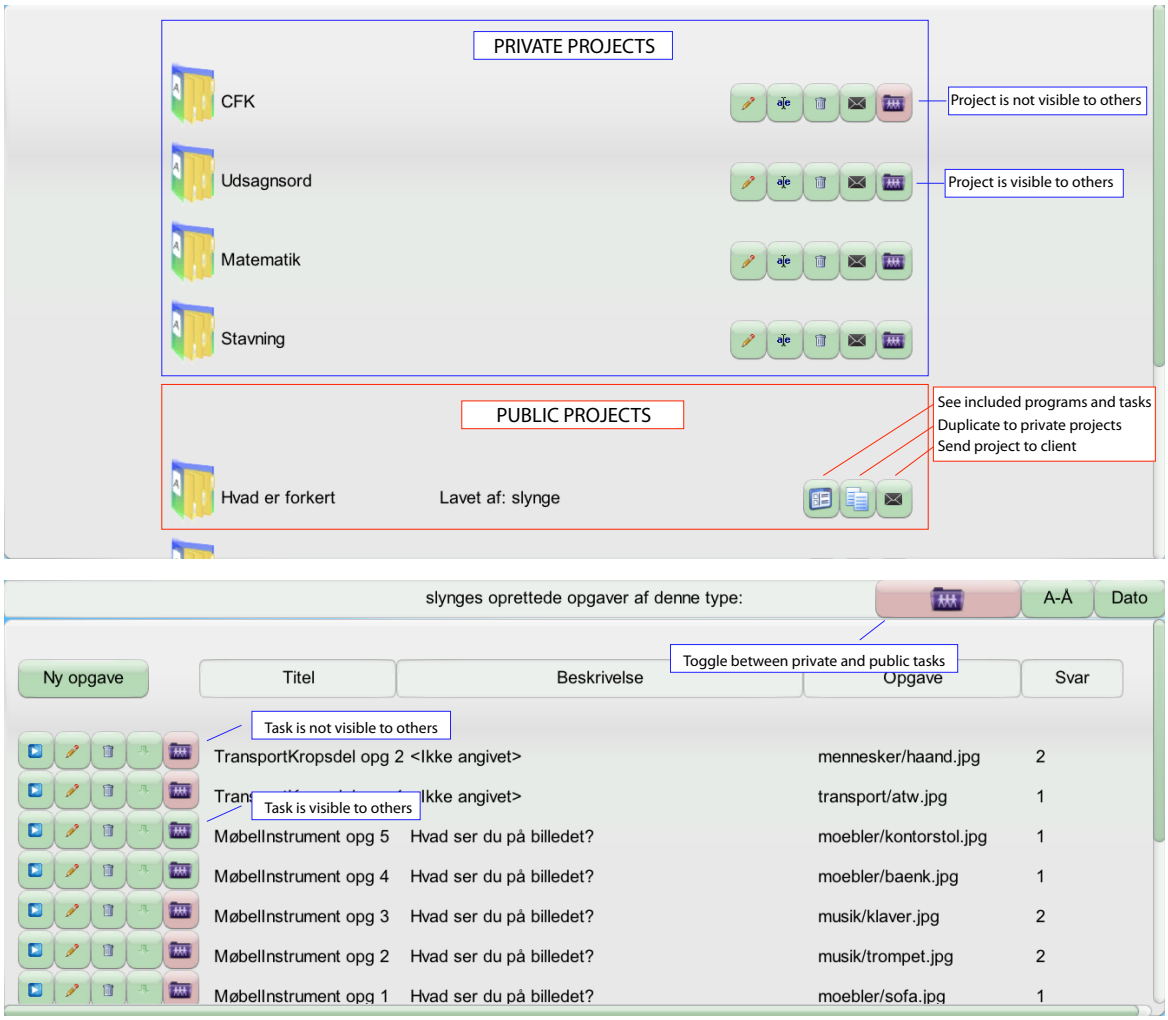


Figure 8.2: *A public/private feature has been added to the Project Overview and the Program Editor that allows a user to share his/her private projects and tasks with other users. Moreover users can duplicate the public projects to their private collection if they want to edit the project. This macro will copy the entire project, including its appurtenant programs and tasks.*

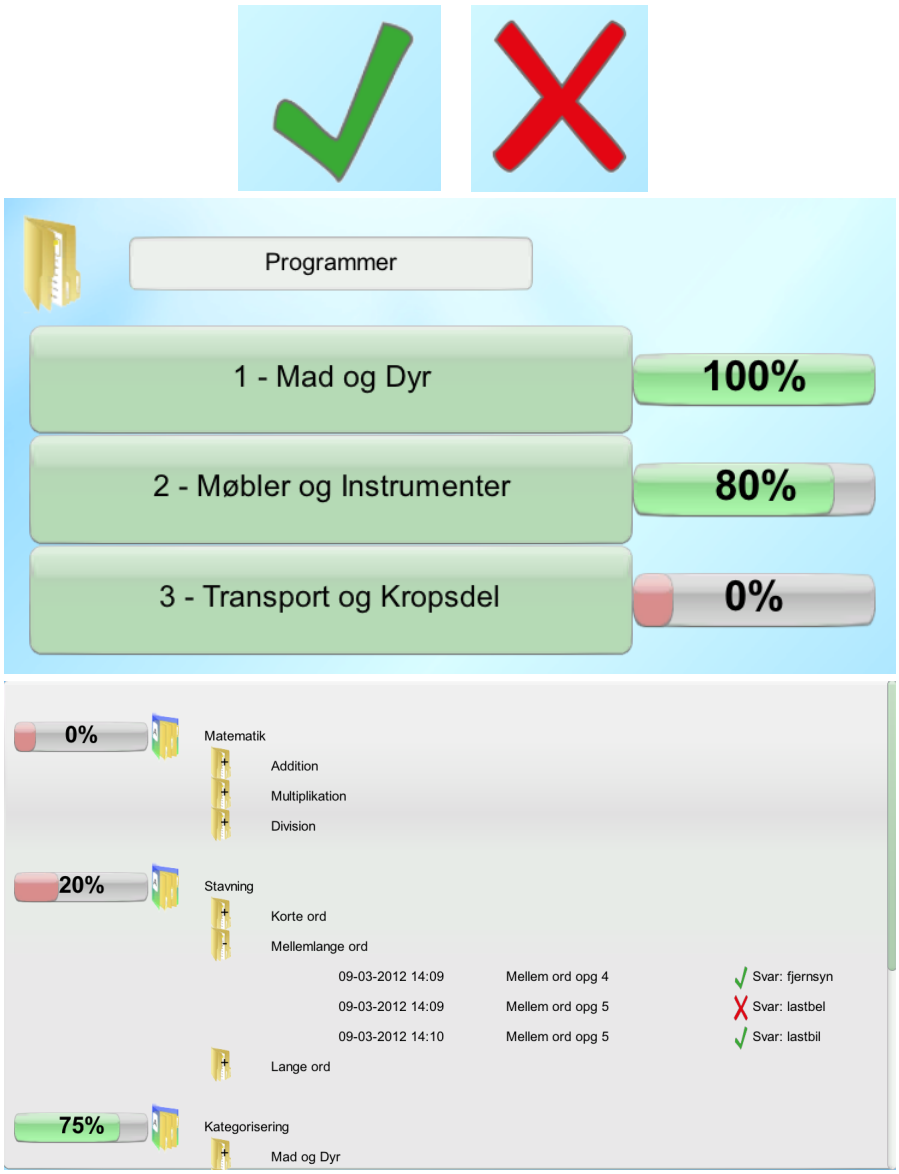


Figure 8.3: *Top: When a client answers a task right or wrong a checkpoint or a cross will be displayed to provide some feedback. Middle: Percentage bars are shown next to projects and programs to let the client follow how he/she advances through them. Bottom: Therapists can monitor their clients results and how they advance through projects, by looking at the percentage bars and examining how many wrong answers has been submitted.*

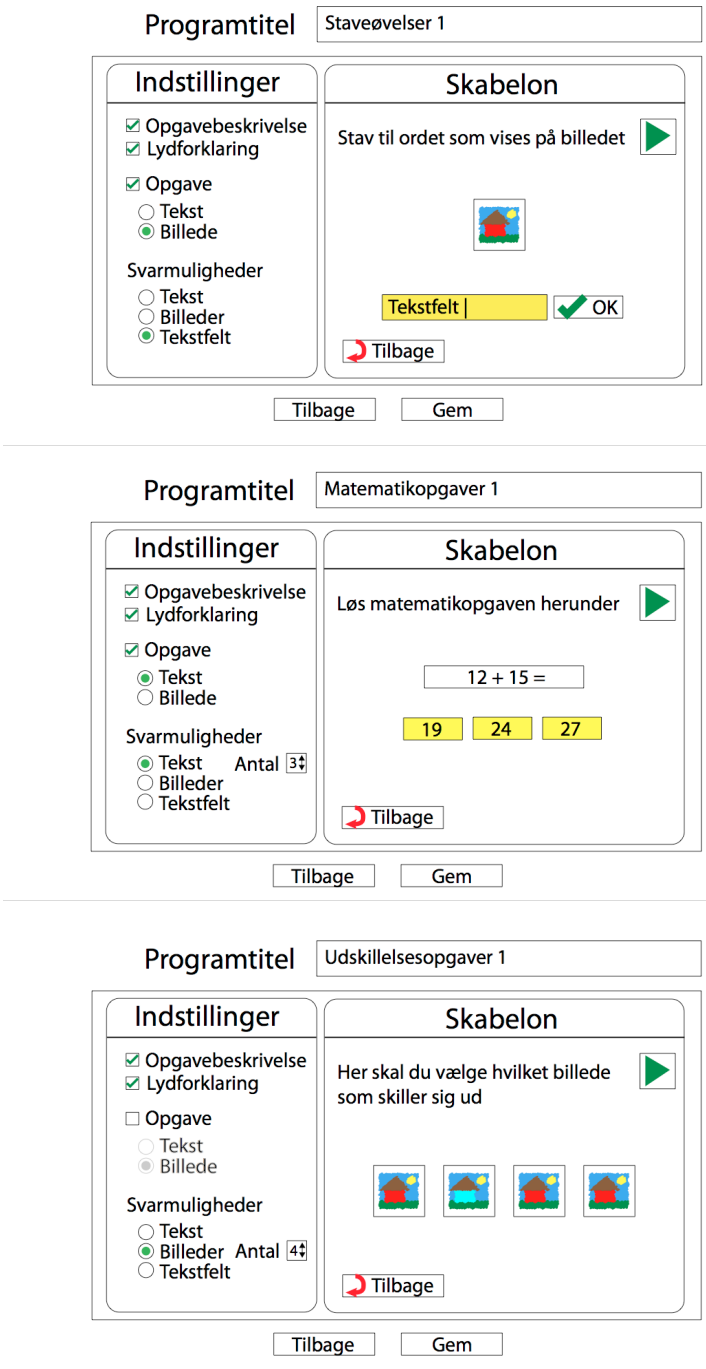


Figure 8.4: *Sketches displaying the Type Editor's intended functionality. Instead of being restricted to four different templates, the Type Editor presents a construction kit that allows the therapist to combine images, text boxes/fields and audio as he/she wishes.*

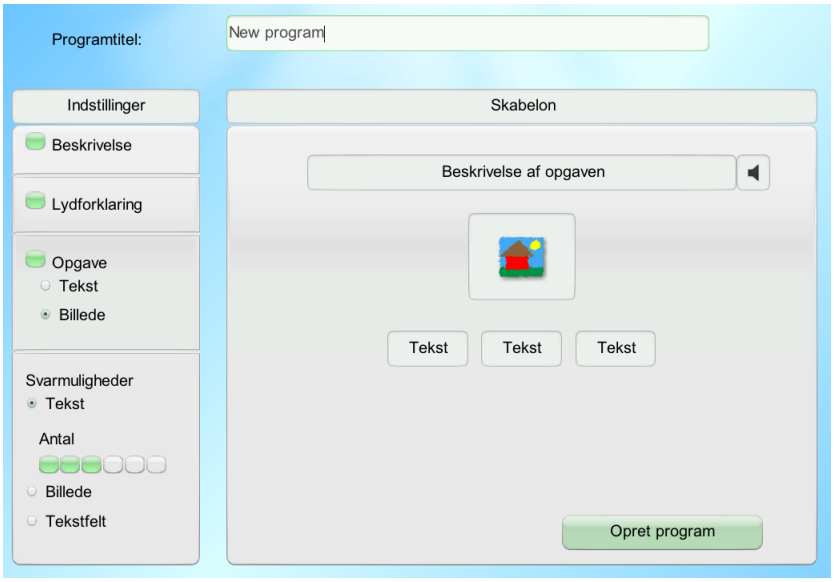


Figure 8.5: *Screenshot taken post implementation. The improved Type Editor lets the speech therapist freely design any type of template that is necessary for a specific program.*

Having reflected on and corrected all the feedback given in the evaluation of the first iteration, another evaluation can be initiated.

8.1 Evaluation of Second Iteration

With a rather fully functional system implemented through the second iteration, it has been decided to conduct another evaluation before initiating the final. This is done in order to get a final assessment from the target group, making it possible to implement some last minor corrections to the system. Prior to this evaluation, several institutions and communication centers have been contacted and asked if they were interested in having a cooperation. Four of the contacted partners were willing to be a part of the evaluation, specifically a private therapist named Bent Givskov from Horsens, Center for Communication in Herning, Hammel Neuro Center and finally Center for Adults in Copenhagen. A meeting with each partner was arranged where a product pitch was made, followed by their respective opinions. An entire walk-through of the system was given to each partner, while notes were taken during the visit.

A lot of feedback about the layout and functionality were given during the four meetings, and the notes can be viewed in appendix C. The most essential and important feedback deduced from the notes are listed below:

- Hints should be provided when a client has answered wrong, e.g. in a spelling task
- It should be possible to answer a task with the numerical keys on the keyboard
- Numbers should be positioned next to the answer possibilities
- It is still too time-consuming to create an entire project from scratch
- More pre-fabricated projects, programs and tasks
- Make it possible to sort projects, programs, tasks and images in different ways, e.g. alphabetically or by date
- Images in the Play Task level should be larger
- In the client portal, buttons and text should be larger
- Using client (klient) as a term for aphasics in treatment, should be changed to student (elev) as this is a more common used term
- Programs should be categorized in types

The implementation of these results will, as previously, be discussed and presented in the following chapter.

Chapter 9

Third Iteration

All the points listed in section 8.1 has been corrected and implemented, except the last point of categorizing programs in types. Hints have been added to spelling tasks, so when a client answers wrong, the system will display the given answer and highlight the wrong letters with red while highlighting the correct letters with green (see figure 9.1). This is considered a great improvement to the system, as aphasics can have difficulties recognizing exactly where the error in a spelling task is, and may become frustrating if no help is available. Furthermore it will presumably heighten the user experience as it adapts to the user's knowledge or skills (see section 4.5).

Numbers have been added to the answer possibilities and it is now possible to answer with numerical keys on the keyboard. Eight different projects have been created to give inspiration to new users and to let them develop further on them. This is also believed to help on the issue that it is too time-consuming to create projects from scratch, and as more and more tasks will be shared by speech therapists, it is hoped not to be as much a nuisance.

Speech therapists can sort projects, programs and tasks either alphabetically or by date, and a search function has been added to the image library (see figure 9.1). Images, buttons and text on the client side have been made larger, and finally all instances of the word client have been replaced by student. All of these minor improvements are seen as being very important to the usability of the system, especially as it is the authors experience, that both speech therapists and aphasics emphasize a lot on such details.

With the last minor changes implemented in the system, a final evaluation can be conducted. The final evaluation will consist of a long-term period where the four partners who also were used in the evaluation of the second iteration, will use and test the system by adding it as a supplement to their everyday work. The methods and results of the evaluation will be explained and discussed in the evaluation part. However, before conducting the final evaluation, it has been found beneficial to develop a website for the SHARP business and as a support tool for the evaluation. Furthermore, the website is developed as a mean for future marketing, but also to communicate with some of the partners who are located in other parts of the country.

Figure 9.1: *Top: The search function lets a speech therapist search inside the image library. Middle: Sort buttons are placed in both the Project Overview, Project Editor and Program Editor. They sort the previously created project, programs and task alphabetically or by date. Bottom: A hint system supports the client when a spelling task has been answered wrong, by highlighting the letters that are incorrect.*

9.1 Website

The SHARP website (http://getsharp.net/) will work as a promotional element both to the company that will be created, but also to the evaluation when presenting the system to the target group.

The website has been programmed with PHP, HTML, CSS and MySQL. These are four scripting languages and database tool often used in collaboration when developing webpages. Five different menus have been implemented in the website. ”Home” presents news about Sharp and the project while also listing some essential sales points that the system provides. ”About Us” includes a short description about the Sharp product and a promotional video which introduce the concept of the system. ”Order” is not just one menu, but includes subpages for each product, as it is a web shop where future customers can buy licenses or subscriptions in order to utilize the SHARP system. As mentioned earlier it is the idea that a company should be launched when the project is finished. ”Contact” presents a form where users can ask various questions or provide feedback about the system. Finally ”My Page”, which is placed at the bottom right corner of the website, allows users of the system to log in and see different details about their profile. These include amount of clients created, projects created, change of password, a help menu that describes how the system should be started if any problems occur and finally a feedback menu where the users can provide feedback about the system. The feedback menu is actually a part of the evaluation, which makes it possible to give the authors ongoing feedback when the partners are testing the product. A screenshot of the website layout can be seen in figure 9.2 and more detailed information can be viewed in the digital superlative flash diagram (appendix C).

Figure 9.2: *The website functions as an informative mean that provides help, info and news for the user. Moreover, a web shop has been implemented that will be launched when the SHARP company is going public.*

Part III
Business Plan

This part of the report describe the theories and methods used when developing a business plan, followed by a short summary of the business plan developed for this project.

Chapter 10

Developing a Business Plan

At the current state of the project, it is expected that a fully operational company should be developed, as it is the conception that there exists a great potential behind the idea and concept. Since the creators of this project possesses their main competences within the field of technology, it is seen as a necessity to gain some knowledge on how to develop a business from scratch.

The content of this chapter is referenced by Morten Dahlgaard's and Kenneth Stenkjær Pedersen's entrepreneur course[13](slides can be found in appendix C), and will intend to clarify some of the crucial elements of business development that is required in order to build a simple idea into a successful company. This is done by describing the key components of a business plan, which is the fundamental tool to create as an entrepreneur. These are:

- Business idea
- Organization
- Products and services
- Market, needs and customers
- Business model
- Rival companies
- Intellectual property
- Budget
- Financing and ressources

10.1 Business Idea

This part of the business plan is a short introduction that describes the essence of the entire idea. This includes the area of possibility that the idea is treating, e.g. the health system as in this case. Furthermore, it should describe exactly why this is a beneficial idea, both financially and customer wise. When developing a business it is most often with the intention of achieving a financial profit. The method on how to get the profit are the essence of the entire business plan, and it is therefore important that it is thoroughly explained. Also what are the advantages to the potential customers, and more important, does the concept include any customer pain? In short, the business idea section must explain how and where the growth potential exists.

10.2 Organization

The organization section is very self describing as it should include a description of all active participants of the company. This includes the founders, key members, staff and also which positions that are missing. Moreover the section should describe collaborates such as the board of directors and advisory boards along with the more peripheral members like counsellors and experts. Each description should consist of a short introduction of the participant, his/her competences, together with a specification of why the participant is important to the company.

10.3 Products and Services

This section can vary in length depending on the kind of business that is being developed. It is very different for each company what it is that provides the financial profit. It can be a simple service such as a cleaning company, a massage clinic or a home carer. It can also be a product, that has some kind of value to people that is high enough for them to buy it. This could for instance be a car, furniture or a software product such as the one developed in this project.

All the products and services of the company should be described in details in this section. It is important when e.g. pitching the idea to new potential customers or a bank, that everybody understands how the service or product is created, which is why a thorough specification of all parts and elements is required. Furthermore, the service or product is the core element of gaining a profit in the business, and a detailed description will therefore also help potential buyers and investors understand why they should invest their money, as they know exactly what it is they are buying.

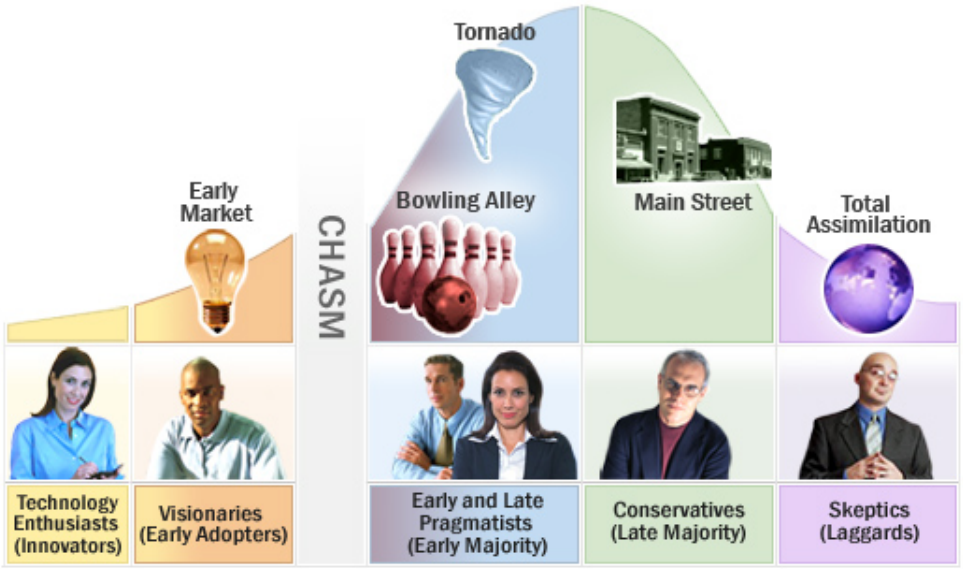
In this project's case, the products and services section should contain specifications of both the front-end graphical appearance and layout, the main construction and context, but also the underlying structure and maybe even some specific programming examples. Even though it is possible that other buyers or investors does not understand the programming, they should still have the opportunity of studying it.

10.4 Market, Needs and Customers

This section is one of the most crucial parts of the entire business plan. First of all it is essential that the correct market is targeted. Having a great product or service is not a key to success in itself. The targeted market might not be ready for the idea, or maybe it is a completely different market that should have been targeted. A deep analysis of the market will help clarify advantages and disadvantages and thereby make it easier to determine which market is the proper one. One part of the analysis is to examine what the needs of the various interesting markets are. Are there some unexploited needs in the market, or are there some latent needs that can be evoked? Also concrete facts about the different markets are important in order to measure the potential turnover for each. This includes size of the market, both expected, historically and present. Are there any barriers that needs to be coped with before it is possible to reach the market, or are there any specific drivers in the market, such as a change of technology or jurisdictionally?

After looking at the market, it is necessary to dig deeper into each to investigate the existing or potential customers that lies within. Defining the target group is about locating those who demand the service or product that is being sold. Those who have common needs and desires, and refer to each other when buying. It is important to get in contact with those who can spread the message of a certain service or product, in order to obtain a larger target group, and not only the obvious customers. This challenge has been illustrated by Geoffrey Moore in his book "Crossing the Chasm", where he explains the technology

adaption lifecycle. The technology adaption lifecycle model describes the adoption or acceptance of a new product, especially within the field of technology, according to the demographic. As seen in figure 10.1 the adoption of a new product can be illustrated as a bell shaped curve. At the beginning of the curve the innovators are positioned. They are enthusiasts and very open to new products, and most of them consist of those who actually develop the products. The early market represent the segment that definitely wants to buy new technology and products, hence the name ”Early Adopters”. They are visionaries searching for new technology and are therefore not skeptic towards innovation. However, this segment is also the segment representing one of the smaller groups of the market. The challenge referred to earlier, which is also the element Moore has added to the technology adaption lifecycle model, following the early market, when trying to conquer the majority of the market, who also are the more pessimistic group of the market, seeking the existing technology. The challenging task is to get across what is referred to as the ”chasm”. If this task can be achieved, and the early and late majority can be reached, there is a great chance of success for the business.



[10]

Figure 10.1: *The technology adaption lifecycle describes the adoption or acceptance of a new product. According to Moore, the challenging task is to get from the small segment of Early Adopters and reach the majority of the population, the Early and Late Pragmatists.*

The method on how to develop a product is also something that can have a great influence on a company’s success and how potential customers will accept the product. Within this area, Steve Blank, a Silicon Valley-based retired entrepreneur, has developed a model that propose a new method of designing and developing products, other than what is usually seen. The most common way of developing a product can be illustrated with the product development model as seen in figure 10.2, where the main catchphrase is ”Build it and they will come”. This model is probably recognized by the majority of people who have ever tried to develop a product, where it is the product itself that is being focused on. The development is initiated with a conceptual phase, where the main ideas about the product are designed, such as visions, prices, data collection, analysis and the business plan where budgets, competitors and venture capitalists are determined. Another step is to figure out how the product will reach the customer and the potential distribution channel. Followed by the conceptual phase is the actual product development, along with marketing and segmentation. This is where engineering designs its product, specifies the first release, and hires a staff to build it. Meanwhile, marketing refines the size of the market defined in the business plan, and begins to target the first customers. In the third part of the model, the actual testing is initiated.

For the first time pilot customers and focus groups are drawn into the development model, as the product is tested for bugs. Finally, it is time to launch the product and make the first customer shipment. This is what the company has been waiting for, and hopefully also what the customers have been waiting for. Even though this is a model that has been used by countless startups to take their product to the market, there are some problems with it, according to Steve Blank.

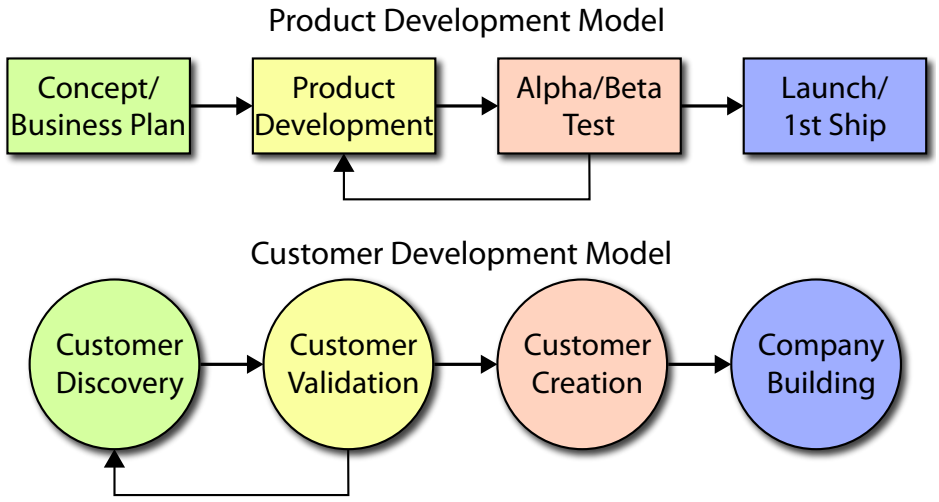


Figure 10.2: *The development in this project is based on the customer development model, as it reduces the risk of failing due to the fact that it is based on the customers premises.*

First of all there are no customers involved in the development of the product. It ignores the fundamental element of product development. Startups do not fail because they lack a product. They fail because they do not have any customers and a valid financial model. The product development model focuses on product instead of customers. It requires a large capital and great reliable knowledge about the customers and market. It focuses on launch and execution instead of learning and discovery. So instead of concentrating on the product throughout the development, Steve Blank has designed a customer development model (see figure 10.2), where, hence the name, customers are the core element. In the first phase of the model, the task is to determine who the customers are, and how they should be targeted. Is there a specific need that the customers have and is that need important to them? Also, this phase is about questioning the hypotheses from the business plan, about customers and the product. This is done by getting into the field, locating the problem and the belonging customers and determining if the product actually can solve that problem.

In step two of the model, the goal is to build the sales road for the sales and marketing department. The sales road is a description of the process where the product has been sold to early customers. Customer validation proves that a set of buyers have been located and that there actually exists a demand for the product. Customer discovery and customer validation is an iterative process, as it is possible that the customer discovery is wrong the first time. In the third step of the model, the actual marketing is initiated, based on phase one and two. The goal is to create an end-user demand and drive that demand into the company's sales channel. Finally it is time to build the actual company. The first three iterations of the model have ensured that there exists a demand from the customers and that the product is needed in order to reduce that demand.

The customer development model is based more on facts than on hypotheses. Furthermore it is based on iterations with customers which reduces the risk of failing, and increases the value. This ensures that whenever there is a production loss, it is affordable loss because the data is so trustworthy. It is not said

that when developing a product, only the customer development model can be used. The chosen model should vary depending of the specific case.

10.5 Business Model

The business model of a company describes the way in which the business creates, delivers and maintain value. It is used to keep an overview of the various connections in the company, and is a great tool when giving a short pitch to customers or investors. The model is often illustrated through a canvas (see figure 10.3) where short sentences or keywords are placed in the nine different building blocks:

- Customer segments

  Who are the customers?

  Who are the company creating value for?

- Value propositions

  What value does the company deliver?

  Which customer problems are the company solving?

  Which customer needs are the company satisfying?

- Channels

  Which channels are used to reach the customers?

  Through which channels does the customers want to be reached?

  Which are the most cost-efficient?

- Revenue streams

  For what value are customers willing to pay?

  For what do they currently pay?

  How would they prefer to pay?

- Customer relationships

  Which customer relationships have been established?

  How are they integrated with the rest of the business model?

  Which customer relationships are expected?

- Cost structure

  What are the most important cost inherent in the business model?

  Which key resources are most expensive?

  Which key activities are most expensive?

- Key resources

  What key resources does the value proposition/distribution channels/customer relationships require?

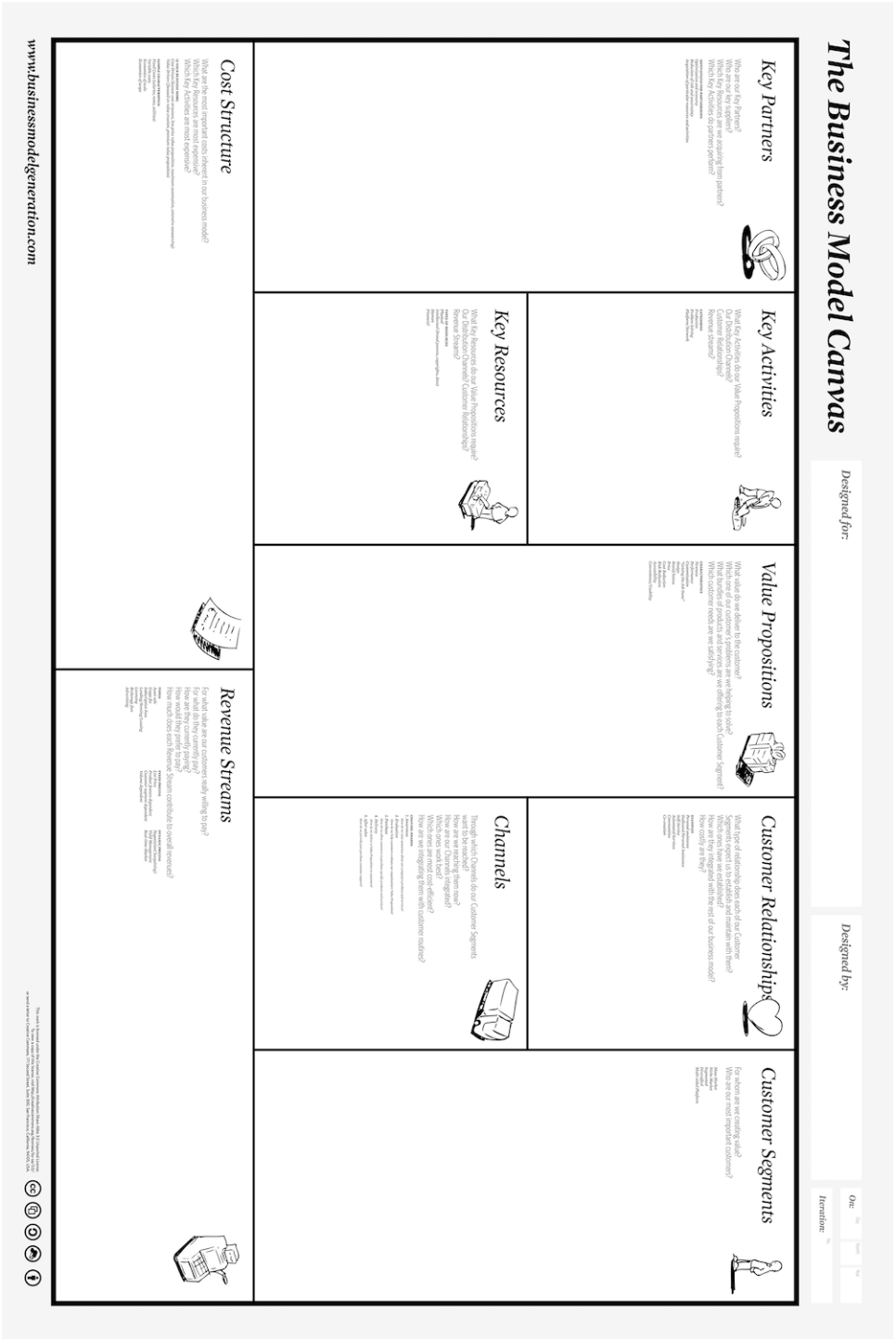
- Key activities

  What key activities does the value proposition/distribution channels/customer relationships require?

- Key partners

  Who are the key partners?

  Who are the key suppliers?



[9]

Figure 10.3: *In order to get an overview of a complete business model, Business Model Generation has designed a canvas that contains all different elements of the model. By inserting keywords into the different areas, a business model can be presented and described shortly and precise.*

10.6 Rival Companies

This section should include an honest detailed description of all the existing rival companies that are on the market. The description should cover revenue, amount of employees and year of establishment. Regarding geographical location, it is important to analyze the companies who are from the same nation, however, it can also be beneficial to investigate markets in other countries. Furthermore the rival companies section should include a description of competing technology or services. These analyses will help clarify the position of the company in the value chain, and more important, make it possible to locate any specific competitive advantages. However, rival companies does not always have to be rivals. Descriptions of the companies can also help determine if any of them are potential collaboration partners.

10.7 Intellectual Properties

When developing a product that in some kind of way is unique compared to other competing products, e.g. in design, or a product that is such an innovative invention that it has not been seen before, it should be carefully considered if a patent or design protection should be taken on the product. A patent is a prohibition against others to use ones invention in any commercial way. It can also be a trademark, a specific name or sign that a company uses, a unique brand or company name, like Coca Cola, or the copyright of the source code of a software product, like in this project.

Intellectual property can be a very expensive venture, e.g. it costs 4200 DKK exclusive of VAT to buy a trademark, while a patent cost more than 10 times the amount of that. It is therefore crucial to be certain that the product or the feature that is taken patent on, is unique and never seen before. The copyright of a software product is a bit more straightforward and inexpensive. The developers of a software product have automatically the copyright of the source code. However, this does not mean that anybody else can not create a software product that is identical, as long as it is a different source code. This section should include all the considerations regarding intellectual property of a company, as it is very important in order to create an honest and trustworthy budget.

10.8 Budget

A budget of an upcoming company should clarify the capital needs up until a break even or exit. A break even is when the revenue reaches zero and a profit is realistic. Moreover it is important to make an honest budget that covers all expenses and subventions. This includes venture capitals, salary, production expenses, marketing and distribution The honest budget is an important asset when meeting potential investors. If investors detect that there are parts of the budget that are not reliable, it will appear as if the research is not done properly.

10.9 Financing and Resources

In this section, all possible financial opportunities of a company should be investigated. In order to avoid the valley of death, which a lot of upstarting companies experience, it is important to ensure some sort of financing. The valley of death represents the time from start up until a company makes its break even. Most often there are many expenses when starting a new company, e.g. for production, salary and materials and resources, and some sort of start capital is therefore essential in order to make the company survive. Financing is available through three different approaches. It can be done through

traditional financing, where the development of the business is supported by bank financing and venture financing. Some might also be so lucky that the company can develop with none or very few means. Finally the business can develop via alternative financing, where the business is supported by lending or equity interest other than traditional financing.

With the fundamental knowledge on how to develop a business plan, the following chapter summarizes the one produced for SHARP, which can be found in appendix E.

Chapter 11

Summary of Business Plan

The entire business plan is attached in appendix E. The business plan has been developed with the purpose of using it when presenting the SHARP concept and system to future investors or customers, and is therefore written in Danish. However, a short summary of the business plan will be presented in the following chapter.

SHARP is an upcoming company which will hopefully launch in the summer 2012. The purpose of the company is to introduce the system presented in this report, which is a rehabilitation tool for people with aphasia, a disorder that reduces the communicational skills, both expressive and receptive aphasia.

The organization behind SHARP consists of the two founders, Rene and Casper. They have developed the entire system, both back-end and front-end. The founders have been working together for five years within various fields of software development, and the skills from these years of experience have created a solid foundation regarding the development of the SHARP system.

SHARP has several existing rivals such as *Afasi-Assistent* and *Ansigt-til-Ansigt*, which are all useful applications for aphasia rehabilitation. However, due to the fact that the motivation for creating the SHARP system comes from these existing products, it is presumed that SHARP will surpass them, as the system and its features are developed, based on the disadvantages of these existing products. This include the fact that the entire system is online and runs through a web browser without any installation. It is built around the science of authoring systems which allows speech therapist to design unique projects for their clients. Speech therapists can share their projects and tasks with others, which will ensure a network of prefabricated projects and tasks, while simultaneously being able to develop further on them. These are just some of the advantages that will function as sales values when presenting the system to future customers or investors and when comparing the system to existing applications.

The system has been developed by following the *customer development model* (see chapter 10), which will ensure that the product is based on reliable data and will therefore minimize the risk of failure when publishing it. Furthermore the system will hopefully be a ”need to have” instead of a ”nice to have”, as several iterations of development via the target group have ensured that there is a demand of the product and that the system fits the end user’s requirements. The customer development model will hopefully also make sure that the chasm in the emphtechnology adaption lifecycle described in chapter 10, will be overcome easily and thereby make it possible to reach a larger market and expand the target group.

The customer segment within the company consists of public institutions, hospitals and communication centres. These are the paying customers, whereas the speech therapist employed in the institutions, and hospitals are the customers who will be using the system. However, before there can exist a demand from the speech therapists, there must exist a demand from the aphasics, as they are the core target group of the SHARP system. It is therefore very important to clarify all value propositions for each of the three

customer segments.

A value proposition for the aphasics is that they will be given more freedom through the entire rehabilitation process. As the system is online, the aphasics can train and be rehabilitated without having to be in the same room as a speech therapist. Tasks can be completed from home, which will make the aphasics more independent and rehabilitation can occur whenever the aphasic wants it to. The speech therapists will have fewer personal sessions with their clients and can therefore treat more clients within the same amount of time. Furthermore, the system provides a greater overview of a client's rehabilitation process and the training completed at home. Finally, the public institutions will be able to buy a piece of software that is up-to-date and includes more beneficial features, while still being in the same price range as its rival products. Moreover, as the SHARP system will reduce the rehabilitation period for an aphasic, more clients can be processed which will increase the amount of subventions given to the public institutions.

Revenue streams in the company will consist of licenses that will be required in order to use the SHARP system. The price for a license will depend on the amount of licenses required. However, a one time payment is not considered to be an ideal revenue stream, as it will entail that income from the customer is restricted to this one payment. In order to maintain a cash flow in the company, it is found more beneficial to lower the price of a license, and then sell a subscription afterwards. With a subscription, the customer will be required to pay per month or year, and a constant income from the customer will be maintained.

Intellectual property describes the property rights that a company have. In the SHARP company, the source code of the system is the biggest asset. Due to the fact that the founders have developed all source code, they have the copyright of the entire system. The company itself will be established as a limited liability company. This is not a very expensive procedure, but will ensure that none of the founders will be personally responsible for any failure in the company. SHARP as a trademark will also be a reality when the company is launched in order to give the company a stronger brand to the public. However it is important to investigate if any other companies already own the trademark.

An expected budget is presented in the complete business plan. The expected sales of licenses is hoped to follow Moore's theories regarding product adjustment in a society. During the first month the marketing will be initialized and in this period of time it is not expected that any licenses will be sold. However, it is presumed that 5-6 licenses will be sold during the first three months to the early adopters that are not afraid to invest in new products and ideas. Within six months, the publicity of the SHARP product is assumed to big enough that the early majority can be reached, which hopefully will accelerate the sales. Besides the income from licenses and subscriptions, a bank loan of 50.000 DKR. is required in order to reach a break even within a year. This is due to expenses such as marketing, salary, server and limited liability company establishment. If the market at some point reaches its maximum, and no more customers can be found, there exists a good breeding ground for making an English version of the SHARP system and go international.

Chapter 12

Evaluation of Business Plan

In the end of April 2012, the authors received a call from Maiken Holm Nors who is a project leader and region responsible for Venture Cup[1]. Venture Cup is a self-owned non-profit organization, which is overseen by a board of directors. Its mission is to inspire university students and researchers to develop their ideas into successful companies. In the phone call received by Maiken, she invited the SHARP project to be a part of the Venture Cup 2012 startup competition. The competition is one of the biggest events within the Danish environment and is an invite-only event. The purpose of the competition is for students and researchers with a great idea, to hand in their business plan, whereafter a jury will pick three winners in each of the five categories that are included. The winner of each category will win 50.000 DKK, and automatically advance to the final where one of the five winners will win 200.000 DKK.

The offer of joining the competition was immediately accepted, as this would also provide some crucial feedback about the SHARP business concept. A business plan was handed in, under the Life Science and MedTech category, even though it was mentioned by Maiken that this was one of the toughest categories. Another category that was considered was the Mobile and Web, however, the Life Science and MedTech seemed more fitting for this project.

The 23rd of May 2012, an email was received, stating that SHARP had advanced to the finals. This means that the project has been selected between 154 participants, as being in the top three in its category. Moreover, the jury[2] gave some feedback during the ruling, which can be seen in figure 12.1.

Since SHARP has advanced to the finals of Venture Cup, the majority of the feedback is very positive, and will be useful e.g. as a supplement when presenting the concept to others. However, there are also constructive criticism in the results, that mentions some flaws in the business plan. These flaws should be considered as future improvements, and will definitely be taken into account prior to the final that will take place in Copenhagen the 13th of July, where the authors will make a product pitch to the jury. This pitch will obviously prepare the ground for a more detailed description on some of the flaws that are mentioned in the feedback. This includes a more thorough analysis of the market that SHARP is targeting, along with a more technical presentation of the SHARP system. However, since the pitch is only allowed to last for four minutes, it is important that the subjects are presented quickly and precise.

Currently, Maiken Holm Nors is searching for a specialist that can help with the development of a more detailed market analysis. This is one of the areas that have not been covered sufficiently in the business plan, as it has been a very difficult task to locate some actual facts and numbers about aphasics, speech therapists and rehabilitation centers. With a more complex market analysis than the current, it will be easier to establish an honest budget and also determine when and if other nationalities should be

[1] Venture Cup: http://www.venturecup.dk/

[2] Jury for Life Science and MedTech: http://www.venturecup.dk/jury/

How innovative is the idea? (15.4) - Feedback
Good inventive step although many competitors
Better solution than the existing.
The idea might be great but the business plan do not provide the nessecary descripton of the core content if the software program to be used by afatic patients and their speech therapists for me to evaluate the project
The idea presents another way to solve the problem than the current solutions in the market with a different business model by focusing on optimizing the experience.
Has the team thought of ways to gain competitive advantages (e.g. through idea protection or other strategies)? And what is the potential for this? (15.4) - Feedback
Although relatively limited USPs the soft seems to be protected....
It has been considered. However he trademark "SHARP" should be protected as soon as possible. However it may already be protected by others, but then it can be protected by its graphic appearance (logo). The copyright of the code coul be strengthened with mannuals descibing the concept and includes the logo.
To protect software programs is not easy. If this project obtain a huge success the team may experience competition from similar programs
Too general specification of how to build competitive advantage except for software source protection. Describe how your activities will build sustainable competitive advantages.

Does the idea relieve a specific customer pain and is the customer base/market attractive? (15.4) - Feedback
well described 'medical need'
Yes, and this is described very well in the business plan.
The project adresses a major problem in the treatment of people experiencing speech problems following brain damage. However, as described above it is not clearly described what is the solution to the problem
Yes, there is a specific need for a product like this. Could there be other customers than public and GPs to extend the customer base? (e.g. the person themselves)
How feasible is a realization of the proposed idea? And has the team described a good path towards this? (15.4) - Feedback
Highly likely
Yes, it is well described, but they need a marketing specialist, and why not go for the international market from the start anyway. The Danish market is too small (also if you need venture capital).
As mentioned above the core content in the software program is not described in a way which give me sufficient knowlede to give this project a fair assessment. The team needs to give a more precise description of the solution they try to provide
Very well described execution plan. Make risk analysis and mitigation to get the complete plan.

Does the team consist of people with different and complementary skills? (15.4) - Feedback
Strong team
No, but they use external consultants. -However a consultant covering marketing is also needed.
The team consists of two programmers bu they have teamed up with a number of experts. Thus the knowledge base within the entire group seems to be sufficient
Good with advisor network. More scientific resources in the team should be included or very detailed customer research / development.
Overall: would you like to see this idea as one of the Venture Cup finalists? (23.1) - Feedback
strong and good business plan and development plan.....should maybe think of expanding the market to other countries.
Yes, but the lack in the plan described above should be addressed.
Based upon the current descripton I do not want to see this project in the final. However, with a better description of the project I might change my mind
Superior edge and differentation compared to current solutions should be illustrated, but there is certainly a strong execution plan and committed team behind.

Figure 12.1: *The jury of Venture Cup provided some essential feedback during the competition which is crucial to take into account when continuing the development of the SHARP company.*

considered. On this point, the jury agrees that going international is something that should be considered as quickly as possible.

The business plan handed in for the Venture Cup competition was at maximum allowed to be 15 pages, and it was therefore decided to omit a thorough technical description of the product. Unfortunately, the jury members mention this as being one of the lacks of the business plan, which gives reason for a more comprehensive presentation of this aspect during the pitch.

Finally, the SHARP business plan was criticized for not providing a clear overview of the company's value propositions. Value propositions are extremely important when presenting the product, as they act as clear statements to the end user, similar to catch phrases, and intrigue the potential buyers. Thus, these should be also be accounted for during the pitch.

Part IV
Evaluation

This part of the report will describe the test that was conducted to evaluate the system, followed by a discussion and conclusion.

Chapter 13

Designing the Experiment

This part of the report will elaborate the long term evaluation that was shortly introduced in the end of chapter 9. The evaluation is the final and conclusive test that will assess the SHARP system by describing the methods used, and present and discuss the results.

The purpose of the pre-evaluations made during the product development (see chapter 5.3) was to get some feedback on technical and graphical improvements, whereas the purpose of this evaluation is to gain some more general feedback on the entire system, the effect of it, if it is usable in real environments and if there are some major improvements to be made.

13.1 Design

The evaluation is conducted as a qualitative experiment, and will provide the respondent's respective opinion. As described in chapter 9.1, the website allows the partners of the evaluation to provide ongoing feedback during the process. Furthermore, the evaluation will be concluded with a questionnaire, where the partners are asked specific questions about the system in general and other aspects.

13.1.1 Environment

A user has been created for each of the four partners that have agreed to test the system, which allows them to create an unlimited amount of projects and clients.

With the product pitch described in chapter 9, the promotional video on the website, an installation guide to the Unity web player along with a description of the type of feedback that is hoped for, it is expected that the partners of the evaluation have a solid foundation when beginning their use of the SHARP system. Even though the product pitch gave a detailed walk-through of the system, it is anticipated that a user should be able to navigate through and utilize it with the intuitive interface, and the help information provided in each level.

13.1.2 Subjects

The four subjects that were presented in chapter 9, were expected to conduct the final experiment as well. However, due to the lack of resources, Hammel Neuro Centre was unable to participate in the final evaluation. This leaves Bent Givskov who is a private practitioner, Centre for Communication in Herning and Centre for Adults in Copenhagen, which are public institutions for aphasia treatment. Hopefully, the

amount of subjects will still be significant enough to conduct some competent conclusions. During the product pitch, both Centre for Communication and Centre for Adults mentioned that they were able to include two speech therapists, each with two clients.

13.1.3 Procedure

The subjects will use the system as an additional tool in their treatment for approximately two months. The subjects have been advised to provide as much ongoing feedback as possible, due to the fact that feedback provided directly while testing the system will be more detailed and precise. When the two months have passed, the subjects will be asked to participate in an interview to answer some carefully considered questions formulated by the authors.

13.2 Results

The questions asked during the interviews are divided into six different topics, and are listed in appendix D. The answers can be found in appendix C.

13.2.1 Existing Products

The existing products that the three subjects are using at the moment, includes three of the five software solutions described in chapter 3. Bent Givskov is using Tell Me More and another application called Vocabulary builder. Centre for Adults utilizes the online system Scientific Brain Training, while Centre for Communication is using the Danish software Afasi-assistent. All three subjects seem to be satisfied with their current solutions, however it could be claimed that they are only adequate as the user in general adjusts to the content of the application and not vice versa.

13.2.2 Usage

Unfortunately, due to the lack of resources and time, the subjects did not utilize the SHARP system as expected. Centre for Adults tested the system on three aphasics with fluent aphasia (Wernicke's) and created their own tasks and projects, however, Bent Givskov did not include any clients because he did not believe the system to be ready yet, nor did he create any tasks himself. Neither Centre for Communication tested it on any aphasics, as they did not have the resources or time. Another significant issue during testing, was some technical problems that occurred during installation of the Unity Web Player and during login. This nuisance obviously reduced the subjects' motivation to use SHARP.

13.2.3 Concept

Regarding the concept, all participants were very positive towards the general ideas and the features in the system. Especially the fact that the entire system can be executed through a web browser that requires no installation, other than the Unity Web Player which is done automatically. The idea about an authoring system where the user can create his/her own tasks and projects is also considered as a great idea, however especially Bent Givskov was skeptical as he does not think that speech therapists have the time or want to create tasks themselves.

Having a system that allows the aphasics to work independently is essential for a system like this, however Bent Givskov believes that the client requires more assistance from the system than what it currently

provides. He specifically mentions one issue where aphasics have cognitive limitations and therefore cannot control a computer mouse. In general Bent Givskov believes that the entire system lacks some fundamental knowledge on how to teach humans language. This is a crucial aspect of aphasia rehabilitation, and should therefore also be included in the system. Moreover, he does not find the graphical layout appealing as he thinks it is a bad choice of colors, the images and text fields should be larger and the graphics are cramped.

All subjects believe that giving results to both the client and speech therapist is important as it provides engagement for the client and gives the speech therapist the advantage of monitoring the client's progression.

Two other improvements that were suggested by Bent Givskov and Centre for Communication were the idea of adding some speech synthesis into the system in order to provide the user with some more auditive feedback, e.g. by pronouncing the purpose of an object when the mouse is hovering above it. Another suggestion was to integrate video communication allowing speech therapist and client to collaborate without having to sit in the same room.

13.2.4 Interface

All subjects provided a score that was above middle when asked how easy and intuitive it was to manage the system, meaning that the subjects (speech therapists) did not have any major issues navigating through the various levels in the system, however, Centre for Adults believe that there are too many mouse clicks before a user actually can create a task. Regarding the structure and layout on the client side, Bent believes that the levels are too identical and in general the entire layout should be made more simple, especially for the aphasic. Bent specified that he would only give the client's side a score of two, which was substantiated by the excessive amount of mouse/keyboard clicks as well.

13.2.5 Usability

The questions regarding usability provided some diverse responses. Centre for Communication answered that any kind of installation should be avoided, even the automatic installation of Unity Web Player. This could also entail that technical issues are avoided. Moreover the system should be able to remember passwords and additional preprogrammed tasks and projects should be added to the database.

Centre for Adults requested that the programs should be available for the iPad or other tablet devices, to increase the amount of access methods. Even so, they still believe that SHARP can be used in a rehabilitation process, especially for home practice, and mentions that it might be able substitute a software solution such as Afasi-assistent, if some of the suggested improvements are made. Even though there was no problems using the system, other than installation and login, the system requires a more intelligent guide/feedback system, especially for the aphasic.

13.2.6 Effect

None of the subjects believe that SHARP can shorten the rehabilitation process for an aphasic, because it lacks some more features regarding context when designing tasks. Moreover, they do not believe that it makes any difference if the exercises are digital or physical. However, SHARP might have a working effect on aphasics as long as the designed tasks are based on professional knowledge. Finally the clients who actually tried the system believed it to be a good solution, even though they did not have the opportunity to utilize it sufficiently.

Chapter 14

Summary

As a continuation of earlier research done within the field of aphasia rehabilitation, this project has developed SHARP, an online platform that features an environment that connects the aphasia patients and speech therapists. The system is fundamentally focused around sharing and producing tasks and challenges, which has origins in acknowledged aphasia theories. The current market of aphasia related software has been examined to create a tangible comparison and identify their respective advantages and downsides. These observations led to a solution that provides freedom to the therapist by making use of an authoring environment and allows creation of tasks taylored specifically for each individual patient.

As a side project, SHARP has been examined from a business perspective, as it is the intention to create a company around the product. This has entailed the establishment of a business plan, which concretizes various important aspects relevant to entrepreneurship.

The development of the system has been conducted through the customer development model, which has evoked an implementation process that has been continuously evaluated by speech therapists, whose feedback has occasioned multiple iterations. The final product was evaluated by the speech therapists, in a realistic environment by integrating SHARP in their regular rehabilitation routine. After a two month period, their opinion was requested and much valuable feedback was obtained. In the following chapters, this data will be discussed to determine whether or not the tool can be a valuable substitution/supplement for current aphasia therapy.

Chapter 15

Discussion of Results

As stated in the experiment description (section 13), three participants were asked to utilize SHARP in their regular working routines, and then give feedback regarding their experience. This chapter will discuss the results acquired.

15.1 Existing Products

Even though all subjects seem to be satisfied with their current software solutions, it can be questioned whether this is because they have become too familiar to these solutions, and by utilizing them for a long period of time, it is difficult to get accustomed to new methods. The current solutions provide predefined contents, which differs from SHARP's general concept. Moreover, the therapists are probably satisfied with their current means because they have not realized the possibilities that lies within modern technology, and therefore can not imagine other working methods. If this is the case, it is crucial to put a lot of effort into explaining the advantages of the product, and thereby persuading them that this concept actually can make the rehabilitation more efficient by shortening the process, as the exercises are specifically adjusted to each client.

15.2 Usage

The participants did not integrate the SHARP system during the two months of testing properly, and therefore could not deliver as much feedback as expected. It is unfortunate that, in the beginning of the evaluation process, no indication was given that there was a lack of time and resources to test the product. It was expected that two of the three participants would include three speech therapists, each affiliated with two to three aphasics, as it was agreed upon. Therefore, it is acknowledged that more participants should have been included in the final evaluation.

Although the system was not tested on more than three aphasics, the primary objective has been achieved, as the therapists feedback is still considered more important due to their professional knowledge and insight in the clients' requirements.

Even though the recorded activity of the test subjects showed that they utilized the SHARP system frequently (see appendix C, Database tables), two of the three participants did not create any tasks or projects themselves. This is obviously unfortunate, since this is the core functionality of the authoring system. However, it is still considered to be crucial data, as it indicates that the fundamental structure should be redesigned. The participants simply believes that it is too time-consuming and inconvenient to

create new content. This could be occasioned by their previously mentioned accustomed way of thinking, where all content are pre-made.

It can not be ignored that the limited amount of usage is partially caused by the technical issues that occurred during the installation of the web player, and when logging in. This was unforeseen complications, which were difficult to resolve since they were caused by the institutions network security on their machines, and of course reduced the evaluation period and motivation for the participants.

15.3 Concept and Interface

While the overall idea was positively received by the participants, some aspects of the implementation, both structural- and interface wise, can be improved. It was a general opinion that the job of creating projects and exercises was too time-consuming and it requires too many mouse clicks to actually create a task, which gives rise to redesign the fundamental structure.

Neither the client side of the software met the participants' demand, due to the lack of assistance and the graphical layout was too indistinctive between each menu. Moreover, the system misses some fundamental knowledge on teaching language. This feedback suggests that, when redesigning the structure and content of the system, it should be done in a closer collaboration with professional experts within the field.

Another complaint regarding the visual presentation was the color choice and sizes of the various elements. The elements' respective sizes can seem too small, which is believed to occur when the system is displayed on a low resolution screen, and the full screen functionality is not activated. A way of solving the technical issues was to provide the participants with a local downloadable version, which provides the option of changing resolution and toggle full screen. With the limited technological knowledge speech therapists and aphasics are expected to have, this can be some confusing terms. Therefore, in a future version of SHARP, these variables should be eliminated from the user interface.

The two improvements suggested that speech synthesis and video communication should be integrated in the SHARP system. By working with Unity, it has been difficult to implement these improvements because of the game engine's limitations, however, changing the development platform when redesigning SHARP could possibly realize these enhancements.

Although the results provide various suggestions towards the implementation, and the front-end structure indeed needs to be rebuilt, it is still believed that there exists a great potential in the fundamental underlying ideas of the system, and the implemented features will definitely be reused in a potential new version.

15.4 Usability

Installing the Unity Web Player entailed various issues during the evaluation. By reprogramming the system entirely in a web scripting language, thereby avoiding Unity, the online aspect can be maintained without installation of any third-party software. Moreover, this will also allow users to access SHARP through their tablet devices, without installing any applications.

As the therapist's agreed upon, there is a great potential in the concept as they mentioned that SHARP can be used in a realistic rehabilitation situation, and is especially efficient and useful for home practice.

15.5 Effect

At the current moment the participants do not believe that SHARP can shorten the rehabilitation process. It is acknowledged that due to the time span and limited resources, it has only given a reduced impression. Therefore, it can be difficult for them to estimate the product's effect, and can not judge the system properly, unless it is applied in a larger context. Even so, the evaluation is considered crucial to the project, as it has provided several new ideas for further development.

Chapter 16

Evaluation of Methods

The system developed throughout the project takes foundation in a project proposal presented on the 8th semester, spring, 2011, concerning aphasia rehabilitation. Immediately, a research process was conducted to investigate both the aphasia disorder and existing means for rehabilitation. Conclusions were drawn from the existing solutions, which claimed that they where neither up to date, nor where they sufficient. In retrospect, these conclusions might have been too hasty, as better solutions on the market have been discovered since, proving that the requirement for new rehabilitation methods is not nearly as demanded as expected. However, none of the discovered solutions applies the same fundamental methods as SHARP, which retains the validity of our initial motivation.

This project was initiated with a functional prototype created by the authors on the previous semester. The choice of initiating this project with a newly designed system is considered to be a rational decision as the earlier system was technologically distant from the new concept. The theories of aphasia rehabilitation analysis are applied in a sufficient degree, as it, contrary to the prototype, allows the user to continuously try new tasks and allows for infinite repetition.

The choice of creating an educational authoring system was reasonable, but to maximize its potential, the structure has to be simplified and made more user friendly. Moreover, focusing on the speech therapist is considered beneficial as it provides more creative freedom when tailoring a rehabilitation program, however, when developing the authoring system, the design was shaped too hasty causing the structure to be too complicated.

The analysis also presented 22 quality measures for developing a web training system, which have been applied as guidelines during the development of SHARP. Although the product has been created through an iterative process, where speech therapists' feedback continuously has shaped the system after their requests, these 22 points of quality assurance has been used as a scientific backup. Documented in the development process (chapter 6 - 9) is a description of some places where and how the measures have been taken into account.

Reviewing the choice of platform, it has been the cause of several technical issues and setbacks such as the integration of sound and image upload, and the installation of the Unity Web Player. These problems give rise to start the development over again, in yet a new programming environment. A reasonable platform to attempt would be through pure web scripting, in a language designed for web browsers, such as PHP. Not picking the optimal development platform from the beginning is definitely regrettable and may seem like a waste of time and resources, but on the other hand, every development iteration carries experiences and new perspectives which will result in a stronger end product.

Throughout the development, it was also considered important to provide as much freedom to the speech therapist as possible. This was achieved by creating a dynamic program editor, and no specific bound-

aries for the combination of task types. Unfortunately, it seems as if this trait has given the therapists too much freedom, probably since they are too familiar with the restricted environment provided by software like Afasi-assitent. Therefore, it quickly becomes too immense to grasp. The new system should therefore include a simpler and more distinctive method for constructing exercises e.g. by categorizing the programs according to scientific acknowledged partitions, where each tasks would be classified by its intended therapy area.

The choice of running the side project of considering SHARP from a business perspective has turned out to be a lucrative decision, as it gave reason to develop important marketing resources, such as a website and a promotional video. Furthermore, the amount of feedback gained from experts in the field, e.g. the jury of Venture Cup (see chapter 12), will be highly important for further development.

During the final evaluation, it is accepted that it did not work out as expected. The amount of participants' feedback was not sufficient, due to limited time and resources. Additional test subjects should have been utilized to ensure a wider range of data and opinions. However, the amount of data collected is highly qualitative and give plenty of useful feedback for improvements. It is assumed, that even if more subjects were included in the evaluation, the outcome would be similar, as the feedback gained from the three participants is nearly identical.

Chapter 17

Conclusion

In the interest of creating a software solution for aphasia therapy that can compete with the existing products available, this project has attempted to merge the advantages of existing products into an innovative concept that utilize the theories of aphasia rehabilitation and web based education. This lead to the initiating problem:

> *How is it possible to develop a software system within the field of aphasia rehabilitation that can, in practice and commercially, exceed the capabilities of existing solutions currently available?*

As a continuation of an earlier project, the product's outline has been shaped on basis of previous research and experiences. It was decided to construct a solution from scratch that would exhibit the qualities of an authoring system, where the speech therapist could construct and design rehabilitation courses for their clients and monitor their progress online.

Three main questions had to be answered for the design process:

- *How should the new authoring system be designed in order to be enjoyable and clear to the speech therapists?*
- *How is it possible to create a system that is simple to use, and has an effective influence on aphasics as well?*
- *Which innovative features could be added in order to make SHARP a more desirable solution than its competitors?*

SHARP definitely qualifies as an authoring system, as it contains features of all four layers of Kearsley's figure (section 4.2, figure 4.1). The 22 quality measures of a web based training system constituted some reasonable guidelines through the development, and the result is a functional, online platform that allows the speech therapists to create, share and send tasks between each other and to their respective clients. Despite their enthusiasm towards a new system, the final evaluation revealed a lack of structure in the system. The attempt of developing an open system that provides the therapists a lot of creative freedom proved to be too immense for them to comprehend, and was frankly too time-consuming for their schedule.

The second goal was thought to be reached simply by making an online system that could be accessed from both the therapist's and the patient's home, and thereby eliminating the majority of personal one-on-one sessions. This hypothesis was later questioned, as the therapists unveiled their personal preferences

regarding software solutions. Software, not even meant for aphasia rehabilitation, is being used as aphasia rehabilitation methods, despite being designed for memory training and teaching languages. This shows how Luria's Approach (2.4.1) can be applied in practice. The findings show, that what SHARP requires in order to become lucrative for the patients is a more context-based learning environment, and does not, at its current state, give the patients a therapeutic experience. So whether SHARP is improving existing methods or not can not be concluded from the data. For sure, it has not reached a state of development that delivers a satisfying experience, but with the collaborating experts' positive view on the concept, it is a shared belief that it contains potential to have a helpful effect on aphasia patients.

The most interesting aspect of examining SHARP in a market-realistic scenario is that it gets to be reviewed from the perspective of multiple end users. In this connection, it is crucial to identify the product's *need to have*, the one crucial feature of the system that makes it indispensable to the buyers. The system at its current state contains multiple features that could be considered very important in a rehabilitation course, here among online access, sharing projects, recording audio clips, uploading image files, etc.; features that speech therapists has requested throughout the development due to the absence of these in other products. However, it is acknowledged that these functionalities may merely be *nice to have*, and does not necessarily convince the buyers to invest in the product. The final evaluation indicates, that not only does the structure need modification, but essential features such as voice recognition and speech synthesis will most likely be necessary to implement for the software's chances of succeeding business wise.

The authors believe that the project has presented a method, and shown proof of concept, that potential exists within the creation of an authoring system that is designed specifically for aphasia patients. Although the findings of the final evaluation indicate that further development is necessary, the concept and general features of the current version seem to be conceivable, as verified by the speech therapists. Also, from a business perspective, SHARP could have immense potential, as concluded in chapter 12.

Chapter 18

Further Development

If SHARP is to be developed further, several improvements and additions could be applied:

- As described in chapter 16, the entire structure of the authoring system (speech therapist part) should be redesigned in order to make it more simple and user friendly.
  - As one of the participants mentioned in the feedback, the system requires too many mouse clicks before a user is able to actually create a task, and therefore this consideration should be taken into notice when developing the system further.
  - The evaluation indicated that the system might be too immense to comprehend due to the large amount of freedom given to the speech therapists. In a new system, the task of creating exercises, projects and programs should therefore be more categorized and administrated with some boundaries, e.g. by the patient's difficulties or the disorder type.
- The layout in the client part of the SHARP system should be reviewed by professional experts (speech therapists) in order to tailor it ideally to aphasics.
- Another observation made in the evaluation was that, at this point, the system does not provide a sufficient amount of assistance, especially to the client. It should be possible to manage the system without any external help, and if this is to be realized, a more intelligent guide system should be implemented.
- Two frequently requested features throughout the iterations are speech recognition and speech synthesis. Speech recognition should be used for evaluating the aphasics pronunciation of words and sentences, and speech synthesis should allow the system to read the text labels of tasks and interface elements aloud.
- While Unity provides some dynamic effects and a crafty developing environment, it has proven to carry some disadvantages. To avoid the limitations that occurred when utilizing Unity, the entire system should be reprogrammed in a web scripting language such as PHP. This carries the following advantages:
  - No installation of third party plug-ins, which is expected to eliminate the security issues experienced during the evaluation.
  - Full integration of features such as sound and image upload, while no installation should be required.
  - A more efficient process of communicating with the database.
  - More likely to possess libraries for speech recognition/synthesis.

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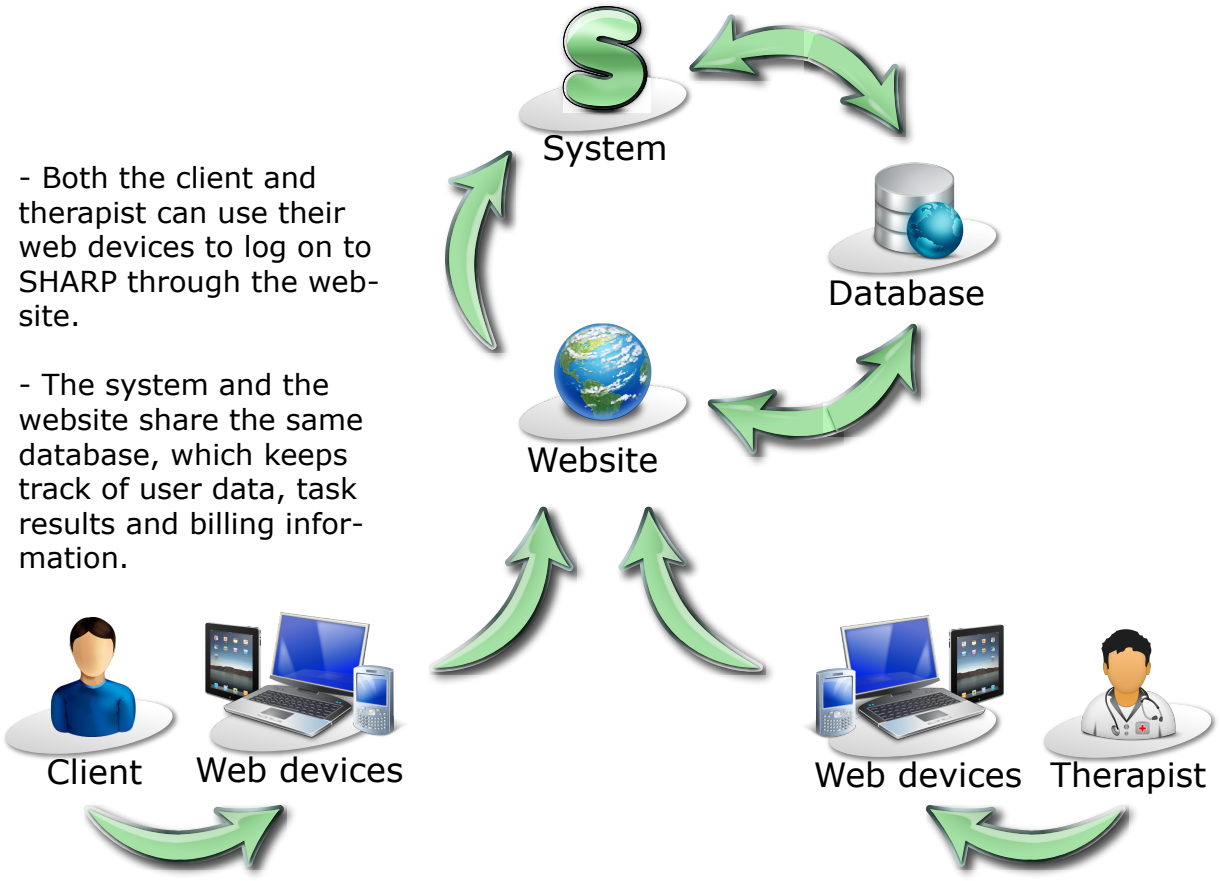
Part V
Appendixes

Appendix A

Superlative Diagram

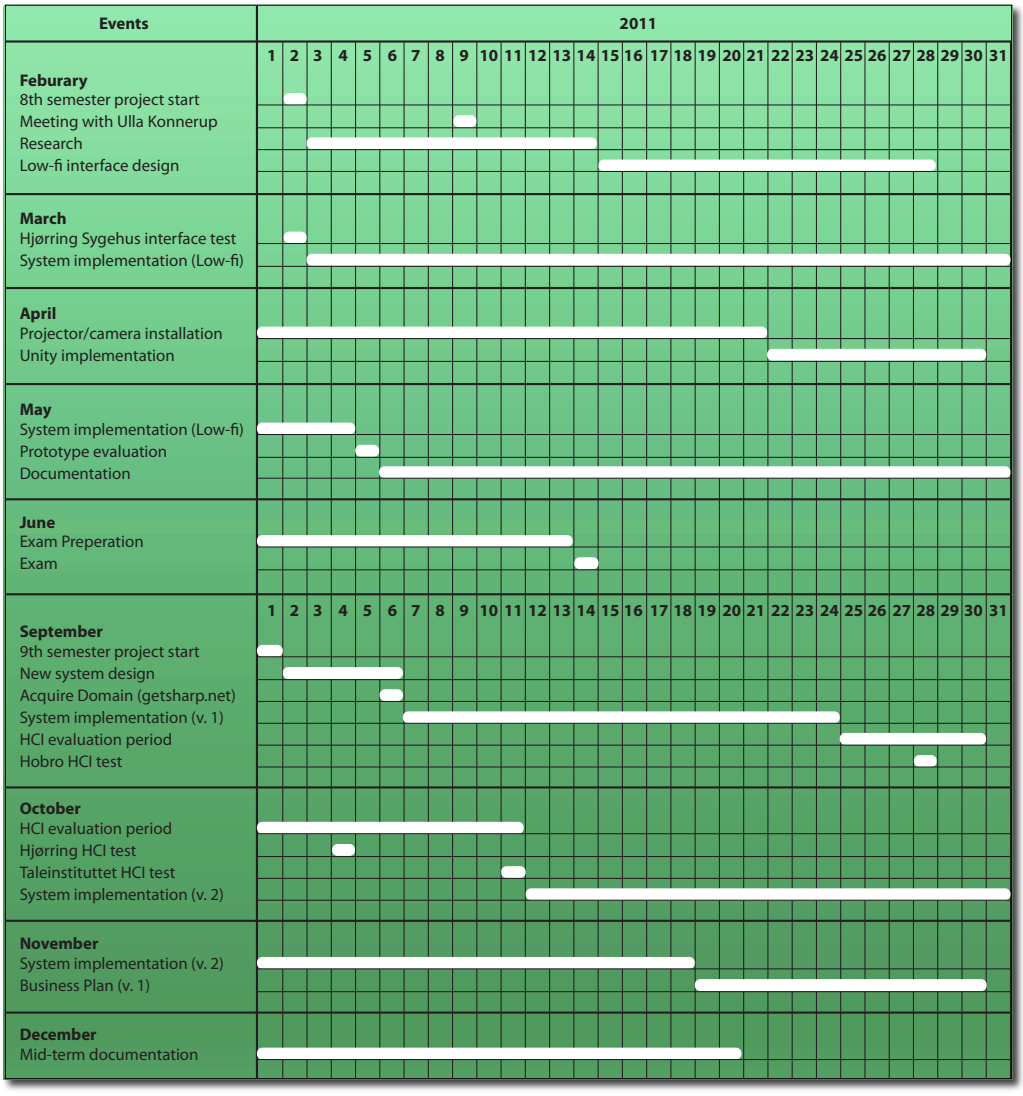
This superlative diagram shows the overall structure of the product. For a more technical description, open the FlashApp *Superlative.swf* in appendix C

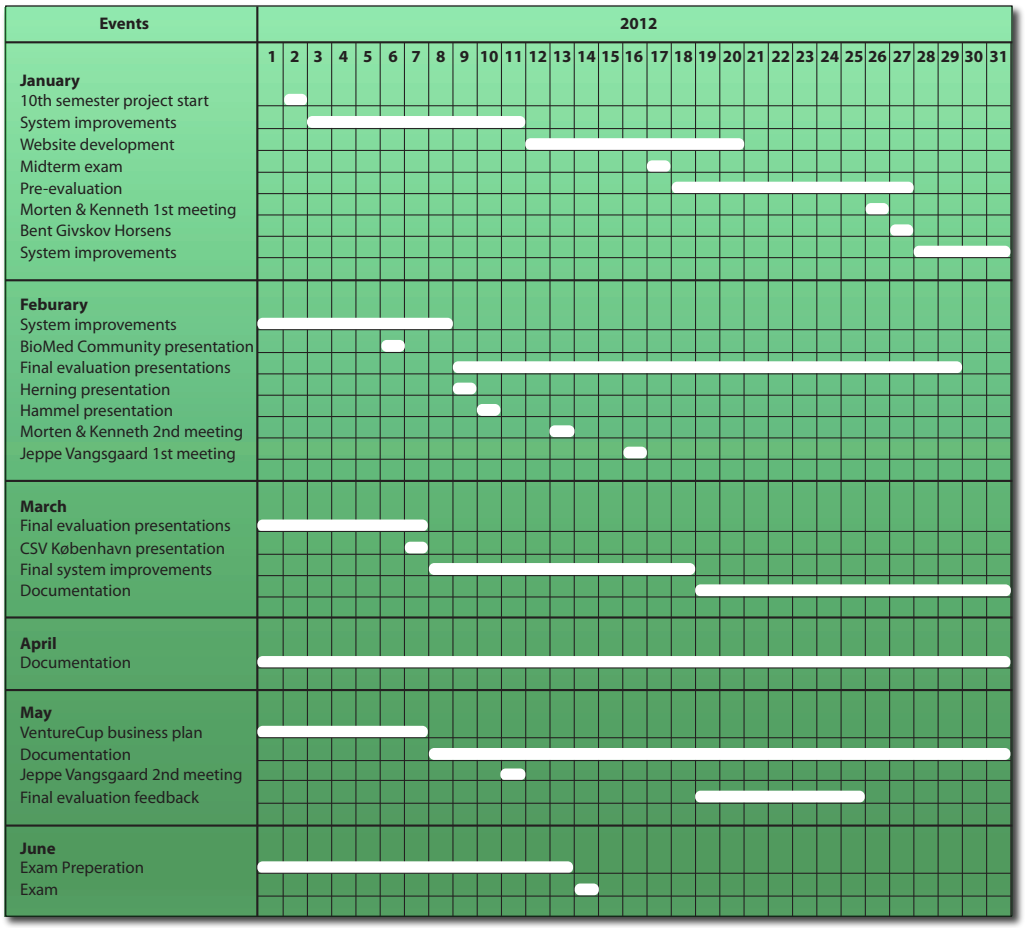


Appendix B

Timeline

Every project related event, since Feburary 2011, when Ulla Konnerup presented the project idea, until June 2012, is plotted in the timeline below.




Events
2012
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
January
10th semester project start
System improvements
Website development
Midterm exam
Pre-evaluation
Morten & Kenneth 1st meeting
Bent Givskov Horsens
System improvements
Feburary
System improvements
BioMed Community presentation
Final evaluation presentations
Herning presentation
Hammel presentation
Morten & Kenneth 2nd meeting
Jeppe Vangsgaard 1st meeting
March
Final evaluation presentations
CSV København presentation
Final system improvements
Documentation
April
Documentation
May
VentureCup business plan
Documentation
Jeppe Vangsgaard 2nd meeting
Final evaluation feedback
June
Exam Preperation
Exam

Appendix C

DVD

Included on the DVD, are:

1. Report incl. appendices
2. Report excl. appendices
3. Business Plan (Danish)
4. 8th semester report
5. Timeline 2011-2012
6. Software source code
    - Unity system
    - PHP files
    - Website
    - Database tables
7. Local executables
    - Mac version
    - Windows version
8. Superlative flash diagram
9. Links to website and online system
10. Conceptual video
11. Presentation video
12. 8th semester video
13. Recordings from first evaluation
14. Notes from second evaluation
15. Final evaluation
    - Recording and results from participants

16. Images
    - Screenshots
    - Low-fi sketches
17. Entrepreneurship 9th semester course slides

Appendix D

Questionnaires

These questionnaires were used to gain feedback from the collaborating speech therapists in the final evaluation. Attached are a Danish and an English version.

- **Eksisterende produkter**
  - Hvilke elektroniske midler gør du brug af i din undervisning?
  - Hvad synes du om dem?
  - Hvorfor bruger du dem?
  - Nævn et konkret eksempel eller situation hvor du gør brug af disse midler.
  - Er de eksisterende midler tilfredsstillende?

- **SHARP afprøvning**
  - Beskriv hvordan du har anvendt SHARP de to forrige måneder.
    - Hvor hyppigt har du haft systemet i brug?
    - Forsøgte du at lave nye opgaver, eller brugte du dem som var tilgængelige i forvejen?
  - Hvilke typer elever har du gjort brug af?
    - Er de ny i behandling?
    - På hvilke områder ligger deres vanskeligheder?

- **Koncept**
  - Hvad synes du generelt om idéen?
  - Kommenter venligst følgende aspekter af programmet:
    - At det er online
    - At du kan designe dine egne opgaver
    - At din elev kan arbejde på egen hånd
    - At du får resultaterne af elevernes besvarelser retur

- **Brugerflade**
  - Nævn venligst de funktionaliteter som SHARP tilbyder.
  - Hvordan var det at navigere igennem menuerne?
  - Var der nogle konkrete ting som var besværlige?
  - Hvor intuitivt/nemt synes du det er at anvende? (sæt x)
    - Besværligt _ _ _ _ _ _ _ _ _ _ Nemt
      1 2 3 4 5 6 7 8 9 10
  - Vil det være en fordel at introducere nye brugere med en video som forklarer hvordan programmet bruges?

- **Brugbarhed i det daglige**
  - Hvad er dit indtryk af installation/opsætning?
  - Stødte du på nogle tekniske problemer? Hvilke?
  - Sammenlignet med eksisterende produkter, hvilke forcer/ulemper har SHARP?
  - Kunne du se SHARP blive anvendt i et genoptræningsforløb?
    - Vil det kunne erstatte eller supplere de værktøjer der findes i forvejen?
    - Forklar en situation hvor programmet vil kunne gøre genoptræning lettere...
      - ... for dig som talepædagog
      - ... for eleven

- **Effekten af produktet**
  - Ved anvendelse i en længere periode, tror du SHARP...
    - ... kan forkorte genoptræningsprocessen?
      - Hvorfor?
    - ... kan have en virkende effekt på afatikere?
      - Hvorfor?
  - Hvad er dit indtryk af elevernes oplevelse?
    - Er der nogle vanskeligheder ved at bruge det?
    - Hvor gode har de været til at bruge det?

- **Existing products**
  - Which electronic means do you use in your rehabilitation?
  - What do you think of them?
  - Why do you use them?
  - Mention a concrete example or situation where you use these means.
  - Are the existing means satisfying?

- **SHARP test period**
  - Describe how you have used SHARP for the last two months
    - How frequently have you been using the system?
    - Did you have a chance of creating new tasks, or did you use the existing ones?
  - Which type of clients did you use for the test period?
    - Have they recently been put in therapy?
    - In which areas are their difficulties?

- **Concept**
  - What do you think of the idea in general?
  - Please comment the following aspects of the program:
    - That it is online
    - That you can design your own tasks
    - That your client can work independently
    - That you get the client's results immediately

- **Interface**
  - Please name the functionality that SHARP delivers.
  - How was it like to navigate through the menus?
  - Was there some concrete things you found difficult?
  - How intuitive/easy did you think it was to use? (mark with x)
    - Difficult _ _ _ _ _ _ _ _ _ _ Easy
      1 2 3 4 5 6 7 8 9 10
  - Would it be a good idea to introduce new users of the system with a presentation video that explains how the software is used?

- **Daily usability**
  - What is your impression of the installation/setup process?
  - Did you encounter any technical problems? Which?
  - Compared to existing products, which advantages/disadvantages does SHARP have?
  - Do you consider SHARP as being useful in a rehabilitation course?
    - Would it be able to replace or supplement the existing means?
    - Describe a scenario where the program could ease the rehabilitation course...
      - ... to you as a speech therapist
      - ... to the client

- **Effect of the product**
  - By utilizing it for a longer period of time, do you think SHARP...
    - ... will be able to shorten the rehabilitation process?
      - Why?
    - ... can have a therapeutic effect on the aphasics?
      - Why?
  - What is your impression of the client's experience?
    - Are there any difficulties using it?
    - How frequently have they been using it?

Appendix E

Business Plan

Forretnings-plan

SHARP

Selvstændigt Hjælpeværktøj til Afasi-Ramte Patienter

Casper Slynge og Rene Olesen, 2012

Indholdsfortegnelse

Produkter og Services

Baggrund

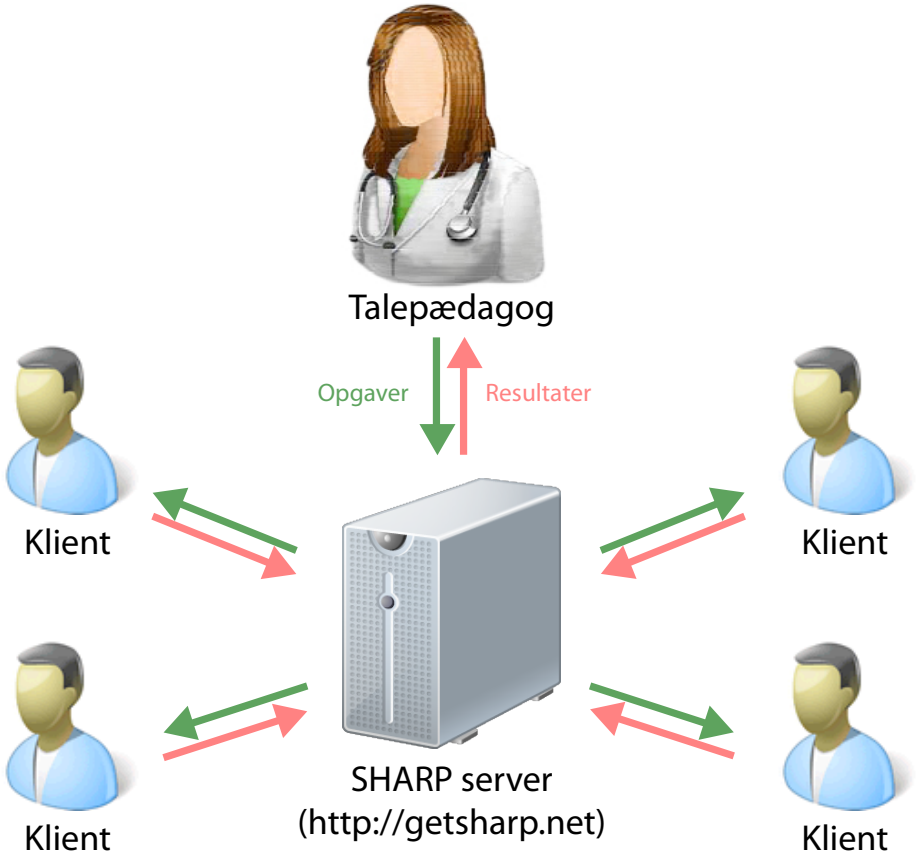
I foråret 2011 præsenterede Ulla Konnerup, forsker i genoptræning af afatikere og talepædagog, et projektforslag der omhandlede udviklingen af et digitalt socialt netværk hvor afatikere kunne interagere med hinanden ved at løse opgaver og kommunikere med hinanden på forskellige måder. Dette projektforslag virkede som en opgave med et stort potentiale og en masse muligheder, og vi besluttede os derfor at indgå et samarbejde med Ulla og arbejde videre med konceptet. På kort tid lavede vi noget research omkring afasi og dets genoptræning mens vi udarbejdede en idé til løsning på Ullas projektforslag. Da idéen blev præsenteret for Ulla, viste det sig dog at vi havde forskellige visioner og retninger, hvilket resulterede i at vi arbejdede videre med vores koncept på egen hånd. Selvom samarbejdet med Ulla ikke fortsatte, var vi alligevel fast besluttet på at arbejde videre inden for afasi rehabilitering. Motivationen bag dette valg bundede ud i at den mængde research der var blevet foretaget under udviklingen af et produkt koncept, havde åbnet øjnene for de eksisterende produkter, som anvendes til genoptræning af afatikere. I vores øjne var og er disse produkter ikke acceptable da de ikke lever op til de teknologiske muligheder og standarder som findes i dag. Denne optik udgjorde grobunden for at udvikle SHARP systemet. Konceptudviklingen og research fasen medførte ydermere at dette projekt og produktet ikke kun blev set som et universitetsprojekt, men også som kernen i en kommende virksomhed. Eftersom afasi er en hyppig lidelse der rammer 3.000 personer årligt plus at der findes omkring 25.000 på landsplan, var det bevist at der eksisterer et kæmpe markedspotentiale og at der eventuelt findes et behov og en efterspørgsel på nye og bedre behandlingsmetoder.

Forretningsidé

Produktet som SHARP tilbyder er et værktøj, der har til opgave at hjælpe afatikere med deres genoptræning, og samtidig simplificere og effektivisere hele processen bag et genoptræningsforløb. Igennem flere evalueringer af det nuværende marked er det en delt mening blandt de to stiftere at der er plads til mange forbedringer hvad angår midler som bliver anvendt til genoptræning. Heriblandt bliver vendespil og andre forældede brætspil stadig taget i brug under rehabiliteringen, og anses ikke som acceptable midler, den nuværende teknologi taget i betragtning, og selvom der eksisterer IT løsninger, som indtil videre er blevet anvendt, er det dog også en delt mening at disse ikke lever op til den standard der eksisterer i nutidens software potentiale.

Målet med SHARP er at lancere et system som først og fremmest opererer online. Alt skal foregå igennem web browser som gør det muligt for talepædagog og klient at kommunikere selv når de ikke er i samme rum. Dette giver også mulighed for at afatikeren kan arbejde hjemme og løse opgaver hvorefter der bliver givet feedback til talepædagog. Ydermere skal produktet fungere som et såkaldt authoring (forfatter) system, der giver talepædagogen en frihed til at designe et unikt program med unikke opgaver til hver klient. Da lidelsen findes i mange varianter og grader findes der ikke to ens afatikere, og det er derfor essentielt at kunne designe opgaver til den individuelle patient, frem for at skulle gennemgå et standardforløb. Det skal i sin helhed være

selvstændigt, automatisk og dynamisk for at give både talepædagog og klient den optimale oplevelse.



SHARP giver mulighed for at klienter og talepædagoger har et fælles opgavedelings-system, hvilket giver en mere effektiv genoptræningsproces.

Indkomsten i virksomheden kommer fra licenser som kunden skal købe for at kunne anvende SHARP systemet. Licenserne skal kunne sælges i forskellige pakker, så der er en forskel i prisklasse hos en kunde der kun skal bruge 5 licenser, sammenlignet med en som skal bruge 50. Kommunikations- og behandlingscentre, institutioner og andre offentlige genoptræningssteder modtager et tilskud per afatiker der skal gennemgå et behandlingsforløb. Det antal ansatte talepædagoger disse kunder har, svarer til den mængde licenser de skal købe. Derudover opkræves der et beløb per klient der oprettes af de forskellige talepædagoger. Ydermere oprettes et abonnement hvor der opkræves en månedlig eller halvårlig betaling for fortsat at kunne anvende systemet. Ifølge en ny sundhedsaftale[1] skal der afsættes 150 mio. kr årligt til genoptræning af hjerneskadede, og netop på grund af de mange penge som bliver investeret i området, kan vi lægge os på samme prisniveau som konkurrenter og måske endda kræve ekstra for forskellige services og tjenester, så længe vi leverer et produkt der er bedre end konkurrenterne og effektiviserer hele genoptræningsprocessen.

[1] http://www.handicap-regionh.dk/bcfr/Menu/Aktuelt/Millioner+til+unge+med+hjerneskade.htm

Skulle det lykkedes at få det forventede kundesegment konverteret til SHARP produktet i Danmark, har vi i sinde at videreudvikle værktøjet til en engelsk udgave og derved prøve at begå os internationalt.

Værditilbud

Kunden vil anvende SHARP systemet, først og fremmest fordi vi ved at der eksisterer et behov og en efterspørgsel for nye og bedre behandlingsmetoder. De offentlige behandlingssteder kan få flere penge på kortere tid, når SHARP systemet forhåbentligt forkorter hele genoptræningsprocessen og sikrer derved at flere afatikere kan gennemgå en behandling. Men hvis der ikke eksisterer en efterspørgsel for dem som skal bruge systemet, så vil parterne som skal investere heller ikke efterspørge produktet.

Talepædagogerne får mere frihed i deres daglige arbejde i og med at SHARP leverer et system der er up-to-date inden for nutidens software med tekniske funktioner som simplificerer hele kommunikationen mellem talepædagog og klient. Talepædagogen kan sidde hjemme og udarbejde unikke opgaver der er tilpasset til den enkelte afatiker, hvorefter de kan sendes direkte afatikeren i hans/hendes hjem, samtidig med at talepædagogen stadig kan følge med i hvordan afatikeren klarer opgaverne. Dermed er der ikke et lige så stort behov for sessioner hvor talepædagog og afatiker tidligere har været nødsaget til at mødes for at der kan ske en udvikling.

Afatikerne får med SHARP systemet mulighed for at have en konstant genoptræning og blive rehabiliteret på kortere tid. Han/hun er ikke nødsaget til at skulle mødes med en talepædagog for at der sker en udvikling. Ydermere får afatiker specielt designede opgaver som er tilpasset den hans/hendes type afasi, og skal derved ikke løse opgaver som vedkommende ikke har problemer med, hvilket er tilfældet hos konkurrenter.

Idébeskyttelse

Med et system som SHARP, er kildekoden det største aktiv virksomheden ejer. Idet stifterne selv står bag alt kildekoden som anvendes i systemet, har de ophavsret på softwaren udviklet i denne forbindelse.

Selve virksomheden skal registreres som anpartsselskab. Det er ikke særligt omkostningsfuldt at opstarte, desuden vælges det for ansvarsbegrænsningen, så ingen af stifterne kommer til at hæfte med private midler i fremtiden.

SHARP som varemærke bliver også en realitet når virksomheden opstartes, for at give firmaet et stærkere brand udadtil, og bliver formegentlig den primære intellektuelle aktiv der tiltaler kunderne, når systemet skal sælges.

Målgruppe

Kundeprofil

Vi anser SHARP for at have et bredt kundesegment idet systemet skal bruges af både afatikere og talepædagoger. På den ene side skal produktet henvende sig til begge disse grupper, men kunden vil i sidste ende være institutionerne og kommunikationscentrene, som godkender og betaler for ydelsen. Dog vil talepædagogen være den primære målgruppe, da det er dem der vurderer produktet i brug, og skal overbevise deres arbejdsgivere om at SHARP er et fordelagtigt valg til genoptræning.

Talepædagoger vil typisk (ifølge http://lonstatistik.dk) være omkring 40 år gamle og have en vis erfaring indenfor IT, men da dette ikke er påkrævet af deres uddannelse, vil der være et behov for at gøre systemet så overskueligt og brugervenligt som muligt. Alle tekniske termer og andre avancerede elementer i brugerfladen er således blevet reduceret, hvilket gør brugen af systemet mere intuitivt. Eksempelvis er der brugt symbolske ikoner og udtryk, såsom tegninger af en skraldespand og en blyant til slet og rediger funktionerne. Igennem udviklingen af softwaren har vi benyttet os af **customer development modellen**, og fået konstant feedback fra talepædagoger, hvilket har struktureret opbygningen præcis efter deres ønsker og behov.

Afatikeren kan befinde sig i en hvilken som helst aldersgruppe, og vil have forskellige behov alt efter hvilken del af hjernen der er beskadiget og i hvor høj grad. Rækkevidden af forståelse, ekspressiv kunnen og motoriske egenskaber er enorm indenfor segmentet, og brugervenligheden af systemet skal derfor designes efter laveste fællesnævner. Derfor antages det, at det er svært for patienten at interagere med et virtuelt interface. Et vigtigt tiltag i systemet er derfor elimineringen af musebrug. Systemet kan anvendes udelukkende med tastatur for at sikre brugere med interaktionsvanskeligheder har flere muligheder for at navigere igennem menuerne. Yderligere diskrimineres der ikke imellem store og små bogstaver ved login eller opgavebesvarelse, da afatikere kan have en medført lammelse i armen. Hvis interaktionen med en computer stadig volder problemer, kan SHARP også benyttes fra tablet devices med en langt mere intuitiv touch-skærm brugerflade.

Institutionerne vil typisk træffe beslutningen om at investere i et nyt stykke software på baggrund af talepædagogernes holdninger og erfaringer, samt det offentlige renommé. Hertil er branding en vigtig faktor, og SHARP som varemærke vil utvivlsomt højne opmærksomheden på markedet. Institutionerne får deres midler fra kommunerne og har derfor formegentlig et meget åbent budget når det kommer til innovative løsninger.

Marked

SHARP har potentielle kunder i kommunikationscentre og sygehuse, der beskæftiger sig med talevanskeligheder og genoptræningen heraf. Eksempelvis er Taleinstituttet Region Nordjylland, med hovedsæde i Aalborg, en institution der vil være en kandidat til at kunne tage systemet i brug. Pia Høgh, som har medvirket i flere af de preliminære undersøgelser til projektet, er ansat på Hjørring Sygehus og har udtalt at deres tilknyttede

klienter og pædagoger utvivlsomt vil få gavn af at integrere SHARP som tilbud til genoptræningen.

På landsplan findes der to uddannelsessteder for talepædagoger, Københavns Universitet og Syddansk Universitet. http://ug.dk angiver at der kommer ca 80 nyuddannede talepædagoger (logopæder) på jobmarkedet hvert år, hvoraf tæt på 100% kommer i arbejde. Hvorvidt der er vækst eller stagnation på markedet kommer an på mængden af afatikere, men da afasi er en lidelse der opstår ved et tilfælde, formodes det at antallet ligger konstant omkring de 25.000, med en udskiftning på ca. 3.000 årligt.

Der eksisterer en opdeling mellem de aktive talepædagoger, bestående af offentligt ansatte og privatpraktiserende. De offentlig ansatte er naturligvis kommunalt støttet, imens de privatpraktiserende selv må finde midler til at købe nye genoptræningsprodukter. Igennem udviklingsprocessen har vi haft kontakt med Bent Givskov som driver sit eget afasi genoptræningscenter. Hans kunder er typisk afatikere, som er blevet opgivet af det offentlige, hvor specialbehandling er nødvendig. Når der skal fastsættes priser for vores services er dette en vigtig faktor at tage højde for, da private pædagoger for det meste ikke har råd til at betale store engangsbeløb.

Konkurrenter

I forbindelse med research fasen er der analyseret på nogle af de nuværende midler til sprogrehabilitering. En af de største motivationer til opstarten af denne virksomhed havde baggrund i netop de eksisterende produkter.

Afasi-Assistenten

Afasi-Assistenten (http://afasi-assistent.dk) af COGNIsoft, er en Windows applikation fra 1997, der tilsyneladende benytter sig fuldt ud af de tekniske muligheder som var tilgængelige på tidspunktet. Det tilbyder en lang række forudlavede træningsopgaver i stil med dem man kan designe med SHARP. Desværre må man erkende at teknologien har overhalet dette stykke softwares funktionalitet, og det nu er muligt at øge patientens kvalitative oplevelse, heriblandt ved at lade den enkelte talepædagog designe opgaverne til sine klienter. Ydermere er brugerfladen utilstrækkelig og billederne der anvendes er illustrationer og kan derved være svære for afatikerne at tyde.

Et licens til Afasi-assistenten koster 950 kr som enkelperson og derudover 1250 kr for opgradering til nyeste version (Vista og Windows 7 kompatibilitet). Et institutionslicens koster et sted imellem 12.500 kr til 18.750 kr, alt efter hvilken licens og funktionaliteter man er interesseret i. Disse priser danner gode retningslinier til hvilket prisniveau SHARP kan tillade sig at lægge sig i, både konkurrence- og kvalitetsmæssigt, når det lanceres.

Det er bevist, igennem møder med diverse talepædagoger, at Afasi-Assistenten er et udbredt stykke software, som anvendes af adskillige institutioner og talecentre. Ifølge www.urlpulse.dk har de under 300 besøgende om måneden, og det umiddelbare indtryk er, at grunden til at dette stykke software anvendes, er fordi der ikke findes andre produkter som kan konkurrere med Afasi-Assistenten. Samtidig er det også stifternes indtryk, at Afasi-Assistenten har begået den fejl som SHARP håber at undgå, nemlig at sælge én licenspakke til én kunde, hvorefter de ikke har mere at tilbyde kunden, og kan derfor ikke tjene flere penge på denne. På denne måde er deres marked hurtigt mættet, og skal derfor til at finde nye indtjeningsstrømme.

Aphasia Tutor

Et andet afasi genoptrænings software er **Aphasia-Tutor** som er udviklet af Bungalow Software (http://bungalowsoftware.com/aphasia1.html). Produktet minder meget om Afasi-Assistenten, men er, som navnet indikerer, på engelsk. Det indeholder over 700 opgaver i 8 forskellige sværhedsgrader, men dette er kun i én af de 22 forskellige pakker som de har udviklet til tale terapi. Bungalow har opdelt de forskellige områder inden for genoptræning i forskellige software pakker, således at kunden er nødsaget til at købe flere forskellige produkter for at få fuldt udbytte af genoptræningen, og for at få adgang til de i alt 1 million opgaver som eksisterer. Denne metode medfører at Bungalow bevarer kundeinteressen selvom der er købt licenser til to eller tre pakker, og er bestemt en metode som SHARP vil overveje at adoptere. Deres forskellige pakker ligger i en prisklasse fra 100 til 270 dollars for ét standard licens, hvilket stemmer godt overens med Afasi-Assistentens

priser. Derudover har Aphasia-Tutor også licenspakker, som kan tilbydes for 2.786 dollars for samtlige 22 programmer.

Ansigt–til–Ansigt

Ansigt-til-Ansigt er et anderledes tilbud til afasiramte. Ligesom SHARP er det netbaseret, og kommunikationen mellem pædagog og klient sker via debattråde i fora. Her har alle tilmeldte mulighed for at oprette tråde og oprette indlæg, og kan dele alt fra seriøse problemstillinger til sjove videoklip. Efter sigende fremmer dette patientens kommunikationsevner, da debatterne motiverer klienterne til at forbedre sig ekspressivt, hvilket i sidste ende kan overføres til sproglige kompetencer i verbal kommunikation.

Denne løsning giver anledning til mere kommunikation end Afasi-Assistenten, men mangler på den anden side et intuitivt og overskueligt interface for dem, der er svært ramt af lidelsen. Ansigt-til-Ansigt er tydeligvis beregnet til afatikere der har været igennem en vis rehabiliteringsperiode, hvor de er i stand til både at læse og skrive på et anstændigt niveau. Sammenlignet med SHARP systemet, er Ansigt-til-Ansigt mere et forum hvor talepædagog og afatiker kan sidde sammen og gennemgå forskellige tekster og billeder, som talepædagogen eller andre har lagt op, hvor SHARP er et mere uafhængigt opgave baseret program der ikke kræver at talepædagog og klient sidder sammen. Ansigt-til-Ansigt kan også bruges af afatikeren på egen hånd, men det forlanger som sagt at hun/han er et godt stykke henne i genoptræningsforløbet.

Organisation

	Rene Olesen	**Casper Slynge**
Betegnelse	Stifter og udvikler Grafisk designer Hjemmeside udvikler	Stifter og udvikler App udvikler
Fødselsdato	3. januar 1987	2. oktober 1986
Uddannelse	B.Sc i Medialogi	B.Sc i Medialogi
Baggrund	Rene påbegyndte sin uddannelse på Aalborg universitet i 2007 hvor han fik sin bachelor i Medialogi. Rene er stadig aktiv studerende og får sin kandidat til sommer 2012. Han har igennem sin studietid bl.a. arbejdet med grafisk design, programmering (hjemmesider og computerspil) og human-computer interaction, hvilket giver ham en bred viden om de miljøer som bliver arbejdet med indenfor virksomheden. Ved siden af studiet har Rene arbejdet med udvikling af hjemmesider, hvilket giver en stor fordel når denne skal udvikles til virksomheden. Rene har endvidere mange kompetencer inden for den grafiske verden, hvilken er fordelagtigt når der skal udvikles marketingsmaterialer og lignende.	Casper har studeret Medialogi på Aalborg universitet og har lige siden første semester arbejdet sammen med Rene. Han får derved også sin kandidat til sommer 2012. Casper har også arbejdet med de samme områder som Rene, og det faktum at der er blevet arbejdet med produkter både fra udviklerens perspektiv men også fra kundens optik, giver en god blanding da det derved er muligt selv at udvikle et produkt som tilfredsstiller kundens behov. Casper har i sit deltidsjob arbejdet med udvikling af iPhone applikationer hvilket giver en mulighed for, i fremtiden, at overføre produktet til andre platforme såsom iPhone eller iPad. Ydermere har Casper mange års erfaring med kunde service hvilket kan udnyttes når det forsøges at sælge SHARP systemet.

Rådgivere / Eksperter	Pia Høgh - Talepædagog ved Region Nordjylland Charlotte Thomsen - Talepædagog ved Region Nordjylland Vibeke Bøgh Kristensen - Talepædagog ved Region Nordjylland Bent Givskov - Privatpraktiserende talepædagog, Horsens Jeppe Vangsgaard - Konsulent, Adm. direktør Saphiens A/S Finn Allan Larsen - Projektleder, BioMed Community Kenneth Stenkjær Pedersen - Incubation Manager AAU Morten Dahlgaard - Regional udviklingschef

SHARP har på nuværende tidspunkt ikke behov for nye ansatte. Det arbejde som skal udføres inden virksomhedens opstart kan administreres af de to stiftere. Dette inkluderer videreudvikling af systemet og markedsføringsmateriale. Det forventes dog i sommeren 2012, at det vil være nødvendigt at ansætte en alsidig udvikler, der kan assistere med frembringelse af kampagner, grafisk design, videreudvikling af systemet og lignende. Det er derfor også en forventning at der skal søges en investor enten igennem traditionel (bank) eller alternativ (långivning og ejerandele) finansiering, til hjælp af startkapital til promovering, løn og indskud til ApS registrering.

Det er allerede lykkedes SHARP organisationen at modtage et økonomisk tilskud igennem BioMed Community[2], som er en organisation der går ind for videnskab og innovation. Organisationen er et netværk bestående af bl.a. Aalborg Universitet, Aalborg hospital og 50 MedTech virksomheder med over 2000 ansatte. Igennem en ansøgning samt en præsentation af systemet, lykkedes det SHARP at modtage 25.000 kr. til bl.a. rejseudgifter og professionel konsulent (Jeppe Vangsgaard) som skal rådgive og hjælpe med udviklingen af virksomheden.

[2] http://biomedcom.dk/

Forretningsmodel

Kundesegmenter

I SHARP består kundesegmentet af institutioner og andre offentlige behandlingssteder. De egentlige kunder ses dog som værende talepædagogerne som er ansat disse steder, samt afatikerne, idet at det er dem som modtager værdien af produktet, dog er det ikke dem som tilfører værdi til virksomheden. Værdien der tilbageleveres til virksomheden kommer fra den offentlige sektor og det tilskud der gives per afatiker.

Kanaler

Da det ikke kan vides med sikkerhed hvilke IT kompetencer kunden har, er det vigtigt at produktet leveres på den nemmeste måde, og igennem en kanal som er velkendt for de fleste. Det er derfor valgt at SHARP skal være browser baseret og derved kunne tilgås via internettet. Dette er et medie som de fleste personer er bekendte med, og det forventes at talepædagogerne har en god forståelse for netop denne kanal da det vides med sikkerhed at de har anvendt den tidligere igennem de konkurrerende produkter. Derimod kan der sættes spørgsmålstegn ved afatikerne, på trods af den brugervenlige og simple brugerflade, da det ikke kan vides med sikkerhed om de har arbejdet med internettet inden de fik afasi. Samtidig kan graden af deres afasi også have en stor indflydelse på deres IT evner.

Internettet ses som det mest effektive medie i forhold til omkostninger, og vil også være det medie der bliver anvendt til promovering af virksomheden og produkt. Dette inkluderer bl.a. hjemmeside og videomateriale. Dog anses det også som værende nødvendigt, at gennemføre ansigt-til-ansigt præsentationer når produktet skal sælges til eventuelle kunder.

Med hensyn til det primære kundesegment som består af institutioner og offentlige behandlingssteder, forventes det at kunden skal opnåes igennem møder hvor hele SHARP konceptet præsenteres. Det er en fælles mening af SHARP bedst beskrives ved at lade selve udviklerne og stifterne af forretningen præsentere hele konceptet direkte til kunden, fremfor at anvende en video eller lignende. Ydermere skal kunden også fanges ved at lade dem afprøve hele systemet gratis i 14 dage for at give dem et indblik i programmets basale funktioner.

Indtjeningsstrømme

Som nævnt tidligere sker indtjeningen igennem de licenser som er nødvendige for at kunne anvende SHARP produktet.

Prisklassen forventes at ligge på niveau med det eksisterende behandlingsprodukt Afasi-Assistenten. For eksakte priser på licenser og abonnement, se budgettet i slutningen af forretningsplanen. Dette gøres for at sikre sig et beløb som kunden med sikkerhed er villig til at betale. Viser der sig en stor interesse for produktet, kan det diskuteres om prisen skal stige på et senere tidspunkt. Udover de normale licenser, er tanken også at der

skal være professionelle abonnementer, dvs. licenser hvor brugeren har adgang til flere funktionaliteter. På denne måde kan virksomheden tilbyde flere alternativer, hvor institutionerne betaler beløb pr. behov.

En engangsudgift i form af en licens pr. institution er formegentligt ikke nok for at opretholde et cash flow. Derfor vil det blive nødvendigt at opkræve et månedligt beløb for at anvende værktøjet, og modsat, gøre det billigere at købe licensen. Dette vil i det lange løb give en højere indtægt fra kunder, som fortsætter med at anvende systemet, samtidig med at det tillader kunder at afprøve systemet uden stor risiko for at miste for mange penge.

Det er forudsagt, at SHARP på et tidspunkt, omend det er succesfuldt eller ej, når et mætningspunkt hos kunderne. Når produktet er blevet præsenteret for alle potentielle kunder, og alle har taget stilling til om det har interesse for deres pågældende institution, vil der ikke være flere kunder at henvende sig til. Her vil det være muligt at forsøge sig internationalt. Med kunderelationer og erfaringer i Danmark, vil der formegentligt være god grobund for at ramme markedet i udlandet.

Nøgleressourcer og aktiviteter

For at opretholde virksomhedens balance mellem indtægter og udgifter, er der flere elementer som skal vedligeholdes. Dette inkluderer softwaren bag produktet som skal opdateres regelmæssigt for at sikre sig at produktet følger de fremtidige standarder indenfor software. Ydermere kræver det en vedligeholdelse af hjemmesiden for at sikre et positivt og godt indtryk af virksomheden. Det er vigtigt at potentielle nye kunder som vil undersøge virksomheden nærmere, får en informativ og flot visuel oplevelse når de besøger hjemmesiden. Kunderelationen er også essentiel at opretholde for at sikre kundens interesse, selv hvis der pludselig bliver lanceret en ny konkurrent. Dette gøres igennem et godt produkt og hjemmeside men også via god service såsom at tilbyde support igennem telefon, chat og email. Endeligt er der de omkostninger som skal vedligeholdes for at sikre indtjeningskanaler. Dette inkluderer fornyelse af server og database der fungerer som host for både SHARP produktet og hjemmeside. Der vil i fremtiden selvfølgelig også være løn, men det er på nuværende tidspunkt ikke muligt at sige i hvilket omfang det bliver. Startkapitalen for firmaet vil enten komme fra interesserede investorer eller igennem et banklån.

Omkostninger

De to stiftere vil i opstartsperioden stå for al udvikling af produkt og hjemmeside. I denne periode vil de også søge eventuelle investorer og selv stå for betaling af server og database. Selv når der skal udarbejdes præsentationsmateriale og fokuseres på salg, vil de to stiftere uddele opgaver så den ene administrerer hjemmeside og systemet, mens den anden opretholder kundekontakt og sørger for marketing.

Implementering

Implementeringsplan

Implementeringen af SHARP blev allerede påbegyndt i starten af 2011 som et universitetsprojekt. Dette bestod dog kun af en prototype der blev udviklet i samarbejde med en talepædagog og afprøvet på tre klienter der havde været igennem 3-4 års terapiforløb. Prototypen gav anledning til, i efteråret 2011, at påbegynde designet af en ny løsning der indeholdt flere funktioner og appelerede til en bredere målgruppe. Siden da har vi udarbejdet et funktionelt system der kan anvendes i praksis. Flere kommunikationscentre er i skrivende stund ved at afprøve SHARP i en videnskabelig kontekst, med rigtige afatikere og realistiske vilkår.

Forbedringer og gøremål

Selvom vores produkt på nuværende tidspunkt er funktionsdygtigt, mangler der stadig nogle fundamentale forbedringer, både for at at eliminere de sidste softwarefejl, og for at gøre det mere selvstændigt og sikkert at bruge. Disse forbedringer inkluderer:

- ★ Automatiseret brugeroprettelse. Kunder skal kunne tilmelde sig vores service helt selvstændigt, sådan deres oplysninger bliver registreret automatisk i vores database
- ★ En del af vores forretningsmodel foreslår at der skal være en almindelig version og en lidt dyrere professionel version som indeholder flere funktioner. Denne distinktion skal implementeres, f.eks. er en standard bruger begrænset ved ikke at kunne indtale lyde og uploade egne billeder
- ★ Selve betalingssystemet skal forbedres, således vi kan opkræve abonnement fra kunderne
- ★ I opstartsfasen vil der være behov for at skabe interesse blandt afatikerne og talepædagogerne, og derfor skal der laves en tilmeldingstype til en gratis prøve-periode, hvor man har mulighed for at afprøve programmets basale funktioner indenfor en vis tidsfrist

Milepæle

På nuværende tidspunkt er SHARP et kandidatprojekt som skal afleveres den 31. maj, 2012. Herefter skal der stiftes virksomhed omkring softwaren, så snart de sidste forbedringer er lavet, hvilket forventes at blive gjort over et par måneder. Dette giver anledning til at påbegynde en marketingskampagne hvilket estimeres at tage yderligere 3 måneder. Efter et år antages det at virksomheden har opnået en kundeskare bestående af omkring 10 institutioner. I løbet af året derefter, vil systemet blive videreudviklet til en engelsk version, for at udbrede kundegrundlaget til et internationalt marked.

Marketing og salg

Så snart virksomheden er stiftet vil en marketingskampagne blive designet, som har til formål at sprede budskabet og overbevise kunderne om at SHARP er en nødvendighed i et genoptræningsforløb. Igennem personlige pitches er det forventet at skabe et godt rygte i talepædagogernes kredse. Dette gøres effektivt ved at klarlægge at produktet er et '**need to have**' frem for et '**nice to have**', hvilket betyder at systemet ikke kun tilbyder funktioner der kunne være fordelagtige, men at det faktisk er uundværligt i rehabiliteringsprocessen. Så snart talepædagogerne er overbevist, er der en god sandsynlighed for at beslutningstageren som har midler til køb af SHARP, altså offentlige institutioner eller private talepædagoger vil investere i produktet.

Et domæne og webhotel (http://getsharp.net) er blevet købt af flere årsager. Det skal bruges til at hoste selve programmet, den bagvedliggende database og billed-/lydarkivet der indeholder de grafiske og auditive elementer af opgaverne. Derudover skal domænet bruges som promovering og bestillingsværktøj, og således har vi designet en hjemmeside der giver et overblik over produktet (med videoforklaring), et udvalg af licenser som tilbydes og et link til selve programmet. Enhver kan derfor gå ind på hjemmesiden og tilmelde sig vores service, hvilket ideelt vil oprette en bruger som er tilladt eller begrænset adgang til forskellige funktioner i programmet, baseret på hvilken type licens der er betalt for.

Alt i alt er SHARP en løsning som forventes at blive anerkendt som et tydeligt bedre alternativ til eksisterende produkter, og vil blive markedsført på følgende punkter:

- ★ Det er 100% online og kan bruges på både PC, Mac og tablet devices med forbindelse til internettet
- ★ Programmet skal ikke installeres på computeren, og kræver derfor ingen installations-CD eller manualer til setup
- ★ Patienten og talepædagogen er ikke afhængige af at mødes til sessioner, tværtimod har de begge frihed til at anvende systemet når det passer dem bedst
- ★ Da talepædagogen selv har mulighed for at designe opgaverne og forløbene er hver udfordring skræddersyet til patienten efter vedkommendes professionelle vurdering. Derved undgår patienten at løse unødvendige opgaver som ligger udenfor hans/hendes behov

Økonomi

Budget

Udgifter	Beløb (kr)
ApS registrering	80,000*
Varemærke (10 år)	5,500**
Marketing (1 år) - Kampagner - Transportafgifter	 50,000 10,000
Server (pr md) - Nuværende - Efter første kvartal	 60 500

Indtægter	Beløb (kr)
Licenser (pr stk) - Standard institutions licens - Pro institutions licens - Standard 5-bruger - Pro 5-bruger - Abonnement pr. md. pr. bruger	 10,000 15,000 5,000 7,500 400
Investor - Banklån (startkapital)	 50.000

	Første måned Juni 2012 - Juli 2012	**Første kvartal** Juni 2012 - September 2012	**Første år** Juni 2012 - Juni 2013
ApS registrering	-80.000	-80.000	-80.000
Varemærke	-5.500	-5.500	-5.500
Marketing	-60.000	-60.000	-60.000
Server	-60	-180	-4680
Licenser+Abonnement	0	20.000	100.000
Investor	50.000	50.000	50.000
Total	-95.560	-75.680	-180

*ApS stiftelse: http://www.jurition.dk
** Varemærke registrering: http://www.rettigheder.dk

Appendix F

Evaluation From 8th Semester Report

Chapter 12

Experiment

Having finished the implementation of the computer vision system, the server and the game, the product was considered testable. To evaluate the product, an experiment with aphasia patients was conducted. The test had the purpose of getting some general feedback on the product, but also to collect information about some concrete aspects such as:

- The tasks and their level of difficulty
- The interface
- The graphical appearance
- The amount of feedback
- The use of the product in therapy

As mentioned, at this point of the development process, the product was considered to be testable. The computer vision system was working well and all tasks except task, except one, were working fine. Due to technical issues with the resolution of the camera, the incoming coordinates from the computer vision system were not precise enough to detect which letter that had been pressed. A simple solution was made, that included the experimenters to press the same letter on the computer, as the one that had been pressed by the user.

12.1 Design

The experiment was conducted as a qualitative test, providing data through video recordings and interviews. This was considered to be the optimal use of method, due to the low amount of subjects. In order to be able to conclude anything from quantitative data, it is important that the data represents a significant amount of subjects. However, qualitative feedback from a low amount of subjects will provide more detailed data as it is personal comments in a semi-structured interview.

12.1.1 Environment

The test was performed in a room with the hardware setup positioned up against a wall, and another table with two computers that handled the software. When the test begun, only the active subject would be present in the room, along with one experimenter and a speech therapist. The speech therapist did

not participate in any way, but was only present in order to observe the product and how the subjects performed. The experimenter was operating all the software, ensuring that no technical issues would occur during the experiment.

During the test the subjects were video recorded as it could become crucial data when evaluating on their performance and, moreover, it could support the data collected in the interviews.

12.1.2 Subjects

Three aphasia patients were participating in the experiment, along with a speech therapist. The subjects were the same as those who participated in the low-fi prototype test (see section 6.2).

12.1.3 Designed Procedure

When a subject entered the test room, he was introduced to the process he was about to experience. For instance how he interacted with the tool and what the purpose of the game was. However, minimum information about the tasks and how to complete them were given. This was important, as it was an essential part of the experiment to evaluate on the amount of feedback included in the game. When the introduction was finished, the first task was initiated and hereafter the subject was intended to be left alone, only getting help from the software. After having completed all six tasks in the game, each subject was asked to answer questions in an interview, which was performed in another room by the second experimenter. This was done immediately after the test to ensure that the subjects would forget as little as possible. After all three subjects had been through the test, an interview was also given to the speech therapist.

Figure 12.1: *Each subject who participated in the experiment was asked to try all six tasks in the game.*

12.1.4 Results

By looking through the video recordings and the qualitative feedback from the interviews, some essential observations have been made. All three subjects seemed to be generally positive towards the entire concept of the product, including the speech therapist. This statement is based on both their respective

responses in the interviews, as well as the observation that all subjects enjoyed the experience as they seemed to be engaged and focused while solving the tasks.

During the demonstration of the product, the subjects completed all six tasks with minor difficulties. Task one, where the user had to spell the name of an item, was the task that caused the most issues, and was only attempted by two of the subjects, but even though the two were able to finish all tasks, they did not collect all diamonds.

It was apparent throughout the experiment that the tool did not provide the optimal amount of guidance. Some of the subjects had difficulties understanding the objective of certain tasks, and needed external assistance, either from the speech therapist or the experimenter, in order to complete the challenges. The therapist was at one point compelled to draw a figure on a piece of paper in order to have the subject understand the purpose of the task.

When trying to grasp a challenge or recognize the visual objects, it was sometimes necessary for the subjects to closely investigate the details, by either putting their eyes closer to the table or by hovering a finger above the images, which lead to unintentional interactions with the system. This was due to the nature of how the image processing part works, where the camera was positioned above the table.

The responses from the interviews can be found as audio recordings in appendix B, along with video recordings from the experiment. The above observations, among several others, will be elaborated in detail in later chapters of the evaluation.

Chapter 13

Summary

In the effort of improving traditional aphasia therapy, this project has developed a digital tool that features a dynamic and adaptive environment. Relevant theories and methods concerning both the psychological aspect of aphasia, as well as modern entertainment development techniques have been considered and applied to shape the tool. By looking into topics such as traditional therapy, ubiquitous computing and game theory, the drawn solution had much potential within the field of aphasia rehabilitation.

Both the hardware and software, required to realize the tool, was developed through an iterative process. What started as a crude mock-up of the interface became, through advice and feedback from the project's collaborators, a piece of software with the ability to track the user's finger presses, when controlling the appertaining interactive installation. This installation was designed on the notion of ubiquitous computing, by building an invisible computer vision system around a regular table, to avoid the unintuitive interaction devices of a computer.

With the developed system working, a final evaluation was conducted. By having three aphasia patients trying and evaluating on the system, various observations were made and valuable feedback was obtained. In the following chapters, this data will be discussed to determine whether or not the tool can be a valuable substitution/supplement for current aphasia therapy.

Chapter 14

Discussion of Results

As stated in the experiment description (section 12), three aphasia patients, all with more than two years of therapy, were asked to complete all six tasks included in the tool, and then give feedback through an interview regarding their experience. This chapter will clarify specific conclusions that could be drawn from the results.

14.1 Game

One of the main criteria for the product to be useful, independently of other assistance, is whether the user is able to comprehend and understand the objectives throughout the tasks. Even though two of the three subjects understood the majority of the tasks, it was clear that the tool did not provide a sufficient amount of guidance at certain points. Considering these patients have been through years of therapy beforehand, this would surely be a larger problem to patients in an earlier stage of their rehabilitation. The option of having the objective repeated was not sufficient for the subjects to understand the goal of the task, possibly because, as the therapist mentioned, aphasia patients need alternative formulations to comprehend a message. As the repeat button merely, as the name implies, repeats the objective, the tool should include different versions of the same description. Perhaps by showing an example video of how the task should be completed. Furthermore, in addition to the repeat button, another help option should be available specific for each task. For instance, in the first task, the system should be able to display the correct answer temporarily, while in the sixth task, the user should be able to hear the sentence again. One of the subjects stated that he required more assistance when spelling out the longer words, like *basketball* (see appendix B[Subject 2, 02:25]).

Although all three subjects collected nearly the maximum possible amount of diamonds, they still had trouble with some of the challenges. All of the subjects claimed that most of the challenges were too easy for their current skill, but one of the subjects acknowledged that many of these would have caused complications to him earlier in his rehabilitation process:

> *[Editors note: Translated, rephrased for comprehension] Considering that I only missed two diamonds, the challenges were probably too easy, but do not put too much into it, as it is meant for patients in earlier stages of aphasia. (Appendix B[Subject 1, 06:35])*

This could indicate that the difficulty level of the tasks suits a large spectrum of aphasia patients. One could imagine that people who recently got the disorder would find the easiest challenges hard, yet comprehensible. However, it is still considered necessary to design more challenges, to create a more refined intensity curve of the difficulty level.

During the experiment and the interviews, it was pointed out, both by the subjects and the speech therapist as well, that the items visualized throughout the tasks, could be difficult to recognize. The intention of the 3D objects was to create a dynamic scene and show the items from all angles, however, it became obvious that the visual representation in some cases caused the objects to lose their recognizability. Both because the animations were rotating too fast, but also simply because the 3D model was not realistic enough. To this effect, one of the subjects replied:

> *[Editors note: Translated, rephrased for comprehension] It is probably meant for some that are more damaged than me, who demands the figures are more accurate. It was hard to recognize the baseball bat, I thought it was a brush. (Appendix B[Subject 1, 05:50])*

The graphical representation of the game was one of the elements that was interesting to evaluate, as it was developed through an intuitive and creative process, without deeper analysis of the target group. Surprisingly, the chosen style did not seem to affect the subjects' experience of the game, since they were too focused on solving the tasks. One of the subjects claimed the following, when asked what impact the Sharp character had on the gameplay:

> *[Editors note: Translated, rephrased for comprehension] I actually do not know, I did not see it. I was only looking at the task. (Appendix B[Subject 2, 03:15])*

To introduce a motivational element to the game, the diamond scoring system was used. During the experiment, one of the subjects failed two challenges in the first task, whereafter he asked to try the task again, as the missing diamonds annoyed him. This could indicate that the diamonds does make a difference, and motivate a user to finish all tasks for completion purposes. An interesting comment to point it out:

> *[Editors note: Translated, rephrased for comprehension] There needs to be something (motivational elements), so diamonds are fine. If there is not anything, it is not possible to see how you progress. (Appendix B[Subject 1, 09:05])*

14.2 Interface

As described in chapter 5, the interface developed in this project was established to investigate if it could heighten the usability for aphasia patients. Despite the technical issues experienced throughout the experiment, where the subjects at certain points unintentionally interacted with the system, it did not seem like the subjects had difficulties grasping the way of interacting with the interface. However, it can be questioned if a traditional interaction device such as a mouse, which does not require the hardware setup and excludes the technical issues, could be just as useful for these patients. When asked which method he preferred, one subject said that because he is used to interact with the computer through a mouse, he would prefer this form of interaction.

The technical difficulties, in which the subject accidentally pressed a button, caused minor nuisances to the user, but in general they all seemed satisfied with the responsiveness of the system, because it reacted as they expected. The technical difficulties could possibly have been prevented, by taking another approach to the camera vision system. For instance, as chapter 7 describes, by building a setup that uses a transparent table surface and detects finger presses from beneath.

14.3 General Opinion

As a concluding part of the interview, the subjects were asked to give some general feedback about the tool. When asked if they could imagine using this software in their everyday life as a part of their rehabilitation, they all agreed that it would have been a helpful tool in the process. One of them even postulated that he could imagine a scenario where he and his grandchildren collaborated on solving the tasks, as the tool qualifies for the skill level of both children and aphasia patients (see appendix B[Subject 3, 13:50]).

The task types were also commented upon. One subject, who was formerly a carpenter, proposed that the tool should not only be limited to linguistic tasks, but also include mathematical challenges. It is surely considered a requirement that the end product should include more tasks and challenges, and also be more adapted to the types of aphasia.

After the subjects had been interviewed, the speech therapist was asked a few questions as well. She has experience with virtual education, however, this is mainly through social networks such as Skype and Second Life, and not within the domain of the game genre.

Some of the feedback the speech therapist provided included that the product was well suited for aphasia patients, as is has easy navigation through the menus and thereby creates a good overview of the options available. In general she was positive towards the concept, and claimed that the tool can supplement, or even replace traditional exercises:

> *[Editors note: Translated] In one way or another, it can replace certain types of exercises or it can be useful as home practice. Home practice can be difficult in early stages, if the patients returns with some exercises on paper where everything is wrong, then there has not been any learning. This is where the computer can correct the patient, by letting him/her know when something is wrong (Appendix B[Speech Therapist, 07:55]).*

In another positive response of using a computer, the speech therapist mentioned that it has great potential of heightening the motivation for a user. She claimed that the motivational element within games will cause the patients to keep on trying, until they succeed. However, the disadvantage of a computer, particularly in the rehabilitation of aphasia patients, is that it can tend to become inflexible and linear, as the exercises are preprogrammed. In traditional therapy, the therapist can create exercises that matches the patients interests to let him or her easier associate with the tasks, where the computer falls short due to its impersonal nature.

Chapter 15

Evaluation of Methods

To achieve the results of this project, several methods and theories have been applied. The form of the tool was shaped on various foundations, here among theories within the field of ubiquitous computing. This approach was merely a concurrent experiment within the project, done to investigate whether the users would become more involved and engaged by removing the barrier of traditional interface devices. With the hardware setup, and an appurtenant software module, a simulation of a touch screen was developed. The goal of implementing the concepts of ubiquitous computing was considered successful, however, for this specific setup, some technical issues occurred. Furthermore, the resulting size of the setup can not be considered realistic, if the tool is to be used for home rehabilitation. In hindsight, the tool would be much more appropriate to implement as a PC version, or even more preferable, for a mobile device, such as an iPhone or iPad. By doing so, the barrier will still be invisible, and the tool would also be available practically everywhere.

The method used for the rehabilitation aspect of the tool, was Luria's approach. This was chosen due to its renowned reputation within the clinical domain, and also because this was the method used by the project's collaborating speech therapist. While the approach itself proved lucrative, by adapting the difficulty of the tasks to the patient's abilities, the utilization in the tool did not seem to be sufficiently widespread, as the range of challenges in each task was limited to only five levels of difficulty. If the product was to be fully developed, it should include a greater amount of tasks and challenges, both in order to be adapted to a wider target group, and also to give an improved sense of progress within each task. Although the types of tasks were suggested by the speech therapist, a further development would also require a deeper analysis of which task types that matches the various aphasia types.

The analysis of the game theories could have been more comprehensive (e.g. storytelling and character development), however, as the product of this project is not considered a traditional game, but rather a tool that possess the characteristics of one, this was neither found relevant nor necessary. Though, what turned out to be one of the essential aspects of the analyzed game theories, was the motivational elements, such as risks and rewards. By applying these, it proved to be an effective driving force for the subjects, probably due to the lack of these elements in traditional exercises.

The choice of computer vision programming environment was chosen because OpenFrameworks contains easy accessible libraries for managing camera input. Also the libraries provide the user with many predetermined functions that are handy when performing image processing.

Instead of utilizing Unity as the game engine, it was initially the intention to implement all game objects, by manually programming them, either through OpenGL or Java Processing. However, when investigating other possibilities, it quickly became apparent that Unity was able to provide the functionality, that fulfilled our demands for creating the objects, in an easier and more accessible way.

Due to the fact that all the subjects of the experiment was in such a late stage of their rehabilitation, and did not have severe communication issues, it was not found significant to discriminate between their individual type of aphasia, by letting them try selected tasks. All subjects tried all six task types, as it was assumed that they were able to complete all, and give constructive criticism.

It is acknowledged that the optimal way to have evaluated the product would have been by having more subjects and time. This would give arise to a more thorough experiment, for instance by measuring the improvements within a group of patients over several months, where they would use the tool frequently. By doing so, it would feed off a large amount of measurable quantitative data, and thereby give an indication of which effect the tool would have during a rehabilitation.

Chapter 16

Conclusion

In the interest of improving traditional aphasia therapy, this project has attempted to integrate formerly approved methods into the digital domain. This lead to the initiating problem:

> *By employing the advantages of computer technology, how is it possible to improve the current methods utilized when treating aphasia, so they become more efficient and motivational to the patient?*

To investigate how this problem could be answered, relevant theories and methods within the field of aphasia rehabilitation and game design were analyzed. Furthermore, it was found interesting to explore the advantages of ubiquitous computing.

With a series of concrete and applicable guidelines, a solution for the initiating problem was shaped, in the form of a tool that could be classified as edutainment, which both integrated traditional therapy methods as well as motivational game mechanics.

Having determined the limitations of the project, a problem statement was produced, to specify the tasks that had to be solved in order to develop the solution. Two main questions had to be answered. The first one being:

> *How is it possible to develop a software tool that utilizes game mechanics, inherits the theories and methods from traditional therapy and is still as useful for rehabilitation?*

Through an iterative process, the concept was developed based on the specified foundation. A mock-up of the concept was initially used to conduct a low-fi test, leading to the final design and implementation of the tool. By utilizing Unity as the game engine, a rehabilitation software was created, with the motivational characteristics of a game.

As a parallel experiment, it was considered interesting to develop a user-friendly interface, based on the premise that aphasia patients may have trouble controlling regular computer interaction devices. The second question of the problem statement was as follows:

> *With such a tool, how is it possible to tailor a natural and user-friendly interface that practice the concept of ubiquitous computing?*

To exclude the barrier that regular interaction devices constitutes, a hardware setup was built that utilizes a computer vision system to detect the user's hand and finger movements. With the product fully implemented, it was possible to conduct a user test to evaluate it.

Some constructive criticism was given on concrete issues that can be improved, but both the collaborating patients and speech therapist agreed that the tool contains great potential. The patients thought that it could be a beneficial supplement in their earlier rehabilitation, and the therapist was certain that it could replace some of the traditional exercises and serve well for home practice. Naturally, for this to be possible, a mobile version of the tool should be developed.

From the perspective of the authors, the project has presented a method, and shown proof of concept, for merging traditional therapy into the digital domain that is considered to have great potential. Throughout the research conducted in this project, it is apparent that there exists a demand for computer based rehabilitation tools, that actually makes a difference to the patient's therapy.

Chapter 17

Further Development

If the theme of this project is to be further studied by others, several improvements and additions could be applied:

- As it has been suggested, if the tool developed in this project were to be marketed, more tasks and challenges would have to be designed and implemented. This would involve a deeper analysis of which task types to implement so the tool is accommodated to more types of aphasia.

  - As one of the subjects suggested, the tool should not only be restricted to linguistic rehabilitation, but also involve tasks that consider other functionalities of the brain, such as mathematics or memory specific exercises.

- One of the observations during the evaluation was that some of the 3D animations used for the challenges were rotating to fast and were visually unrecognizable. This problem would obviously have to be solved, either by slowing down the rotation or using another approach, for instance by utilizing photos.

- Another observation made in the evaluation was that, at this point, the tool does not include a sufficient amount of feedback. The purpose of the tool is that it can be used by patients at home, alone. If this is to be realized, more auditive and visual feedback is required to be implemented.

  - The artificial intelligence of the Sharp avatar could be improved by providing the user with hints after a predetermined time interval.

- The most essential point in further development is to modify the tool so it can be used by other interfaces. The interface in this project was merely a study to investigate the potentials of such an interface. If the tool is to be utilized in rehabilitation therapy, e.g. for home exercises, it would be much more convenient to implement the tool on a PC, iPhone or iPad.

- As presented in chapter 5, it would be an interesting study to see how the tool could be integrated into a social network. This could be done by having a system where patients could collaborate on different tasks or compete against each other by comparing collected diamonds.