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Accessibility in Internet Services – Case Electronic Banking

Master's Thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Technology

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Supervisor: Professor Timo Korhonen
Instructor: M.Sc. Teppo Jansson

HELSINKI UNIVERSITY OF TECHNOLOGY Abstract of the Master's Thesis

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Abstract:

Accessibility means easy access for all people regardless of disabilities. Accessibility in Internet services means an equal access to information and applications provided in the Internet regardless of a user terminal or assistive technology. Web accessibility is a young but important field, and is closely connected to usability. Legislation demanding equal access in Web-based services is also a possibility in Europe in the near future.

This thesis investigates accessibility in electronic banking. Nordea Netbank's text version is being evaluated for accessibility, and the accessibility and usability are being improved according to the Web Content Accessibility Guidelines (WCAG). User testing with a blind user is also being carried out, giving practical overview to accessibility.

The evaluation of the netbank service showed it reached level A conformance to WCAG 1.0, and level AA with certain exclusions. Therefore, the netbank application can claim to be accessible; it does not contain insuperable barriers or major difficulties for use, and it also offers some help for improved accessibility. Accessibility improves the user experience for all users. Taking accessibility guidelines into account while developing Internet services is not very demanding, but the benefits may be great for the end users and service providers.

Keywords:
Accessibility, disability, design for all, usability, electronic banking, netbank, product development

TEKNILLINEN KORKEAKOULU Diplomityön tiivistelmä

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Tiivistelmäteksti:

Saavutettavuus tarkoittaa yhtäläistä käyttömahdollisuutta riippumatta vammaisuudesta tai päätelaitteesta. Saavutettavuus verkkopalveluissa on yhä nuori, mutta erittäin tärkeä ala, ja sillä on läheinen yhteys käytettävyyteen. Verkkopalveluiden saavutettavuutta vaativa lainsäädäntö on mahdollinen myös Euroopassa lähitulevaisuudessa.

Tässä diplomityössä tutkitaan saavutettavuutta verkkopankkiasioinnissa. Työssä arvioidaan Nordean verkkopankin tekstiversion saavutettavuutta, lisäksi verkkopankin saavutettavuutta ja käytettävyyttä parannetaan Verkkosisällön saavutettavuusohjeiden (Web Content Accessibility Guidelines, WCAG) mukaisesti. Työssä suoritetaan myös käyttäjätesti sokean käyttäjän kanssa, mikä antaa käytännön näkemystä saavutettavuuteen.

Verkkopankkipalvelun arvioitiin saavuttavan tason A sekä tason AA tietyin poikkeuksin WCAG 1.0 ohjeiden mukaisesti. Tällöin palvelua voidaan pitää saavutettavana: käytössä ei ole ylitsepääsemättömiä esteitä tai erityisiä vaikeuksia aiheuttavia kohtia, ja lisäksi siinä on saavutettavuutta helpottavia osia. Saavutettavuus hyödyntää kaikkia käyttäjiä. Saavutettavuusohjeiden huomioiminen verkkopalveluita kehitettäessä ei ole erityisen vaativaa, mutta siitä saatavat hyödyt voivat olla hyvin merkittäviä sekä loppukäyttäjille että palvelun tarjoajille.

Avainsanat:
Saavutettavuus, esteettömyys, esteetön suunnittelu, käytön esteet, design-for-all, käytettävyys, verkkopankki, tuotekehitys

Preface

A simple reason for paying attention to Web accessibility is easiness. The World Wide Web indeed enables different types of users to act independently. It is possible, for example, for a blind person to read breaking news on their own in any place at any time, or a person with restricted mobility to do their banking in the privacy of their own home without queuing or rushing around. The wider importance and possibilities that the Internet provides have actually arrived quite unobserved, as the hype has been on new technologies and solutions that give good marketing prospects. The European Union has clearly noticed the importance of information and communication technologies, and is striving for everybody's access, in terms of broadband connections and accessible technologies. And in terms of easiness the accessible Web design is not any kind of occultism. Basically all it requires is a structured, scientific approach and use of proper markup techniques.

This thesis works as a curtain raiser in the accessibility field in netbank development. This thesis has been carried out as a part of a facelift project of Nordea Netbank's text version in Fidenta in cooperation with Nordea during the spring and summer of 2006. The empirical part consists of accessibility evaluation and improvement of Nordea Netbank's text version. It is beneficial to see in practice how much work is required to improve accessibility. The development costs can then be further evaluated from the amount of required work in hours, education and commitment.

I want to thank Fidenta and Nordea for the support for this thesis. I would also like to thank my instructor, M.Sc. Teppo Jansson, examiner, professor Timo Korhonen, and especially Timo Karppinen and Tiina Tamminen among other colleagues at Nordea and TietoEnator corporations who have given their invaluable help. At last, my special acknowledgement should go to my wife Tarja for her overall presence and support, "for better or worse".

Table of contents

Table of Key Concepts

Accessibility

- Equal access regardless of a disability. See **Web accessibility**.

Discrimination

- Treating someone worse than other people for some reason. Law prohibits discrimination on the basis of for example disability. Offering a public service excluding certain group of people is discrimination. (DRC, Finlex)

Electronic banking

- An electronic information, payment initiation and communication provided by most banks to their customers. Mainly used for account information and payments, but includes increasingly other functionality. (Nordea Intranet)

Internet

- Worldwide, publicly accessible system of interconnected computer networks that transmit data. Includes the Web, but is a wider concept. (Wikipedia)

ICT

- **Information and Communication(s) Technology/Technologies,** a broad subject concerning technology and other aspects of managing and processing information (Wikipedia). Means for instance computers, mobile phones and many other similar technologies that handle and transmit/receive information.

Netbank

- An electronic banking service provided over the Internet. Banking via netbank is called **Internet banking** or net banking. Netbank is a term used by Nordea, and therefore in this thesis Netbank is written with a capital when referring specifically to Nordea's Netbank. Sampo bank uses the term Web Bank and OP bank correspondingly Internet Bank. (Nordea Intranet, Sampo, OP)

Usability

- A quality attribute that assesses how easy *user interfaces* are to use. (Nielsen 2003)

User agent

- Software to access Web content, including desktop graphical browsers, text browsers, voice browsers, mobile phones, multimedia players, plug-ins, and some software assistive technologies used in conjunction with browsers such as screen readers, screen magnifiers, and voice recognition software. (Chisholm et al. 1999a)

User interface

- The aggregate of how a computer interacts with and presents information to the user. Consists of: (Nordea Intranet, Wikipedia)
  - *Input*: how the user controls the system; and
  - *Output*: how the system informs the user

Validator

- Software program that reads Web pages and detects errors. A well known one is the HTML validator that detects errors on a Web page's markup language. There are also various accessibility validators that detect technical accessibility barriers on a Web page. Accessibility validators cannot, however, check for all accessibility guidelines, and human checking is essential. (WAI Eval)

Web, WWW, World Wide Web

- Global information space operating over the Internet. Constructs of Web sites that are collections of Web pages. Often mistakenly used as a synonym for the Internet itself. (Wikipedia)

Web accessibility

- Information presented over the Internet so that it is easily accessed by any user. (Paciello 2000)

Web Accessibility Initiative, WAI

- WAI develops guidelines widely regarded as the international standard for Web accessibility. Part of World Wide Web Consortium (W3C).

Abbreviations

ATAG	= Authoring Tool Accessibility Guidelines
CSS	= Cascading Style Sheets
DfA	= Design for All
EC	= European Commission
GUI	= Graphical user interface
(X)HTML	= (eXtensible) Hypertext Markup Language
ICT	= Information and Communications Technology
IS	= Information Society
PDA	= Personal Digital Assistant
Section 508	= Section 508 of the Rehabilitation Act of 1973 (has been revised since)
SC	= Success Criteria
SSH	= Secure Shell, provides secure encrypted connection over a network
UAAG	= User Agent Accessibility Guidelines
WAI	= Web Accessibility Initiative
WCAG	= Web Content Accessibility Guidelines
W3C	= World Wide Web Consortium

1 Introduction

Accessibility is a known concept from construction engineering, targeting to enable equal access for all people. Similarly, accessibility in information technology and Web-based services is an important concept, targeting to enable equal access for all people regardless of their physical abilities. There are guidelines for building accessible Web sites, and World Wide Web Consortium (W3C) has published an international standard for accessible Web design (Chisholm et al. 1999a).

Usability and accessibility are two different concepts that go hand in hand. Accessibility can be seen as more concrete and technical quality, while many characteristics of usability cannot be measured universally. However, a technically accessible service with poorly designed usability can be practically impossible to use and therefore inaccessible.

The purpose of this Master's Thesis is to study the aspects of accessibility in Internet services, including views on standardization and legislation concerning accessibility. The empirical part of the study focuses on netbank accessibility. Accessibility in Internet is a fairly new field, and there still seems to be more theory than practice.

The accessibility factors in electronic banking are investigated by evaluating the accessibility level of the text version of Nordea Netbank. This research was part of facelift project of Nordea Netbank's text version, in which the outlook of the text version was improved regarding usability and accessibility. The main target group for the text version is the mobile phone users, but the experiences in the accessibility work can and will be used in other Nordea Netbank versions too.

Goals for this study are:

1. Overview the present theory of accessibility in Web-based services, including standards and legislation.
2. Investigate the accessibility factors in electronic banking.
    a) Improve accessibility and usability of Nordea Netbank's text version.
    b) Find a conformance level of Nordea Netbank's text version for accessibility.
3. Gain accessibility experience in practice, in comparison to the theory.

1.1 Author's contribution

In this chapter I describe my contribution to the research methodology and implementation. The accessibility in information and communication technologies is a fairly new field that requires interpretation and a broad view. The actual technological guidelines for Web accessibility are quite clear, however, there is still room for interpretation. In this thesis, I have set the object to cover accessibility in a broad sense, including the influences from regulation, standardization, technology advancement, and both social and economical views.

The facelift project of Nordea Netbank's text version gave me quite a free hand in executing the accessibility evaluation. Carrying out the evaluation in the first phase was challenging, since I did not have any personal experience in doing such evaluation in practice. Web Accessibility Initiative offers guidance on Web accessibility evaluation (WAI Eval), but I modified the methodology in order to make it more suitable for the Netbank case. WAI lists many accessibility evaluation tools, but most of them were not suitable for evaluating a netbank application. Therefore I have used only one accessibility tool, Wave. Otherwise, in addition to what WAI recommends on accessibility evaluation, I have added more browsers to browser testing, and carried out user testing. Also some HTML techniques had to be studied at several times, which was a good learning experience.

The outcome was a satisfying result, as I could set a conformance level for the Netbank application. Through the research I could re-analyse the importance of different accessibility guidelines, and make my own recommendations for netbank development. The experimental part mostly supported the theory and presumptions, but I have also found my own differing opinions on some specific guidelines and their importance levels.

1.2 Structure of this thesis

The structure of the thesis can be seen in **figure 1.** The figure consists of two pyramids that describe the approaches to the experimental part that is marked as a circle in between the pyramids. The main concept, the pyramid on top, stands for *user interface*. User interface handles the interconnection between the user and the system, and it includes input and output devices. Another concerned concept is *accessibility*. In figure 1 accessibility is drawn as a separate box, and its subsection Web accessibility is related to user interface. Web accessibility is also intertwined with usability. Web accessibility is achieved through standards, and the accessibility level can be evaluated. The second pyramid on bottom stands for *banking services.* Electronic banking services are an important field for the society at large for its effect on people's everyday life. *Accessibility of electronic banking user interfaces* is the combination of all these concepts, serving as the focus of the study.

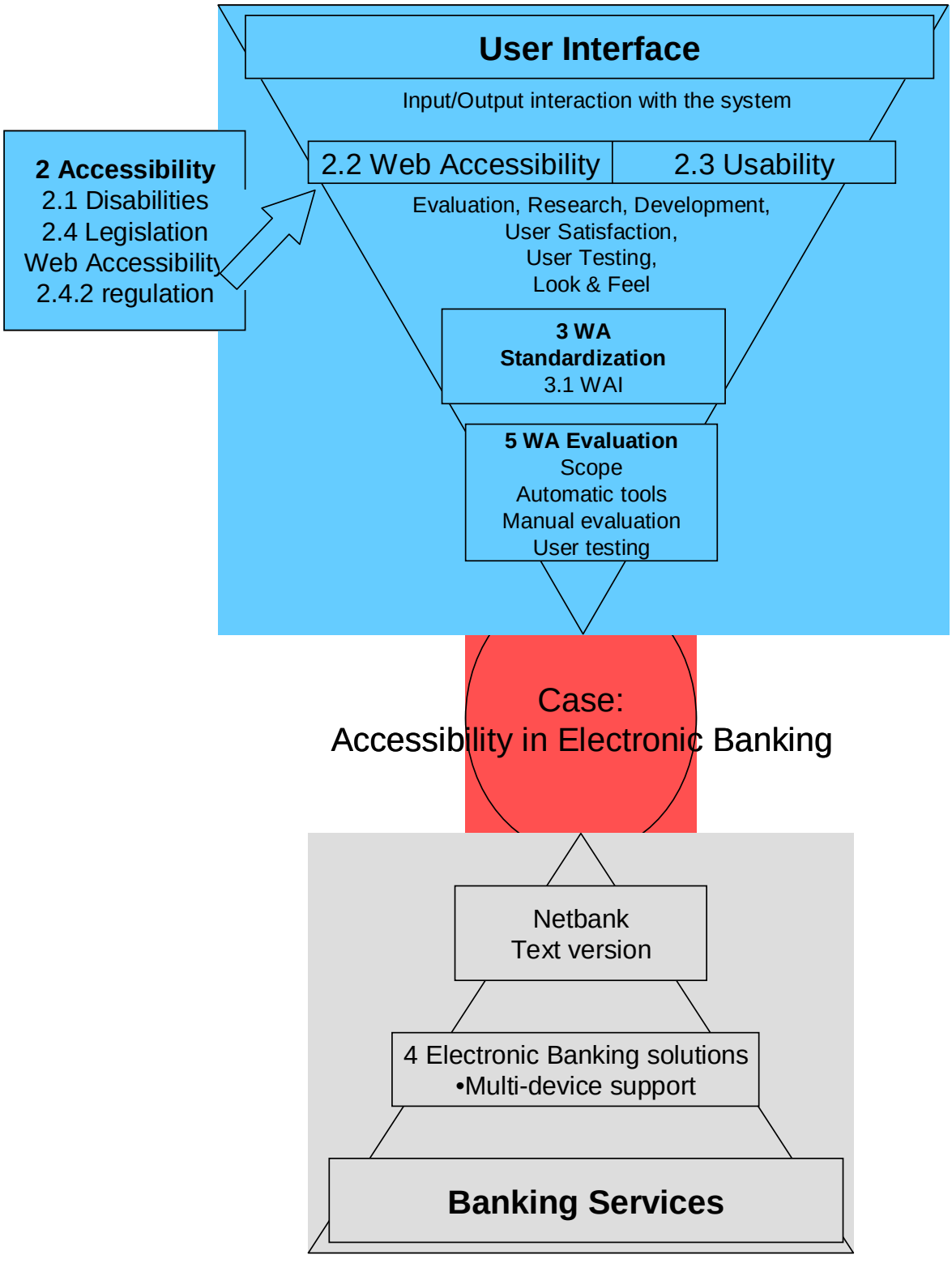


Figure 1. Structure of the thesis. The numbers next to some topics refer to the according chapter numbers.

User interface means the layer between machine and human. User interface constitutes the look and feel of the product, and defines how the user perceives the product. Accessibility and usability are qualities of user interface; they are qualities that can be evaluated with heuristic expert testing or with user testing (Sinkkonen et al. 2002, Clark 2002, Faulkner 2000). Accessibility and usability aspects are discussed in chapter 2 Accessibility.

Accessibility's aim is to enable access for all users. There are different disabilities that affect use of a product, for example computer, and accessibility strives to enable the equal access regardless of disabilities. Web accessibility means design for Web pages that enable everybody's access to the information. There are guidelines and standards for accessible Web design (Chisholm et al. 1999a, Section 508). Finland does not have legislation demanding Web accessibility, but there are laws enforcing accessibility for example in building houses. European Union is striving for accessibility in information and communication technologies, while in United States there is already in place legislation for Web accessibility. Common disability types in computer use are described in chapter 2.1, and accessibility legislation and regulation views are covered in chapter 2.4. Web accessibility standardization is covered in chapter 3. (Clark 2002, Paciello 2000)

Electronic banking is an important service provided over the Internet. In Finland there are three banks that cover over 80 percent of Finland's banking. All the three banks have naturally net banking services, and they all offer alternative netbank forms for better terminal adaptation. The main purpose of terminal adaptation is in mobile use; net banking with mobile phone and Personal Digital Assistant (PDA) is a fast and emerging growth area. Nordea is the biggest bank in Finland and world leader in Internet banking. Nordea Netbank's text version and electronic banking in Finland are introduced in chapter 4. (FBA, Jansson 2006)

The empirical part of this study focuses on investigating and improving the accessibility in Nordea Netbank's text version. Applied Web accessibility evaluation methods are partly adapted from World Wide Web Consortium's recommendations (WAI Eval). The evaluation was done in two phases. The first phase evaluation focused on finding possible barriers for use, which could be corrected. User testing was realized with a blind computer

user. The purpose of the user testing was to gain experience and understanding of the adaptive technology and to develop a view of a blind user's behaviour.

The second phase evaluation focused on finding a final accessibility conformance level for the Netbank text version. The evaluation was done at the end of the text version product development project. The research methodology is described in chapter 5 Accessibility evaluation methods, the experimental part in chapter 6 Facelift of Nordea Netbank's text version, and results in chapter 7. Lastly, the conclusions are drawn in chapter 8.

2 Accessibility

This chapter discusses the definition of accessibility, and describes disabilities laying a special motivation for accessible design, especially in computer use. Usability is an important subject in Web design, and usability and accessibility are clearly intertwined. This chapter also discusses about the similarities and differences between accessibility and usability, and the usability aspects in electronic banking that affect accessibility. Also legal view to accessibility and equal user rights are addressed in sub-chapter 2.4.

Concept of accessibility can be divided into two parts:

a) Accessibility in physical environments; and
b) Accessibility in information and communication technologies, ICT.

The former is older and well known in building public places, such as malls, busses, markets, dwelling houses and the like. For example, an accessible building has a ramp or a lift besides the stairs, and wide enough doorways for a wheelchair. The idea is that constructions should be made so that all people have equal access to places, regardless of any disability. There is also some legislation forcing the contractors to obey the accessible solutions. More about accessibility legislation can be found in chapter 2.4. (UN 1993, Clark 2002)

Accessibility in ICT is the newer concept, but equally important. Accessibility in ICT means that for example a person with low vision should be able to use mobile phone and computer. More precisely, *Web accessibility* means accessibility in Web sites and Web-based services. Web site design defines how special user groups can access the content and use the sites. Web accessibility guidelines are covered in more detail in chapter 3. (Clark 2002, UN 1993)

Michael Paciello defines *accessibility* (Paciello 2000 p.373) as follows: “Information, regardless of form, structure or presentation, that can be easily accessed by any person, regardless of ability.” In practice, there are several terms meaning the same. Web accessibility, also called *eAccessibility*, aims to make information distributed over the Internet accessible to all people, irrespective of their disabilities. Aging-related difficulties can be accommodated by the same Web accessibility solutions that are made for people with disabilities. *Universal Design*, also called *Design for All, DfA*, means design that

benefits not only people with disabilities but also non-disabled users. (W3C 2004, European Commission 2005c)

2.1 Disabilities affecting computer use

Impairment could be, for example, the loss of use of lower limbs, which entails the *disability* of not being able to walk. *Handicap* is a disadvantage created by a gap between personal capability and environmental demand. A disabled person is defined as "an individual in their own right placed in a disabling situation." This chapter lists some disability types and how they affect computer use. Disabilities are more frequent in older people, and the elderly often face several impairments, for example both in hearing and in vision. (Roe 1995)

There are as yet no universally accepted categorizations of disability, despite efforts towards that goal (W3C 2004). One approach in computer technology design is to categorise four groups of natural disabilities concerning hearing, vision, physical qualities and cognition. Abilities vary from person to person, and over time, for different people with the same type of disability. Aging usually increases the number and severity of limitations. Many people who have some disabilities do not consider themselves as being disabled. This is an important point of view to internalise: people with disabilities are not regarded as a marginal group in accessibility field nor in this thesis. In fact, the true minority is the young adults in their full mental and physical strength: without any sickness, tiredness or other inconvenience. Considering all age groups from infants to the elderly, there are more people with challenges than those without. (Clark 2002, EDF, W3C 2004)

A deaf person is someone with significantly impaired hearing. Someone with a lower degree of hearing may be more accurately called hard-of-hearing. Hearing impaired is a more medical-sounding term that is not as often used. Note that even though many of the 80 million hard of hearing people in geographical Europe (Roe 1995) will have problems, for example, using a public phone in a noisy location, they will not necessarily consider themselves as disabled or be registered as such. Hearing problems do not usually harm computer use in that sense that computers are usually very silent. Most interaction is visual and only few Web sites use voice at all. However, multimedia applications like videos

should provide also captions or written alternatives for the hard-of-hearing. (Clark 2002, Roe 1995, W3C 2004)

A blind person is someone with significantly impaired vision. Someone with a lower degree of sight may be more accurately called visually impaired. A low-vision person means practically the same as visually impaired but the term ‘visually impaired’ is used more. There are estimates that even only about 10 % of people with any kind of visual impairment read Braille. According to Roe (1995), there are 1,1 million blind and 11,5 million people with low vision in geographical Europe. This number does not even include people who use glasses, but who could as well benefit for example from text magnification on computer screen. (Clark 2002, Roe 1995) Vision loss has most effects on computer use. The Disability Rights Commission (DRC 2004) in Great Britain has made accessibility tests with different impairment groups and found that the blind users had clearly the most difficulties using public Web sites. The blind can use the Web with assistive technologies, which are discussed in the next chapter 2.2.

Mobility impairment means difficulty moving any part or parts of the body. In this study, it is more relevant to focus on impairments that especially affect the use of a computer or relevant device, meaning in practice hands, arms or fingers. Dexterity impairment is a reduced function of arms and hands making it difficult for example to use a mouse accurately. This makes it important that a Web page can be used and accessed with the keyboard or a specialized mouse. (Clark 2002, Roe 1995, W3C 2004) Mobility impairments are very important in physical environment accessibility, but designing accessible Internet services also creates more opportunities for them; for example an accessible electronic banking solution enables an elderly with moving difficulties to do his banking at home.

Cognitive, neurological, language, and learning disabilities can affect the perception, processing, understanding, and/or reception of information and other stimuli. A well-known example is dyslexia that causes confusion in reading and some other tasks. The text in Web pages should be as understandable and clear as possible, which helps not only the dyslexic users, but makes it easier for everybody to read. Cognitive and learning difficulties are very vague grouping of users, as there are very different effects on computer use. Also user testing with this user group may be difficult; the level and effects

of the impairment may be quite dissimilar. One very important and simple accessibility guide is to avoid flickering content in Web pages, which could cause seizures to photosensitive people. (Clark 2002, Roe 1995, W3C 2004)

2.2 Help for the disabled in computer use

Disabilities have very different effects on a person's computer usage. Some need adaptive technology, some need better design from the programs and Web sites and some don't have any influence on computer use at all. (Clark 2002) There are several terms in disability technology field referring to devices or software interfaces that help the disabled users, and they all mean basically the same thing. Such are, for example, *assistive technology*, *access systems*, *adaptive technology* and *adaptive computing.* Examples of these include the following: (Paciello 2000, W3C 2004)

- People who are blind may use synthetic voice, digital audio, or Braille display (RNIB) for reading the content. An example of a Braille display can be seen in **figure 2.**
- Screen magnification and large text fonts are especially helpful for people with diminished vision or dyslexia.
- People who are deaf or have hearing disabilities may use descriptive text, captioning, and visual cues for understanding multimedia and audible content.
- Specialised adaptations are possible for people who have physical disabilities involving the use of a keyboard, voice recognition mechanism, mouse, or other input device that requires a part of their body other than their hands and fingers to control a Web browser.

Figure 2. Braille display for visually impaired users.

The assistive technologies help the disabled in computer use, but there can appear more problems due to poor technical design. There are good practices in developing Web pages, which enhance the compatibility with assistive technologies, different browsers, different user terminals and different styles of use. This is called Web accessibility. The good practices are collected to guidelines, and there are various sources that have made accessibility guidelines. However, the salient source of Web accessibility research is the Web Accessibility Initiative, WAI. The Web accessibility standardization and WAI are discussed in more detail in chapter 3. (Clark 2002, Paciello 2000)

The Web accessibility guidelines and standards are meant to guide developers to create Web sites that are compatible with all the technologies that are compliant to standards as well. Therefore, it is said that the developer does not even have to know how the assistive and adaptive devices display the Web sites. The important thing is to make sure that the Web sites function according to relevant standards. (Clark 2002)

There has been critique that the Web accessibility guidelines are not enough for true accessibility. For example American Foundation for the Blind (Gerber 2002) has stated that compliance with accessibility guidelines is necessary but not sufficient for users to access what they need. It is stressed that poor usability for disabled users presents

problems for Web site use. Hence, the disabled users should be consulted and taken into user tests in order to improve usability and accessibility.

The Disability Rights Commission (DRC 2004) has come to a similar conclusion: in their research in 2004, 45 % of the problems encountered by disabled users in Web sites could not be regarded as explicit violations of the Web Accessibility Initiative Checkpoints. DRC suggests good improvements to the Web Accessibilty Initiative's guidelines (DRC 2004, pp.47-48), but most of the DRC suggestions, in fact, are existing accessibility recommendations or can be regarded as usability guidelines (WAI 2004).

2.3 Usability in Web based services

This chapter discusses briefly the overall concept of usability. Usability is a far wider field than could be covered in this thesis, but too important to be left out completely when dealing with accessibility. The sub-chapter 2.3.1 discusses about the relation between usability and accessibility, and sub-chapter 2.3.2 goes deeper into usability aspects in electronic banking. Naturally, the accessibility view is kept in mind, making the usability view focus on parts that are important for accessibility.

Jakob Nielsen defines usability as a "*quality attribute* that assesses how easy user interfaces are to use." Nielsen categorises usability into five components: (Nielsen 2003, Sinkkonen et al. 2002, Faulkner 2000)

- **Learnability**: How easy is it for users to accomplish basic tasks the first time they encounter the design?
- **Efficiency**: Once users have learned the design, how quickly can they perform tasks?
- **Memorability**: When users return to the design after a period of not using it, how easily can they re-establish proficiency?
- **Errors**: How many errors do users make, how severe are these errors, and how easily can they recover from the errors?
- **Satisfaction**: How pleasant is it to use the design?

On the other hand, International Organization for Standardization's ISO standard 9241-11 Guidance on usability lists three components of usability (ISO 9241-11 1998):

- **Effectiveness**
- **Efficiency**
- **Satisfaction**

In more precisely, the ISO standard says that it is these values with which *specified users* can achieve *specified goals* in *particular environments.* To improve usability, one should start by getting to know the user in the user's own environment. (Faulkner 2000, Sinkkonen et al. 2002, Nielsen 2003)

2.3.1 Difference between usability and accessibility

As noted in the beginning of chapter 2, Web accessibility, or Design-for-All, or Universal Design all mean design that is made accessible for everyone. The solutions for accessibility strive for common engineering including all user groups. Here lays the main difference between accessibility and usability. Usability requires specification of the user, the task, and the environment, while in accessibility the common factor is the task. It is clear that both accessibility and usability strive for what is good for the user, and most aspects in both do that without interfering with the other field. For example separating content from presentation should not decrease the usability, or providing shortcuts for experienced users does not prevent the use with a different user terminal. (W3C 2004, European Commission 2005c, Krug 2006 pp.168-179, Nielsen 2003, Paciello 2000, Clark 2002, Turkki & Sinkkonen 2004)

Accessibility and usability are also interdependent; some say that accessibility is part of usability, while others may word it the opposite way. (Nielsen 2003, Paciello 2000, Clark 2002) A recent study (Helin 2005, p.45) has estimated that 40 % of the accessibility guidelines improve usability. For example a technically accessible but difficult to use, meaning not usable, Web page is not really accessible for people with learning difficulties. On the other hand, a Web page that is very usable for a professional user is not necessarily accessible to a novice or a person with disabilities.

In practice, accessibility can be regarded as technical design of reducing barriers for use, as usability covers the user experience as a whole (Turkki & Sinkkonen 2004). Nielsen

(1999), such as other usability advocates, tends to emphasise that users are different, and that different user groups would be best served with tailored user interfaces. Therefore, he suggests that also Web sites should have separate versions, and doubts if optimal usability can be delivered through single-design pages. On the other hand, accessibility advocates often resist the use of separate text-versions, because alternative versions can be discriminating: a separate text version of a Web site may be significantly less comprehensive and updated less often (Clark 2002, Gerber 2002). Also providing single-design pages that serve all users is more cost efficient than having separate versions.

2.3.2 Usability in electronic banking

There are certain specifics in electronic banking that separate it from other Internet services. Above all, electronic banking service has to be safe. The user interactions must be secured, and the user should have a feeling that he is operating reliably, and that the netbank is robust. Most Web usability principles apply directly to electronic banking services, and some are listed here for reference for this study (Heng 2005). Nordea has its own Netbank Style Guide (Heng 2005) for developers, which can be compared to general Web usability guides (Nielsen 1999, Nielsen 2004, Faulkner 2000).

Nielsen has listed top ten mistakes of Web usability design (Nielsen 2004):

1. Bad search
2. PDF files for online reading
3. Not changing the colour of visited links
4. Non-scannable text
5. Fixed font size
6. Page titles with low search engine visibility
7. Anything that looks like an advertisement
8. Violating design conventions
9. Opening new browser windows
10. Not answering users' questions

Most of these are very applicable to electronic banking as well. Especially influential to accessible electronic banking design are numbers 4, 5, 7, 8 and 9: non-scannable text, fixed font size, elements resembling advertisement, non-consistent style and opening

unnecessary pop-up windows. The text should be scannable, meaning that there are not too many elements or information on a page. The font size should be adjustable on the browser. The netbank outlook must conform to bank branding guidelines; the colours, structure and general layout must be in accordance to the bank's general design. This avoids mistakes numbers 7 and 8 on Nielsen's list. Opening new browser windows is done only on specific occasions when it is desirable. Clicking a link to an outside source should never drift the user out of the netbank application. Instead, the log out method has to be clear and consistent, and the user must be aware when he is inside the netbank. (Heng 2005)

Nielsen (2000 p.104) has studied users' way of reading text from the computer screen. He has found out in a research with John Morkes that 79 % of users only scan the text of a new Web page. Only few users read the text word by word. This has led to the conclusion that the Web encourages users to impatience and people read Web pages browsing for links and relevant information. This can be said to be applicable to netbank services as well (Heng 2005).

For accessible electronic banking design, the usability experts play an important part. In **table 1** there are listed some design guides for accessible usability in electronic banking, adapted from Nielsen's usability guides and Nordea Netbank Style Guide. The list is not comprehensive, but the table gives a view to some disabilities that can be helped with these guidelines. On the first column of the table there are listed some guidelines adapted from Nordea Netbank Style Guide (Heng 2005), and on the second column there are listed some disability types and positive influences (Caldwell et al. 2005) deriving from these guidelines.

Table 1. Some usability guidelines that improve accessibility in electronic banking**.** (Adapted from Heng 2005 and Caldwell et al. 2005)

Usability guideline	How does it help people with disabilities
The link text must give the user information on where it leads	Learning difficulties, elderly users, blind users using a screen reader
Limit the number of elements on a page	Low-vision users, users with reading difficulties, dyslexia
Make clear and simple path for the eye to follow, and clear order of things	Users with low dexterity who navigate with keyboard tabulator, blind users
Make consistent link menu that does not change illogically	People who figure out the functionality on one page can find the desired functions later
Use white space, do not place elements too close to each other	Low-vision users can use screen magnification, dyslexic users outline the page more easily
Group only related elements on a same page	Users can navigate and find the desired pages better

In summary, good usability improves accessibility. Many usability guidelines can be directly mapped to accessibility features, and positive influences are self-evident. Hence, the accessibility aspect emphasises usability engineering even more.

2.4 Legislation and regulation of accessibility

This chapter discusses the legal requirements towards accessibility focusing especially on Finland and Nordic countries. This is an important point of view since there is not yet clear legal requirement for Web accessibility in Finland, but still some indirect points that need to be taken into account. There is some legislation towards physical environment accessibility, which also serves as an example for Web accessibility regulation.

In **table 2** there are listed some examples of accessibility norms in different levels regarding both physical and Web environments. On global level there are United Nations principles regarding physical accessibility, and World Wide Web Consortium's Web Accessibility Initiative regarding Web accessibility. On European level there are directives concerning equality, for example in employment, and European Commission work towards Web accessibility, including statement for accessible governmental Web sites. In Finland there is Land Use and Building Decree that requires accessibility in public buildings for

reasons of equality. On the other hand, the Finnish Ministry of the Interior has published a recommendation on accessibility of authority Web sites. On corporate and organizational level there are municipality policies for building accessible environment, and company policies for building Web sites, for example Nordea Accessibility Policy (Hansson et al. 2006). (Essityöryhmä 2003, Finlex)

Table 2. Examples of accessibility regulation at different levels. (Adapted from Essityöryhmä 2003 and Finlex)

Level	Examples, physical accessibility	Web accessibility
Global	*UN recommendations* (common principles) (UN 1993)	W3C's WAI: *WCAG* (Chisholm et al. 1999a)
Europe	*EU directive* of equal treatment in employment (Directive 2000/78)	*European Commission recommendation* on public Web sites (European Commission 2005b)
Finland	*Land Use and Building Decree*, Ensuring accessibility in building (Finlex, 1999/132)	*Ministry of the Interior recommendation on public administration Web sites* (JUHTA 2005)
Corporations, organizations	Municipality policy, e.g. *Accessible Helsinki project 2002-2011*	Company policy, e.g. *Nordea Accessibility Policy* (Hansson et al. 2006)

2.4.1 Legislation of equal rights and everybody's access

United Nations' *Universal Declaration of Human Rights* first Article states: "*All human beings are born free and equal in dignity and rights. They are endowed with reason and conscience and should act towards one another in a spirit of brotherhood.*" (UN 1948). More precise statement for accessibility has been declared in the 1990's. UN has published *the Standard Rules on the Equalization of Opportunities for Persons with Disabilities* in 1993, already before the big boom of the World Wide Web. Still there are very applicable statements for today's information society. Rule 5, *Accessibility*, is divided into two parts: "*States should*

a) introduce programmes of action to make the physical environment accessible; and

b) undertake measures to provide access to information and communication."

(UN 1993, Essityöryhmä 2003)

Here can be seen the background for accessibility in ICT, which comes from the accessibility in physical environment. There is legislation concerning accessibility in physical environments, for example in building houses. It has been often acknowledged that building accessible physical environment has helped not only the disabled but also wide range of people, including for example children and people moving with bicycles or prams. (Essityöryhmä 2003)

The b –part of the UN Accessibility rule, *Access to information and communication,* lists the following actions:

- "*Persons with disabilities and, where appropriate, their families and advocates should have access to full information on diagnosis, rights and available services and programmes, at all stages. Such information should be presented in forms accessible to persons with disabilities.*
- *States should develop strategies to make information services and documentation accessible for different groups of persons with disabilities. Braille, tape services, large print and other appropriate technologies should be used to provide access to written information and documentation for persons with visual impairments. Similarly, appropriate technologies should be used to provide access to spoken information for persons with auditory impairments or comprehension difficulties.*
- *Consideration should be given to the use of sign language in the education of deaf children, in their families and communities. Sign language interpretation services should also be provided to facilitate the communication between deaf persons and others.*
- *Consideration should also be given to the needs of people with other communication disabilities.*
- *States should encourage the media, especially television, radio and newspapers, to make their services accessible.*
- *States should ensure that new computerized information and service systems offered to the general public are either made initially accessible or are adapted to be made accessible to persons with disabilities.*
- *Organizations of persons with disabilities should be consulted when measures to make information services accessible are being developed.*" (UN 1993)

These actions strive to define what we call Web accessibility improvement. Especially the second last bullet point, *computerized information and service systems offered to the general public*, refers clearly to World Wide Web services, and *initially accessible or adapted to made accessible* refers to accessible Web design and adaptive technologies. (UN 1993, Essityöryhmä 2003)

The UN statements have often worked as the basis for the member states' legislation. The Finnish Non-Discrimination Act Section 6 Prohibition of discrimination states: "*Nobody may be discriminated against on the basis of age, ethnic or national origin, nationality, language, religion, belief, opinion, health, disability, sexual orientation or other personal characteristics*" (Finlex). The anti-discrimination laws are very similar in most industrialised countries. More precisely, in some countries there are clear laws for accessibility. For example, in US there is the Americans with Disabilities Act, in Canada, the Canadian Human Rights Act, in Australia and United Kingdom the Disability Discrimination Act that all relate to discrimination by disabilities. (Clark 2002, RNIB)

2.4.2 Legislation concerning Web accessibility

The anti-discrimination laws usually do not explicitly refer to Web accessibility but there is international consensus that they are applicable to the Internet (Clark 2002). In Finland there does not yet exist legislation demanding Web accessibility. Hence, this chapter discusses the international situation and reveals some recommendations on the subject that have indirect influence to Finland. In United States there is a law (Section 508) requiring certain accessibility level for governmental Web sites, which has served as an example for other countries and the European Union.

In United States, the Section 508 accessibility standards must be met unless satisfying them causes 'an undue burden'. The law requires Federal agencies to purchase electronic and information technology that is accessible to employees with disabilities, and to the extent that those agencies provide information technology to the public, it too shall be

accessible by persons with disabilities. The suppliers must prove themselves that their Web sites apply to the regulations. If there was the same law in Finland, for example electronic banking service providers who have governmental clients should make their services standard compliant. Possible loophole is the 'undue burden' part by which the company could explain how it would cost extensively to make the services accessible. The Section 508 Web content standards are based on Web Content Accessibility Guidelines, WCAG, version 1.0 but the US version is modified to enable clearer law enforcement. WCAG and Web accessibility standardisation is discussed in chapter 3. (Section 508, Thatcher 2005, Clark 2002)

A law case in Australia made connection between anti-discrimination laws and Web accessibility. Bruce Maguire sued the Sydney Organizing Committee for the Olympic Games for not making the 2000 Olympic Games Web sites accessible for him as a blind person. The Web site owners were given time to make corrections, and were heard on how much it would require making the necessary corrections. Instead of entirely improving the Web site as requested, the owners decided to fight in court. The result was a landmark decision against the Web site owners, ordering them to pay a fine of 20,000 Australian dollars. This decision has lead to the conclusion that the anti-discrimination laws may indeed require accessibility in Web sites. The law case has served as a warning example for Web site manufacturers, and there has been paid more attention to accessibility in Australia since the case. Also the decision that Olympic Games Web site was regarded as a public site, which requires equal access for all, stresses that for example net banking services may be very well seen similarly as a public service. (Clark 2002, Worthington 2001)

European Commission (2005b) has published a survey on accessibility of public sector services. Included is a recommendation for setting a clear target for making all public sector Web sites conform to WCAG 1.0 level "double A" by 2010. The Finnish Ministry of Interior has published a recommendation for public administration Web sites, mentioning that one of the general principles in Web page design should be accessibility, and the pages should conform to at least level "A" of the Web Accessibility Initiative's WCAG (JUHTA 2005).

2.4.3 European Union view

Activities towards accessibility at EU level have an added value as several Member States are developing legislation, regulations, standards or guidelines to tackle the accessibility issues at national level. These actions are leading to similar but yet different accessibility requirements for products and services, thus creating a high risk for the European industry, that is, being forced to operate in a fragmented market with the consequent loss of competitiveness and effectiveness. The risk is even greater for the consumers: a fragmented market means costlier, more unfamiliar and incompatible products, and more difficulty in accessing or moving information across borders. EU actions also take into account international experiences, like those in the USA and Canada, with which a dialogue has been initiated by the European Commission, particularly regarding the use of legislative provisions in the context of public procurement as a powerful leverage factor. (European Commission 2005a)

General view in European Union is to try to form a common practice in order to further the accessibility in Information and Communication Technologies, ICT (Cullen 2005 p.16). The European Commission "*has the objective of achieving an information Society for all. Community action is needed to ensure the inclusion and participation of all Europeans, as this will not happen by itself*." The Commission is proposing action based on three pillars:

1. Accessibility requirements in public procurement. There will be revised directives on public procurement.
2. Explore certification and assessment. A certification mechanism should be set up, providing guidance to customers and recognition to manufacturers and service providers.
3. Use available legal instruments in current legislation. Some Member States and countries outside Europe already have legislation demanding accessibility. Full potential of the legislation will be explored.

(European Commission 2005a, 2005b)

Number 1, accessibility requirements in public procurement, is a correlative action to the US Section 508 law. There is a lately revised directive that refers to accessibility in public supplies. Directive on procedures of public work contracts, public supply contracts and public service contracts (Directive 2004/18/EC) implements accessibility criteria on public procurements: "*Contracting authorities should, whenever possible, lay down technical*

specifications so as to take into account accessibility criteria for people with disabilities or design for all users."

A universal certification system would be the cornerstone for demanding accessibility as a legal requirement. There has been formed EuroAccessibility Consortium, that has claimed their goal to form a harmonised methodology for evaluating Web accessibility across Europe. EuroAccessibility's work seems to be in process, but if they will succeed in forming a harmonised evaluation methodology, it is likely that the EU will be interested. (EuroAccessibility, Vilén 2005)

Generally there is no direct legislation requiring Web accessibility in Europe, but different EU member states have varying legislation for non-discrimination and equal access. A European level legislation may be possible from 2008, but the process will likely not be as firm and quick as in United States. (European Commission 2005a) The European Union will build a European initiative on e-Inclusion in 2008 focusing on everybody's access to broadband and eAccessibility (Reding 2005). The European Commission initiated eAccessibility in 2005. There will be a follow-up for this in early 2007 evaluating the results for accessibility so far. At that time the Commission may also "*consider additional measures, including new legislation, if deemed necessary*." In other words, the legislation concerning Web accessibility at EU level is a possibility after 2007. (European Commission 2005a)

3 Web Accessibility standardization

Web accessibility standardization means the guidelines that are made for developers in order to apply accessible design. The guidelines describe how to form accessible Web pages by avoiding problematic design and using good practices. The guidelines are very technical and focus mainly on code level, for example how to implement images, tables, frames and the like. (Clark 2002, Chisholm et al. 1999a)

Web Accessibility Initiative and Web Content Accessibility Guidelines, WCAG, are clearly the salient source of Web accessibility development. It is said that, “the entire base of widespread understanding, knowledge and scholarship on Web access can be traced to the WAI” (Clark 2002, pp. 50-51). There are other instances that do Web accessibility research and development, for example IBM, but all the main stakeholders in the accessibility field work in cooperation with WAI (WAI Web site). European Union is also one of the supporters of the WAI and is following their work intensively. Therefore, this thesis focuses on the WAI guidelines, even though they have also received critique from many sources (for example Clark 2002, DRC 2004, Clark 2006).

3.1 Web Accessibility Initiative (WAI)

Web Accessibility Initiative is part of World Wide Web Consortium, well known by its abbreviation W3C. W3C is a non-profit organisation that creates Web standards and guidelines to ensure long-term growth and interoperability. The work is important since different commercial manufacturers – at least competitors – do not naturally produce interoperable technology standards by default. W3C was founded in 1994, and WAI was founded in 1997. (W3C Web site) It can be said that the Web and Internet have changed quite dramatically since the launch of the World Wide Web, and have changed also today’s society at a larger scale.

WAI promotes itself on their Web site (WAI Web site):”The World Wide Web Consortium's (W3C) commitment to lead the Web to its full potential includes promoting a high degree of usability for people with disabilities. The Web Accessibility Initiative

(WAI) develops its work through W3C's consensus-based process, involving different stakeholders in Web accessibility. These include industry, disability organizations, government, accessibility research organizations, and more."

The Web Accessibility Initiative is working on three different guidelines:

1. Web Content Accessibility Guidelines (WCAG)
2. Authoring Tool Accessibility Guidelines (ATAG)
3. User Agent Accessibility Guidelines (UAAG)

The relation of the WAI guidelines can be seen on **figure 3**. On top is the most important, the content, which is guided by WCAG, Web Content Accessibility Guidelines. On one side are the developers who create and manage the content, which is guided by ATAG, Authoring Tool Accessibility Guidelines. And naturally on the other side are the users who access the content through their user agents (browsers or other devices that display Web pages) and this is related to UAAG, User Agent Accessibility Guidelines. (Paciello 2000 pp. 48-67, WAI Web site)

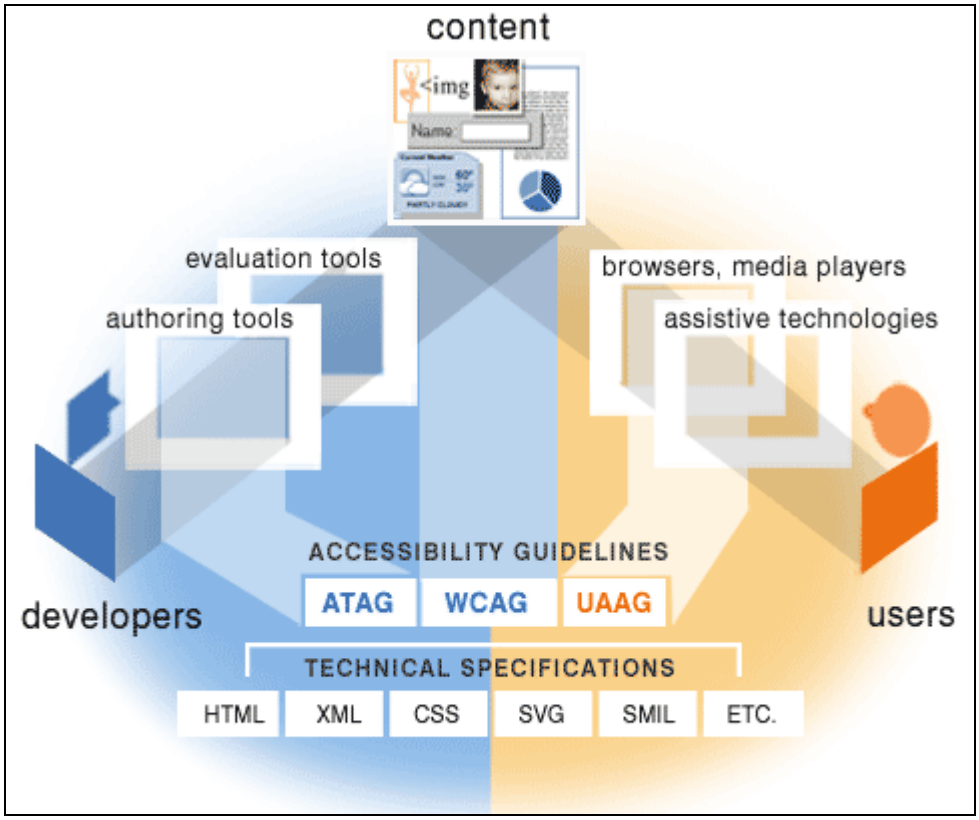


Figure 3. Web Accessibility Initiative: Accessibility guidelines, illustration of how the guidelines relate (WAI).

3.1.1 Web Content Accessibility Guidelines (WCAG)

The goal of the guidelines is to encourage good design practice. The Web Content Accessibility Guidelines, WCAG, is the most important document, covering the accessibility issues of Web page content. An old misunderstanding is that accessible Web design means minimal and imageless page design. There are also checklist and techniques documents that assist Web page developers to comply the guidelines. (Paciello 2000 pp.48-51, WAI Web site)

The WAI has published the first version 1.0 of Web Content Accessibility Guidelines in 1999. There are 14 guidelines that form general principles of accessible design, and they all have one or more accessibility checkpoints. All checkpoints are prioritized on a scale 1-3. Priority 1 techniques are the highest; Web content developers "must" do them. The developers "should" satisfy the Priority 2, and "may" address Priority 3 checkpoints. There are three conformance levels, A, AA and AAA.

- Level A: all Priority 1 checkpoints have to be satisfied
- Level AA: all Priority 1 and 2 checkpoints have to be satisfied
- Level AAA: all Priority 1, 2 and 3 checkpoints have to be satisfied

The list of the WCAG 1.0 checkpoints is in appendix A. (Chisholm et al. 1999a)

WCAG version 2.0 is a work under process. The guidelines form four principles of accessibility, and one or more success criteria for each principle. The principles are as follows:

1) Content must be perceivable.
2) User interface components in the content must be operable.
3) Content and controls must be understandable.
4) Content must be robust enough to work with current and future technologies.

The success criteria are organized in current draft version to three levels of conformance. WCAG version 2.0 will be more applicable to different coding languages, as WCAG version 1.0 is very HTML, HyperText Markup Language specific. Version 2.0 will also have benefits sections that explain how the success criteria benefit people with specific disabilities. Version 2.0 will be published quite soon as an official W3C Recommendation. Now during spring and summer 2006 the WCAG 2.0 Last Call Working Draft is asked to being commented. However, in this study the focus is still on version 1.0 as the official published version, while it may still take undefined time for the version 2.0 to be published

as an official W3C Recommendation. (Caldwell et al. 2006, WAI Web site) The WCAG 2.0 draft guidelines can be seen in appendix B.

3.1.2 Authoring Tool and User Agent Guidelines (ATAG & UAAG)

Authoring Tool Accessibility Guidelines is for authoring tools that generate Web pages, such as MS Frontpage. This aspect is very important since many Web page developers – especially millions of non-professionals – are not even familiar with proper HTML recommendations, let alone accessible content recommendations. The ATAG has two purposes: the authoring tools should generate accessible Web content, and the authoring tools themselves should be accessible. (Treviranus 2000, Paciello 2000 pp. 51-52, WAI Web site)

On the other end of the table, User Agent Accessibility Guidelines is made for Web browsers and media players, such as Internet Explorer, Mozilla Firefox or Opera. Also for example mobile phones, personal digital assistants, PDAs and assistive technologies are *user agents*, meaning that they can be used to display Web content. User agent does not mean the same as user terminal. Harshly classified the user terminal means the hardware and user agent the software of the user device, although the difference is not that clear. A certain mobile phone with a Web browser is a user terminal, while the phone has a user agent, meaning the Web browser. (Jacobs et al. 2002, Paciello 2000, WAI Web site)

It is important that if a Web site satisfies accessible content guidelines, that there is also a user agent that utilizes the accessibility for the user, for example enlargement of the font size. There are also some repair requirements in UAAG for cases where the page content does not conform to WCAG. It is good that the WAI admits that it is not a perfect world – or Web – and there do occur errors on Web pages that the user agents should try to overcome. (Jacobs et al. 2002, Paciello 2000 pp. 52-53, WAI Web site)

3.2 Development of standards

WCAG 1.0 was published as an official W3C recommendation in May 1999, and it was the first official document by the WAI. ATAG 1.0 was published in February 2000, and

UAAG 1.0 in December 2002. There has been approved UAAG version 1.1 in July 2005. WCAG version 2.0 is aimed to be finalised in 2006, and following that there will be published a finalised ATAG version 2.0. WCAG is the leader in the development, and especially ATAG has to naturally follow WCAG, as the authoring tools have to produce content that is compliant to WCAG. The research and development for all guideline versions 2.0 have been started practically right after the publication of versions 1.0. This indicates how rapidly the Web technologies have been developing during the past years, and the development seems to continue in future. (WAI Web site, Vilén 2005)

The differences between WCAG version 1.0 from 1999 and later WCAG 2.0 draft versions suggest that the trend in Web accessibility standards is towards more universally applicable and concrete requirements, covering more disability types (Bartlett 2001, Vilén 2005). The course of development since first version in 1999 also indicates that there would continue to be an inevitable and expected advancement also in the browsing and assistive technologies. These points have lead to the conclusion that the Web accessibility concepts will not be stable but rather emerging also in future. The development will not make the present standards useless but they will be revised and improved, and the new standards are likely going to be backwards compatible. The priority levels may change, making some specifications more important than before. (WAI Web site, Vilén 2005 p.15)

4 Electronic banking

Banking matters are handled over the Internet more than ever before, and net banking is still a fast growing area. There are different electronic banking solutions, covering different types of customers and different user terminals. Finland is one of the leading countries in using electronic banking, and Nordea bank holds the world record in netbank usage. (FBA, Jansson 2006, Nordea)

4.1 Electronic banking solutions in Finland

Finland's three biggest banks are Nordea, OP-ryhmä and Sampo, respectively. Their market share of Finnish banking was over 80 percent in the end of 2004. Finnish banking technology differs from common European banking. In 2005, the payment automation degree was 95 percent, and there were 283,7 million telebanking transactions. As comparison, in 1996 there were 18,7 million and in 2000 92,0 million telebanking transactions. Telebanking includes both electronic banking and telephone banking. Electronic banking and banking with mobile phone are still growing rapidly. (FBA, Risikko 2006)

Predictably, all the three biggest banks in Finland offer electronic banking services. Electronic banking is also called Internet banking or net banking. In the end of 2005, there were over 3,5 million bank customers in Finland who had a net banking agreement (FBA). The biggest Finnish banks offer also an alternative version of net banking solutions. All the three banks have a smaller netbank version for users who use for example PDAs, mobile phones with Internet connections, or just otherwise slow Internet connections. OP has also a netbank version with simplified user interface. The version is called Helppo, "easy" in English. It is advertised as a version for new users and users who need to enlarge text on the screen. (Nordea, OP, Sampo)

Most common functionalities of Nordea's text version, OP's text version and easy version, and Sampo's text version are listed in **table 3**. All the versions advertise that with them it is possible look at the accounts and balances, transactions, do payments and view credit card

balance, and make transfer from credit card account to own account. All these versions have more functions than listed here, so that it can be said that the basic needs for electronic banking service are well satisfied.

Table 3. Most common functionalities of Finnish netbank alternative versions.

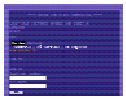
	Nordea text version	**OP text version**	**OP Helppo**	**Sampo text version**
Accounts: view account balances and transactions	x	x	x	x
Payments: domestic and cross-border	x	x	Only domestic payments possible	x
Cards: credit card balance and transfer to own account	x	x	x	x

4.2 Different versions of Nordea Netbank

Nordea is the world leader in Internet banking, having 4.4 million e-banking customers and largest netbank usage in the world. Nordea offers several net banking solutions. The best known is the 2005 renewed Netbank for private users. Besides this, there is also Netbank for corporate users, WAP services for mobile devices using Wireless Application Protocol browser, text version of the Netbank and Mobile Netbank. The text version, WAP services and Mobile Netbank are providing multi-channel accessibility to e-banking services, as they enable use of net banking services with mobile or small terminals overcoming limitations of screen size and text input. (Jansson 2006, Nordea)

In **table 4** can be seen the different Nordea Netbank solutions for different user terminals. In the first column there are described different types of user terminals with example images, and the second column contains the respective Nordea Netbank versions.

Table 4. Nordea Netbank solutions for different user terminals. (Mobile phone pictures taken from Nokia's Web site)

User terminal		Netbank version
	Full-size desktop / laptop computer	Netbank for private users
		Netbank for corporate users
	Communicator, wide screen	Text version
	Text-browser, assistive technology	
	Mobile phone with Web-browser, narrow screen	Mobile Netbank
	Mobile phone with WAP-browser	WAP services

In **table 4**, the text version is listed as the recommended Netbank version when using assistive technology. This is because the text version can offer better terminal adaptation due to its lighter page contents and accessible design. For example, the text version pages can be accessed easily with a screen reader, and the pages contain few enough content that they can be well magnified without hiding parts of the pages. However, most assistive technologies are likely to be able to use the main version of the netbank, meaning Netbank for private users.

4.3 Text version of Nordea Netbank

The text version of Nordea Netbank was first published in the mid 1990s, and its main purpose is to serve different user terminals, including slow Internet connections, text browsers and mobile devices. The page sizes are generally about half of those in the full size version, and therefore downloading times are shorter. The text version is also used as a back-up solution for the main Netbank version for private users. Even though the old name is "text version", there are some small images, and it would be more descriptive to use the term "*light version*" instead. The name *text version* has been kept for user friendliness, as

it is a known name for many years, and changing the name could cause more confusion than user satisfaction. (Jansson 2006, Nordea)

Figure 4 presents Nordea's text version in communicator size in spring 2006, before the facelift project. The name text version is a bit misleading as there are images and otherwise the text is kept very minimal. Netbank usage, especially with mobile phones, is a growth area (FBA).

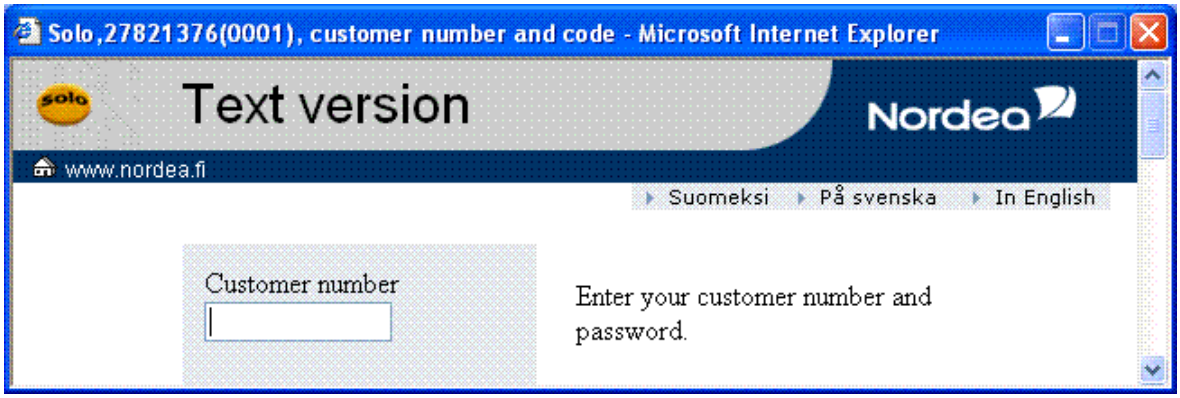


Figure 4. Nordea Netbank's text version in communicator size in spring 2006.

This thesis is a part of the text version's facelift project, in which the user interface and accessibility of the application have been improved. Accessibility experts often state that text-only versions of Web pages are discrimination, because they try to separate disabled users from "normal" users by providing different versions. The content is usually updated less often and is in many cases less comprehensive. (Slatin & Rush 2003, Clark 2002)

However, Nordea Netbank's text version is meant mainly for lighter connections and smaller displays, thus the content should in principle be as comprehensive as the main version's. The text version provides the same netbank functionalities as the full size version, leaving out basically only long texts, advertisements and big images. This may also appear to an inexperienced user as an easier user interface. Reijo Juntunen from Finnish Federation of the Visually Impaired has stated that lighter versions of netbank are "*feasible as long as the main versions are so difficult to use*". He also stresses that many netbank main versions do not work in different platforms, but is concerned that lighter versions may not offer all the same functionalities as the main versions. (Jansson 2006, Juntunen 2006)

In fact, Nordea Netbank's text version is the most comprehensive netbank text version in the world. This is because the text version has been created on the former main Netbank version, with adaptation in the page structure. The text version does not have frames, nor show a link menu on the side of the page, and the top part is minimized in images and links. Below is a list of some of the text version's functionalities: (Jansson 2006, Nordea)

- View account balances and transactions
- Pay bills and transfer money between customer's own accounts
- Check when bills fall due
- View loan balances and maturity dates
- Apply for cards
- Monitor MasterCard and Visa transactions
- Transfer money from MasterCard credit to another account
- Apply for insurance and check insurance information
- Follow stock exchange prices
- Invest in funds
- Make an agreement on regular saving in funds
- Trade in securities
- Order services and make agreements
- Order travel exchange in advance

As can be seen the offered services cover easily the needs for day-to-day banking. There are some additional services in Netbank that a user cannot find from the text version, for example account alerts. However, the text version is comprehensive enough that it enables equal net banking to the main version. (Nordea, Jansson 2006)

In the text version facelift project, the application has been modified to look more like the present version of the Nordea Netbank main version, some use cases have been simplified to improve usability, and most accessibility issues have been corrected or improved. A picture of the old text version's payment page is seen on appendix C. The experiences from the accessibility work of the text version are intended to be used in the future for other electronic banking portal versions as well.

5 Accessibility evaluation methods

This chapter discusses the methodology to evaluate and improve the accessibility level of a Web-based service. The WAI describes methods for evaluating conformance level of Web site accessibility (WAI Eval). The WAI's list has been used as a starting point, and some modifications and additions have been made to the methods to make it more suitable for netbank evaluation.

WAI's Evaluation site (WAI Eval) recommends doing the conformance evaluation in three steps:

1) *Determining evaluation scope*, introduced in chapter 5.1
2) *Using Web accessibility evaluation tools*, chapter 5.2
3) *Manual evaluation of representative page sample*, chapter 5.3

And in addition to these heuristic parts recommended by WAI, there is

4) *User testing*, introduced in chapter 5.4.

The empirical implementations of these parts in the research are listed respectively in chapters 6.1, 6.2, 6.3 and 6.4.

5.1 Determining evaluation scope

According to WAI, during the first step of the accessibility evaluation, the target conformance level of WCAG 1.0 should be set. The target conformance level means either A, AA or AAA, that were described in chapter 3.1.1, *Web Content Accessibility Guidelines*. Furthermore, a representative page sample should be selected for manual evaluation, and the entire Web site should be identified and disclosed for semi-automatic and automatic evaluation.

Representative page sample should contain the most used pages, or at least pages that cover most of the elements used in the site. Such elements could be for example tables, forms, link lists, scripts or images. Many Web sites have page templates that are used in most, if not in all, of the pages. Therefore, the pages are structurally very similar, which reduces the need to do the same checks again and again. Identifying and disclosing the

entire Web site at the same URL for semi-automatic and automatic evaluation is for static Web sites. If covering the whole site is not feasible, an expanded page selection for semi-automatic and automatic evaluation should be used instead. (WAI Eval)

5.2 Using Web accessibility evaluation tools

The second step of the accessibility evaluation includes testing the pages with automatic testing software. This includes testing the markup language validity including syntax and style sheets, and testing the pages with automatic accessibility validators. WAI advises to check on all pages the HTML and CSS, Cascading Style Sheets. The sample pages should also be checked with at least two different accessibility evaluation tools, and all pages should be evaluated with at least one tool. (WAI Eval, Clark 2002, HiSoftware)

W3C is providing HTML and CSS validators itself, but for accessibility evaluation tools the WAI offers a list of known tools that can be found in the Internet. WAI does not give preference to any accessibility tools. Some of the most referenced tools in literature are Bobby, Cynthia Says and WAVE. The recommendation of using two different accessibility tools is grounded because the automatic tools may have misidentifications. The automatic validation should be used only as assistance for the accessibility evaluation, since many checkpoints cannot be checked with automatic software. For example, an automatic tool cannot judge whether an alternative text to an image is descriptive or not. Furthermore, an automatic software program cannot analyse if the reading order of a page or the progression order on a form are logical for the user. (WAI Eval, Clark 2002, HiSoftware)

5.3 Manual evaluation of representative page sample

The manual evaluation includes checking the sample pages with WCAG 1.0 Checklist (Chisholm et al. 1999b), testing the sample pages with different browsers, and evaluating the language used in the pages. WAI recommends using at least three different combinations of graphical user interface, GUI, browsers, browser versions and platforms. According to some Web statistics (TheCounter.com 2006) the Microsoft Internet Explorer is used by over 80 % of Web surfers. Similarly, in Nordea, the employees use Internet Explorer with Microsoft Windows operating system as the main browser type, and the

adaptability with different browsers should not be taken for granted. Also some adjustments to the settings should be made with one or more GUI browsers (WAI Eval, WebAIM):

- Turn off images, and check whether alternative text is available and understandable.
- Check whether audio content, if present, is available as text.
- Use browser controls to vary font-size: verify that the font size changes on the screen accordingly; and that the page is still usable at larger font sizes.
- Test with different screen resolution, and/or by resizing the application window to less than maximum, to verify that horizontal scrolling is not required (caution: test with different browsers, or examine code for absolute sizing, to ensure that it is a content problem not a browser problem).
- Check that the colour contrast is sufficient by changing the display colour to grey scale or look at print preview with grey scale.
- Use the pages with just keyboard, making sure that you can access all links and form controls, and that the links clearly indicate what they lead to.
- Turn off tables, and check that the reading order makes sense.
- Disable CSS, and check that the content makes sense and is in a logical format.
- Disable JavaScript, and check that the page is still operable and usable.

The manual evaluation is not to be done with just GUI browsers. The sample pages should be tested also with a text browser and a voice browser. With these specialized browsers it should be checked whether there is equivalent information presented to the GUI browsers. The functionality should be equivalent as well. The content should be in a meaningful order when read or spoken serially. (WAI Eval)

The manual evaluation includes also checking the language. This task is impossible to do automatically, but for example mistyping could be best detected with a text processor. The text should be clear and understandable, and abbreviations and difficult terms should be explained. Long and strange words should be avoided. Short and simple sentences should be used, and the text structure should be clear and logical. (WAI Eval, Freyhoff et al. 1998)

5.4 User testing

The WAI evaluation methods are all expert evaluations using heuristics, but actual user testing should be made as well. Compliance with just accessibility guidelines is not necessarily sufficient for users to access what they need (Gerber 2002). In accessibility evaluation, usability tests should be conducted with disabled users. User testing enables to know the user, and in all user interface testing the tester should have neutral test-users. The end-user should show in the test how he would use the service as naturally as possible. Therefore it would be best if the tests were made in the end-user's own work place or home. (Faulkner 2000, Slatin & Rush 2003, Sinkkonen et al. 2002, Paciello 2000)

Usability test has three parts: (Sinkkonen et al. 2002)

1. Planning and organizing the test.
2. Implementing the test.
3. Analyzing the test, test results and reporting.

Organizing the test includes at least:

- Setting the goals for the test
- Setting usability requirements
- Getting to know the product
- Selecting the users and number of users
- Selecting the test method

With qualitative test the goal is to find as many usability problems as possible. Other option would be to do quantitative test in which there would be comparable results, for example number of clicks or errors during a given task. Qualitative test suits accessibility study since the overall goal is to find and identify any accessibility barriers on the Web service. (Sinkkonen et al. 2002, Slatin & Rush 2003)

The most suitable test method for accessibility testing is to go through the tasks together with the tester. The tester asks the test user questions while the test user is doing the test tasks. This reveals the user's mental models, but requires good atmosphere and social skills from the tester. After the tests, there should be an interview that clarifies the test user's satisfaction towards the product. The first questions should be of type: "How was it? How did it feel?" As noted in chapter 2.3 *Usability in Web based services*, user satisfaction is

only one part of usability, and it should not be over-emphasized at the expense of other parts. For this type of accessibility testing, a suitable interview method is the semi-structured questionnaire, which would have a few pre-defined questions and emphasis on the conversation. The questions will give structure for the interview, but the idea is to concentrate on what comes up at the situation. This can give new points of view to the whole situation, which is not necessarily possible with just pre-defined questions. (Sinkkonen et al. 2002, Slatin & Rush 2003, Faulkner 2000)

6 Facelift of Nordea Netbank's text version

The facelift project of Nordea Netbank's text version was executed during spring 2006. The goal of the project was to upgrade the usability of the Netbank's text version in use with specified mobile device classes and accessibility with different user agents, including assistive technologies. This thesis, including analysis and evaluation of the accessibility level, was done in order to identify the accessibility factors concerning electronic banking services, and hence the accessibility level of the text version could be improved. The actual composition of the source code was not part of the thesis, but thorough understanding of the composition was essential.

This chapter also describes how the accessibility evaluation methods introduced in chapter 5 were implemented in the evaluation of the text version of Nordea Netbank. The evaluation was done in two phases, due to the nature of the facelift project of Nordea Netbank's text version. In the first phase a preliminary accessibility evaluation was done. The first phase results were then used for correcting the found barriers. In the second and final phase, after the corrections, a more thorough analysis of the actual accessibility level was conducted. The first phase results are discussed in chapter 7.1, and the second phase results are described in chapter 7.3. There was also carried out user testing with a blind user, which turned out to be a very valuable learning experience. The user test results are described in chapter 7.2. The evaluated accessibility is summarised to chapter 7.4.

6.1 Scope of evaluation

A target level was not set before the first phase evaluation. Instead, the goal was to tentatively evaluate the level of the accessibility and see what kind of target level is possible in this netbank application. There was, however, decided the representative page sample that was also the facelift project scope. The page sample comprised of the following pages:

- Login
- Front page
- Menu page

- Payments
- New payment + Confirmation
- Transfer
- Accounts + Transactions
- Investments
- Cards + Transactions
- Logout

These pages are the most used, and comprise over 95 % of the mobile usage (Risikko 2006).

The same sample pages were used also in the second phase evaluation and user testing. Only the sample pages were evaluated, and the few excluded pages were completely left out of the scope. This was decided in the facelift project scope, and therefore this thesis' results are only applicable in the defined scope of pages. After the first phase evaluation, the target level was set to AA of WCAG 1.0, but also some level AAA requirements would be looked at. This means that all level A and AA checkpoints would be aimed to satisfy, and additionally some level AAA requirements where they could be seen applicable.

6.2 Web accessibility evaluation tools

WAI offers a list of known tools available on the Internet (WAI Eval), and in this study the free software or free samples were tested for feasibility. However, using automated Web accessibility tools turned out to be a complicated task. The problem that arose was due to the fact that the netbank application forms the pages dynamically through a secured connection. Most of the automatic validators accept only Web page addresses (URL, Uniform Resource Locator) as input, and therefore the pages of a secured-connection netbank application could not be tested on the fly.

6.2.1 Accessibility validators

Cynthia Says (HiSoftware) is probably the best-known accessibility tool, and for example Firefox and Internet Explorer offer additional Web developer toolbars that have shortcut to Cynthia Says. Another often-referenced tool in accessibility literature is Bobby that has

changed its owner and name to Watchfire WebXact (Watchfire). Neither Cynthia Says nor Bobby could be used for the dynamic page validation. The reason was that they would require a page URL as input, and that is not possible to use with dynamic pages inside the netbank application. Several free tools were tried, but there was found only one accessibility tool that could be easily used for netbank evaluation.

An accessibility tool called Wave (WebAIM Wave) accepts also file upload as page input. This can be used so that the pages are saved to user's own computer and then uploaded to the Wave validator in Web. Wave is user-friendly because it displays the check results visually. Wave searches for certain code elements and displays an icon next to those elements that may have a positive or negative effect on accessibility. An example of an analysis is seen in **figure 5.** There can be seen different colours indicating if an element has positive or negative effect. Red icons present errors, yellow icons for alerts, green icons for accessibility features, and light blue icons display structural elements, such as reading order of page element for screen readers. Multi-coloured icons are like alerts, they indicate that it should be checked if some elements are used inappropriately.

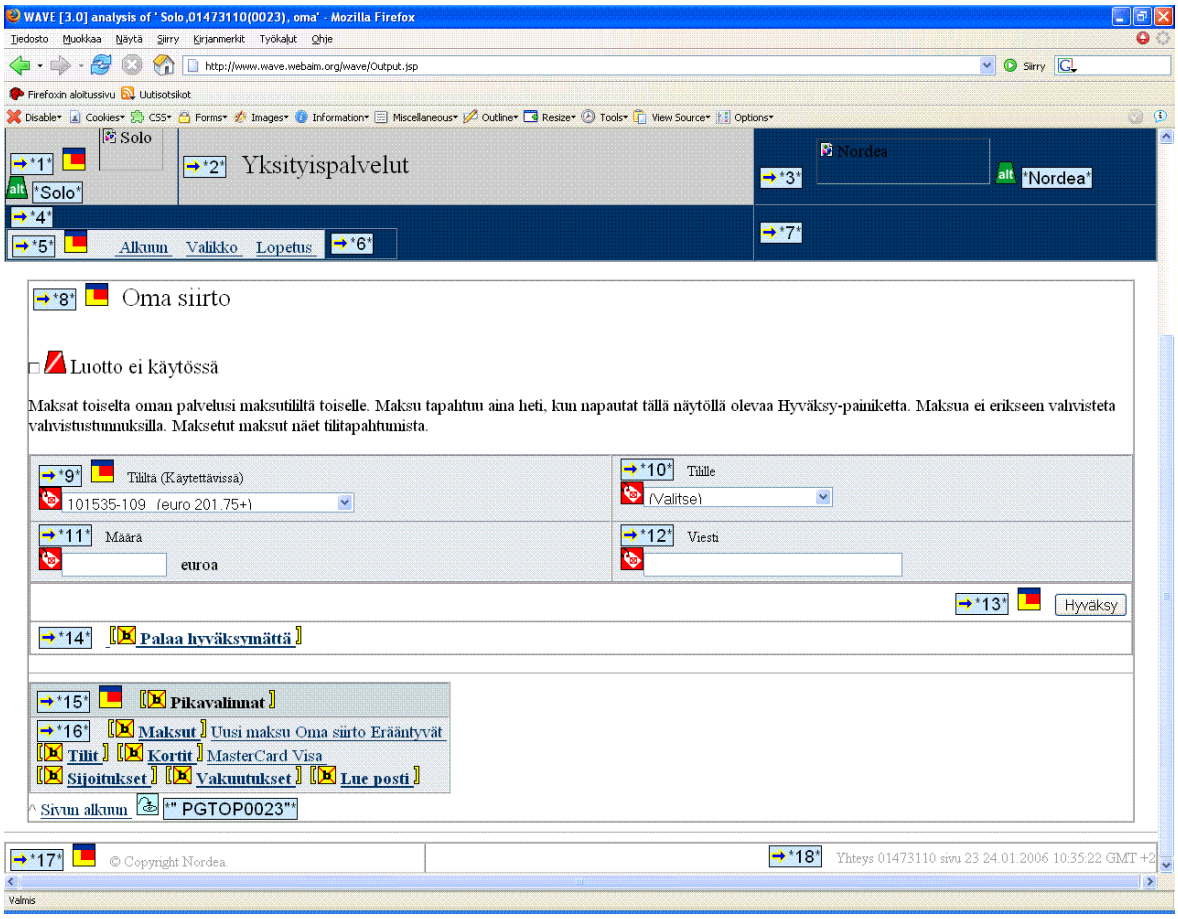


Figure 5. Wave accessibility analysis result of the transfer page of Netbank's old text version.

The most advantageous feature of Wave is that it is very quick to see the elements visually. This works especially as there often seems to be many similar notifications on a page. For example, in **figure 5** there are seen some input fields that are all missing the *label* attribute, and therefore they all have a similar red icon marking that. Another option for a validator would be to show all results as text, but that is a more boring and slower style. The upside of having results written out in text is that the exact line of the code can be displayed. However, since dynamic netbank pages are constructed from page templates, the exact line of the page code does not bring any added value for the application developer.

Wave has its own page explaining the meaning of the icons and their reference to WCAG 1.0 and Section 508 requirements. There are also some Wave's own recommendations, for example the check whether two images in a row have the same *alt* text. This is smart, as in such case there may have been used copy-paste or automatic software, and the alt texts may not be correct and descriptive for all images individually. Wave was an effective tool for swift understanding and finding several elements that may have an effect on the

accessibility of netbank pages. Thus, Wave worked well for the purpose of an automatic accessibility tool: to provide systematical help for quickly finding possible accessibility problems.

6.2.2 W3C HTML and CSS validators

Some of the sample pages were also checked for correct coding language. The W3C has Markup Validation Service (http://validator.w3.org) for checking the mark-up, and CSS Validation Service (http://jigsaw.w3.org/css-validator/) for checking the style sheets of a site for conformity. Again, the problem with secured connection and dynamic pages caused difficulties when checking the validity.

In the old version of Netbank's text version the style sheets were not used at all. This worked both for and against the accessibility guidelines. The pages worked without CSS, which satisfies WCAG 1.0 priority 1 checkpoint 6.1: "document must be possible to read without associated style sheets", but then again fails priority 2 checkpoint 3.3: "use style sheets to control layout" (Chisholm et al. 1999a).

One short style sheet was created during the facelift project and added as embedded to the pages. The style sheet is stored in only one file but it is included in all pages in the page header. This enables centralized updating. Embedded style sheets are more robust than external CSS files in mobile use, since some mobile phone browsers cannot use external style sheets (Jansson 2006). The style sheet was simple to test with the W3C CSS validator. The lines were copy-pasted into the input field in the CSS validator in Web.

Checking the HTML language for W3C standard conformance was challenging. The text version is over 11 years old product, and the application has been developed through several eras with different Web browsers dominating the end user markets. Therefore it was known already before the facelift project that the code would not be valid due to strict W3C HTML specifications. The HTML validation was easiest to do with direct input, by copy-pasting the source code of each page to the validator in Web.

In the first phase testing, first error on each page was a missing document type declaration, "*!DOCTYPE"*. There were several repeating errors that actually caused the majority of the

reported errors, for example one very frequent error was the use of ampersand symbol *"&"*. Due to specifications, the ampersand symbol should be used encoded, "*&*" also when they are used in links as a separator. The browsers should then interpret the encoded ampersands in links. Secondly, the used ampersands caused often more errors elsewhere, as the validator interprets wrongly the characters following it.

However, some old Internet browsers do not comply with all valid HTML elements. Therefore, only some of the reported HTML errors were corrected. A good example of very useful, but not valid W3C HTML element is the *autocomplete* tag. When autocomplete is set off, the browser does not save the contents of a user input field. This is very useful for example in login screen where the user types in the user ID and password.

6.3 Manual evaluation

The sample pages were checked with WAI Checklist of Checkpoints for Web Content Accessibility Guidelines 1.0 (Chisholm et al. 1999b). This checking needs also familiarity with HTML techniques. The results of first phase evaluation are presented in chapter 7.1, and the second phase results in chapter 7.3.

The sample pages were tested for operability with the following browsers:

- Internet Explorer 6 (Windows XP operating system)
- Internet Explorer for Mac 5.2.2 (Mac)
- Firefox 1.0.2, 1.5 (Windows XP)
- Firefox 1.5 (Linux)
- Mozilla 1.7.12 (Windows XP, Mac)
- Opera 6.05, 7.54, 8.01, 8.51 (Windows XP)
- Netscape 7.2 (Windows XP)
- Konqueror 3.3.2 (Linux)
- Safari 1.0.3 (Mac)
- Lynx (via SSH-connection), text browser
- JAWS with Internet Explorer and Mikropuhe speech synthesizer, and Tieman Braille display in user test (see chapter 6.4)

It was very revealing to test the same pages with different browsers. Browser testing showed in practice how difficult it could be to browse simple and familiar netbank pages. The browsers looked and worked bit differently, which makes the testing with different browsers grounded. The sample pages were used “normally” with mouse and keyboard, and also with only keyboard. Changing the browser settings was done with Internet Explorer, Firefox and Opera. The setting changes were described in detail in chapter 5.3 *Manual evaluation of representative page sample.* With other browsers at least the font size scalability was tested. Short notes from the second phase browser tests can be seen in appendix E.

Browsing with only keyboard was challenging, because there are no universal styles for keyboard use in all browsers. Internet Explorer and Firefox work generally with tabulator switching between links and input fields, and space or enter pressing a button. Opera uses keys Q, A, W, S, E and D for certain switching, and control + arrow keys for general switching between links and input field. Learning to use Opera with keyboard required at least 15 minutes for training and finding guidance on the Web, which is very long time in Web surfing and requires good patience.

Similarly, different browsers and operating systems may have required further studying for their efficient use. The meaning of the research was to test the netbank application for accessibility, and not to test different Web browsers for accessibility. Therefore it was seen satisfactory to test the keyboard-only use with a couple of the most used browsers, and otherwise test general operability with both mouse and keyboard.

6.4 **User testing**

User testing was conducted with a blind bank employee. He uses JAWS program that interprets the elements on the screen to a readable format. JAWS features connection to a speech synthesizer program called Mikropuhe that reads aloud the content in Finnish. Besides JAWS he also has a Braille display, manufactured by Tieman. The tests were made in the test user’s own work office with his personal laptop computer. He uses the computer at work and also at home every day. **Figure 6** displays the user test setting.

Figure 6. User testing was carried out in the test user's own office.

The user test was started with an open conversation with some questions about the test user's computer use habits and adaptive technology. There were also some predefined questions about the test user's use of banking services, Nordea's Web pages, and good and bad experiences in Web pages in general. The introduction before the actual testing gave background to the test and shed light into the user's expectations.

The test plan was to go through the sample pages introduced in chapter 6.1, *Scope of the evaluation*. The same pages and functions had already been evaluated in the first phase manual testing with different browsers. Hence, there would already be extensive experience of the test target. The goals for the test were to see how the pages look and feel with adaptive technology, and that way to find any possible accessibility barriers and as many usability problems as possible. The emphasis was on testing whether the test user is able to perform the given tasks with the Netbank application, or would there occur any insuperable obstacles.

The user test was conducted between the first phase preliminary evaluation and the final evaluation of the completed version. This was useful for the facelift project, since the user

test gave feedback on the Netbank application in its production cycle, when the product was mostly developed but could still be corrected and improved if necessary.

7 Results

In this study the accessibility of Nordea Netbank's text version was first evaluated, then improved, and at the end it was re-evaluated. The first phase evaluation was done in the beginning of the text version's facelift project. During the first phase the accessibility checkpoints became familiar and the evaluation could be trained. After the first phase evaluation, the found errors were assessed and corrected where applicable.

The end result of the research is the conformance level for accessibility of Nordea Netbank's text version. The preliminary first phase results are described in chapter 7.1, the user test results in chapter 7.2, the second phase evaluation results in chapter 7.3, and the final accessibility level is revealed in chapter 7.4. Another result is naturally the improved Netbank application. A screen caption of the modified Netbank New payment page can be seen in appendix F. The same page can be seen before the modifications in appendix C.

7.1 First phase results

The first phase evaluation results were fairly promising. As there were practically no images, CSS, JavaScripts, multimedia nor frames in the application, the most common accessibility problems were already absent. Therefore, the text version almost reached the conformance level A without modifications. However, accessibility tool Wave reported some errors and the manual evaluation did not pass all the checkpoints of level A. The most often reported shortcomings were concerning data tables, there should be better handling of the table headers and markup, namely the use of "th", "theader" and "tfooter" in HTML. Since the text version is technically very "light", the level AA could be achieved as well. However, that would require more corrections, and the biggest problem would be to try to make the markup language totally valid so that it would pass the automatic HTML validations.

The level AAA was found too high-level for this type of an existing product, and reaching that level was not seen beneficial. The level AAA could be more feasible for building a new site, or with a site that provides mainly just information, like a news site without any

user input forms. Since Nordea Netbank's text version is over 11 years old product that has to be interactive and form the pages dynamically, it is not wise at this stage to try to aim for the level AAA. On the other hand, all the checkpoints and success criteria were revised and taken into account, because they all are beneficial at least to some users regardless of their requirement level.

The short notes from the first phase evaluation are listed in appendix D. The level A and AA checkpoints of WCAG 1.0 that were not met in the first phase evaluation are listed in **table 5**. Level AAA checkpoints were not evaluated in the first phase. There was one certain shortcoming of priority level A checkpoints, concerning table markup. Table headers should be used according to specification, which was not always the case. Another checkpoint was concerning the text equivalents for objects; there were very few images, including the Nordea logo that did not have an alt text. In those cases all images should have at least an empty *alt* text for the screen readers and text browsers. Also some other highest priority, level A, checkpoints must be kept in mind in the development. If style sheets were added, the content should be readable and understandable also without them. The used language should be as clear and simple as possible. If colour is used, the information provided with colour should be also available without colour.

Table 5. The levels A and AA notes in the first phase accessibility evaluation.

Priority level	WCAG 1.0 Checkpoint	Occurred error
A	1.1 Provide a text equivalent for every non-text element.	The Nordea logo was an image but did not have an alt text.
A	5.1 For data tables, identify row and column headers.	Table headers “th” were not always used in data tables.
AA	3.2 Create documents that validate to published formal grammars.	The HTML validation failed. Some unofficial markup was used.
AA	3.3 Use style sheets to control layout and presentation.	There were not used style sheets, but some markup for layout.
AA	3.4 Use relative rather than absolute units in markup language attribute values and style sheet property values	Some font sizes were marked in absolute values.
AA	3.5 Use header elements to convey document structure and use them according to specification.	The headers were often used for layout purposes. The header level was often chosen for font size.
AA	7.5 Until user agents provide the ability to stop auto-redirect, do not use markup to redirect pages automatically. Instead, configure the server to perform redirects.	The intermediate pages needed further study if they violate this rule.
AA	12.4 Associate labels explicitly with their controls.	The input fields in forms did not have a label attribute.

Furthermore, there were six checkpoints of priority level 2 that were not satisfied at this stage. As noted earlier, the most difficult requirement in level AA is the use of valid HTML. However, where possible, the markup should be corrected to be more formal, so that the number of reported HTML errors could be smaller, hence enabling better adaptability to different user agents. Other corrections required for meeting level AA guidelines included adding the missing style sheets, removing absolute font sizes, using text headers in their proper order and adding labels to input fields. It should be further studied whether the intermediate pages violate the auto-redirect prohibition, and whether they could be removed completely.

7.2 User test results

Overall the test results from the user test were encouraging. Generally the test user could access and use all the tested pages and forms. Nevertheless, some parts were found to cause problems for the test user, which also made the test fruitful. On the learning part, the

test was even more beneficial. The test showed how a blind user would browse Web pages, which is useful to understand for the development of the page structures. The test proved in practice why satisfying some certain accessibility guidelines really help the use of Web pages.

The four most important test results are numbered and listed in **table 6.** There is also mapped a relevant guideline for each case, and their correspondence in WCAG 1.0 and WCAG 2.0 draft from 27 April 2006. On the last column of the table 6, a significance level is rated from one to three, and a comment on the guideline's importance. The WCAG 1.0 checkpoints and WCAG 2.0 draft version guidelines are listed for review on appendices A and B, respectively.

Table 6. The most important notes from the user test. WCAG recommendations are seen on appendices A and B.

Number	Observation in user test	Relevant guideline	WAI recommendation	Significance 1-3 (1 imperative)
1	The user often uses link list of the page.	The link names should clearly identify the target without other text.	WCAG 1.0: 13.1 (AA) WCAG 2.0: 2.4.4 (level 2)	1. This is inevitable requirement for all users; link texts should be understandable alone.
2	The account number was typed in incorrectly during the test.	Identify errors and show them to the user.	WCAG 1.0: – WCAG 2.0: 2.5.1 (level 1)	2. The WCAG 2.0 guides to describe the error, but a blind user cannot read a printed payment form. See text for detailed analysis.
3	The screen reader tells the number of links and headings when a page has been loaded.	Divide content into logical blocks and use descriptive headings.	WCAG 1.0: 12.3 (AA) WCAG 2.0: e.g. 2.4.5 (level 3)	2. Make sure there is not too much information on one page.
4	The heading list is often used as stand-alone for page browsing.	Page structure; use headings according to specification.	WCAG 1.0: 3.5 (AA) WCAG 2.0: 1.3.1 (level 1)	3. Make sure the page structure is short, logical and clear, but do not stress about heading numbers.

The first note in table 6 is that the user used often link list of the pages. JAWS screen reader software offers functionality that the user can view all the links of a page with a simple key combination on the keyboard. There is a guideline that requires making the link texts descriptive, in WCAG 1.0 it is checkpoint number 13.1 with priority 2, and in WCAG 2.0 draft version Success Criterion number 2.4.4, as well with priority 2. Based on the user test, this guideline should be rated higher, and therefore it is given level 1 significance in this context. Descriptive link texts are very important, not only to the blind users, but also for anybody's understanding and especially for people with dyslexia or learning difficulties.

The number 2 note from the test was that the test user typed in incorrectly the account number when making a new payment. The tester read out the account number and the test user typed it on the page. There is a new level 1 guideline in WCAG 2.0 that requires error identification and description for the user. In fact, during the test, the test user got an error message claiming that the account number was not an existing account number. Anyhow, the whole situation revealed the true problem in electronic banking: a blind user cannot read printed invoices; the account number, payment reference number and the like have to be in an electronic format. A feasible solution in the near future is the electronic invoice that is already used in some banks. The test user commented that typing in the account number or payment amount was not a problem per se because he could check the input using the Braille display.

The number 3 note was that the screen reader read automatically the number of headings and number of links when the page was loaded. This emphasises the usability aspect that a massive page with too many headings and links is difficult to use. The relevant guidelines for this subject are that the page should be divided into manageable groups and the headings should be descriptive. The first part, divide into manageable groups, is in WCAG 1.0 as checkpoint 12.3, but the requirement is no longer required as such in WCAG 2.0. There is, however Guideline 3.1 in WCAG 2.0 that requires readable and understandable text content. The Success Criterion 2.4.5 in WCAG 2.0 requires descriptive titles, headings and labels. Checkpoint 12.3 in WCAG 1.0 and Success Criterion 2.4.5 in WCAG 2.0 are a level 2 and level 3 requirements, respectively. This subject has been rated to significance level 2, since failure to comply this does not create an impossible barrier for accessibility, but makes the Web site use very difficult.

The number 4 note in the table 6 is about the heading list that the screen reader displays. The test user used the heading list often to browse the pages. The heading list gives a quick overview of the page, allowing the user to scan the pages lightly. As noted in chapter 2.3.2, *Usability in electronic banking*, most Web users do not read the pages word-by-word, and the test indicated that scanning the pages is common also amongst blind users. WAI has made a requirement that headings should be in order, for example H2 should be a subsection of H1, and H3 a subsection of H2. Headings and their paragraphs in the correct order make the pages and page structures logical. Anyway, the sample pages contained in some cases only level 3 headings on a page without any level 1 or level 2 headings. In the test, this was not seen as a significant problem, as those pages contained only three to five headings as maximum. Level 3 headings suit the outlook of the pages, and do not have too big font size. Therefore this subject is rated for significance level 3 in this case.

There were naturally other observations made during the test, and here are collected couple more fairly important as a list. The numbering is continued from table 6 for this list:

5. Screen reader did not read the remaining text after an input field on the same row.
6. On payment confirmation page the account name was not displayed anymore.
7. The payment list page was difficult to use since there were so many payments. The test data was not suitable for use testing.

Number 5 refers to a case where the test user was filling in a form and could not see some text after an input field. There was some descriptive text before an input, and some more text after the input field. The screen reader read the text until it reached the input field and then stopped. This made the text after the input field “invisible”. These occurrences were corrected afterwards, so that there is no descriptive text after the input fields.

Number 6 is about the payment confirmation page. When typing in a payment, the user could see the optional name for the from-account. However, on the payment confirmation page there was shown only the account number, and the user could not see the account name anymore. This is a usability subject, which may cause confusion for the user. This feature was changed since, and the from-account is not visible without the account name.

Number 7 refers to the test data. In the test the test user logged in with an already existing test user ID of the Netbank. There were already existing accounts and old payments for the Netbank user that had been made by other people. Therefore, the test user in this user test was not familiar with the test data, which caused some problems. There were too many accounts and old payments in the test user's system, which confused the test user in the test. This is not a problem of the Netbank product, but an important lesson about user testing. The test data should always be as realistic as possible.

7.3 Second phase results

The second phase evaluation was conducted on the final product after modifications. The same evaluations were made as in the first phase evaluation, with some additional browsers in the manual evaluation and more thorough estimation of the conformance to the WCAG 1.0. Also style sheets were investigated, as they had been included into the application.

The tests with different browsers proved that the application was generally accessible. The application functionalities could be done with all browsers. The tests with different browsers also revealed how differently a Web page could be displayed. The text browser did not give access to external links, meaning links outside the Netbank application. Those links opened in new windows in other browsers, except old version of Opera 6.05 that opened the links in the same window. The restriction of Lynx text browser was due to link addresses and secured/non-secured connections. Nordea has decided not to give access to pop-up links with text browser for better usability. In **figure 7** can be seen the indentation on the menu page with text browser. The indentation works well, as the page heading "Everyday finances" is aligned to the left end of the screen. Then there are some sublevel headings, "Payments", "Accounts" and "Cards" that are aligned a little bit more to left than the rest of the links. Graphical browsers display theses subsections in separate boxes.

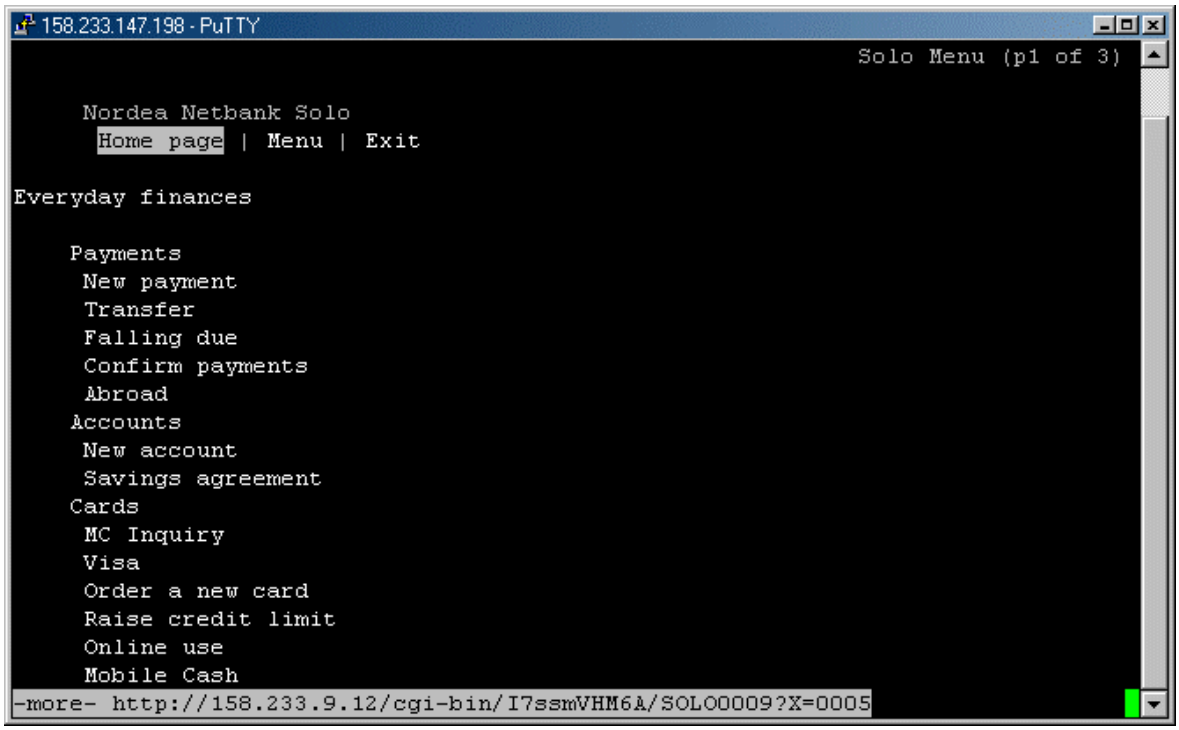


Figure 7. Menu page with text browser shows the indentation of the different level headings.

Some browsers could not solely or at all be used with the keyboard. There were problems with keyboard use in Konqueror and Firefox with Macintosh operating system, and Safari with Linux operating system. At first there were problems with Opera browsers, but after studying the Opera functionality it could be used just by keyboard. This revealed the fact that usability problems may have caused all the barriers in keyboard use. However, it was not seen convenient to study different functionalities of different browsers anymore, and redo the tests. It was sufficient to use the most familiar browsers for more comprehensive testing. The keyboard use was easy with Internet Explorer and Firefox in Windows operating system, and all the links, forms and pages could be accessed with just a keyboard, which was a satisfying result. Anyway, all browsers could access the pages at least with mouse and keyboard combination.

In chapter 7.1 table 5 were listed the WCAG 1.0 checkpoints that were not met in the first phase evaluation. In **table 7** there are listed the same checkpoints with comments whether they were corrected or not during the facelift project. The first column tells the priority level according to WCAG 1.0, the second column describes the checkpoints, and in the third column there is shortly explained whether the checkpoint is satisfied during the facelift project. There are two level A and six level AA checkpoints that were not fully satisfied before the facelift project.

Table 7. Unmet accessibility checkpoints in first phase evaluation and their status after the project.

Priority level	WCAG 1.0 Checkpoint	Corrected
A	1.1 Provide a text equivalent for every non-text element.	Yes, all images have an alt-attribute.
A	5.1 For data tables, identify row and column headers.	Yes, the table headers are now used in accordance to specification.
AA	3.2 Create documents that validate to published formal grammars.	Not met. It was not seen feasible – or even grounded – to change the HTML to completely valid.
AA	3.3 Use style sheets to control layout and presentation.	Yes, there is implemented embedded and minimal CSS, but some background colours are defined still in markup.
AA	3.4 Use relative rather than absolute units in markup language attribute values and style sheet property values	Yes, the font sizes are not defined in markup anymore.
AA	3.5 Use header elements to convey document structure and use them according to specification.	The headers are in order, but not fully according to specification, as noted also in table 6.
AA	7.5 Until user agents provide the ability to stop auto-redirect, do not use markup to redirect pages automatically. Instead, configure the server to perform redirects.	Satisfied, but not changed. The intermediate pages do have an auto-redirect, but the browsers are able stop the auto-redirect, which satisfies the checkpoint.
AA	12.4 Associate labels explicitly with their controls.	Not completely. The label attribute is used on the login page, but old browsers did not understand the element. Therefore the labels were left out elsewhere.

Both previously unmet level A checkpoints were satisfied during the facelift project. Alt attributes were included to all images in the project scope. Table headers were also added to all data tables so that the table structures are according to specification. Satisfying all level A checkpoints means that the Netbank application is at least level A conformant in the project scope.

All previously unmet level AA checkpoints were improved during the project. A clear correction is that the font sizes are not defined in the markup anymore at all. Otherwise the checkpoints had to be followed where feasible, meaning that there are still left some unmet level AA checkpoints. Correcting the markup language to totally validate official W3C HTML validation was not seen feasible because the application is very old and the needed

corrections would be very extensive. Another ground for not making the markup entirely valid was that there are in use some old browsers that do not support all elements of completely valid HTML. However, some corrections were made to the markup so that the number of reported errors in HTML validation decreased significantly.

There was found one instance where the invalid HTML was visible for the end user. On New payment page, Mozilla browser version 1.7.12 does not align two buttons. **Figure 8** shows a part of the New payment page where two overlapping HTML elements cause the browser to display “Accept” and “Read barcode” buttons unaligned. However, the instance was only cosmetic, since the buttons functioned well with Mozilla browser.

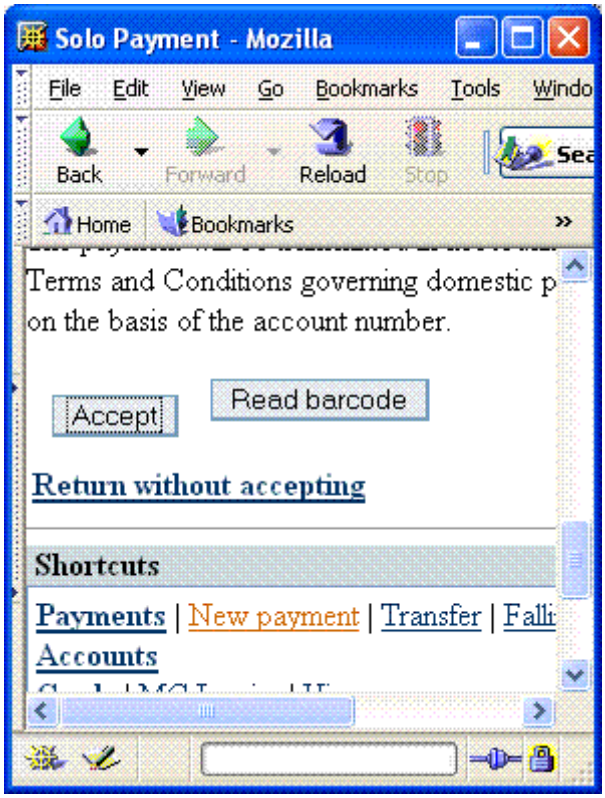


Figure 8. Mozilla browser displayed two buttons unaligned due to overlapping HTML elements.

Style sheets were implemented to define colours and layout. Embedded and minimal CSS was added to the page headers. The CSS was desired to be kept minimal because there were doubts on how some mobile terminal browsers would use them. The CSS was embedded to the pages for the same reason; some mobile browsers cannot use external style sheet files. One exception was left due to uncertainty of some old browser functionalities: in account tables, where account data is listed, background colour was left to every other row for better visualization. An example of present background colours in

Internet Explorer can be seen in **figure 9**. Opera can disable also styles that are defined in the markup, and Opera could display the same page without any colours.

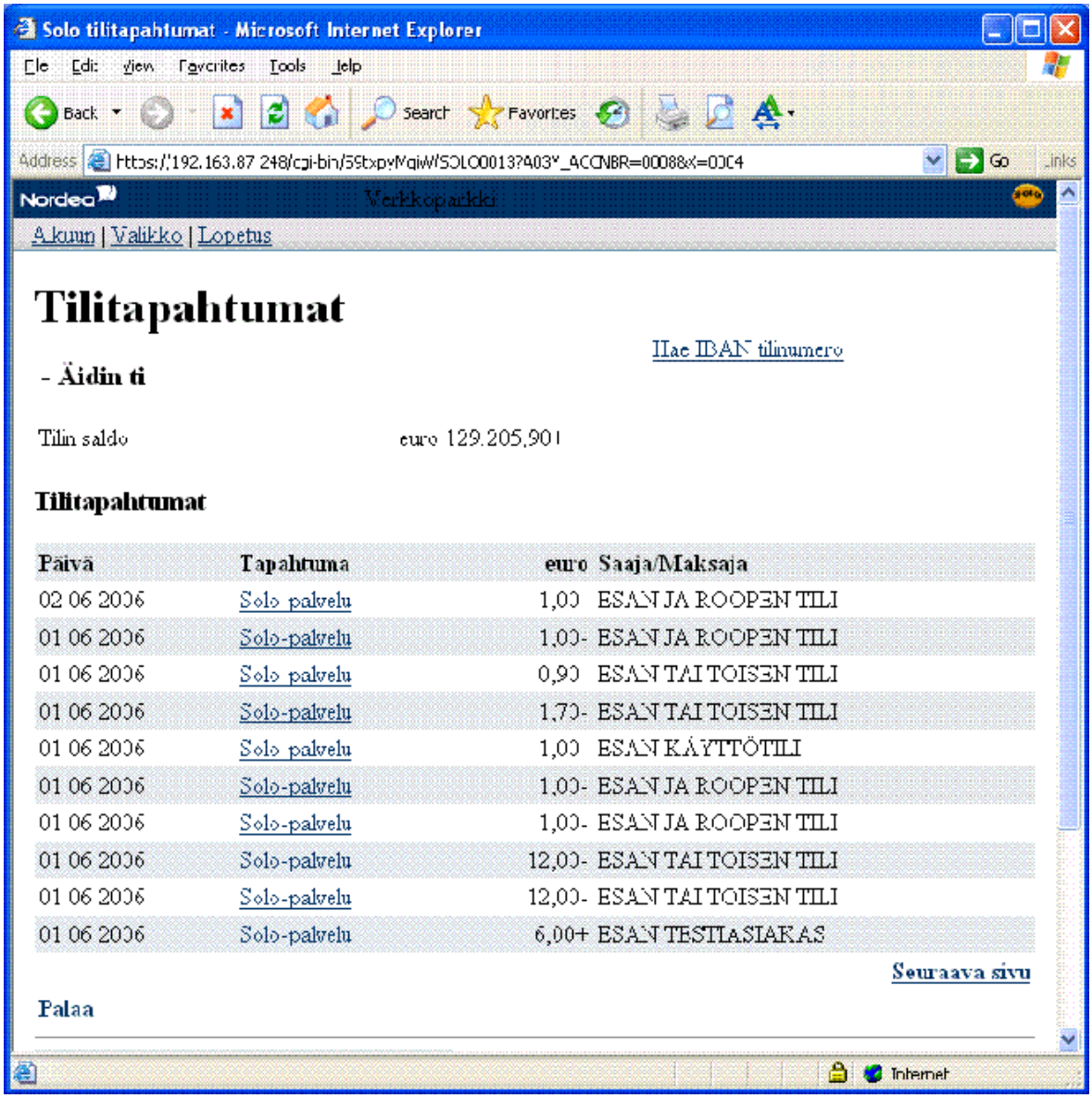


Figure 9. Account transactions page in IE with CSS disabled. Some background colour is defined in the markup and is therefore still visible.

Other unmet checkpoints concerned page headers, auto-redirect and label elements. The page headers were not fully according to specification before the facelift project. Many pages had only level 3 headings. This was improved in most pages; there are now level 1 headers in all pages in the project scope. However, the specification would require existing level 2 headers if there are level 3 headers, and this rule was not satisfied everywhere. This point was also noted in the user testing in chapter 7.2, and it was not seen a significant

shortcoming in the user test either. There are few enough headings in the pages, hence the structure of pages is easy to outline.

Auto-redirect is used in the intermediate pages, but those pages also have a link, if the browser does not support the auto-redirect. The text browser did not perform auto-redirects, hence the link had to be clicked. The WCAG 1.0 checkpoint 7.5 forbids using the auto-redirect until “user agents provide the ability to stop auto-redirect”. At least the newer browsers had a setting that could stop the redirect. The intermediate pages do not confuse the user nor cause any flashing or flickering. Therefore the checkpoint is satisfied.

The last missing point is the label attribute. The label tag is meant for marking the text that explains any input field. The label element was not used with the control fields. In the Netbank application there are several input text boxes, especially on the payment pages. The label element was inserted to the login page but not to other instances. The reason was that there was found problems with older browsers, for example Opera 6.05. The browser displayed a warning on the page claiming: “a script wants to read the password(s) in the form.” This happened because the browser did not understand the label attribute, and displaying such a message for input fields is not good usability, as the user could wrongly regard the pages insecure.

7.4 Conformance level of Nordea Netbank’s text version for accessibility

The achieved Conformance level of Nordea Netbank’s text version for Web Content Accessibility Guidelines 1.0 is **A**. With certain exclusions, the Conformance level is AA.

The Nordea Netbank’s text version, in the scope defined in the facelift project, satisfies all Priority 1 checkpoints, and most of the Priority 2 checkpoints. The scope comprises of the pages that are also listed in chapter 6.1, S*cope of the evaluation*:

- Login
- Front page
- Menu page
- Payments
- New payment + Confirmation

- Transfer
- Accounts + Transactions
- Investments
- Cards + Transactions
- Logout

All 16 level A checkpoints were satisfied. The remaining checkpoints of level AA that were not totally satisfied are:

- 3.2 Create documents that validate to published formal grammars.
- 3.3 Use style sheets to control layout and presentation.
- 3.5 Use header elements to convey document structure and use them according to specification.
- 12.4 Associate labels explicitly with their controls.

The reasons for not satisfying these checkpoints were explained in chapter 7.3. All the rest of the 30 level AA checkpoints were satisfied.

Additionally, Nordea Netbank's text version satisfies these level AAA checkpoints:

- 4.3 Identify the primary natural language of a document.
- 9.4 Create a logical tab order through links, form controls, and objects.
- 11.3 Provide information so that users may receive documents according to their preferences (e.g., language, content type, etc.)
- 14.3 Create a style of presentation that is consistent across pages.

8 Conclusions

An initial note on the whole accessibility study is that I have become clearly an accessibility advocate myself. This is not because I had strong personal experiences or views about the subject when starting the work, but explaining the subject to other people and answering questions have made their influence. This is in fact very good, since the most important outcome of the work is to build awareness within my employer Fidenta and in Nordea. The awareness concept has been brought up in several sources that I have referenced, for example Paciello (2000 p. 61), Gerber (2002) and Clark (2002) are stressing how important it is to explain the benefits and importance of accessibility. Accessibility would and likely will be taken into account much more when people/companies actually know what it really means and what it requires in practice. Therefore, the most important goals of this thesis are numbers 1 and 3; create an image of accessibility in Web; and gain experience in practice.

8.1 Reliability and validity of study

To recap on the objectives of this thesis:

1. Overview the present theory of accessibility in Web-based services, including standards and legislation.
2. Investigate the accessibility factors in electronic banking.
    a. Improve accessibility and usability of Nordea Netbank's text version.
    b. Find a conformance level of Nordea Netbank's text version for accessibility.
3. Gain accessibility experience in practice, in comparison to the theory.

Overall, the objectives of the thesis were achieved. The study has built an image of Web accessibility, but the work has only just started. Promoting accessibility requires continuous work, and giving presentations and practical advice are ways to enhance accessible design further. Investigating accessibility factors in electronic banking was the most concrete goal of the thesis. Both the improving accessibility and usability part and the finding a standard conformance level for accessibility part were done successfully. Most

importantly, the last goal, gaining experience in practice, was met. There is no substitute for actually doing and seeing for oneself in order to learn.

The found accessibility level can be regarded as reliable and valid. However, the WCAG 1.0 checkpoints are, to some degree, open to interpretations. Thus, another evaluator could come to a dissimilar result regarding some checkpoints, but I would see that very unlikely. On the other hand, the accessibility evaluation was done in two phases, which gave a better overview to the evaluation. Also the user testing spoke for the achieved results, but then again there was only one user test. Results from one user test should not be generalized lightly. In order to improve reliability of the study, there could have been more user tests with users who have different disability types. Nevertheless, this was not seen necessary in the given scope of the project.

8.2 Accessibility level of Nordea Netbank's text version

According to Web Content Accessibility Guidelines (Chisholm et al. 1999a) by Web Accessibility Initiative, achieving conformance level A means that the pages do not contain technical barriers that would make their use impossible. Furthermore, achieving level AA means that the pages do not contain technical barriers that would make their use difficult. Satisfying level AAA checkpoints improves access to Web documents. Nordea Netbank's text version satisfied all level A, most of the level AA and some level AAA checkpoints of WCAG 1.0. Accordingly, *Nordea Netbank's text version does not contain insuperable barriers or major difficulties for use, and it also offers some help for improved accessibility*.

It is very difficult to estimate the likely conformance level to WCAG 2.0 at this stage. The WCAG 2.0 draft document is very short, and requires additional documents *Understanding WCAG 2.0* and *Techniques for WCAG 2.0* just for understanding the requirements in practice. The additional documents describe in detail which techniques should be used to satisfy the accessibility criteria. However, the additional documents are not completed yet. Therefore judging whether a single success criterion is satisfied is not possible at this stage. Nonetheless, the conformance level to WCAG 1.0 should remain as a referable achievement even when the WCAG 2.0 will be completed.

The meaning of achieving level A conformance to WCAG 1.0 is a little abstract but important. Accessible netbank service means that users can access the netbank application without facing insuperable barriers, and a certain standard can only refer to that. A standard does not make a service easy to use automatically, but compliance to the standard claims that the accessibility is taken into account in the technical development. Furthermore, a widely recognized standard is the best way to prove and promote that the Nordea Netbank's text version is accessible.

Accessibility improves the user interface for all types of users. The users that benefit the most from accessible design may have disabilities in computer use. They may not be able to see, hear, move, or may not be able to process some types of information easily or at all. Or they may have difficulty in reading or comprehending text, or may not have or be able to use a keyboard or a mouse. They also may have a text-only screen, a small screen, or a slow Internet connection. Accessible design helps all users, at the latest when they reach the respectable older ages. Netbank is made for all bank customers, and it is everybody's right to use it.

8.3 Recommendations for netbank development

I see the accessibility field as twofold: *why* and *how*. *Why* to design accessible systems, and *how* to do it? There are several aspects speaking for why to do it. Answering the question requires background study and understanding of the benefits of accessibility. Answering how to do accessible should give a realistic and achievable solution. Furthermore, it should be divided up into small and concrete enough parts, so that the question is *what* instead of *how*. "*What can be done to improve the accessibility of this product*?" requires a concrete answer, *how* is too high-level for practical implementation.

As stated in chapter 2.1 *Disabilities in computer use*, the disabilities in computer use do not mean only a few people. Quite the contrary, most people are served better with accessible design. It is not even profitable to make special solutions only for certain user groups, unless there is a wider advantage. Hence, there is strong reasoning to make all Internet services accessible by default. For example, the Netbank text version concerned in this study is intended for varying user terminals and user devices, especially mobile phones. In mobile use there is not usually a mouse or a standard keyboard to use and the demand for accessible solutions are therefore built-in. Also the accessibility work enables

the text version for different kinds of users, including those who need assistive technologies. Likewise, other netbank versions should also be developed further for better accessibility, and that way to serve better all users.

As noted earlier, the most important goals for the study have been building the image of accessibility and gaining experience in practice. Regarding the latter, in the following sub-chapters there are short-term and long-term recommendations regarding accessibility in electronic banking. The intention is to show how little effort the short-term improvements require. The long-term recommendations include visions of how the whole netbank product development process could be improved regarding both accessibility and usability. The long-term recommendations are useful to acknowledge for planning product development processes in the future.

There are also some tasks listed for different roles in netbank development. It should be noted and emphasised that Nordea employees also have the Nordea Accessibility Policy (Hansson et al. 2006) available that should be studied for reference. Nordea's Accessibility Policy relies mainly on WCAG 1.0, so those who are familiar with WAI recommendations should not face anything surprising.

8.3.1 Short-term recommendations

Short-term recommendation, note the possible law-enforcement and **build awareness**. Law enforcement is possible in Europe in the near future. The European Union is striving for accessibility, and legislative actions may be taken into account after 2007. Nordic countries are active in promoting equality, and the EU member states may take legislative actions even earlier than the end of 2007. At this stage it is important to build awareness about accessibility, and generalize good basic principles in user interface design. In developing Web-based services, including netbank, the emphasis should be on satisfying the easiest guidelines first. And, more importantly, the development should not make the pages less accessible than their present level.

Recommendations in developing:

- Developers validate the pages as they build them

    - Use accessibility tool, for example Wave, and HTML and CSS validators
- Testers (and developers) check the basic accessibility features at testing phase
    - Use keyboard only
    - Disable images, check carefully image links and buttons
    - Disable JavaScript
    - Check for sufficient colour contrast
    - Check font size scalability
    - Disable CSS

Carrying out these simple manoeuvres does not require much extra time or effort in addition to the normal workload. The developers and testers need only from 15 minutes to half an hour to familiarise themselves with these techniques.

8.3.2 Long-term recommendations

Long-term recommendation, emphasise the importance of **quality** in UI. Quality in user interface development will certainly become a more crucial subject in the future. Today, the Internet users have been using the Web for information seeking for about a decade, at maximum. Imagine the situation in ten, twenty years, when even the elderly are as familiar with computers as most people are with their televisions now. Besides, an emerging area is the mobile use. It is very difficult to predict the success of mobile terminal use in the future, but small-sized browsers will likely have their ever-growing requirements for Web-based services, which is already at stake today. W3C is striving for “one Web for all” and is also developing the mobile technologies in Web use.

Building competence through education secures the benefit for customers and growth in developing quality services.

- Provide education and information
    - Developers: include developers in UI projects who know the WCAG guidelines and are also familiar with usability engineering
    - Testers: use different platforms and browsers; emphasize accessibility features
    - Usability experts: consult disability organizations and include disabled users to testing

8.4 Discussion and future perspectives

The term *accessibility* is fairly settled in English, both regarding accessibility in the physical environment and accessibility in information and communication technologies. Another very used term is Design for All. In Finnish the situation may more blurrier. There are two terms that are usually translated from the word accessible: *saavutettava* (reachable) and *esteetön* (barrier-free). The latter term is used to describe physical environment accessibility, and is well established in that sense.

Saavutettava is used by Finnish ministry of interior in their translation of Web Content Accessibility Guidelines, and, in my opinion, is the preferable one. The reason for using *saavutettava* is the nature of the term: there are different levels of accessibility, and there is not a simple "either or" division, like *esteetön* is. Or could one say, "this solution is more barrier-free than the previous one"? The terminology is very important since unclear terms may cause confusion. I have witnessed how accessibility is sometimes confused with usability when the concepts have been understood to be the same. This is not necessarily a bad thing, as accessibility may also benefit from the better-known concept of usability. Yet, the best understanding comes from using commonly established terminology.

The users with disabilities are naturally noticed easiest in accessibility work. This is because there are laws that require equal treatment for all people, and the disability organizations have done a lot of work to promote equal treatment, both in physical and information societies. Web accessibility has quite often been a bit mistakenly regarded as help for the blind to use computers. That is not exactly true, as accessibility means taking all types of people into account, including the blind but also people with and without other disability types. However, the false assumption is understandable, as the visually impaired are an identifiable computer user group for their need of assistive technology, and their active involvement in forming accessibility guidelines has been obvious.

Legislative enforcement would be very remarkable for Web accessibility. After studying numerous statements, recommendations, comments and some directives, I have noticed how important and beneficial the European Union could be in this issue. Web accessibility is a fairly new field and clearly needs continuous research, and therefore financial support

is required but especially there is need for a multinational view to the progress. Many organizations have done some accessibility guidelines in the late 1990's, but most seem to have handed the task to the Web Accessibility Initiative of the World Wide Web Consortium, which has its benefits. When the research is centralized to one organization, all the work may be done effectively avoiding overlapping work, and particularly avoiding dissimilar guidelines. The same should apply to the legislation concerning Web accessibility. Multinational companies in Europe should be able to reference to Europe-wide requirements, as opposed to study all stakeholder countries' legal requirements.

Naturally the Web Accessibility Initiative is receiving a lot of critique as well. The main problem may be their style to work openly including large amount of different parties. Trying to compromise with everybody is a good target, but of course it opens up more possibilities to argue about everything. Therefore it seems at the moment that in the accessibility field people are waiting what will happen next. The new Web Content Accessibility Guidelines version 2.0 will be published probably during 2006, and the future will show how it will be accepted. If it is a success, the European Union may start forcing the accessibility in Web-based services at some degree.

The thesis also raised further areas that could be researched. Different browsers and user terminals could be investigated for their accessibility. It would be interesting to know which user agent provides the best accessibility in general and also specifically for certain user groups. A closer subject to this thesis would be another evaluation of the same Netbank application with revised standard. A further research subject could be to evaluate the Nordea Netbank text version for conformance to WCAG 2.0 when the new standard is finalised. That would also reveal the true differences between WCAG 1.0 and 2.0.

An exciting field for further study would be the mobile browsers. Accessibility is a certain issue, while there are constantly emerging mobile phone models that change or develop their browsers frequently. Assistive technologies give also inspiration on future technologies. Now that there are already very competent, but yet expensive, voice-browsers, the possibilities to use them in wider markets could be interesting. For example, a commuter could listen his emails and favourite Web sites while driving or sitting in a bus.

Electronic banking is still a growing area, and there is also room for improvements. The bills, passwords and the like need to be entirely in digital form in order to make the whole banking process accessible for blind users. Electronic invoicing and direct debit are solutions that improve accessibility, usability and help all users. And additionally, the automatic payment procedures bring cost savings to the bank.

Paying attention to accessibility in producing Web-based services is worthwhile. Accessible design requires a positive attitude towards serving customers, and the winners are all end-users – not just certain user groups. The overall results are the satisfied customers, succeeding service providers, and a sustainable Information Society.

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Appendix

Appendix A.

Web Content Accessibility Guidelines (WCAG) version 1.0 checkpoints. Full guidelines is available at http://www.w3.org/TR/1999/WAI-WEBCONTENT-19990505
See reference list for Chisholm et al. (1999a).

In General (Priority 1)

1.1 Provide a text equivalent for every non-text element (e.g., via "alt", "longdesc", or in element content). This includes: images, graphical representations of text (including symbols), image map regions, animations (e.g., animated GIFs), applets and programmatic objects, ascii art, frames, scripts, images used as list bullets, spacers, graphical buttons, sounds (played with or without user interaction), stand-alone audio files, audio tracks of video, and video.
2.1 Ensure that all information conveyed with color is also available without color, for example from context or markup.
4.1 Clearly identify changes in the natural language of a document's text and any text equivalents (e.g., captions).
6.1 Organize documents so they may be read without style sheets. For example, when an HTML document is rendered without associated style sheets, it must still be possible to read the document.
6.2 Ensure that equivalents for dynamic content are updated when the dynamic content changes.
7.1 Until user agents allow users to control flickering, avoid causing the screen to flicker.
14.1 Use the clearest and simplest language appropriate for a site's content.

And if you use images and image maps (Priority 1)

1.2 Provide redundant text links for each active region of a server-side image map.
9.1 Provide client-side image maps instead of server-side image maps except where the regions cannot be defined with an available geometric shape.

And if you use tables (Priority 1)

5.1 For data tables, identify row and column headers.
5.2 For data tables that have two or more logical levels of row or column headers, use markup to associate data cells and header cells.

And if you use frames (Priority 1)

12.1 Title each frame to facilitate frame identification and navigation.

And if you use applets and scripts (Priority 1)

6.3 Ensure that pages are usable when scripts, applets, or other programmatic objects are turned off or not supported. If this is not possible, provide equivalent information on an alternative accessible page.

And if you use multimedia (Priority 1)

1.3 Until user agents can automatically read aloud the text equivalent of a visual track, provide an auditory description of the important information of the visual track of a multimedia presentation.
1.4 For any time-based multimedia presentation (e.g., a movie or animation), synchronize equivalent alternatives (e.g., captions or auditory descriptions of the visual track) with the presentation.

And if all else fails (Priority 1)

11.4 If, after best efforts, you cannot create an accessible page, provide a link to an alternative page that uses W3C technologies, is accessible, has equivalent information (or functionality), and is updated as often as the inaccessible (original) page.

Priority 2 checkpoints

In General (Priority 2)

2.2 Ensure that foreground and background color combinations provide sufficient contrast when viewed by someone having color deficits or when viewed on a black and white screen. [Priority 2 for images, Priority 3 for text].
3.1 When an appropriate markup language exists, use markup rather than images to convey information.
3.2 Create documents that validate to published formal grammars.
3.3 Use style sheets to control layout and presentation.
3.4 Use relative rather than absolute units in markup language attribute values and style sheet property values.
3.5 Use header elements to convey document structure and use them according to specification.
3.6 Mark up lists and list items properly.
3.7 Mark up quotations. Do not use quotation markup for formatting effects such as indentation.
6.5 Ensure that dynamic content is accessible or provide an alternative presentation or page.
7.2 Until user agents allow users to control blinking, avoid causing content to blink (i.e., change presentation at a regular rate, such as turning on and off).
7.4 Until user agents provide the ability to stop the refresh, do not create periodically auto-refreshing pages.
7.5 Until user agents provide the ability to stop auto-redirect, do not use markup to redirect pages automatically. Instead, configure the server to perform redirects.
10.1 Until user agents allow users to turn off spawned windows, do not cause pop-ups or other windows to appear and do not change the current window without informing the user.
11.1 Use W3C technologies when they are available and appropriate for a task and use the latest versions when supported.
11.2 Avoid deprecated features of W3C technologies.
12.3 Divide large blocks of information into more manageable groups where natural and appropriate.
13.1 Clearly identify the target of each link.
13.2 Provide metadata to add semantic information to pages and sites.
13.3 Provide information about the general layout of a site (e.g., a site map or table of contents).
13.4 Use navigation mechanisms in a consistent manner.

And if you use tables (Priority 2)

5.3 Do not use tables for layout unless the table makes sense when linearized. Otherwise, if the table does not make sense, provide an alternative equivalent (which may be a linearized version).
5.4 If a table is used for layout, do not use any structural markup for the purpose of visual formatting.

And if you use frames (Priority 2)

12.2 Describe the purpose of frames and how frames relate to each other if it is not obvious by frame titles alone.

And if you use forms (Priority 2)

10.2 Until user agents support explicit associations between labels and form controls, for all form controls with implicitly associated labels, ensure that the label is properly positioned.
12.4 Associate labels explicitly with their controls.
And if you use applets and scripts (Priority 2)
6.4 For scripts and applets, ensure that event handlers are input device-independent.
7.3 Until user agents allow users to freeze moving content, avoid movement in pages.
8.1 Make programmatic elements such as scripts and applets directly accessible or compatible with assistive technologies [Priority 1 if functionality is important and not presented elsewhere, otherwise Priority 2.]
9.2 Ensure that any element that has its own interface can be operated in a device-independent manner.
9.3 For scripts, specify logical event handlers rather than device-dependent event handlers.

Priority 3 checkpoints
In General (Priority 3)
4.2 Specify the expansion of each abbreviation or acronym in a document where it first occurs.
4.3 Identify the primary natural language of a document.
9.4 Create a logical tab order through links, form controls, and objects.
9.5 Provide keyboard shortcuts to important links (including those in client-side image maps), form controls, and groups of form controls.
10.5 Until user agents (including assistive technologies) render adjacent links distinctly, include non-link, printable characters (surrounded by spaces) between adjacent links.
11.3 Provide information so that users may receive documents according to their preferences (e.g., language, content type, etc.)
13.5 Provide navigation bars to highlight and give access to the navigation mechanism.
13.6 Group related links, identify the group (for user agents), and, until user agents do so, provide a way to bypass the group.
13.7 If search functions are provided, enable different types of searches for different skill levels and preferences.
13.8 Place distinguishing information at the beginning of headings, paragraphs, lists, etc.
13.9 Provide information about document collections (i.e., documents comprising multiple pages.).
13.10 Provide a means to skip over multi-line ASCII art.
14.2 Supplement text with graphic or auditory presentations where they will facilitate comprehension of the page.
14.3 Create a style of presentation that is consistent across pages.
And if you use images and image maps (Priority 3)
1.5 Until user agents render text equivalents for client-side image map links, provide redundant text links for each active region of a client-side image map.
And if you use tables (Priority 3)
5.5 Provide summaries for tables.
5.6 Provide abbreviations for header labels.
10.3 Until user agents (including assistive technologies) render side-by-side text correctly, provide a linear text alternative (on the current page or some other) for all tables that lay out text in parallel, word-wrapped columns.
And if you use forms (Priority 3)
10.4 Until user agents handle empty controls correctly, include default, place-holding characters in edit boxes and text areas.

Appendix B.
WCAG version 2.0 Guidelines. Working draft 27th April 2006.

Principle 1: Content must be perceivable.

- Guideline 1.1 Provide text alternatives for all non-text content.
- Guideline 1.2 Provide synchronized alternatives for multimedia.
- Guideline 1.3 Ensure that information and structure can be separated from presentation.
- Guideline 1.4 Make it easy to distinguish foreground information from its background.

Principle 2: Interface components in the content must be operable.

- Guideline 2.1 Make all functionality operable via a keyboard interface.
- Guideline 2.2 Allow users to control time limits on their reading or interaction.
- Guideline 2.3 Allow users to avoid content that could cause seizures due to photosensitivity.
- Guideline 2.4 Provide mechanisms to help users find content, orient themselves within it, and navigate through it.
- Guideline 2.5 Help users avoid mistakes and make it easy to correct mistakes that do occur.

Principle 3: Content and controls must be understandable.

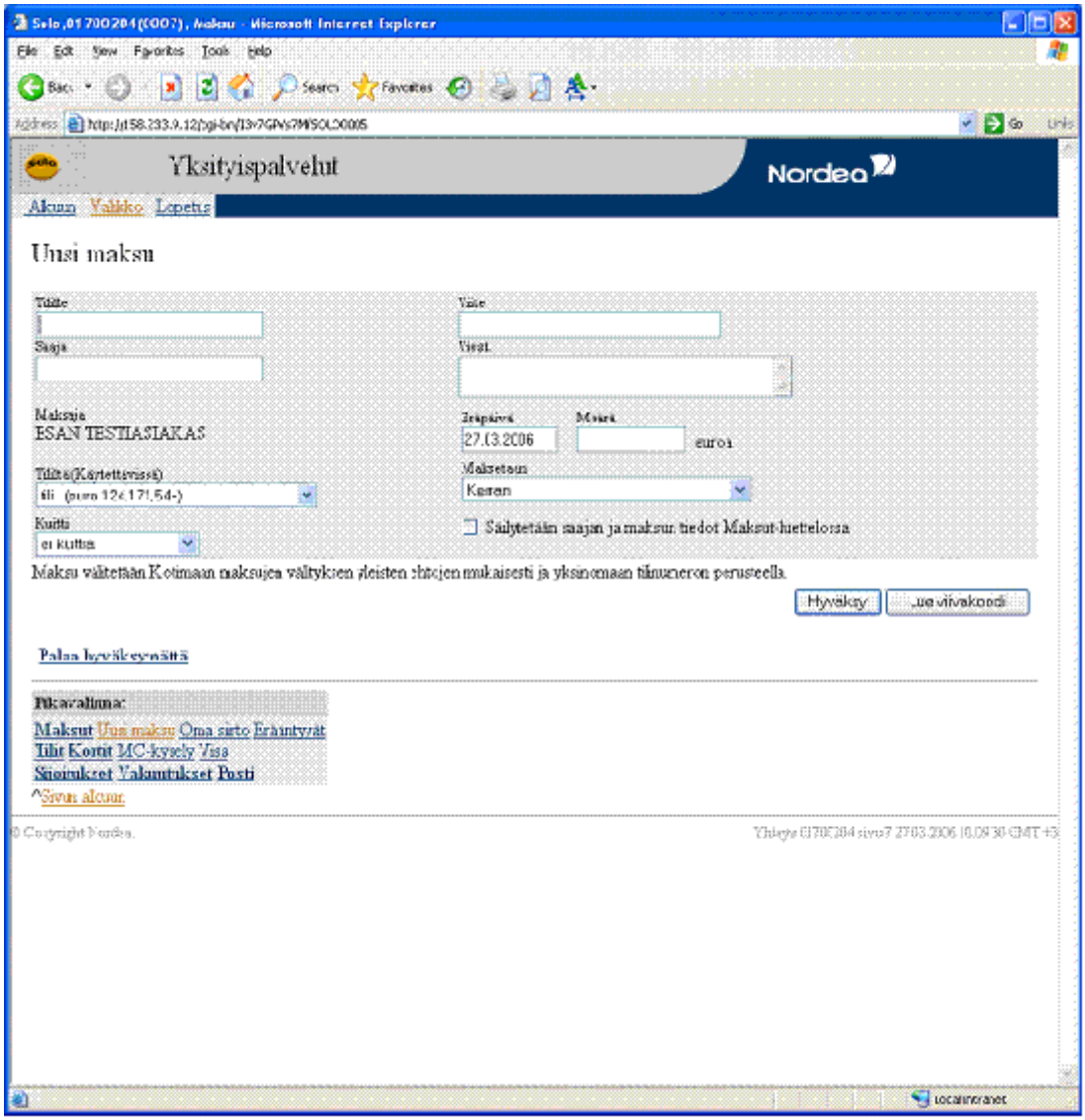
- Guideline 3.1 Make text content readable and understandable.
- Guideline 3.2 Make the placement and functionality of content predictable.

Principle 4: Content should be robust enough to work with current and future user agents (including assistive technologies).

- Guideline 4.1 Support compatibility with current and future user agents (including assistive technologies).
- Guideline 4.2 Ensure that content is accessible or provide an accessible alternative.

Appendix C.

New payment page before the facelift project



Appendix D.

Preliminary conformance evaluation of Nordea Netbank's text version for accessibility

January 2006, WCAG 1.0

- "A" level almost reached, some fine tuning needed, e.g. th, theader, tfooter, alt-texts to all images
- "AA" would be desirable target level, needs:
  e.g. labels to input fields, valid html, DOCTYPE (valid code and input labels are A-level requirements in WCAG 2.0?)
- "AAA" too complicated, but some features may be very useful

Automatic validators report errors on HTML, accessibility validators do not accept the pages (only Wave).

Manual evaluation: Tested browsers (systems): IE 6 (Windows XP), Firefox 1.0.2, 1.5, Opera 6.05, 7.54, 8.01, Netscape 7.2, Konqueror 3.3.2 (Linux), Safari 2.0.3 (Mac), Lynx (ssh-connection)

- All browsers worked fine, Opera 6 and Konqueror did not work properly with keyboard (browser failures?). Only Firefox 1.5 zoomed also dropdowns when growing the font size from browser. Lynx showed message field strangely in new payment field, alignment was to the right.

HTML code validation, add or correct the following:

- HTML doctype 4.01 transitional
- Lang -code
- <b> change to
- "label" to input fields
- use "th"
- alt-text to images
- JavaScript: type="text/javascript"
- STYLE: type="text/css"
- Diaeresis to width, size jne: size=+2 -> size="+2"
- topmargin, leftmargin, rightmargin, marginwidth, marginheight
- & -> & in links
- color, autocomplete (IE specific?)
- wrap (?)
- nobr (?)
- Crossing tags in new payment page
- Menu page: close tag without an opening tag
- Accounts: extra tag
- Some pages didn't have declaration: <meta http-equiv="Content-Type" content="text/html; charset=ISO-8859-1"> this resulted in errors with Scandinavian letters
- Menu, also quick menu: use "th" on higher level options: Payments, Accounts, Cards, Loans

Appendix E.

Notes from the second phase manual evaluation with different browsers

The notes are in the order in which the browsers were tested.

Macintosh operating system. The settings for JavaScript were not found in any browser in Mac.

Safari 1.0.3 Macintosh operating system

- Tabulator reached only input fields
  - Requires studying the browser, look Opera
  - Same applied to Firefox 1.0.7 and 1.5.0.1 in Mac
- Does not display alt-texts when the cursor is over the image (only IE does it, otherwise should be used image *title*)

Opera 8.54 Macintosh operating system

- Same problem with tabulator as FF and Safari

Mozilla 1.7.12 Macintosh operating system

- Did not allow tabbing
- Enlargens buttons and dropdowns

IE 5.2.2 for Mac

- Tabulator reached the links, good
- Did not find the browser settings
- Does not enlarge buttons or dropdowns

Debian GNU/Linux 3.1

Firefox 1.5

- Worked fine, no problems

Konqueror 3.3.2

- Tabulator reached the links but got stuck to text input fields. Keyboard navigation stopped in those.
- Enlarged nicely dropdowns and buttons
- After the end of a page the tabulator moved the cursor to the first input field of the form, not the beginning of the page.

PuTTY SSH secure shell connection

Text browser

- Did not open a link from external source (a pop-up link)
- Connection was breaking badly and was slow
  - The text browser was retested for these problems, and worked well

- Intermediate page (to Investments) showed the refresh address, but did not perform refresh automatically
- Menu page displays very nicely
    - Payments, Accounts and Cards were smoothly aligned to a level between headers and content links
- Accounts page had line division badly because the alt texts were shown and a row content (an account's info) did not fit into a row
- Direct debit page (link from the main page) showed help-image image name because there was no alt text (corrected)

Windows XP

Opera 6.05 (the oldest browser in the test)

- First could not use keyboard for navigation
- Login page displayed an alarm that there was a script that wants to read the passwords
    - The browser did not understand *label* attribute, hence the error
- Did not open a new window for pop-up links; I accidentally closed the whole browser when a pop-up page gave "close the window" link

Opera 7.54

- Did not reach links by tabulator
- Account transactions page: "Previous page" link did not work due to changing JavaScript on and off during the connection

Opera 8.01 and 8.51 (the latest version)

- The keyboard navigation with Opera became clear (only) at this stage
- Opera has dissimilar keyboard functionality, had to study Opera's keyboard with Google for 15 minutes
    - Opera has SHIFT + arrows for navigation between links and input fields
        - On Login page could not reach www.nordea.fi link in top right corner with arrows. Inaccessible browser functionality
    - A and Q browse between links
    - W and S are supposed to navigate the headers, in practice reached also texts with different font sizes
    - E and D navigate through all elements on a page
    - Tabulator navigates between input fields
    - F9 needs to be pressed sometimes to get the focus on the page
    - Comma (,) and dot (.) start find for links and text respectively
        - Backspace erases text in input fields, but otherwise it takes to previous page, like in other browsers
- Zoom is very beautiful with Opera browsers, Opera also zooms images (may be a positive or negative thing)
    - Nordea and SOLO logos were quite understandable at least with 500% zoom
- Zooms also buttons and dropdowns
- With whole 19 inch monitor window, the pages could be zoomed to 230% without need for any horizontal scrolling

- Even with 300%, the Netbank text version is well understandable and usable on the screen
- The “Back to top” link did not always work, likely due to changing JS on and off during the use

Netscape 7.2

- Navigation worked fine with tabulator
- Space could not be used to click the links, but buttons ok

Mozilla 1.7.12 (newest version was 1.7.13)

- Some pages had problems with “Page top” link
- Space moves the page, like Page Down button
- However, checkboxes must be selected with space, as Enter and Return launched the submit button of a form. Inconsistency!

Appendix F.

New payment page after the facelift project

Input fields are arranged on top of each other. This enables better use with narrow screen and improves usability since the progression is clearer. Compare to the old screen in appendix C.