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BACHELOR THESIS

Visually impaired and websites

- How to improve websites to support the aiding devices of the visually impaired

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Abstract

The modern IT society is based on Internet access, and many corporations, organizations and persons take advantage of the increased accessibility and flexibility that the Internet provides for products, services and information. This can also cause problems for the visually impaired since they cannot always access and use all websites, because of that their aiding devices cannot always interpret all the contents of the website, or that they freeze or sometimes even crash. The purpose of this thesis is therefore to find out how websites should be designed so that they function as well as possible with the aiding devices of the visually impaired, as well as how to make websites as accessible as possible for the visually impaired.

By comparing the result of a case study with existing theory, it was concluded that the existing standards and guidelines should be followed to make websites as accessible and user friendly as possible for the visually impaired. One of the many important things regarding accessibility for the visually impaired is the importance of providing ALT texts to images and links, to allow the aiding devices to interpret these. Because it is very common to forget to provide ALT texts on websites today.

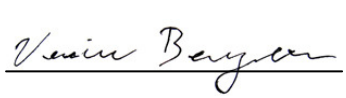
It is also important to follow the accessibility standards and guidelines that are available for both Flash animations and PDF documents. Modern aiding devices can interpret Flash animations if they follow these standards and guidelines, but most of the aiding devices can still not interpret Flash at all. The aiding devices can also interpret PDF documents if these are made correctly, which, sadly, the often are not.

To find a solution for all these problems, and many more, the authors have concluded a number of good advice and requirements based on the experience of visually impaired persons, as well as giving some advice on how to increase accessibility in websites.

Preface

This thesis is a bachelor's essay for the division of Information Systems Sciences and the department of Business Administration and Social Sciences at Luleå University of Technology

We would like to express our gratitude towards the people who agreed on being interviewed for this thesis, and to the organizations that provided us with both contacts and information. We would also like to express many thanks to Ingela Johansson at the division of Information Systems Sciences on Luleå University of Technology for her help with some formal difficulties, and another thank you goes to our tutors Sören Samuelsson and Dan Harnesk. Finally, we would like to thank our families and friends, especially Max Ocklind, for their encouragement and support.



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1 Introduction

This chapter will introduce the background and problem area of this thesis, as well as the research question, purpose, delimitations and the explanation of important words.

1.1 Background and problem area

Today there exist a lot of people with some kind of visual impairment. There are also many different kinds of visual impairment. Synskadades Riksförbund (2009), the Swedish Association of the Visually Impaired, write on their website that approximately 120 000 people have some form of visual impairment in Sweden, and that it is hard to determine an exact number. According to Wirström (2005) there are about 100 000 people registered at local centres for the visually impaired in Sweden. Synskadades Riksförbund (2009) also write that there are approximately 3 000 children with visual impairments, and that more than half of these children also have additional disabilities.

There are different types of vision correction, which can be divided into the categories of refractive errors and visual impairment. Refractive errors are very common among people and are treated with glasses, but there are also other kinds of visual impairments that cannot always be cured. Some of the most common are diabetic retinopathy, cataracts, glaucoma, macular degeneration, retinal detachment and retinitis pigmentosa. Just because a person has a visual impairment, it does not mean that everyone with the same kind of visual impairment experience exactly the same visual defects in their field of vision. Figure 1 shows the field of vision for a person without any visual impairment.

Figure 1 How a normal seeing person might experience their field of vision. (Synskadades Riksförbund, 2009)

Diabetes can cause diabetic retinopathy, which affect the field of vision (see Figure 2). People with glaucoma, one of the most common causes of blindness, have a field of vision much like the one shown in Figure 3.

Figure 2 How a person with diabetic retinopathy might experience their field of vision. (Synskadades Riksförbund, 2009)

Figure 3 How a person with glaucoma might experience their field of vision. (Synskadades Riksförbund, 2009)

Figure 4 shows how the field of vision may appear to a person with macular degeneration. Macular degeneration is also known as age related changes of the so-called macula, a yellow spot located on the retina (Synskadades Riksförbund, 2009). Cataract is one of the most common, and best-known, eye diseases. It clouds the lens and prevents light from entering (Synskadades Riksförbund, 2009). Figure 5 shows how cataract may affect the field of vision.

Figure 4 How a person with macular degeneration might experience their field of vision. (Synskadades Riksförbund, 2009)

Figure 5 How a person with cataract might experience their field of vision. (Synskadades Riksförbund, 2009)

Figure 6 shows the field of vision of a person with retinitis pigmentosa. This is a collective name for a large group of eye diseases. Retinal detachment mostly affects the middle-aged and the elderly population (S:t Eriks Ögonsjukhus, 2009), and causes the field of vision to become like the one shown in Figure 7.

Figure 6 How a person with retinitis pigmentosa might experience their field of vision. (Synskadades Riksförbund, 2009)

Figure 7 How a person with a retinal detachment might experience their field of vision. (Synskadades Riksförbund, 2009)

Approximately 85% of all the visually impaired are older people with minor visual impairment. People with minor visual impairment can read printed text if the letters are big enough, the contrast between the letters and the background is high enough, and if the layout of the text is logical. The remaining 15% have major visual impairments, such as complete or partial blindness, and need special equipment to be able to interpret written text. There are many aids for the visually impaired, such as Braille writing, recorded audio-cassettes, guide dogs, white canes or synthesized speech via computer software. There are also some aiding devices designed to make it easier for the visually impaired to use the Internet. Some examples of such aiding devices are speech synthesizers, Braille displays, screen readers and magnification programs. But these aiding devices do not always work well together with websites (Wirström, 2005).

The modern society that we live in strives towards an IT-based society and most companies, organisations and individuals start to realise that the Internet provides both increased availability and more flexible business solutions (Wirström, 2005). More and more companies and organizations are also starting to use the Internet as their main channel for information, customer contact, products and services. Because the Internet obviously is less costly than actual warehouses or stores, it can sometimes also be the only channel. Thus you need a computer to be able to access all the information and all the services (Wirström, 2005).

However, with the shift from direct physical interaction to web-based interfaces, it gets more difficult for people with visual impairments to perform everyday tasks on the Internet, such as banking and looking for information. Computers are also not adapted to people with visual impairments since they present most of the interaction and information visually to the user. Therefore the interface, tools and main output devices must compensate for this (Lundin & Näslund, 2005). The design of the interface will be of significant importance if the person using the computer has some form of visual impairment. Even though the computers of today are not adapted for the visually impaired, there still exist many different aiding devices that make it possible for this group of people to use computers. But the problem still remains since websites are usually not designed with any aiding devices in mind (Lundin & Näslund, 2005). Because of this problem and the increasingly common techniques and functionality used on websites to represent multimedia (Lundin & Näslund, 2005), among other things, make it difficult for the visually impaired to navigate these websites and access information online, even with the help of their aiding devices.

Developers of websites often see themselves as the general users of the websites (Edwards, 1995), which according to Molich (2002) causes problems. Because of this many developers tend to overlook the needs of the actual users, further limiting the possibilities of the visually impaired that want to use the website. Many developers also think that usability and accessibility are cumbersome subjects, and that bringing any of these up is just a way of criticizing their, from their viewpoint, well working websites (Molich, 2002). Other similar problems include that developers design websites with the main user group in mind, which is of course a good design principle, but forget to add support for other groups of users. This of course also affects the possibilities of the visually impaired.

1.2 Purpose

The purpose of this thesis is to find out how websites should be designed so that they function as well as possible with the aiding devices of the visually impaired, as well as how to make websites as accessible as possible for the visually impaired.

1.3 Research

How should websites be designed to make it as easy as possible for the visually impaired to navigate them with the help of existing aiding devices, and what needs to be considered when designing such websites?

1.4 Delimitation

This thesis will only examine the layout and navigation possibilities of websites, and how these can be adapted to support the different aiding devices that exist to help the visually impaired to navigate the Internet. The possibilities of existing tools for creating websites will not be examined.

Because of the big responsibility to improve things for the visually impaired lie with the official associations of the visually impaired, and to get a better overall picture of the problem, the interviews will be made with persons that have a connection to these associations.

1.5 Word explanations

This chapter introduces and explains some of the most important words used in this thesis.

ALT text
An HTML attribute used to provide a hidden text description of an image, a part of an image or an input field. The description is the text that appears when you hold the mouse pointer over the image or text field.

Flash
A vector based animation technique created for the web. Flash animations are embedded into websites and can be viewed by browsers with the aid of a plug-in.

Frames
An HTML technique that allows a website to divide a browser window into many frames. Each frame is independent and may display and update different contents and even other websites.

HTML
HTML is an acronym for HyperText Markup Language and is a tag-based language for constructing and describing websites. The tags describe how the website should look and how it should be displayed.

JavaScript
A scripting language for the web that, among other things, allows the contents of websites to be manipulated after the website has been fetched. It is typically used for automatic error checking of filled out web forms.

Java Applet
A small program with a very specific task, which is written in the Java programming language. Java Applets do not work as independent programs, but are imbedded into and used by websites to provide functionality, such as user log in and authentication, or other functionality not supported by HTML.

Pop-up windows
Often unwanted browser windows containing ads or similar contents that usually open without any request from the user. Pop-up windows may also be opened as a side effect of the user's interaction with a website. A common example of a pop-up window is the window containing a larger picture of a product that usually opens when a user clicks on the smaller picture of the product on a website.

Visual impairment
A visually impaired person is blind or has partially reduced vision due to inherent diseases, age, illness or injury. Visually impaired people have difficulties to read and to find their way with the help of their eyesight, according to Synskadades Riksförbund. Many of the visually impaired can vaguely make out colours and objects or they may suffer from a very limited field of vision. It is also common that they find it hard to see well in the dark and in bright light.

2 Theory

This chapter brings up Human-Computer Interaction, user friendliness and some of the different aiding devices for the visually impaired, as well as existing guidelines for making websites accessible and user friendly.

2.1 Human-Computer Interaction (HCI)

The study of Human-Computer Interaction (HCI) is, according to Kaptelinin & Nardi (2006), the study of interaction between humans (the users) and computers. Preece et al. (1995) write ”the goal of Human-Computer Interaction is to produce usable and safe systems, as well as functional systems.” (pp. 14). Studies in Human-Computer Interaction are often regarded as the intersection of computer science, behavioural sciences, design and several other study fields. Interaction between users and computers occurs at the user interface, often simply called the interface. The interface includes both software and hardware, such as general-purpose computers and large-scale mechanical systems, such as aircraft and power plants.

The Association for Computing Machinery gives the following definition of Human-Computer Interaction: *"Human-Computer Interaction is a discipline concerned with the design, evaluation and implementation of interactive computing systems for human use and with the study of major phenomena surrounding them.*" (Hewett et al., 1996, pp. 5).

Preece et al. (1995) write that there are many disciplines contributing to Human-Computer Interaction. Amongst these many disciplines Kaptelinin & Nardi (2006) and Preece et al. (1995) write that computer science, cognitive psychology, social and organizational psychology, ergonomics and human factors are the most important.

Dix et al. (1998) write that vision, hearing and touch play important roles in Human-Computer Interaction. The blind must make use of their hearing and touch to interact with their environment. For people with severe visual disabilities hearing is the most important way of interacting with computers. For people without disabilities, vision is the most important way of interacting with computers, followed by hearing and touch.

Kaptelinin & Nardi (2006) and Preece et al. (1995) write that Human-Computer Interaction is very a complex and broad concept, and that Human-Computer Interaction covers numerous aspects. According to Preece et al. (1995) the following are some of the main aspects:

- Human-Computer Interaction is concerned with designing computer systems to meet the need of the users.

- Computer science provides knowledge about technology and a wide range of software tools and methods for facilitating design and development.

- Cognitive psychology provides knowledge about the capabilities and limitations of the users of a system.

- Social psychology helps explain the structure and functions of organizations through the use of ethnomethodology.

- Ergonomics and human factors provide knowledge of how to ensure that hardware and software are designed so that they do not harm the user physically.

- Human-Computer Interaction can be viewed as a model in which people, (often work related) activities, technology and the social, organizational, and physical environment are closely related.

- Human-Computer Interaction should be user-cantered and combine knowledge from many different disciplines, and should also be highly iterative.

Both Kaptelinin & Nardi (2006) and Dix et al. (1998) write that there are no general and unified theories about Human-Computer Interaction, and that it may be impossible to ever derive one. There are however underlying principles that form the basis of Human-Computer Interaction that can be found in the statement that people use computer to accomplish work. This statement outlines the three major parts of Human-Computer Interaction: the people, the computer and the task. Since Human-Computer Interaction studies the interaction between humans and machines, it draws conclusions and knowledge from both the machine and the human side. The most relevant aspects on the machine side are the techniques of computer graphics, operating systems, programming languages, and development environments. The most relevant aspects on the human side are communication theory, graphic and industrial design disciplines, linguistics, social sciences, cognitive psychology, and human performance. There are also some parts of engineering and design methods that are very relevant. There are many people with different backgrounds that contribute to Human-Computer Interaction, due to its multidisciplinary nature. Human-Computer Interaction is also sometimes referred to as Man-Machine Interaction (MMI) or Computer-Human Interaction (CHI).

2.1.1 Differently abled users

Preece et al. (1995) write that the development of computer systems should put users at the heart, and that their needs, capacity and capability to perform should determine how the system will be developed. Kaptelinin & Nardi (2006) and Preece et al. (1995) also write that users should not have to adapt to the system but that the system should be able to adapt to the users.

Murrell (2001) states that people with physical challenges, such as the blind or the deaf, may use any computer program. Even in areas where it is unlikely for the physically disabled to be accepted, there may be occasions when a user is temporarily disabled and still needs access to the equipment (Englund & Sundin, 2003). For instance if one of the user's hands is plastered, the user should still be able to access information.

Edwards (1995) states *"Many HCI designers see serving disabled users as a fringe activity of a charitable rather than a professional nature."* (pp. 4). Edwards (1995) also writes that there is a tendency for system designers to view themselves and their immediate colleagues as archetype users of the system.

For a person who is severely visually impaired or blind, hearing is the most important sense instead of sight. When visually impaired people interact with computers, the computer environment as Ökvist & Nöjd (2003) state, must be adapted and support aiding devices to compensate for the lack of any senses.

2.1.2 Learning time

Murrell (2001) states that *"any system which cannot be well taught to a layman in ten minutes, by a tutor in the presence of a responding set-up, is too complicated"*. They also state that factors that contribute to shortening the learning time include familiarity, consistency and the use of metaphors that are easy to understand. If a user can visualize the structure of a system and is able to predict the outcome of their actions, they will gain more confidence in the system along with quicker interaction and a lower error rates.

2.2 Usability and user friendliness

Usability deals with how easy a product or system is to use. The international standard ISO 9241-11 provides guidelines for usability and defines it as the degree to which users in a given context may operate a product to achieve specific objectives in an efficient, effective and satisfying way (Usability Partners, 2009). Englund & Sundin (2004) also think that efficiency, effectiveness and satisfaction are important factors of usability, and that usability is a measure of how simple a product is to use in contrast to its purpose. They also think that it is important to let users customize the settings of the programs that they use. Sundström (2005) gives a simple definition of usability that captures its two most important aspects: usability equals usefulness times user friendliness.

Dix et al. (1998) write that in Human-Computer Interaction and computer science, usability usually refers to the flexibility and clarity of the interaction with a computer program or a website. Murrell (2001) states that any computer program or website should be able to be used by people with physical challenges, like the blind or the deaf. Murrell (2001) also state that this point is crucial when considering that for most users the computer is simply one of many tools that can be used to perform a certain task. If a tool is not easily accessible and easy to use

it will be discarded in preference of another. This view is also supported by Sundström (2005) who thinks that systems and websites should be developed so that anyone can use them.

Usability consult Jakob Nielsen (1994) have defined a framework of system acceptability, where user friendliness is a part of usefulness. This framework is divided into learnability, efficiency, memorability, errors and satisfaction, which are explained below. This framework is also supported by Molich (2002), as he uses the same definitions as a foundation for when motivating guidelines and advice on how to make accessible websites.

- Learnability
  How easy it is for users to accomplish basic tasks the first time they encounter the design. Dix et al. (1998) write that even if a design works in theory, new users abandon the system or the website of the design is too cluttered or if it takes too long to learn how to use it.

- Efficiency
  How quickly users can perform tasks once they have learned the design. Dix et al. (1998) write that how quickly a user can perform the intended task has a great impact on whether users will continue to use the design or the website. Molich (2002) points out that the number of error messages presented to the user also affects efficiency.

- Memorability
  How easily users can re-establish competence when they return to the design after a period of time. Dix et al. (1998) write that a design that is easy for the users to establish competence with have a greater chance of getting more returning users than a design were it takes longer time to establish competence with.

- Errors
  The number of errors users makes, how severe these errors are, and how easily users can recover from the errors they make. Löwgren (1993) writes that a design or website should be designed so that it is easy to recover from any errors that the user makes, and that serious errors should not be able to occur.

- Satisfaction
  How pleasant it is to use the design. Löwgren (1993) writes that a design that is pleasant to use will be used more than a design that is less pleasant to use.

When a user is working with a computer program there is an interaction between the user and the computer. This interaction can be initiated by either the user, with some kind of input, or by the computer, with pop-up menus for example. Each style of interaction needs to be adapted for a user with visual disabilities. A user driven type of dialogue can be obtained by analyzing the user's input and only

causes a few conceptual problems. However, if the computer program contains some information, such as a menu, error message or status message anywhere on the screen in a asynchronous manner, the output device has to inform the user, even if the user is currently busy reading or typing (Alistar, 1995). Sundström (2005) also points out that increased security generally means lower usability, since the basic idea behind increased security is to make it harder to access information.

The necessity of providing access to existing devices has often outweighed the desire to design systems specifically for a small, although important, group of users (Alistar, 1995). According to Yates (2005), there are a three main points that inhibits accessibility on the Internet. The first of these is that many organizations are "not interested" in making websites accessible, suggesting that strong incentives, such as legal requirements, are not strong enough to create active accessibility initiatives. Usability often follows accessibility, and according to Molich (2002) it always pays off from a competitive point of view to have at least the same amount of usability as the competitors, and that high usability gives the organization a better image.

The second argument is "making websites accessible makes them boring". This common statement is based on the erroneous belief that an accessible website does not have any graphics or other multimedia elements, when this is clearly not the case. A website with high usability also gives the users better opportunities to discover all the functions of the website, and makes users more satisfied, as well as making the website more comfortable to use (Molich, 2002).

The third argument is "we do not want to spend the money on it" is an often-quoted phrase that perpetuates the myth that additional resources are required to make websites accessible, especially that web accessibility specialists are needed. Molich (2002) writes that on the contrary to what many organizations think, working together with users can reduce costs. Unnecessary or too complicated functions can be identified and removed or remade, which in the end can reduce maintenance and support costs.

2.3 Aiding devices

This section looks at the functions of the different aiding devices used by the visually impaired to navigate computers and the Internet. The aiding devices that are looked at are screen readers, speech synthesizers, Braille displays and magnification programs. Some different problems that can arise when using the Internet with the help of these aiding devices are also addressed.

2.3.1 Speech synthesizer

Wirström (2005) writes that a speech synthesizer is either software or computer hardware that converts text into speech. Initially mechanical voices were used for the speech, but more recently human voices have also begun to be used (Wirström,

2005). These systems use a database of audio clips consisting of short human voice clips that can be linked together to form words and sentences.

There are different types of speech synthesizers, such as the computer based (see Figure 8), that can be used by people with different needs. The speech synthesizers are not only designed for people with visual impairments, but also for people with reading and writing disabilities (Östgötabibliotek, 2009).

Figure 8 Speech synthesizers help to read the text on computers out loud (Gällivare kommun, 2009).

Holm & Tenhunen (2004) write that speech synthesizers read text out loud according to the user's instructions, and that you need something that can play the sound, such as speakers or headphones. Speech synthesizers can also be configured to meet the user's needs, like changing the reading speed (Wirström, 2005). It is possible to set the reading speed of speech synthesizers to up to 400 words per minute, but it is also possible to set it to read single syllables, words and sentences, as well as full texts (Wirström, 2005).

2.3.2 Braille display

People with visual impairment can use a special keyboard, called a Braille display, which uses Braille writing (Holm & Tenhunen, 2004). Braille is a written language perceived by touch, were different formations of dots represents different letters and characters, which is also called tactile writing. A normal Braille character consists of no more than six dots, which can be seen in Figure (9). The Braille display uses an extended version of Braille writing consisting of groups of eight dots (Westling, 2004).

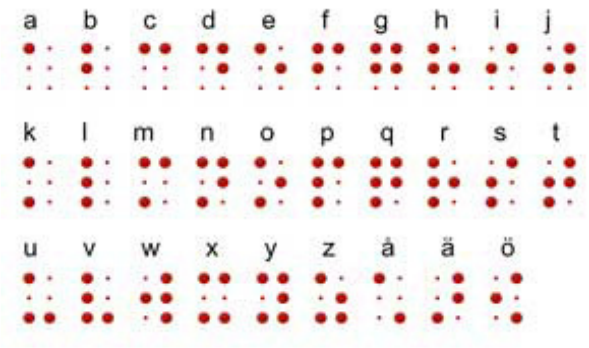

Figure 9 The standard Braille alphabet, using no more than six dots. (Westling, 2006).

A Braille display has a number of cells in a long row, were each cell has eight holes with metal pins that can be raised to form various letters or characters (see Figure 10). The fingertips are then used to these (Holm & Tenhunen, 2004). Figure (11) shows what it might look like when using a Braille display, a keyboard and a mouse.

Figure 10 A setup of a Braille display and a regular keyboard and mouse (Holm & Tenhunen, 2004).

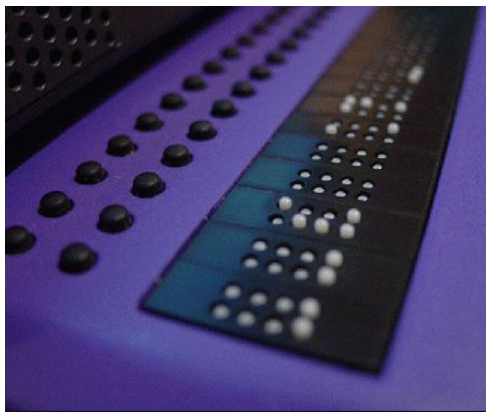

Figure 11 A closer look of the cells of a Braille display (Unga Synskadade Stockholm, 2009).

The Braille display shows the text displayed on the screen, and many visually impaired persons use the combination of screen readers, Braille display and speech synthesizers. This setup allows the users to rest their hands and take a break from using the Braille display (Englund & Sundin, 2004).

2.3.3 Screen reader

Holm & Tenhunen (2004) writes that the screen reader is a kind of software that converts text to either speech or Braille writing. It is common to use a speech synthesizer or a Braille display, and these are most often used together by people who can read Braille writing. Although, it is not certain that those who have become visually impaired in old age can read Braille writing (Krantz, 2009).

A common use for screen readers is to let them interpret contents on the Internet. However, a screen reader can pretty much only interpret the text on websites, omitting the graphic content (Holm & Tenhunen, 2004), which makes it important to have descriptive text as alternatives. ALT texts for images are one example of such an alternative. The screen reader also interprets some of the structure of the website, such as lists, frames and tables (Krantz, 2009). Figure 12 shows a simple website and Figure 13 shows how a screen reader interprets the website.

Figure 12 An example of a simple website: the Hjälpmedelsinstitutet website (Wirström, 2005).

```
Så gör man webbsidor tillgängliga - Hjälpmedelsinstitutet.

"BILD" Hjälpmedelsinstitutets logotype
"LÄNK" Hjälpmedelsinstitutet |
"LÄNK" Tillgänglighet |
"LÄNK" Tillbaka |

Så gör man webbplatser tillgängliga

"LÄNK" Hjälpmedel |
"LÄNK" Boktips |
"LÄNK" Länkar |
"LÄNK" FAQ - vanliga frågor och svar

Internet ökar jämlikheten!
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Figure 13 This is how the screen reader interprets the website shown above in Figure 12. Note that the first row is the title of the website, and that the second row is the ALT text of the logotype image (Wirström, 2005).

Wirström (2005) writes that some examples of different screen readers are Jaws, Hal and Super Nova. Usually the user has to use the tab key to move between links, but Jaws also support keyboard shortcuts for links (Wirström, 2005).

2.3.4 Magnification programs

Users that still have partial vision can use magnification programs to help them see what is available on websites (Krantz, 2009). Magnification programs are computer software that magnifies portions of the screen by zooming. You can use magnification programs in two different ways; either by magnifying the whole screen at once, or by magnifying only a part of the screen, much like a

magnifying glass (Englund & Sundin, 2004). It is also possible to customize the settings and choose how many times the magnification should be when only magnifying parts of the screen (Krantz, 2009). Magnification program magnifies all elements that are shown on screen, which can cause some problems with sub-menus that are only visible when the user hovers the mouse cursor over them (Wirström, 2005). Figure (14) shows how a magnification program magnifies a part of a website to allow the user to read the text.

Figure 14 A magnification program is used to enlarge a part of the screen to allow the user to read the text of a website (Wirström, 2005).

Modern browsers have built-in functions for enlarging various parts of the websites. Text can be enlarged in both Internet Explorer and Mozilla Firefox while images and surfaces remain unaffected. The Opera and Safari browsers work more like a magnifying glass and can magnify the entire contents of a website.

2.3.5 Problems with aiding devices

There are many different things on websites that can cause problems for the different aiding devices. Some of these problems are related to websites that uses a lot of graphics, making it hard for the visually impaired to get around and find the right information, since screen readers cannot interpret images and graphics (Holm & Tenhunen 2004).

In most cases images or graphics are missing ALT texts, which makes it very hard for the visually impaired to interpret this information. It is therefore important to write good and descriptive ALT texts for each image or graphic, since screen readers read the ALT texts provided for images and graphics (Wirström, 2005). Another alternative is to allow the users choose a version of the website without images or graphics (Holm & Tenhunen 2004).

PDF files (Portable Document Format) can be seen as another when it comes to aiding devices for the visually impaired, since PDF files often are locked by the author, making it difficult for screen readers to interpret and send to a speech synthesizer or a Braille display (Holm & Tenhunen 2004). Holm & Tenhunen (2004) suggest that when there is a PDF document on a website, there should also be a Word or text version of the document to make it easier for visually impaired users to read it.

Flash animations can also become a problem for the visually impaired because screen readers generally cannot interpret Flash animations. However, there are some newer types of screen readers that can interpret Flash, but these are not particularly common since Flash is a rather new technique (Holm & Tenhunen 2004). When a website is composed of much Flash or consists entirely of Flash animations, there should also be an alternate version with no Flash animations or a link to a text document containing a summary of the website (Wirström, 2005).

2.4 Existing guidelines for website accessibility

World Wide Web Consortium (W3C) is an international consortium that develops standards and guidelines for the Internet with the goal to make the websites accessible to all, regardless of any circumstance of life. Standards of accessibility and usability are according to Yates (2005), key elements of any good design practices. Although W3C's guidelines for websites are not mandatory, they have been internationally accepted as standards for how websites should be designed to be as accessible and usable as possible. W3C has started the Web Accessibility Initiative (WAI) in which they work together with organizations worldwide to develop strategies, guidelines and resources for developing websites to make them accessible to persons with disabilities. They have also produced the document Web Content Accessibility Guidlines (WCAG), which contains a large amount of both general and specific guidelines for increased accessibility of many web-based technologies. This is supplemented with material on their website that justifies, explains and suggests what techniques should be used to conform to the guidelines. By supporting as many types of users and technical accessories and tools as possible when developing websites, the overall usability is increased for all users according to Yates (2005).

WCAG summarizes that an accessible website should be perceivable, operable, understandable and robust. These principles are summarized below with quotes from W3C's website along with additional summaries of important points regarding the aids for the visually impaired.

- **Principle 1: Perceivable**
  "Information and user interface components must be presentable to users in ways they can perceive."

- **Guideline 1.1 Text alternatives**
  "Provide text alternatives for any non-text content so that it can be changed into other forms people need, such as large print, Braille, speech, symbols or simpler language." This guideline holds with the exception of control panels and input, as well as for contents that is for decorative purposes only and do not contain or should convey any information (World Wide Web Consortium, 2008). Although background images that are relevant to the website should be described in text (Ross, 2002). ALT tags should be used with relevant and descriptive texts for all images on the website according to both Yates (2005) and Holm & Tenhunen (2004).

- **Guideline 1.2 Time-based media**
  "Provide captions and alternatives for audio and video content." This guideline holds with the exception of media content that is an alternative to the text, and that is clearly marked as such (World Wide Web Consortium, 2008). According to Ross (2002) images and videos should always have adequate but not unnecessarily long descriptions.

- **Guideline 1.3 Adaptable**
  "Make content adaptable; and make it available to assistive technologies." Information, structure and the relationships between them, as well as the intended website sequence should be clear, meaningful and interpretable by the aids. Instructions for using the website should not be based solely on a component's shape, size, location or sound effects (World Wide Web Consortium, 2008). Since there exists programs and built-in functions in the web browsers to enlarge text, it is important to ensure that the website is consistent, easy to navigate and still works with larger text sizes (Ross, 2002). For users with screen readers there is, according to Ross (2002), a big advantage if the website is available in a version consisting of only text. According to Ross (2002), websites should also be easy to print for users who want to use other aids, or simply prefer to read from paper.

- **Guideline 1.4 Distinguishable**
  "Use sufficient contrast to make things easy to see and hear." Background sounds should be played with a low volume, or be able to be turned off by the user, to not to disturb foreground sound such as recorded or read out speech (World Wide Web Consortium, 2008). Do not use color as the only means to convey information, present an event, ask for user input or to highlight a particular component (World Wide Web Consortium, 2008). Ross (2002) points out that you should avoid using the combination of red and green, and the

combination of blue and yellow, to make it easier for color-blind users. Shades of gray that cannot be distinguished in black and white form should also be avoided, as this makes it difficult for people with any visual defects that make small contrasts hard to see. Small text and small images are often difficult to see for all types of users. The contrast of the text should according to World Wide Web Consortium (2008) be at least 4.5:1, and should be able to be enlarged to at least twice the size without the help from any aids, without affecting the website's contents or functionality in a bad way. To increase readability, images of text should also be avoided, and text and background colors should be allowed to be chosen by the user. Also text lines should not be any longer than 80 characters, nor should text be justified.

- **Principle 2: Operable**
  "User interface components and navigation must be operable."

  - **Guideline 2.1 Keyboard accessible**
    "Make all functionality keyboard accessible." All parts of a website that a user can navigate to using only the keyboard should be as easy to navigate away from using only the keyboard (World Wide Web Consortium, 2008).

  - **Guideline 2.2 Enough time**
    "*Give users enough time to read and use content."* Users should be able to pause, stop or hide components or texts that move, flash, scroll, or automatically updates. Timing should not be the main or an important part of the normal events or activities that occur on the website (World Wide Web Consortium, 2008).

  - **Guideline 2.3 Seizures**
    "Do not use content that causes seizures." Ross (2002) believe that one should avoid flashing text for everyone's comfort and readability, and according to the World Wide Web Consortium (2008), components may not flash more than three times per second.

  - **Guideline 2.4 Navigable**
    "Help users navigate and find content." The websites title and headings should describe the website's topic or purpose, and link text should also be descriptive (World Wide Web Consortium, 2008). It is, according to Yates (2005) important that website's design and navigation is consistent and intuitive throughout the entire website, and Ross (2002) adds that navigation instructions should be short, clear and meaningful, avoiding unnecessary text and redundancy. When the navigation works well on a website, users can focus more on

the contents rather than the navigation (Yates, 2005). It is also useful to have a function that allows users to skip past reoccurring parts of the website such as a top menu (the World Wide Web Consortium, 2008). According to Yates (2005) users should also be led through the website without losing any control of the navigation, rather than being pushed through the website. This can be achieved by making the navigational elements simple, and by using traditional and familiar design layouts. The focus of the website's components should also, if possible, follow the website's sequential structure, according to the World Wide Web Consortium (2008).

- **Principle 3: Understandable**
  "Information and the operation of user interface must be understandable."

  - **Guideline 3.1 Readable**
    "Make text readable and understandable." Correct spelling, grammar and punctuation makes things much easier for screen readers (Ross, 2002), and functions for automatically extending abbreviations should also exist (World Wide Web Consortium, 2008). Both Ross (2002) and Yates (2005) points out that the frames, tables with columns and similar layout structures should be avoided, as most screen readers read from top to bottom and from left to right, more precisely the first line of each column before reading the next line in the same fashion.

  - **Guideline 3.2 Predictable**
    "Make content appear and operate in predictable ways." The website's context may only be changed at the request of the user and navigation, such as menus, should have a consistent placement (World Wide Web Consortium, 2008). If some kind of standard is followed, it is also easier for users to navigate websites, since the structure and layout will most likely be similar or identical to the structure and layout of other websites that the users have visited.

  - **Guideline 3.3 Input assistance**
    "Help users avoid and correct mistakes." Labels or descriptions should be available when input is required from the user, and automatically detected input errors should be identified and described in text and possible solutions should also be presented to the user. In order to avoid errors, all kinds of input should be either reversible, automatically checked for errors, or have to be verified and approved by the user, before any data is sent (World Wide Web Consortium, 2008).

- **Principle 4: Robust**
  "Content must be robust enough that it can be interpreted reliably by a wide variety of user agents, including assistive technologies."

  - **Guideline 4.1 Compatible**
    "Maximize compatibility with current and future user agents, including assistive technologies." Ensure that all the underlying code of the website is correctly written and follows the standards (Ross, 2002), and that all the interface elements have their name, role and value specified (World Wide Web Consortium, 2008).

3 Method

This chapter describes the scientific method used in this thesis, as well as how the data collection and the data analysis were done, and finally the result of the literature study is presented.

3.1 Approach

This section covers the approaches that this thesis follows. The approaches that are described below are the scientific approach, validity and reliability, and quantitative or qualitative methods.

3.1.1 Scientific approach

There are two different main approaches to consider, which are called positivism and hermeneutics.

Egidius (1986) writes that the term positivism comprises logical and rational thinking, presenting understandable results, carefully testing theories and statements as well as basing these tests on rational reasoning or argumentation.

Positivism deals with quantitatively searching for facts about a certain phenomena and trying to explain and generalize the phenomena itself. Reality is objective and you seek patterns and cause and effect relationships. Only that which can be measured and follows certain laws is seen as interesting and is considered to be knowledge. Andersson (1979) points out that positivism is very close to mathematical ideals, where statistics, which often form the basis for many surveys, is the most evident example.

Egidius (1986) writes that hermeneutics has Greek roots and literally means interpretation of messages or interpretation of texts. The need for interpretation of text comes from the fact that texts are not a blueprint of reality, but rather contain information between the lines.

Hermeneutics deals with qualitatively assessing phenomena and to find out what the meaning and significance of the phenomena itself. Hermeneutics are also about seeking an understanding of this significance, trying to explain and understand it. Reality is subjective where interpretations and estimations must correlate to known facts. There are no absolute truths, instead one should study and interpret correlations and different world-views. According to Gunnarsson (2009), research questions that can be formulated in terms of “what does this phenomenon mean to this group of people” are suited for hermeneutic research.

This thesis follows the hermeneutics, because of its more social approach, where personal experiences and opinions of the respondents are needed for the result of this thesis.

3.1.2 Qualitative and quantitative methods

There are two different kind of methods used to interpret data, namely qualitative and quantitative methods. Starrin & Svensson (1994) write in their book "Kvalitativ metod och vetenskapsteori" that even though quantitative measurements and positivism are the dominating methods that are used, research within social areas continue to use traditional qualitative methods and a non-positivistic approach.

In their book,"Att skriva en bra uppsats", Rienecker & Jørgensen (2008) writes that quantitative methods are all about describing quantitative data in numbers, volume and size. They also write that if there is a large amount of data, the problem can be formulated more generally and a more general conclusion can be made.

Rienecker & Jørgensen (2008) continue to write that qualitative data makes the outcome very narrow and that it makes it harder to form general conclusions from the usually limited amount of observations. Instead, you are looking for special qualities or properties of the studied object.

The authors of this thesis have chosen to use qualitative methods; because the planned qualitative interviews more or less exclude quantitative methods, since there will not be enough data collected to form a good quantitative statistical basis.

3.2 Deduction and induction

The authors have chosen to use a deductive approach during this thesis. A (hypothetical) deductive approach is, according to Boolsen (2007), to start out with existing theories and your own assumptions and hypotheses, and ideas inspired by hypotheses. These are then tested against empirical data, to be either confirmed or disproved. Deduction is a method by which you derive logical conclusions from premises (assumptions) and the consequences of these assumptions. Deduced conclusions can also be examined by this method, and according to Wadenström (2006), new knowledge can also be obtain through deductive conclusions. Deductive conclusions, however, are never true or false, but either valid or invalid. A deductive conclusion is valid if, and only if it is a logical consequence of the premises. A valid conclusion, in which all premises are true, is said to be sound. If any of the premises are false, or if the conclusion is invalid, the conclusion is said to be unsound. Deductive conclusions can however be both valid and unsound.

An inductive approach is, according to Boolsen (2007), to start out with only data, and let theories be derived from generalization of the data. Induction is a method that derives conclusions from experiences and observations, although these conclusions are not necessarily true.

The authors' choice to use a deductive approach during this thesis is based on that this kind of approach will most likely get the most credible results from the study, which of course is the intention of the authors.

3.3 Literature review

A literature review was made in order for the authors to increase their knowledge of the subject and to define the theoretical framework for the thesis. The authors visited several libraries; Luleå University of Technology Library, Chalmers University of Technology Library and Gothenburg City Library. The authors have also used both of the English and Swedish versions of the Google search engine, as well as Google Scholar to find information on the Internet.

There were four areas that the authors had to look up, namely visual disabilities, aids for the visually impaired, Human-Computer Interaction and usability.

3.4 Case study

Nationalencyklopedin (2009) defines a case study as a study method applied in social and behavioural and medical research, where collected data is used to confirm, deepen, and broaden concepts, theories and hypotheses in the field.

The authors have chosen to make their case study within some organizations that all work with the visually impaired and chosen respondents with a connection to these organizations.

3.4.1 Criteria's of organization

The organizations chosen for the thesis will work to strengthen the role of the visually impaired in society, and must also be active in some form on the Internet.

The authors will also give a short description of the chosen organizations in 4.2.1 Choice of organizations.

3.4.2 Criteria's of respondents

The respondents that the authors chose to interview should possess knowledge of the visually impaired. They must also be knowledgeable about aids for the visually impaired, especially when it comes to aids that help the visually impaired to navigate website, or they should be knowledgeable about websites.

The authors will let the respondents be anonymous throughout the entire thesis and simply refer to them as respondent 1, respondent 2 and so on, although a short description of the respondents will be available in 4.2.2 Choice of respondents.

3.5 Data gathering

When doing a thesis like this, it is important to interview subjects to collect data. This is of course not as easy as it sounds, but there are three different base types of interviews that make it a bit easier. The three different interview types are; unstructured, semi-structured and structured interviews.

During an unstructured or open interview a discussion is held about a wide area of interest, often allowing the interviewee to freely develop his or her thoughts about the subject without intervention from the interviewer. The unstructured interview can also be split in to two different sub-types. If there is a predetermined area or subject that the interviewer wants to discuss, the interview will be an aimed open interview and if the interviewer does not have a specific area or subject to discuss, then it will be a completely open interview. Winberg & Hildingsson (2005) describes the unstructured interview as unplanned and compares it to a social meeting where the interpretation of the answers is completely subjective.

A semi-structured interview is an interview with concrete questions that concentrate on specific parts of the discussed area. Winberg & Hildingsson (2005) compares the semi-structured interview to a guided conversation, which requires the interviewer to firmly keep the conversation relevant and within the frames of the interview.

A structured interview is an interview where the interviewer only asks predetermined questions, in a certain order, with set answers to choose from for the interviewee. Winberg & Hildingsson (2005) describes the structured interview as a standardized and more reliable form of interview.

The authors of this thesis have chosen to utilize the semi-structured form of interview. Structured interviews would control the answers of the interviewee too much. However, making the interview completely unstructured would not be optimal either, as it would be too easy to stray from the subject. By using a semi-structured interview one can talk freely but still control the conversation towards the subject, and ask more directed questions. Any complementary questions will be asked via e-mail, since it is the easiest and most time efficient way of getting quick answers without pressuring the respondents to come up with answers right away.

3.6 Data analysis

According Boolsen (2007) a transcribed interview is considered a text, and thus also considered data that can be analyzed in the same way as any other text. Before the data can be analyzed it must first be categorized and classified, dividing it into smaller parts and categories according to predetermined categorization principles (Boolsen, 2007). These principles are simply that which you are looking for, and are crucial to the quality of the outcome of the categorization. A good categorization is, according to Boolsen (2007), required in order to identify and interconnect the various parts according to specified analysis

methods. Boolsen (2007) also recommends these twelve steps as a beginning of the analysis:

1. First categorize the data, and then look for patterns, themes, and such.

2. Use your empathy ability, intuition and imagination.

3. If necessary, create new categories and new top categories.

4. Use images and metaphors to identify and highlight certain points of view.

5. Do enumerations.

6. Do comparisons.

7. Break up some variables into sub-categories.

8. Find common features and similarities.

9. Find and define new variables.

10. Find relationships and connections between variables, as well as the causes and effects of these relationships and connections.

11. Define a logical sequence of events.

12. Define the concepts and the analysis within a theoretical framework.

3.6.1 Content analysis

The authors chose to do a content analysis, since they already from the start had defined a number of areas and categories to examine. A content analysis is an analytical technique used to analyze a large number of different types of documents and texts by either quantification or systematic categorization (Boolsen, 2007). Boolsen (2007) also splits this analysis process into several distinct steps:

1. The problem formulation and purpose of the analysis determines which texts to be included in the analysis.

2. Describe how texts are selected and how texts are discarded.

3. Set up a framework for the analysis that take into account both the type and character of the data. The most important variables in the analysis must consider both theory and empirical data,

because it is not always possible to investigate and gather data directly from the intended main sources. It can, for instance, be very difficult or impossible to interview soldiers during a firefight, if certain aspects of this are to be analyzed.

4. Perform a small test and do a smaller analysis, and define the categorization rules to be used.

5. Test the categories' reliability and look for weak cases, where the same word or sentence can be categorized in several ways.

6. Categorize all the data and perform a reliability test of the overall process, for example by having different people categorize the same parts of text and compare the results. Higher consistency between the results indicates higher reliability of the categorization.

7. When steps 4, 5 and 6 are working well, the entire content analysis can be performed on all data.

8. Using a computer program also makes it easy to do a statistical analysis.

9. During the work it is important to note the framework of the analysis and the reasoning behind the categories, the frequency distribution of the various categories, and the reliability of the categorization process itself.

When texts are categorized, it is important to try to maintain both an overview and context, since it, according to Boolsen (2007), is easy to loose track of these during the categorization process when the texts are divided.

3.7 Validity and reliability

Ruan (2006) writes that validity and reliability are about the information being valid and reliable. Validity and reliability are mostly used in quantitative research, but also increasingly more often in qualitative research (Gunnarsson, 2002), to rate how well measurements and the results of these correspond to each other and to reality (Leander & Vejde, 2005). Validity and reliability can according to Leander & Vejde (2005) also be seen as the degree of absence of systematical errors and random errors respectively in the measurements. According to Gunnarsson (2002), in qualitative contexts validity and reliability is both about describing the data gathering process and analyzing data systematically and in an honest way. Gunnarsson (2002) also states two simple rules: high reliability does not guarantee high validity, and high validity requires high reliability.

In this thesis validity is about making sure that the content, methods and conclusions are valid and correctly performed, and that the thesis actually

examines and answers the posed purpose and scientific question. Reliability in this thesis is about making a good and earnest impression towards the reader, and that the thesis is well structured and formally written, as well as describing and motivating all used methods, reasoning and conclusions in a sufficient and satisfactory way.

To increase the validity of the paper, the interviews will for example be recorded. The reason for this is that it will be easier to extract all the information from the interviews, and to be able to listen to the interviews and recheck the information. To further increase the reliability of the interviews and the thesis, the interviewees will, as previously stated, be persons from or with a connection to organizations that work with the visually impaired.

4 Empirics

This chapter summarizes the result of the interviews, motivates the choice of organizations and respondents. Some of the problems associated with aiding devices and websites are also addressed.

4.1 Case study organizations and respondents

The authors present and motivate the choice of organizations and respondents in the case study of this thesis.

4.1.1 Choice of organization

The authors have chosen two different organizations for their interviews, namely Syncentralen in Luleå and Synskadades Riksförbund.

Syncentralen in Luleå work with the visually impaired, and they have a common website with all of the other centres for the visually impaired in Sweden; http://www.syncentralerna.se/. Their work consists of rehabilitating the visually impaired, and their goal is that the centre and the visually impaired work together to provide good conditions for participating and for equality for the visually impaired in society (Syncentralerna i Sverige, 2009). The authors chose this organization because they work with the visually impaired in such a way that it promotes the role of visually impaired people in society, and because this organization has much experience working with the aiding devices for the visually impaired.

Synskadades Riksförbund is a non-profit organization for the visually impaired, which is also politically and religiously independent. They have three organizational levels; the national association, the district associations and local associations (Synskadades Riksförbund, 2009). Synskadades Riksförbund is an open and democratic organization that gives its members the opportunity to be heard. They formed the organization based on the foundation that all people are equal and to claim the right of participation and equality for the visually impaired in society, as well as to create a social community and to support each other, so that a person with visual disabilities can live an active and independent life. Synskadades Riksförbund website can be found at http://www.srfriks.org/.

The authors chose to focus on SRF Gothenburg and SRF Norrbotten, which are district associations within Synskadades Riksförbund. The reasons why the authors chose these are because the associations are on opposite ends of Sweden, and because each district association has an independent website, which can be found at http://www.srfgoteborg.se/ and at http://www.srfnorrbotten.se/ respectively.

4.1.2 Choice of respondents

The authors have chosen to interview the respondents described below.

Respondent 1
This person had a tumour disease called retinoblastoma at a very young age, and had residual vision until later in life when this person went completely blind due to an accident. The aiding devices this person uses are a speech synthesizer, a Braille display and a screen reader program called JAWS. This person is an educated sound technician with a Masters in English and additional journalistic and public relations education. This person has also taken a computer license and received training in the various aiding devices. This person was up until recently a member of Synskadades Riksförbund in Gothenburg.

Respondent 2
This person has no visual impairment, and works at Syncentralen in Luleå. This person works with rehabilitating the visually impaired, and works a lot with their aiding devices, as well as helping the visually impaired to find what aiding devices fit them best.

Respondent 3
This person works at the same place as respondent 2, and has similar tasks.

Respondent 4
This person is blind since the age of two, when a tumour disease that forced this person to surgically remove both eyes and replace them with prostheses. The aiding devices that this person uses are a Braille display, a speech synthesizer and the JAWS screen reader. This person has studied to become a Bachelor in computer technology, and has been a member of Synskadades Riksförbund since school age. This person has also been active as a director of the board of the local association in Skellefteå since the year 2005, and has previously been a board member of the county association in Västerbotten. This person works at a company that provides and adapts computer solutions, with an emphasis on the visually impaired, for people, companies and organizations.

Respondent 5
This person has an inherent eye disease that causes this person to not be able to see details or contrasts. The aiding devices this person uses are a Braille display and the JAWS screen reader. This person is an educated construction worker, but had to quit when the eye disease broke out. This person is a member of Synskadades Riksförbund, and is employed by Synskadades Riksförbund Northern Region, which includes both Norrbotten county and Västerbotten county.

4.2 Interview summary

When the authors did the interviews there were of course a lot of questions, which are all found in Appendix A. The questions are categorized, and each category will be presented below along with a summary of what each respondent had to say.

Most of the interviews were performed with only one respondent at a time, but respondents 2 and 3 wanted to do it together since they felt that they complemented each other's knowledge well.

4.2.1 Problems with websites and aiding devices

This section covers various problems related with websites and aiding devices, and some examples of well and badly designed websites.

Respondent 1
The respondent talks about that it is either difficult to find alternatives if the aiding device is incapable of handling a website, or that the alternatives are more expensive than if the user could do it via the Internet. Websites seldom have a clear structure, making it hard to find out how get a hold of contacts if the website is incompatible with the aiding devices and the user cannot perform the intended task on the website.

The respondent provides an example in the Gothenburg City staff administrative systems. It is very difficult to use the system if you have some form of speech synthesizer, which means that an employee with aiding devices cannot report their working hours by themselves. Instead they must have the help of a person without visual impairment to do anything in the system. The respondent thinks that this makes things difficult, since a visually impaired person will not only occupy their own time, but other peoples' time as well, with something that they should be able to do on their own.

The respondent mentions that websites that are made by people without any knowledge of the visually impaired or their aiding devices are difficult or complicated to use.

Respondent 2 & 3
Some of the newer screen readers and speech synthesizers are capable of interpreting Flash animations and JavaScript, but there are still many aiding devices that are unable to interpret Flash animations or JavaScript. Java Applets is something that is still not supported in modern aiding devices, and another thing that also makes things difficult are tables. Both tables and Java Applets should be avoided as much as possible. Support for JavaScript has become better but there are still some things in JavaScript that the aiding devices cannot handle. Many JavaScript functions that require the user to move the mouse cursor over a certain point can be hard to use with aiding devices. The respondents talk about JAWS being able to emulate cursor movement, but that this also requires that the user of JAWS knows a lot of keyboard shortcuts.
The respondents think that Flash works poorly with most aiding devices. They mention a number of websites that mostly consists of Flash that does not work particularly well with the aiding devices available, such as ATG's website, the Swedish body of horse race betting, that is entirely made up of Flash animations. This makes it very difficult or impossible for a screen reader to interpret the

website. The respondents also believe that some newspapers' websites are to cluttered and difficult to navigate with aiding devices.

The Respondents think that the Norrbotten County Council website is very good, which depends on that a number of reference groups were involved in the creation of the website.

PDF documents on the Internet works if the PDF documents are created in the correct way, which is not as a scanned image.

Respondent 4
The respondent believes that images and links without ALT text, Flash animations, empty frames and so-called capture codes are the main problems today for aiding devices when using the Internet. Especially capture codes – a code presented as an image that a user has to enter to verify that it actually is a person sitting behind the keyboard and not an automated program that automatically posts in forums and such – is a major problem, since the screen reader cannot interpret the code when it is embedded in an image.

The respondent mentions Java Applets and advanced Flash functions as examples of things that are hard for the aiding devices to handle on the Internet. The reason for this is that the technological development of the aiding devices has not caught up to technological development of web design.

The respondent compares the usability of Hitta.se and Eniro.se, two competing websites that both provide online maps and the Swedish yellow pages. The Hitta.se website is a good website that is easy to use, but the Eniro.se website is less usable, because it is too cluttered. The respondent also thinks that the travel planner website Resrobot, formerly known as Resplus, has become much better and easier to use of late.

Respondent 5
The respondent thinks that the major problems with aiding devices and websites today are that the developers tend to add to many movies and Flash animations. This makes it difficult for the visually impaired to access information and to navigate the websites. This, of course, differs from person to person, depending on their aiding devices and knowledge. Evening newspapers' websites are, according to the respondent, never very accessible.

4.2.2 Aiding devices and layout of websites

This section covers the layout of websites and how it affects the different aiding devices, and how the relationship between the two can be improved. The authors also asked what the respondents thought of maybe classifying websites to make it easier to adapt them to the aiding devices, and if they thought some kind of classification system was needed.

Respondent 1
Websites should be made accessible to all. A good way to achieve this is to make sure to put ALT texts on all links. The respondent also talks about the difference between the websites of the airline companies SAS and Ryanair. Ryanair abides by the British laws, and a person must be able to enter if they need an escort or have a seeing-eye dog. However, SAS that abides by the Swedish laws have no such choices on their website. This means that you have to call SAS in order to get what you need. The respondent says that there is a need for a similar law like the one in Great Britain, which states that everything must be accessible to everyone, and that it is thus illegal to make websites inaccessible.

The respondent says that the deeper the website's structure is, the more likely it is to cause problems for the aiding devices and the visually impaired. The common attitude amongst people is that you can always ask someone else to help you if you are visually impaired. This is a bad attitude according to the respondent, because the visually impaired should be able to be more independent when using the Internet.

The respondent also thinks that the layout of a website has some impact on how the aiding device works. Images and links without ALT texts, and Flash animations are not working well with the current aiding devices. There are features to block Flash animations, but at the risk of loosing important parts of the website. The aiding devices do not register, or cannot interpret, all Flash animations on websites.

When it comes to classifying websites the respondent asks, "Who benefits from this? Is it the visually impaired or others?". Because of the fact that people want to divide other people into categories, the respondent does not believe that a classification system would benefit the visually impaired.

Respondent 2 & 3
When you make a website it is important to think through what it is that you want to show on the website, and what people will want to do on the website. Something else to think about is to always add ALT texts to images and links, and to give links sensible names and avoid naming links just "Read more". The websites should also be simple and not contain unnecessary graphics and such. The most important information on a website should be in the top left corner, because it makes it easier for people with speech synthesizers and screen readers that both start reading from the upper left corner and read to the bottom right hand corner.

Tables are, according to the respondents, making it difficult for the visually impaired with aiding devices to navigate websites, and tables should not be used at all if possible. Lists of links located to the left is something that unfortunately has become a standard, which causes the screen reader to always start reading the list of links, if you do not tell it to start anywhere else.

The World Health Organization (WHO) has a classification scale, that ranges from mild visual impairment (almost full vision) to severe visual impairment

(hardly any residual vision left), which is used by doctors to decide if a person is referred to the centre of the visually impaired to get aiding devices or not. The classification scale is, however, very subjective since it is always based on the vision of a specific individual.

Respondent 4
The respondent says that the layout of a website has an impact on how the aiding devices work, ant that one of the major irritations are websites that have a lot of images and no ALT texts. A developer should add ALT texts to the images and use the standard tags that exist in the HTML language to mark and format the headers and other elements correctly.

Flash animations may interfere with the aiding devices, depending on how they are made. This can cause the aiding device to jump from where the user was reading to an animation. The respondent thinks that there should be functions to turn off the Flash animations. Some good websites have this functionality, but it can also sometimes remove important parts.

Something that the respondent also thinks is a problem is all the capture codes that many websites have started to use. There are still very few websites that have the functionality to read the capture code out loud. Because the capture code is embedded in an image, the screen reader interprets it as an image, rather than text.

A website with many frames can be cluttered and very hard to use for a person with aiding devices. One important example is that if a website has many empty frames or non-standard HTML tags, it can cause some aiding devices to freeze or stop working properly. The respondent speaks about whether it would be easy or not to separate the layout and contents, to simply be able to update these separately.

The respondent comes back to, when it comes to classifying websites, that a classification system might work if the layout and the contents are separated. This would be good, because then all the contents would be in one place and there is no risk of forgetting to update it when updating the layout. However, the updating can still be a problem if there are many different versions of the website made for different aiding devices.

Respondent 5
What is important is that the developers learn about how aiding devices work and become aware of how they should design websites to be as accessible as possible. The most important thing is that the developers and the clients learn how important it is to have an accessible website.

The respondent would prefer that the developers avoid using much JavaScript, Flash or Java Applets, because these make websites less accessible to persons with aiding devices.

The respondent talks about some websites that may cause the aiding device to freeze up. The respondent does not know if there are special characters that may

be the cause of this or if there is something in the HTML code. Respondents also think it is important to developers who put up everything in a right and proper way.

To classify websites could work in theory, but it would be neither practical nor cost effective to do so. The respondent thinks that there is a risk if you mirror one website to make another version another to make it more accessible, can result in the entire website to be mirrored as an image. This would mean that screen readers could not read what was on the website, because it would be just one big picture.

4.2.3 Frames

This section covers frames, and how it affects the different aiding devices.

Respondent 1
It works according to the respondent, but they are a bit difficult to navigate if you do not know the screen reader's keyboard shortcuts by heart.

Respondent 2 & 3
The current aiding devices are intelligent enough to manage and list all the frames on a website, making it possible for the user to jump between the different frames through keyboard shortcuts. In order to make it easier for people with screen readers, the developers should name all frames with relevant names since the screen reader reads the names of all the frames out loud to the user. Compare this with writing ALT texts for images and links.

Respondent 4
Respondent believes that frames works well with the JAWS screen reader, if the frames have been made correctly. It can cause problems for the aiding devices if the frames are empty or unnamed. Since JAWS can list all the frames by the press of a button, unnamed frames or frames that do not have logical names can make the user frustrated or unable to obtain the information he or she wants.

Respondent 5
Unless a frame is correctly made, the screen readers or speech synthesizers can read straight through several frames instead of reading frame by frame as intended.

4.2.4 Advertising and pop-up

This section covers advertising and pop-ups on websites, and how it affects the different aiding devices.

Respondent 1
The respondent does not think pop-ups are a problem since modern browsers can block pop-ups. One problem with this is that a user sometimes could miss important information that will appear in a pop-up window.

Respondent 2 & 3
The respondents think that neither pop-ups nor advertising is a big problem since modern browsers can block both pop-ups and moving images. However, some magnification programs tend to focus on some advertisements or other nuisances.

Respondent 4
The respondent says that pop-ups are not a big problem since most modern browsers can block pop-ups, which means that they will not disturb screen readers and similar devices. Advertising is not a big problem either, unless the advertising is a Flash animation that updates automatically. If this is the case, it may interfere with the aiding devices, especially magnification programs that are set to focus and zoom in where things are happening on the website. This will cause it to jump to such adverts.

Respondent 5
Advertising and pop-ups can be annoying according to the respondent. Pop-ups my open while the screen reader continues to read the text of the window in the background, which can be disorienting for a visually impaired person. Fortunately, modern browsers can block pop-ups, but at the same time you may miss important information.

4.2.5 Flash

This section covers Flash, and how it affects the aiding devices.

Respondent 1
Flash animations are not working well with the current aiding devices. There are options to not show Flash animations, but you may miss important parts of the website at the same time. The aiding devices do not register, or cannot interpret, all Flash animations on the websites.

Respondent 2 & 3
The respondents say that Flash can work with some aiding devices but the websites consists of only Flash animation does not work particularly well with the aiding devices available.

Respondent 4
Flash animations are one of the most irritating things that a visually impaired with aiding devices can encounter on websites, because a screen reader cannot interpret a Flash animation other then as a blank image. Some browsers have a function to turn off Flash, but then you might miss something important, such as a menu.

Some Flash animations can interfere with the aiding devices depending on how they are made, which can cause the aiding device to lose track of were the user was and instead jump directly to where the Flash animation when this updates. There should, according to the respondent, be functions available on websites to turn off Flash animations.

Respondent 5
Flash is not user friendly for the visually impaired. If you have the latest software you might be able to interpret some of the Flash animations, but it is still difficult and much information is lost since the aiding devices are not able to interpret all Flash contents.

4.2.6 Common documents on websites

This section covers various common text documents that the user can use.

Respondent 1
The respondent says that it of course would be best for users with aiding devices if there were a reoccurring recognizable structure on all websites, but that this does not exist today. The respondent also mentions that it is desirable for the creators of websites to follow the rulebook on how to make and structure documents and websites to be accessible and usable by aiding devices. Documents that are made in the right way usually works, but users should be able to turn off Flash based functions and rolling text and images. The respondent believes that these features often cause computers with aiding devices to freeze, and that the aiding devices could be designed to work in all situations if there were only one way to do each step in the process of creating websites and documents. The respondent also says that to limit the flexibility of websites because of screen readers and the needs of the disabled, is probably neither possible nor a desirable demand. However, the respondent believes that some official organization or association should be clearer with and inform about the opportunities of the WAI-standard and the reasons of why it exists. The respondent also believes that a penalty for inaccessible government, state, municipality, region, counties and businesses websites would be a step in the right direction to help users dependent on aiding devices.

The respondent also thinks that if PDF documents are all right as long as they are created correctly so that they work with screen readers. Since the respondent often does not know the underlying cause of why a PDF document cannot be opened, the respondent cannot tell whether the document is locked or if there is some other cause.

Respondent 2 & 3
The authors have not been able to reach the respondents regarding this subject.

Respondent 4
The respondent thinks that documents on websites preferably should be in HTML or Word format. PDF documents are generally not good for severely visually impaired users, and if PDF documents are on a website, there should also be an alternative format available. Although aiding devices have become better at interpreting PDF documents, it is far from perfect, and the respondent also says that you can often read a large part of the PDF document without major problems, but that the screen reader suddenly cannot read, for instance, a table. Sometimes the text of PDF documents are rearranged, garbled or mashed up so that it

becomes very complicated to interpret, and requires you to jump back and forth in the text.

The respondent also thinks that there seems to be many different ways to create PDF documents, depending on what software is used, which causes the result and quality of the document to vary greatly. The respondent came across a PDF document a few years ago that, when read, only consisted of several pages of illegible garbage. But when the respondent's colleague opened the document, it looked perfectly normal and correct. The respondent also believes that PDF documents far too often consist of scanned images, which makes them impossible to read with speech synthesizers and Braille displays. What the respondent then tries to do is to run the PDF document through an OCR program, such as OmniPage, to see if it can interpret the text in the images.

When it comes to locked PDF documents, the respondent believes that the JAWS screen reader can handle this, at least most of the time. But it has happened that the respondent has come across PDF documents that could not be read, because these were probably totally blocked according to the respondent. But it is often difficult to find out the reason why a program cannot open a PDF document.

Respondent 5
The authors have not been able to reach the respondent regarding this subject.

5 Analysis and discussion

This chapter covers the author's analysis. The analysis is divided into categories corresponding to the four main principles of WCAG: Perceivable, Operable, Understandable and Robust (World Wide Web Consortium, 2008). These categories are divided into sub categories such as Flash, Links and Images to further connect to the outcome of the empirics.

5.1 Principle 1: Perceivable

One of the respondents is reasoning about that it would be good if the layout and contents of a website could be separated, as this would make it easier for the visually impaired. This might be achieved by using some kind of HTML templates, where the contents is divided into blocks that are defined by special HTML tags or some other sort of identification supported by aiding devices, or future aiding devices. Different layout styles, layout methods and layout elements would also need to be identified to be able to read the contents and the sequence of the website correctly. On this basis, it is easy to make a program that, quickly and easily, automatically generates a plain text version of the current website, which is also one of the recurring requests and recommendations for increasing accessibility. With such a program, the developer would also not have to worry about updating multiple versions of the website each time. But if the layout and contents were to be separated clearly, it would require a new standard that defines how this should be done, which should be based on the principles of Human-Computer Interaction and usability, as well as the standards that exist today. However, if you follow the existing guidelines, you can often actually separate the contents and the layout, even though more websites need to have links early on that makes it possible for the user to skip past the menus and directly to the website's contents. This kind of functionality is exactly what is mentioned in the World Wide Web Consortium's (2008) guideline 2.4 Navigable of the WCAG.

5.1.1 Flash

Flash animations are something that has become popular in recent years, both as the main contents with more and more videos, like YouTube, and as small commercials animated ads. There are even websites that are fully built around- and only consist of Flash animations. According to all the respondents, Flash animations are something that is very irritating, and something that most aiding devices cannot interpret completely or at all, and occasionally only registers as a blank image. This is also a good example of that the technological development of aiding devices is still behind the technological development of the Internet. There are, however, according to respondents 2 and 3 and also according to Holm & Tenhunen (2004) modern screen readers that are capable of interpreting Flash. Holm & Tenhunen (2004) think that websites that have many Flash animations or are entirely Flash-based website should also provide an alternative version without Flash or a text summary of the website, which is completely along the

lines of guideline 1.1 Text alternatives of the WCAG (World Wide Web Consortium, 2008).

Respondent 4 and 5 believe that Flash animations are not user friendly for the visually impaired, and that these make it difficult to navigate websites and access information. In addition, if Flash animations are used to implement important functions on the website, it is easier to miss important details and information, which also makes the website less accessible for the visually impaired. Flash-based websites has also received criticism from ordinary users, as this often requires that the user has the latest version of the Flash plug-in installed, and since it is not possible to copy text from Flash animations. You can make very nice, cool and aesthetically compelling websites with the help of Flash, but this often means that some of the usability and accessibility are sacrificed in favour of visual effects.

Although some browsers can disable Flash, respondent 1 and 4 think that there should be an option to turn off Flash animations available directly on the website, and that more websites should have such an option. However, they also believe that the user may miss important information on the website. Respondent 1 thinks that the developers should follow the guidelines provided by Adobe (2009) to make Flash animations accessible, which is also part of the objective of guideline 1.3 Adaptable of the WCAG (World Wide Web Consortium, 2008). Flash animations should preferably be used sparingly and as supplements, as well as following the available guidelines.

5.1.2 Advertising and pop-ups

Pop-ups were something that for a long time irritated Internet users, both fully sighted and the visually impaired (Wegert, 2002). It was neither pleasant nor particularly user friendly to plough through all the pop-ups, and it was especially disorienting for the visually impaired with all of the extra unwanted browser windows. Murrell (2001) also states that one of the basic ideas of Human-Computer Interaction is that unless a computer system or a website is easy and convenient to use, users may abandon the system or the website in favour of others. All the respondents no longer think that pop-ups are a problem in itself, since modern browsers are able to block pop-ups. This increases the accessibility and gives a more pleasant experience when using the Internet. However, one problem related to this is that you may sometimes miss important information that would normally have opened in a new window. It is therefore, as previously mentioned, important that links that opens in new windows also indicate this.

Shneiderman (1980), Nielsen (1994) and Molich (2002) have brought up the issue of how pleasant a system is to use, and have even defined it as one of the cornerstones of usability in their books. Advertising on websites can, however, reduce how pleasant they are to use for both fully sighted people and for the visually impaired. The respondents also think that persons with aiding devices may be more disturbed than others by advertising available on websites. Browsers can reduce this problem by also being able to block animated images, which often

contain ads. However, if the user uses a magnification program and the advertising is in the form of Flash animations, or something else that automatically updates, the magnification program will jump to the ad, because these programs are, as previously mentioned, set to focus on events and updates on the website. This goes against the World Wide Web Consortium's (2008) guidelines of the WCAG, namely 1.3 Adaptable, 2.2 Enough time, 2.4 Navigable, 3.2 Predictable and 4.1 Compatible, and more easily confuses the user as well as making it more difficult for the user to grasp the information on the website. Advertising is not only annoying, but also risk failing to convey their message if they are made in a bad or incorrect way so that the aiding devices of the visually impaired are unable to interpret them. This may instead cause the users to become hostile towards the sender of the advertisement.

5.2 Principle 2: Operable

The layout has a major impact on how users perceive the website, and it is both easier and faster to navigate a website that has a good layout since it takes less time to learn the website, which in turn increases the usability of the website. The respondents were also unanimous about that it has an impact on how the website is made. A good thing when it comes to making websites that respondents 2 and 3 mention, is that it is important to think about what it is you want to show on the website, and what users will do on the website. The structure of a website is often clearer if the website also has a clear purpose and a clear goal, and can thus also meet the need of the users better and become more usable. Respondent 1 also said that the deeper the structure of a website is, the more likely it is for a visually impaired person with aiding devices to have problems navigating the website. Both Human-Computer Interaction and usability state that websites should be accessible to everyone, including people with some kind of disability. This view is further reinforced in World Wide Web Consortium's (2008) guidelines of the WCAG, more precisely in guidelines 1.3 Adaptable and 2.4 Navigable.

Respondents 2 and 3 think that websites should be kept simple, without unnecessary images or unnecessary graphics, and that websites generally have an unclear structure that makes it difficult to find contact information if you cannot do what you had intended on the website. A standardized header or a standardized footer, or some form of link to the contact information that is always at the top or in the beginning of the website would benefit all types of users. Respondents 2 and 3 also believe that the most important information on a website should be to the top left, because screen readers read from the top left corner to the bottom right corner. To have a list of links or menus to the left has, according to the respondents, almost become a standard, which causes the screen reader to always start reading these. The need of a link that sends the user directly to the contents is evident here as well, which also is a technology that the World Wide Web Consortium (2008) recommends in guideline 2.4 Navigable of the WCAG.

5.2.1 Navigation

As mentioned above, it may be difficult to navigate far into the structure of a website that has a deep or complicated structure. Murrell (2001) writes that the computer and websites are tools used by people to achieve a goal. Even if the goal is a simple one, for example reading news or booking tickets, the users will use other tools and means if it is too complicated to use the website. It is also important that business' websites are able to meet the need of its users, are user friendly and actually work for all types of users, since many companies want to save resources by moving large parts of both information and services to the Internet.

5.2.2 Links

The respondents mention that a big problem with links is that they often do not have good or informative names. One example is that many newspaper websites name their links "read more" instead of naming the links with names that describe what they lead to, which also violates guideline 2.4 Navigable of the WCAG (World Wide Web Consortium, 2008), and is neither a very pleasant or efficient design from a usability standpoint. Respondent 5 points out that this also applies to image links, and that these usually have no ALT texts or sensible link names. It would also be good if the link text stated if the link opens in a new window, to clarify and avoid confusion and irritation. It is also important that look of the links is consistent throughout the entire website in order to not confuse users, and that the links can be clearly discerned in text and contents, as well as clearly marking visited links. Ideally, one should keep the default appearance of the links, that is, blue and purple underlined text for unvisited and visited links respectively. Then the guideline 3.2 Predictable of the WCAG (World Wide Web Consortium, 2008) is also met to a higher degree, and the users will not have to learn or understand as much of the structure of the website as they otherwise would.

5.2.3 Images

Images without ALT texts cannot be interpreted at all by screen readers, and are according to the respondents, one of the biggest and most irritating problems for the aiding devices today. The World Wide Web Consortium's (2008) guidelines, Holm & Tenhunen (2004) Sundström (2005) and Englund & Sundin (2004) also point out that this as a very important requirement. It can be both very annoying and confusing for the visually impaired if there is no other explanatory text for the images. Guideline 1.4 Distinguishable of the WCAG (World Wide Web Consortium, 2008) states that images containing text should be avoided. Repeating all the text of the image in the ALT text to make it accessible to the visually impaired would make the image itself redundant. However, there are images that contain explanatory text, such as maps or diagrams. But this is not a problem, because of the HTML imagemap technique, which makes it possible to divide an image into different custom sized and custom shaped areas, and assign

an ALT text to each area. This should, however, usually be combined with a text in relation to the image that describes the entire picture as a whole.

So-called captcha codes (Completely Automated Public Turing-test to tell Computers and Humans Apart) are small, deliberately distorted, images of random-generated text and numbers that cannot be interpreted automatically by any software. The capture codes must be interpreted and entered in a text field to confirm the information entered in web forms, during registrations and such. This is done in order to avoid spamming by computer programs, and to make sure that it is a human that fills out the forms. This obviously makes it difficult for screen readers because of the whole idea with forcing the user to manually interpret the image. Magnification programs could solve this problem for people with minor visual impairments, but probably not for blind people or people with severe visual impairments. Google, among others, have a very good solution to this problem, giving the user the option of playing an auto-generated sound clip, in which a voice in the selected language, reads a couple of numbers out loud with one second intervals. The user is then informed that the whole sequence will be repeated, before the numbers are repeated in the same manner. To avoid that programs that use voice recognition takes advantage of this and circumvents the purpose of the captcha codes, a nonsensical combination of mixed up numbers is played, with mixed speed and lower volume, in the background between the real numbers. How well people with hearing difficulties manage this is not in the scope of this thesis.

5.2.4 Tables

Tables should, according to respondents 2 and 3, be avoided as much as possible, preferably completely, because screen readers tend to read straight through all the columns of a table. This is perhaps not a problem if the table contains simple data, but if the table contains columns of different size, or if any of the table cells contains a line break, there is a risk that the problem of reading through the columns will occur. This problem is also described by the World Wide Web Consortium's (2008) guideline 3.1 Readable of the WCAG, and by both Ross (2002) and Yates (2005).

Since HTML tables are clearly structured with rows and cells, where it is also possible to specify how many rows and columns each cell spans, it should be easy to make a screen reader that is capable of reading the tables correctly. However, it can be a problem, and difficult to navigate with a screen reader, if there are too many nested tables. Nested tables are common on websites, where the outmost table divides the website contents and the contents also contain tables, because it is a simple alternative to frames, as some developers want to avoid frames due to problems associated with search engines and other frame related issues (Johansson, 2004).

5.2.5 Frames

Many websites are still based on frames nowadays, and the use of frames has only recently stopped increasing (Johansson, 2004). Frames are, according to all the respondents no major problem since the aiding devices are intelligent enough to be able to sort and present all available frames on a website to the user. This is true as long as the developers follow the standard for how frames should be made, and as long as all the frames have relevant and descriptive names of their contents. One problem that respondent 5 points out is that if a frame is not done properly, has no name or is empty, then screen readers or speech synthesizers may miss them, and read straight through several frames instead of reading them frame by frame as intended. This goes against the World Wide Web Consortium's (2008) guidelines 1.3 Adaptable, 2.4 Navigable, 3.2 Predictable and 4.1 Compatible of the WCAG.

Something that can also make it harder for the visually impaired with aiding devices is if there are many frames on a website. This makes it more difficult for a visually impaired person with aiding devices to navigate and use the Internet, which directly violates what Preece (1995) writes, namely that a computer system or a website should be available to all, and that it should go smoothly to perform actions in the computer system or on the website. Respondent 4 also says that many frames will make the website messy and easy to get lost in, particularly if a website has many empty frames, which may even cause the adding devices to crash. This also goes against the World Wide Web Consortium's (2008) guidelines 1.3 Adaptable, 2.4 Navigable, 3.2 Predictable and 4.1 Compatible of the WCAG.

5.2.6 Documents

Because PDF documents can often be locked by their creator and be difficult to read for the aiding devices, Holm & Tenhunen (2004) suggest, with support from World Wide Web Consortium's (2008) guideline 1.1 Text alternatives of the WCAG and respondent 4, that there should also be a text version of any PDF documents. If PDF documents are created correctly and according to Adobe's guidelines for accessibility (Adobe, 2009), there is no problem for the aiding devices to read these according to the respondents. According to respondent 4, there are many different ways and programs used to create PDF documents, which widely varies if and how much of the documents an aiding device can read. Often PDF files also contain pictures of scanned text, which aiding devices cannot interpret. These documents have to be run through another type of software that can detect text within images in order to interpret such documents. These types of programs are expensive to buy, just like many other programs with more uncommon tasks, which probably deter many visually impaired users from getting such a program.

5.2.7 JavaScript and Java Applets

Respondents 2 and 3 say that some newer screen readers and speech synthesizers are capable of handling JavaScript and that this has worked better over time, but that the majority of the aiding devices cannot interpret JavaScript at all. This also goes against the World Wide Web Consortium's (2008) guideline 4.1 Compatible of the WCAG. Respondent 2 and 3 also point out that many JavaScript functions require the user to move the mouse cursor over a particular point on the website, which can be very difficult to understand and do for a person with a visual impairment. It is not certain that the aiding device notes the effect of such an action, such as a sub-menu being displayed. Major events and changes to the website's contents, as a result of similar JavaScript functions, will probably be very confusing for the visually impaired and not that user friendly. This also goes against the World Wide Web Consortium's (2008) guidelines 1.4 Distinguishable and 2.4 Navigable of the WCAG.

Java Applets, however, are something that is not supported by the aiding devices today, which makes it difficult for blind persons or persons with severe visual impairments to identify themselves on the Internet with certain types of electronic identifications that uses Java Applets. Respondent 5 also says that JavaScript and Java Applets make it difficult to navigate a website, and that developers should avoid using too much JavaScript and Java Applets. Of course, this also goes against the World Wide Web Consortium's (2008) guideline 4.1 Compatible of the WCAG.

5.3 Principle 3: Understandable

The respondents mention that non-standardized HTML tags, or HTML tags used in an unintended way might cause some aiding devices to freeze or stop working properly, like the case with incorrectly used frames. World Wide Web Consortium (2008) have free tools on their website that can be used to quickly and easily check if a website conforms to the HTML standard, among other things. Any errors and warnings are clearly listed in the test result, making it easy to fix these.

Respondent 1 thinks that it would be practical for a user with aiding devices if there was a reoccurring recognizable structure that on all websites, which does not exist today according to the respondent. The respondent does not believe that flexibility and functionality on websites will be limited in favour of increased support for aiding devices. The respondent also does not believe that this should be done, but instead inform about the possibilities and purpose of W3C's WAI standards and guidelines (World Wide Web Consortium, 2008). It would also be desirable if all who makes websites could follow the standards, including HTML, accessibility and aiding devices, which exist for both websites and documents. Websites are typically made by people who lack knowledge of the visually impaired and their aiding devices, which according to respondent 1, often make websites difficult, and sometimes impossible, to use for the visually impaired. The problem mentioned by Yates (2005) and Molich (2002), that too few developers

and companies know or understand why it is important to make websites accessible and usable for all users is one of the largest and most important problems. More campaigns, seminars and training courses are needed to teach that increased accessibility means increased usability, and benefits all types of users, and ultimately the person or company responsible for the website (Molich, 2002).

5.4 Principle 4: Robust

Designing separate websites adapted to each form of visual impairment may be a good idea in theory, but the cost of defining a classification system to regulate this is far greater than any possible gain. All the respondents are of the opinion that a classification system and separate websites would make them more complicated, rather than making them more accessible. A disadvantage of having separate websites is that this would generate many versions of the same website that all have to be updated separately. The risk of inconsistent and contradicting information on the separate websites increases as the risk of forgetting to update all the websites also increases with the number of separate versions. A classification system would also contradict the fact that a system should be usable by all (Murrell, 2001), since it is not possible to make separate versions of a website for every type of visual impairment. However, as previously mentioned, it would not be that hard to implement support for an automated system that creates text versions of websites, which would solve a large part of this problem.

5.4.1 Problems with websites and aiding devices

A large part of the Human-Computer Interaction and usability is to make websites accessible to all. This may be referred to that Preece (1995) writes that a great part of Human-Computer Interaction is about systems being functional and useful. The main problems for the visually impaired with aiding devices when using the Internet today, in terms of usability and accessibility of websites, are as previously mentioned by the respondents image links without ALT texts, Flash animations, empty frames, and images of captcha codes. According to respondent 1, texts and images that automatically rolls or scrolls should also be avoided, because these may cause the aiding devices to get stuck and crash since the aiding devices focus on the things that are updated and changed on the website. This goes against the World Wide Web Consortium's (2008) guideline 4.1 Compatible of the WCAG. A simple thing, such as just letting the aiding devices have some form of timeout, the choice to ignore the current element or a setting to ignore elements that are updated faster than a specified frequency, could solve this problem. The reason for many of these problems is that the technical aiding devices are far behind in the development of the technologies used on the Internet.

6 Conclusions and advice on making websites accessible

The purpose of this thesis is to find out how websites should be designed so that they function as well as possible with the aiding devices of the visually impaired, as well as how to make websites as accessible as possible for the visually impaired. A general observation that can be made from the results of the interviews and the analysis is that there is much that can make it difficult for the aiding devices of the visually impaired to interpret websites. A first, and obvious conclusion, is that it is important to follow the standards of HTML and the guidelines for accessibility developed by the World Wide Web Consortium (2008), when making websites to make these accessible and user friendly for users in general, and especially for the visually impaired and their aiding devices. There are also good and freely available tools that can be used to verify if websites follow standards or not, which should be used by all website developers.

The posed research question was: How should websites be designed to make it as easy as possible for the visually impaired to navigate them with the help of existing aiding devices, and what needs to be considered when designing such websites? To further answer this question, in addition to the other conclusions, the authors have concluded that it is important to have a clear purpose and a clear goal when developing a website. Because this often brings about a good basic structure and often makes the website's layout more logical and predictable to navigate and use for all types of users.

Through the analysis, the authors have also been able to draw the same conclusions and confirm the need for virtually all of the existing guidelines of the Web Content Accessibility Guidelines provided by World Wide Web Consortium (2008) through their work with the Web Accessibility Initiative. It should however be noted that the authors did not find anything that contradicted any of these guidelines. The authors also think that all their posed hypotheses have been confirmed; with the exception that it is not entirely safe to say how often documents on websites are difficult to interpret for the visually impaired.

Besides all this, the authors have concluded the following demands on websites, seen from the perspectives of both the aiding devices and the visually impaired users. Finally, some advice is given for increased accessibility in websites.

6.1 Demands on websites by aiding devices

The functionality of the aiding devices for the visually impaired are often based on the standards for HTML and the like that are used to build and structure websites, and it is therefore obviously important that those standards are followed on websites. A good and logical layout also makes it easier for the aiding devices to interpret the website in the right order and sequence. Websites should not contain elements that automatically updates and makes the user lose control over what happens on the website, since many aiding devices automatically focuses on

updates and events on websites. Since the aiding devices are also far behind, when considering website technologies, most of these cannot interpret much more than basic HTML and have a difficult time with relatively new technologies such as JavaScript and Flash.

6.2 Demands on websites by visually impaired users

Visually impaired users have the same basic requirements as other users when it comes to websites, but require a higher-grade compliance with these requirements. A website should be consistent, clear, logical and predictable in both navigation and layout to be usable, accessible and easy to use for visually impaired users. It is also a big advantage if the website can be navigated using only the keyboard, because the visually impaired may have difficulties using the mouse cursor.

The contents of a website must be interpretable and understandable, which often means that alternative versions of parts, or whole websites, consisting of only text or audio are needed. Important contents and important information should also be at the top of the website. For the user to be in control of the website there should be no time limits or deadlines that cannot be stopped or extended, and the user must be allowed to correct errors and recover from errors without loss of data. All events and updates should also only happen on the user's request.

6.3 Advice for increased accessibility in websites

Below follows the 13 pieces of advice for increased accessibility in websites concluded by the authors. These are divided into the four main principles of the Web Content Accessibility Guidelines. The pieces of advice that is found under Principle 2: Operable also belong under Principle 4: Robust, but are not repeated to avoid unnecessary redundancy.

6.3.1 Principle 1: Perceivable

- Pure or simple text versions of all documents and websites should always be available. With the help of, for example, templates and simple tools, you can also automatically generate these versions.

- Important information, or links to this information, should preferably be either at the top or near the top of the website.

- Alternatives to capture codes, which are adapted for the aiding devices of the visually impaired, should be available.

6.3.2 Principle 2: Operable

- Frames should be used sparingly, always named with meaningful descriptive names, and never be left completely empty.

- Avoid using tables, because these are often interpreted in the wrong way by the aiding devices.

- Avoid using too much JavaScript, and provide a version without JavaScript. If JavaScript is used, then functions that require the user to move the mouse cursor over objects should not only be available through these objects. The objects should also not be too small and there should be instructions or descriptive text links with the same functionality in connection to these objects.

- Avoid rolling and scrolling text and pictures, as this risk causing the aiding devices to crash and make the website completely inaccessible for the visually impaired with aiding devices.

- Avoid using too many Flash animations, and provide a version without Flash. If Flash is used, then important functions and information on the website should not only be available through Flash animations, because the aiding devices cannot interpret Flash. Flash animations should also always have their own volume control, or a function to completely mute the sound, to avoid clashes with other generated sounds, like a speech synthesizer.

6.3.3 Principle 3: Understandable

- Use templates for websites to ensure that recurring parts are consistent, and to make it easier to update the contents of the website.

- Links should have a consistent appearance and behaviour, as well as relevant, brief and informative names that also inform the user if the link opens in a new window.

6.3.4 Principle 4: Robust

- The standards and guidelines for accessibility, which are available for websites, Flash animations and PDF documents, should be followed carefully. These guidelines are freely available on the websites of World Wide Web Consortium and Adobe respectively.

- Only tools and programs that follow the standards and guidelines to create documents should be used.

- Advertising should not be Flash-based, since this may disrupt the aiding devices of the visually impaired.

7 References

The sources used as the base for this thesis is presented below. These include articles, books, e-books, scientific papers and websites.

7.1 Books

- Andersson, S. (1979) *Positivism kontra hermeneutik.* Göteborg: Korpen. ISBN 91-7374-044-6

- Apple Computer. (1995) *Macintosh Human Interface Guidelines Reading*. [Electronic] Mass. : Addison-Wesley ISBN 0-201-62216-5 http://interface.free.fr/Archives/Apple_HIGuidelines.pdf (03 Aug 2009).

- Boolsen, M.W. (2007) *Kvalitativa analyser.* Malmö: Gleerups Utbildning AB. ISBN 91-40-65071-5

- Dix, A.J., Finlay J.E., Abowd, G.D. and Beal R. (1998) *Human-computer interaction.* London: Prentice Hall Europé. ISBN 0-13-239864-8

- Edwards, A.D.N. (1995*) Extra-ordinary human-computer interaction : interfaces for users with disabilities.* Cambridge: Cambridge University Press. ISBN 0-521-43413-0

- Egidius, H. (1986) *Positivism - fenomenologi - hermeneutik: konsekvenser för didaktik och vårdvetenskap.* Lund: Studentlitteratur. ISBN 91-44-25731-7

- Englund, H. & Sundin, M. (2004) Tillgängliga webbplatser i praktiken. Stockholm: Jure Förlag AB. ISBN 91-7223-197-1

- Hewett, T.T., Baecker, R., Card, S., Carey, T., Gasen, J,, Mantei, M., Perlman, G., Strong, G. and Verplank, W. (1996) *ACM SIGCHI Curricula for Human-Computer Interaction.* [Electronic] New York: Association for Computing Machinery, Inc. ISBN 0-89791-474-0 http://sigchi.org/cdg/ (03 Aug 2009).

- Holm, J. and Tenhunen, K. (2004) *Webbhjälpmedel för synskadade.* Huddinge: Södertörns högskola. (Institutionen för kommunikation, teknik och design) http://urn.kb.se/resolve?urn=urn:nbn:se:sh:diva-346 (03 Aug 2009).

- Kaptelinin, V. & Nardi, B.A. (2006) Acting with Technology : Activity Theory and Interaction Design Cambridge London: MIT Press ISBN 9780262112987

- Leander, E. & Vejde, O. (2005) *Ordbok i statistik*. Borlänge: Olle Vejde Förlag ISBN 9197519383. http://home.swipnet.se/ollevejde/statistikord/reliabilitet.htm (20 Oct 2009).

- Lundin, J. and Näslund, J., (2005) *Webbdesign ur ett tillgänglighetsperspektiv: Varför utvecklas inte huvuddelen av alla webbapplikationer med användarstöd för funktionshindrade?* Luleå: Luleå Tekniska Universitet (Institutionen för Industriell ekonomi och samhällsvetenskap), ISSN: 1404-5508

- Löwgren, J. (1993) *Human-Computer Interaction: what every system developer should know*. Lund: Studentlitteratur. ISBN: 91-44-39651-1.

- Molich, R. (2002) Webbdesign med fokus på användbarhet. Lund: Studentlitteratur. ISBN 91-44-02064-3

- Nielsen, J. (1994) *Usability Engineering*. San Francisco: Morgan Kaufmann Publishers. ISBN 0-12-518406-9

- Preece, J., Rogers, Y., Sharp, H., Holland, S. and Carey, T. (1994) *Human-computer interaction.* Wokingham: Addison-Wesley. ISBN 0-201-62769-8

- Rienecker, L. and Jørgensen, P.S. (2008) *Att skriva en bra uppsats.* Malmö: Liber. ISBN 91-47-08767-6

- Ross, M. (2002) Quality in Web Design for Visually Impaired Users. *Software Quality Journal*, vol. 10, nr 4, ss. 285-298. ISSN: 0963-9314.

- Ruane, J.M. (2006) *A och O i forskningsmetodik : en vägledning i samhällsvetenskaplig forskning.* Lund: Studentlitteratur. ISBN 91-44-04457-7

- Starrin, B. and Svensson, P-G. (1994) *Kvalitativ metod och vetenskapsteori* Lund : Studentlitteratur. ISBN 91-44-39861-1

- Sundström, T. (2005) Användbarhetsboken. Lund: Studentlitteratur. ISBN 91-44-03743-0

- Westling, B. (redaktör) 2006 *Punktskrift och dess användning.* Enskede: Talboks- och punktskriftsbiblioteket ISBN

- Winberg, K. and Hildingsson, L. (2005) *Anställningsintervjuns betydelse i rekryteringsprocessen.* Örebro: Örebro universitet(Pedagogiska institutionen) http://oru.diva-portal.org/smash/record.jsf?pid=diva2:134891 (03 Aug 2009).

- Wirström, s. 2005 *E-handel under nya villkor – portal för synskadade* Kungliga Tekniska högskolan (Numerisk analys och datalogi) http://www.nada.kth.se/utbildning/grukth/exjobb/rapportlistor/2005/rapporter05/wirstrom_sara_05194.pdf (27 Oct 2009).

- Yates, R. (2005) Web site accessibility and usability: towards more functional sites for all. *Campus-Wide Information Systems*, vol. 22, nr 4, ss. 180-188. ISSN: 1065-0741. http://www.emeraldinsight.com/Insight/viewContentItem.do?contentType=Article&contentId=1515317 (20 Oct 2009).

- Ökvist, s. and Nöjd, D. *Användbarhetsstudie för skärmläsare* Luleå: Luleå Tekniska Universitet (Institutionen för Industriell ekonomi och samhällsvetenskap) ISSN 1404-5508

7.2 Web links

- Adobe (2009) *Adobe – Accessibility Resource Center.* http://www.adobe.com/accessibility/ (11 Aug 2009).

- Gunnarsson, R. (2007) *Forskningsmetodik - Kvantitativa (statistiska) och kvalitativa ansatser* http://www.infovoice.se/ (2009-10-20).

- Gällivare Kommun (2009) *Talsyntes – gellivare* http://www.gellivare.se/templates/Page____2519.aspx (20 Okt 2009).

- Johansson, R. (2004) *Who framed the web: Frames and usability.* http://www.456bereastreet.com/archive/200411/ (20 Aug 2009).

- Krantz, P. 2009 *Eutveckling* http://www.eutveckling.se/riktlinjer/webb/8/ (27 Oct 2009).

- Murrell, K. (2001) *The Interactive Instructional Material Research and Resources.* http://www.und.ac.za/users/murrell/classrm/genprin.html (24 May 2009).

- Nationalencyklopedin (2009) http://www.ne.se.proxy.lib.ltu.se/lang/fallstudie# (03 Aug 2009).

- S:T Eriks ögonsjukhus (2009)http://www.sankterik.se/ (03 Aug 2009).

- Synskadades Riksförbund (2009) http://www.srfriks.org/ (03 Aug 2009).

- Usability Partners (2009) *Användbarhet – Vad är det ?!.* http://www.usabilitypartners.se/ (11 Aug 2009).

- Unga Synskadade Stockholm (2009) *Lär dig punktskrift - Unga Synskadade Stockhom*

http://www.uss.ungasyn.se/viewpage.php?page=32&moduleinfo=1&show=5 (20 Okt 2009).

- Wadenström,R. (2006) *Vetenskapsfilosofi*. http://www.wadenstrom.net/vetfil (11 Aug 2009).

- Wegert, T. (2002) *Pop-Up Ads, Part 1: Good? Bad? Ugly?*. http://www.clickz.com/991121 (20 Aug 2009).

- World Wide Web Consortium (2008) *Web Standards*. http://www.w3.org/ (11 Aug 2009).

- Östgötabibliotek (2009) *Uppläsning i dator - Svårt att läsa? – Östgötabibliotek* http://www.ostgotabibliotek.se/Default.asp?LibraryID=1&MenuItemID=5587&SelectedMenuItemID=5825&CategoryID=5803 (20 Okt 2009).

Appendices

Appendix A – Interview questions

All of the respondents were asked these questions during the interviews.

Personal questions

1. What kind of visual impairment do you have?
2. Do you use any aiding devices?
3. What kind of IT related education do you have?
4. What is your connection to Synskadades Riksförbund or Syncentralen?

Websites and aiding devices

1. How can you improve the layout of websites to make it work better with the aiding devices?
2. In what ways would you like too see websites support the aiding devices of the visually impaired?
3. According to you, what is the biggest problem associated with aiding devices and websites today?
4. Do the layout of websites have any impact on how the aiding devices of the visually impaired work?
5. Are there websites that work better with some aiding devices and worse with others, and why? Can you give an example?
6. Are there something related with websites that the aiding devices cannot handle, and why? Can you give an example?
7. How do the aiding devices work with frames that exist on websites?
8. How are the aiding devices affected by the advertising and pop-ups that exist on websites?
9. How are the aiding devices affected by Flash that exists on websites?

Appendix B - Complementing questions

All of the respondents were asked these questions during the interviews.

1. What do you think of the different types of documents that exist in websites, and how do these work with your aiding devices?

2. What kind of document do you prefer that websites have, regarding how easy these are to interpret with the help of your aiding devices?

3. What do you think of PDF documents? Are they a good thing or a bad thing, and why?

4. What kind of impact does it have on you and your aiding devices if a PDF document is locked or not?