

The impact of web accessibility on e-service design

1. Introduction

This report gives some background information about web accessibility – an approach to designing web sites, e-applications and services so that they work well for people with disabilities. It covers information about what accessibility means, what regulations there are in the different North Sea Region countries; suggests how to set up an accessibility project and provides guidelines and links to other resources.

The importance of the web as an information source has rocketed over the last 10 years and is still growing. With this, development focus is now starting to shift from technical and aesthetic features to also include good usability, for which accessibility is an important factor. For people who don't fully understand the importance of good usability, it might (in some cases) seem like taking a step back. Good accessibility is all about making things simple – going back to basics in many cases. It is good to remember that if a product is not usable, it will not meet its objectives and therefore could be a waste of time and money.

No report on accessibility could ever be made without mentioning the importance of the World Wide Web Consortium, W3C¹. The W3C is leading the web accessibility initiative, WAI². The collected resources and guidelines provided by W3C and WAI are internationally recognised as the standards for any work with e-inclusion. Useful resources and relevant links to these are provided at the end of this document.

¹ <http://www.w3.org/>

² <http://www.w3.org/WAI/>

2. Difference between Usability and Accessibility

The definition of usability is relatively precise and widely accepted:

“The extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use”.

For accessibility the definition is less clear. One way to describe web accessibility is:

“...that people with disabilities can perceive, understand, navigate, and interact with the Web, and that they can contribute to the Web” (<http://www.w3.org/WAI/intro/accessibility>). It is also important that web accessibility “encompasses all disabilities that affect access to the Web, including visual, auditory, physical, speech, cognitive, and neurological disabilities.”

In the literature there are different opinions about what accessibility is and its scope. Some writers feel that accessibility is distinct from usability, while others see it as a subset of usability, meaning that accessibility is specific types of usability problems (Thatcher et al, 2003). Shneiderman (2003) introduced another term – ‘universal usability’ arguing that “Universal usability goes one step further [from accessibility], striving to make the content and functionality accessible and usable by all”. Petri and Kheir (2007) believe that “accessibility and usability problems can be seen as two overlapping sets, which would include three categories:

- Problems that only affect disabled people; these can be termed “pure accessibility” problems;
- Problems that only affect non-disabled people; these can be termed “pure usability” problems;
- Problems that affect both disabled and nondisabled people; these can be termed “universal usability” problems.

Regardless of how it is defined, accessibility and usability are important elements in web design. Both accessibility and usability should be implemented in a well designed product. Interaction design is all about putting humans rather than technology first. To achieve this there are some key concerns that needs to be considered - these are usually referred to as Accessibility, Usability, Acceptability and Engagement.

Usability

Usability describes how efficient and effective an interactive product is. To achieve usability, you need to set a number of usability objectives. Usually these objectives include:

Efficiency – how quickly can a user perform a task?

Learn-ability – is it easy to use the first time?

Memory – Can people remember how to work the product next time they use it?

High utility – The product does the things that people want to get done

Effectiveness – Does it have the right functions and information content and are these well organized?

Accessibility

Design for accessibility should take usability objectives into consideration and make sure that they also enable people with different types of disabilities to use an interactive product.

Acceptability

To achieve acceptability you need to take into consideration the context in which the product will be used. Key features might be political, cultural and social habits, convenience and economic. For example a product that makes noises when used might not be acceptable in a library.

Engagement

A well design product should also be engaging to use, in order to be enjoyable, rewarding, memorable and satisfying. In its essence engagement is about ensuring that the interaction flows.



3. What is accessibility?

Accessibility stands for something that should be easily *obtainable, approached or entered*. In usability terms, accessibility refers to **the degree to which an interactive product is usable by people with disabilities**.

According to Benyon, Turner & Turner (Designing Interactive Systems, 2004), there are two main approaches to designing for accessibility; *Design for all* (a.k.a. universal design, see Appendix 1) and *inclusive design*. While 'Design for all' goes beyond the design of interactive systems and applies to all design endeavours, 'Inclusive Design' takes a more pragmatic approach. The advocates of inclusive design argue that there will often be technical and economic (etc.) reasons why total inclusion is unattainable. Benyon, Turner & Turner state that inclusive design is based on four premises:

1. Varying ability is not a special condition of the few but common characteristics of being human and we change physically and intellectually throughout our lives.
2. If a design works well for people with disabilities, it works better for everyone.
3. At any point in our lives, personal self-esteem, identity and well-being are deeply affected by our ability to function in our physical surroundings with a sense of comfort, independence and control.
4. Usability and aesthetics are mutually compatible.

They continue by suggesting that in order for designers to be able to ensure an accessible system they should:

- Include people with special needs in requirements analysis and testing of existing systems.
- Consider whether new features affect users with special needs (positively or negatively) and note this in the specification.
- Take account of guidelines and include evaluation against guidelines.
- Include special needs users in usability testing and beta tests.

Web accessibility, or e-inclusion as it often is referred to, is more specifically targeted at online services and information provision, but the same basic design guidelines described above are applicable. 'Design for all' is also the basis for the W3C's work on creating a web accessibility standard.

4. Web accessibility

First, let make clear what is meant by online services, information provision and mobile devices.

Online services

Online services could range from e-banking, e-commerce, e-learning, providing website hosting, chat rooms etc..

Electronic information provision

Providing information online in some form, usually via downloadable documents like *.doc, *.pdf or the publication of text on a website. The information should of course be accurate and reliable and should be provided equally to all members of the community.

Mobile devices

A mobile device could be a mobile phone, a hand-held computer or any other hand-held device. The great advantage of these devices it that they can be used where traditional computing would be impossible. With the development of cheap, mobile broadband connection, this form of computing has become very popular. These devices are often a fraction of the size of a 'normal' computer or laptop, so it is important to include mobile devices when testing your service.

Web accessibility is all about enabling people with disabilities to interact with websites, online services etc.. To have a fully accessible website or e-service, it should enable disabled people to:

- perceive
- understand
- navigate
- interact

with the service that's being provided. Web accessibility should also make sure that there will be no:

- visual
- auditory
- physical
- speech
- cognitive
- neurological

hindrance to accessing the website or service.



5. People with special needs

According to WHO (World Health Organization) some 750 million people around the world have some kind of disability. But what exactly are those impairments, and how would their needs present themselves in this context?

According to Rogers, Preece and Sharp (Interaction Design, 2007), a person is considered to be disabled if:

- They have a mental or physical impairment.
- The impairment has an adverse effect on their ability to carry out normal day-to-day activities.
- The adverse effect is substantial and long-term (lasted 12 months, likely to last more than 12 months or for the rest of their life).

However, people may be temporarily impaired through different stages in life, for example by breaking an arm, catching a disease etc – these and other short-term disabilities affect the way a person can interact with a website or other interactive product. Examples of other specific needs are people with dyslexia or colour blindness (which affects about 8% of the male and 1% of the female population). That is approximately 240 million men to take into consideration. To make a web site accessible for this group of people takes just a few simple adjustments.

Apart from physical and mental disabilities, Benyon, Turner & Turner (Designing Interactive Systems, 2004) suggests it is good to consider not excluding people because of any of the following reasons:

- economic (i.e. they cannot afford the technology required)
- cultural (e.g. they don't understand metaphors or complicated language being used),
- social (i.e. they cannot understand the particular social mores or inferences of messages).

More specifically, this could include people that:

- Have impaired vision and need help to enlarge the text and improve contrast.
- Are blind and need to hear instead of reading the text.
- Have trouble reading which must be helped with clear language and a thought through layout.
- Have a mental disability which demands easy to read text with simplified content.
- Have a physical disability and thus having problems using the mouse and other pointers.

- Are deaf and need information in signed language.
- Using an old version of a web browser.
- Have a slow internet connection.
- Are using new technical platforms such as mobile phones or iPad.

To create a truly accessible e-service, whether it is a website, on a mobile device or any other interactive product, you need to take all this into consideration. It's not just a person's physical or intellectual needs, but also consideration of their economic, cultural and social situation.

6. Accessibility laws in the NSR

All of the countries in NSR have signed the *Convention on the Rights of Persons with Disabilities*, although not all of them have ratified it. The purpose of the convention is

“to promote, protect and ensure the full and equal enjoyment of all human rights and fundamental freedoms by all persons with disabilities, and to promote respect for their inherent dignity”.

By doing so, the NSR countries all agree that discriminating disabled people by not providing them with the means to a normal life, is not acceptable. More so, all of the NSR countries also have national policies and resolutions that state the importance of e-inclusion, but only UK, France and Germany have laws supporting this.

The EU currently has no encompassing legislation that relates solely to web accessibility. Despite this, all the member countries of the EU have agreed to comply with W3C's guidelines on their national, official websites. The guidelines created by W3C's WAI (Web accessibility initiative) are recognised as the international standard for accessibility.

These facts lead to a conclusion that all of the NSR countries have similar views on accessibility. However, since some countries have chosen to legislate on accessibility, it might indicate that they feel more strongly about the issue. There might be other 'reasons' to why some countries, like Sweden for example, have not yet passed a law that covers web accessibility. There is a fear that legislation would constrain the development of new software and e-services and that this could be used by big actors in the market to enforce their standards as something that others must follow.

All the NSR countries seem to have similar views on the importance of creating accessible websites and other e-services. They all recommend the use of the guidelines presented by WAI and by doing so they all stand behind WAI as the leader of developing standards for web accessibility.

7. Different laws in NSR countries

It was difficult to find out what legislation was applicable in Norway, Denmark and the Netherlands. It is advisable that representatives from these countries further investigate the situation for each country.

Belgium

Belgium ratified the UN treaty in 2009. Although having a national accessibility law, nothing is found on e-services specifically.

Sweden

Ratified the UN treaty in 2008. Has a discrimination law but no specific web accessibility law at present. Suggestions are being reviewed by the Swedish government.

Denmark

Ratified the UN treaty in 2009. No web accessibility law at present.

Norway

Have signed but not ratified the UN treaty. Has a discrimination law but no specific web accessibility law at present. Suggestions are being reviewed by the government.

United Kingdom

Ratified the UN treaty in 2009. The UK also has a national law against discrimination, the DDA or Disability Discrimination Act of 2005. This law gives disabled people rights of access to everyday services such as web sites. Service providers have an obligation to make reasonable adjustment to premises or to the way they provide a service.

Germany

Ratified the UN treaty in 2009. Germany has a relevant law – the “*Act on Equal Opportunities for Disabled*”, Bundesbehindertengleichstellungsgesetz, BGG. From this extract below³ it is clear that web sites could be included as a “*system for information processing*” or “*visual information source*”.

“Section 1 also contains a definition of barrier free access (§ 4).

According to this definition infrastructures and devices are barrier free if they are normally accessible and usable for people with disabilities. As “infrastructures and devices” are determined: built and other constructions, transportation, technical equipment, systems for information processing, audio and visual information

³ <http://brailenet.org/colloques/policies/documents/WallBruch.rtf>

sources and communication facilities and other built living environments. What is meant by “normally” in the definition is described as “usual, without significant increase of difficulty and in principle without assistance”.

Section 2 of BGG describes the obligation for equal treatment and barrier free access with the objective of “Anti-discrimination in interaction with public administration/ authorities” at a federal level. Four fields are further described: § 8 Barrier free building and transportation, § 9 Sign language and communication aids, § 10 printed official information and forms, § 11 Barrier free Information Technology – BITV.”

Netherlands

Has signed but not ratified the UN treaty.

France

Ratified the UN treaty in 2010. In 2005, France extended its national accessibility law to include electronic communications and Web sites. It also states that e-government web sites should conform to international standards by December 2009.

8. Making websites accessible

Some advice when setting out to make your website accessible.

Create a web accessibility team

It is advisable to create a team within the organization that will make sure that a certain level of web accessibility is enforced. One of the team members should be appointed to keep track of any new development in the area of web accessibility and report back to the group. Another should be designated to inform the rest of the organization about web accessibility etc.. The team would ideally include people that work with web design, usability, marketing and support.

Decide the extent of your accessibility

Ask yourselves if it possible for you to design to cater for all disabilities? What/ who is your main audience? Make a list of what is most important vs. less important. Remember that accessibility also benefits people without disabilities.

Laws and regulations

Are there any laws or external or internal policies for your organization that should be taken into consideration?

Involve usability designers and developers from the start

As with all usability work, the result will be most cost effective and thorough if it is implemented from the beginning of a project. It enables the project to 'go down the right path' from the start and unnecessary development costs, due to changes in implemented code, can be avoided. If you are about to make changes to an existing website, make sure to do an evaluation to map out what changes need to be made.

Involve users with disabilities

It is a good idea to get into contact with disabled users right from the start. This enables you to get first hand input from them on different disabilities and to involve them in testing of prototypes and finished product.

Use WAI's guidelines throughout your project

The World Wide Web Consortium (W3C), are the founders of the Web Accessibility Initiative, WAI. WAI is working with countries around the world to develop support materials, guidelines and other resources to make the web accessible to people with disabilities. All of the member countries of the EU recognise the W3C's Web Content Accessibility Guidelines, to be the best current standard for web accessibility. Use this powerful resource to get your web accessibility on the right track. Relevant links to this information are provided at the end of this document.

9. Different levels of WAI guidelines conformance

W3C have defined a set of accessibility levels to categorise the level of conformance to their WACAG 2.0 guidelines (you can find reference to WACAG 2.0 at the end of document). Below is a short description of these levels of which Level A is described in more detail.

Level A is the minimum level of conformance. A simplified list of requirements that can be found on the WAI web page would be:

1. Use alt tags/attributes.
2. Don't depend on color to show anything of importance (eg. red images for warnings).
3. Use clear and simple language.
4. Use language mark-up for foreign words.
5. No flickering or blinking.
6. For html tables, identify row and column headers.
7. Check that your page looks OK with its style sheets missing.
8. Provide an auditory description of the important information of the visual track of a multimedia presentation.

9. 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.
10. Provide client-side image maps instead of server-side image maps except where the regions cannot be defined with an available geometric shape.
11. Title each frame to facilitate frame identification and navigation.
12. Check that your page is still usable if all the fancy bits don't work, for example the JavaScript, applets and multimedia elements.
13. 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.

10. Examples of disabilities and web accessibility implementation

Colour blindness

Make sure you use sufficient colour contrasts. For example; black text on white background is good whereas grey background and light blue text is not good. Using red text to indicate an error may not be recognised by a person with colour blindness.

Use style sheets throughout the site. This way a user can apply their own style sheet and enhance it in a way that suits their needs. The use of style sheets is also a necessity to help people with poor vision.

Hand and arm injuries

If a person has problems using their hands and arms then speech recognition could be used. In this case the person might use a voice browser and the website must have full keyboard navigation support. Examples of keyboard support could include designing site navigation so it is made up of text links which can be selected using the tab key on the key board. Examples on key board short-cuts and how to use them can be found at <http://www.google.com/support/chrome/bin/answer.py?answer=95743>

To help further, you could add the ACCESSKEY=xx feature to the site's html code. This means that when the user press, in this example, the 'x' key, he will jump to the feature on the web page with ACCESSKEY=x implemented in the code.



Deafness

Any audio material should be captioned. Any videos should also have text descriptions. This will also help people that are hard of hearing.

Blindness

Blind people can use a screen reader to interpret the text on a screen. This will generate a combination of speech and Braille output. The Braille is read by using a separate device.

Make sure that it is possible to tab the navigation on the website and that any html tables have column and row headers. If you use frames, these should also be captioned with meaningful titles. Images should have alternative text descriptors (ALT=xx attribute). For acronyms and abbreviations, use the ABBR and ACRONYM html attributes to help screen readers.

Deaf-Blind

See the above sections on Deafness and Blindness.

Difficulty reading e.g. due to dyslexia

People with trouble reading might find it easier to use a speech reader to combine reading and hearing. To enable this, look at the Blindness section above. For people that find it difficult to focus on the text, it might help to use a lot of images incorporated in the text, however animated graphics have the opposite effect. Make sure that any visual or audio elements can be turned off. Since it might be difficult for people with focusing problems to search masses of text or complex navigation, a search engine could prove very useful. Make sure that the search function has added functionality so that users can refine the search – commonly called ‘advanced search functions’.

Cognitive disabilities

Some might find it difficult with abstract concepts, reading and doing calculations. They may find it helpful to have images that describe the product, scenario etc. Searchable material could help in finding information; see the ‘Difficulty reading’ section above. Use consistent design and navigation throughout the web site or it might get confusing. Avoid complicated language; make text as clear and simple as possible.

Seizures

Avoid the use of flashing graphics or video as this can trigger seizures for people with photosensitive epilepsy.

As one can see, there is not one solution for each disability, but a combination of these adjustments enables web accessibility for many different users. There might also be people with a combination of disabilities that will benefit from all of the above adjustments.

If these suggestions are implemented, they do not only enable people with different disabilities to use your web site or application, they also make it easier for all users. It might also give you the added bonus of high ranking in search engines like Google since all of your content is searchable and easy to index. If more people are being able to use your web site and also linking to it, this too will add to the possibility of getting high up in the ranking.

11. Accessibility on mobile devices

The main challenge when developing websites for mobile devices would be to keep the product standardized, simple and efficient. The differences between developing an interactive product for a desktop computer vs. a mobile device are mainly defined by the specification of the mobile device and the context in which it will be used - how it handles images, content, scripts and plug-ins, colors etc. For example, on a traditional mobile phone you might want to develop for navigation via a numeric key pad instead of via a mouse, so you might want to enable the user to 'tab' their way through the site's content etc.. You need to put a lot of thought into how to arrange the navigation to keep it simple. Mobile device users are usually easily distracted, so you need to make sure that the interaction is simple, efficient and quick or you will "loose" this user.

You might want to have an exact replica of your desktop version, but this might not always be possible. For example, on a mobile device you are more limited in screen size, navigation options and bandwidth. Your accessibility goals might not be met if you do a direct adaptation of your standard product.

Some main considerations to keep in mind are:

Complexity

Complex menu structures and navigation options might cause difficulties for mobile users. Simplicity is a key element. For example make sure that tab-navigation is done in a logical order, don't use frames, and preferably no overly complex tables.



Content

Images, video and other content might not be usable on a mobile device due to their size and format. Check current recommendations at WAI to get it right. Contrast in color might also differ from desktop PCs and this needs to be considered.

Scripts and plug-ins

Make sure that the scripts, plug-ins, character encoding and any other programs and protocols that are used in your website are supported by the mobile device you are targeting.

Cost

Cellular network connectivity is commonly charged in terms of data volume. The size of images and other content should be kept to a minimum.

Memory and battery

Battery capacity, processing capability and working memory are all very constrained on mobile devices.

A more thorough explanation on issues to consider as well as technical specifications can be found at WAI's webpage where they have a section of "Mobile best practices" (<http://www.w3.org/TR/mobile-bp/>).

12. Resources and recommended reading

Nielsen, J., Pernice, K. (2001) Making the Web Easy to Use for Users with Disabilities. Norman and Nielsen group, USA.

Petri, H. And Kheir, O (2007) The relationship between Accessibility and Usability of websites

CHI 2007, Empirical studies of web interaction, San Jose, USA.

Shneiderman, B. (2003). Promoting universal usability with multi-layer interface design.

Proceedings of the 2003 Conference on Universal Usability (CUU 2003). New York: ACM Press.

Thatcher, J., Waddell, C.D., Henry, S.L., Swierenga, S., Urban, M.D., Burks, M., Regan, B. and Bohman, P.

Constructing accessible web sites. (2003) San Francisco: glasshaus.

Peter Abrahams, Practice Leader - Accessibility and Usability, Bloor Research
<http://www.it-director.com/business/compliance/content.php?cid=9258>

A power point presentation by Mike Davies, senior developer at Yahoo! Europe.

<http://www.isolani.co.uk/presentations/wsg/wsg-webaccessibility.pdf>

World Wide Web Consortium (W3C)

The WAI website is the ideal place to find out more about the ongoing work of making the web more accessible and to find guidelines for creating accessible websites.

<http://www.w3.org/WAI/>

<http://www.w3.org/WAI/intro/accessibility.php>

<http://www.w3.org/WAI/intro/components.php>

The W3C code validation toolbox should be used to check whether your website is up to standard. If not, users might have problems accessing your website.

<http://www.w3.org/QA/Tools/>

Link to WAI latest accessibility guidelines, WCAG 2.0

<http://www.w3.org/WAI/intro/wcag.php>

<http://www.w3.org/TR/WCAG20/>

Disability laws for different countries:

<http://www.w3.org/WAI/Policy/>

UN

Find more information about UN's disability work and the Convention on the Rights of Persons with Disabilities.

Accessibility: A guiding principle of the Convention

<http://www.un.org/esa/socdev/enable/disacc.htm>

Enable - Rights and Dignity of Persons with Disabilities

Un's web site for the Secretariat for the Convention on the Rights of Persons with Disabilities

<http://www.un.org/disabilities/default.asp?navid=15&pid=156>



Other resources

More about the UK DDA Law

http://www.direct.gov.uk/en/Disabledpeople/RightsandObligations/DisabilityRights/DG_4001068

Lynx

If you have the possibility to install Lynx, you can test your web page in a text based web browser.

<http://lynx.browser.org/>

Create accessible pdf documents

http://www.adobe.com/enterprise/accessibility/pdfs/acro7_pg_ue.pdf

Learn about Braille

<http://en.wikipedia.org/wiki/Braille>

Example of speech reader

<http://www.naturalreaders.com/>

Appendix 1

The Principles of Universal Design

Version 2.0 - 4/1/97 Copyright 1997 NC State University, The Center for Universal Design

Compiled by advocates of universal design, listed in alphabetical order: Bettye Rose Connell, Mike Jones, Ron Mace, Jim Mueller, Abir Mullick, Elaine Ostroff, Jon Sanford, Ed Steinfeld, Molly Story, and Gregg Vanderheiden

Universal design

The design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design.

The authors, a working group of architects, product designers, engineers and environmental design researchers, collaborated to establish the Principles of Universal Design to guide a wide range of design disciplines covering environments, products, and communications. These seven principles may be applied to evaluate existing designs, to guide the design process and to educate both designers and consumers about the characteristics of more usable products and environments.

The Principles of Universal Design are presented here, in the following format: name of the principle, intended to be a concise and easily remembered statement of the key concept embodied in the principle; definition of the principle, a brief description of the principle's primary directive for design; and guidelines, a list of the key elements that should be present in a design which adheres to the principle. (Note: all guidelines may not be relevant to all designs.)

Principle 1 - Equitable Use

The design is useful and marketable to people with diverse abilities.

Guidelines:

- 1a. Provide the same means of use for all users: identical whenever possible; equivalent when not.
- 1b. Avoid segregating or stigmatizing any users.
- 1c. Provisions for privacy, security, and safety should be equally available to all users.
- 1d. Make the design appealing to all users.



Principle 2 - Flexibility in Use

The design accommodates a wide range of individual preferences and abilities.

Guidelines:

- 2a. Provide choice in methods of use.
- 2b. Accommodate right- or left-handed access and use.
- 2c. Facilitate the user's accuracy and precision.
- 2d. Provide adaptability to the user's pace.

Principle 3 - Simple and Intuitive Use

Use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level.

Guidelines:

- 3a. Eliminate unnecessary complexity.
- 3b. Be consistent with user expectations and intuition.
- 3c. Accommodate a wide range of literacy and language skills.
- 3d. Arrange information consistent with its importance.
- 3e. Provide effective prompting and feedback during and after task completion.

Principle 4 - Perceptible Information

The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities.

Guidelines:

- 4a. Use different modes (pictorial, verbal, tactile) for redundant presentation of essential information.
- 4b. Provide adequate contrast between essential information and its surroundings.
- 4c. Maximize "legibility" of essential information.
- 4d. Differentiate elements in ways that can be described (i.e., make it easy to give instructions or directions).
- 4e. Provide compatibility with a variety of techniques or devices used by people with sensory limitations.

Principle 5 - Tolerance for Error

The design minimizes hazards and the adverse consequences of accidental or unintended actions.

Guidelines:

- 5a. Arrange elements to minimize hazards and errors: most used elements, most accessible; hazardous elements eliminated, isolated, or shielded.
- 5b. Provide warnings of hazards and errors.
- 5c. Provide fail safe features.
- 5d. Discourage unconscious action in tasks that require vigilance.

Principle 6 - Low Physical Effort

The design can be used efficiently and comfortably and with a minimum of fatigue.

Guidelines:

- 6a. Allow user to maintain a neutral body position.
- 6b. Use reasonable operating forces.
- 6c. Minimize repetitive actions.
- 6d. Minimize sustained physical effort.

Principle 7 - Size and Space for Approach and Use

Appropriate size and space is provided for approach, reach, manipulation, and use regardless of user's body size, posture, or mobility.

Guidelines:

- 7a. Provide a clear line of sight to important elements for any seated or standing user.
- 7b. Make reach to all components comfortable for any seated or standing user.
- 7c. Accommodate variations in hand and grip size.
- 7d. Provide adequate space for the use of assistive devices or personal assistance.

Note that the Principles of Universal Design address only universally usable design, while the practice of design involves more than consideration for usability. Designers must also incorporate other considerations such as economic, engineering, cultural, gender, and environmental concerns in their design processes. These Principles offer designers guidance to better integrate features that meet the needs of as many users as possible.

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This report was prepared for Smart Cities by Maria Lindström from Karlstad University <http://www.kau.se>





www.smartcities.info

www.epractice.eu/community/smartcities

The Smart Cities project is creating an innovation network between cities and academic partners to develop and deliver better e-services to citizens and businesses in the North Sea Region. Smart Cities is funded by the Interreg IVB North Sea Region Programme of the European Union.

Smart Cities is PARTLY funded by the Interreg IVB North Sea Region Programme of the European Union. The North Sea Region Programme 2007-2013 works with regional development projects around the North Sea. Promoting transnational cooperation, the Programme aims to make the region a better place to live, work and invest in.

