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WEB 2.0 – END OF ACCESSIBILITY?

- ANALYSIS OF MOST COMMON PROBLEMS WITH WEB 2.0 BASED APPLICATIONS REGARDING WEB ACCESSIBILITY

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Abstract

On the one side accessible Web sites are becoming increasingly important in general and are a statutory provision in the context of eGovernment. On the other side the trend of creating Web 2.0 based applications is growing exponentially due to the richness of graphical user interfaces, effects, high interactivity and collective intelligence potentials that Web 2.0 based applications can provide. This article describes the primary purpose of Web 2.0, accessibility and the symbiotic application. It highlights major problems and feasible approaches to a solution and introduces common guidelines and laws in the context of accessibility and Web 2.0.

Keywords: Web 2.0, accessibility, eGovernment, electronic government, collective intelligence, problems, symbiosis, AJAX, eInclusion, W3C, applications, Web sites, BITV, WCAG 1.0, WCAG 2.0, Section 508

1. Introduction

According to several studies and market observations there has been a massive growth of Web 2.0 based Web sites and related technologies (cf. section 3.2 later in this article) due to the richness of graphical user interfaces, effects, high interactivity and collective intelligence potentials that Web 2.0 based applications can provide (cf. section 3.3 later in this article).

On the other side, accessible Web sites are becoming increasingly important (cf. section 2.2 later in this article) in general and are a statuary provision in the context of eGovernment (cf. section 2.3.3 later in this article).

Although Web 2.0 applications behave more and more like desktop applications, the underlying technologies used for presentation, transmission and encoding are still the same as in regular Web 1.0 applications [Cooper, 2007]. As a consequence there are deficiencies in Web 2.0 applications regarding accessibility features, which have been available in desktop applications for many years and are presently becoming mainstream in Web 1.0 based Web sites [Cooper, 2007].

This article aims at describing the primary purpose of Web 2.0, accessibility and the symbiotic application. It highlights major problems and feasible approaches to a solution and introduces common guidelines and laws in the context of accessibility and Web 2.0.

2. Web accessibility

2.1. Definition

There are various definitions of Web accessibility based on different point of views or different central themes. Web accessibility is a subset of electronic accessibility (eAccessibility) which is confined to Web sites and Web applications. According to the European Commission [2005], Electronic accessibility or eAccessibility means overcoming the technical barriers and problems that disabled people or people with other disadvantages undergo when they attempt to interact on equal terms within the Information Society [Webster, 1995; Martin, 2005].

Henry [2005] defines Web accessibility by saying "Web accessibility means that people with disabilities can use the Web".

According to ISO [2008] accessibility can be defined as the "*usability of a product, service, environment or facility by people with the widest range of capabilities"*. ISO [1998] concludes this definition by describing usability as 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"*. Regarding Web accessibility the definition of ISO [2008] has to be applied to Web sites and Web applications.

Zajicek states that effort, interest and inclination form the central aspects of Web accessibility [Zajicek, 2007]. She explains that a community Web site is accessible if it includes users in its group and if the users are keen on being members of the group. Additionally, Zajicek mentions the importance for Web sites to make their benefits apparent, which is a relevant issue for older people who, for instance, frequently suffer from a lack of technological knowledge and an understanding of its benefits.

In summation, Web accessibility can be defined as making Web resources accessible to all users, regardless of the technical, physical or mental restrictions on the client side. This means that accessible Web sites are aimed at being equally accessible for all people – disabled or not. It also implies that a Web site has to work irrespectively of the browsing technology on the client side. Furthermore it is stated that a Web site has to be inclusive and attractive to users and has also to make its benefits visible to potential users.

Despite checklists with precise requirements and detailed evaluation criteria, such as the Web Content Accessibility Guidelines 1.0 (WCAG 1.0) [W3C, 1999], Web accessibility is a great deal more than ensuring compliance by means of some easy to validate requirements. It also demands a different approach to Web design. Language level and the use of technical terms have to be adapted to the target audience and maintained at the most simple but appropriate standard, for example. It is not possible to automatically and reliably check these requirements by means of the currently available technologies but these are still important aspects.

2.2. Relevance

After dealing with a variety of definitions for the term Web accessibility it is now time to realise the relevance of Web accessibility.

2.2.1. Eliminating disadvantages of disabled people in ICT

Web accessibility helps disabled people. Its major intention is to allow people with disabilities to use Web sites without or, at the least with minimal disadvantages, as

compared to non-disabled people resulting from the user interface design of the Web sites.

According to Waldrop and Stern, 49.7 million Americans or 19.3 percent of all Americans suffer from a long lasting condition or have a handicap [Waldrop and Stern, 2003]. Within this population 9.3 million people have a sensory disability which mainly relates to sight or hearing. Another 21.2 million people have conditions restricting their basic physical activities, such as walking or climbing stairs. The last major group of 12.4 million people (4.8 percent) suffer from a physical, mental, or emotional condition which can have a negative impact on learning, remembering and concentrating.

Moreover, Harris Interactive Inc. [2004] highlights the importance of assistive technologies. In this context, consideration must be given to the fact that assistive technologies require structured and syntactically correct content which is a basic requirement of most accessibility guidelines and laws.

2.2.2. Support of simple and comprehensible information access

Firstly, consideration should be given to the fact that the Web is used by 10 percent of people older than 65 years, 24 percent of people with poor education levels and 32 percent of unemployed people [Ministerial Conference "ICT for an inclusive society", 2006]. To include all of the above groups, even people with poor education levels and decreased receptiveness, it is necessary to structure information as simply as possible. This also applies to the language level of the Web site content, which should be as simple as possible but also appropriate to the designated target audience.

Secondly the group of the so-called silver surfers is increasing at a high rate, namely by 17 percent between 2004 and 2005 and 26 percent between 2005 and 2006 [European Interactive Advertising Association, 2007]. Ageing does not imply becoming disabled but many older people suffer from mental or physical deterioration. Additionally, impairments in sight and hearing are often symptoms of old age. This natural decrease in older people's abilities can be compensated for by creating accessible Web sites because there are some similarities in impairment of health between disabled and older people, e.g. visual or hearing impairment. A simple solution for mental limitations would be, for instance to use a simple but appropriate level of language.

In summation, there are a great number of people who could benefit from accessible Web sites, even outside the field of disabled people.

2.2.3. Support of mobile devices

According to Gartner's study on the development of mobile services, there is currently a major trend towards mobile devices [IDG Business Media GmbH, 2005], which is additionally boosted by the increasing popularity of location based services [Küpper, 2005].

Usually, mobile devices involve hardware limitations on memory and processing capabilities because of restrictions associated with the device size. As a consequence of small screens, applications such as Web browsers can render Web sites only with productivity-reducing scroll bars or with very small font sizes or resolutions. Additionally, Web applications which are mainly based on JavaScript or asynchronous JavaScript and XML (AJAX) functionality are unlikely to work on such devices.

Therefore it is eminently important to create Web sites which have the ability to adapt to a variety of client system parameters, such as screen size and JavaScript

support. Moreover, the amount of transferred data must be kept to a minimum because of the slow to medium mobile download rates, higher costs compared to stationary flat rate offerings and reduced processing power. These requirements are also the main requirements of most Web accessibility guidelines and laws.

2.3. Reasons to implement Web accessibility

In spite of the additional work, there are many reasons to implement Web accessibility. This section will investigate the rationale from a number of different points of views.

2.3.1. Altruistic reasons

As already mentioned, accessible Web sites can help to

- minimize disadvantages for disabled people in using the Web,
- improve the usability for older people,
- make it easier for people with low education to benefit from the Web.

It is also a main objective to improve the integration of disabled or people faced with other discriminations by using information and communication technologies (ICT). This matter is also called eIntegration or eInclusion [European Commission, 2007]. This can be achieved by creating accessible Web sites to lower the hurdles for Web site usage and to make it possible for people to be at least part of the information society [Abecasis and Fernandes, 2001].

Integrating people in the information society not only assists the parties involved, but it also increases the range of people who can participate in science and can therefore help mankind to ethically and technically evolve.

Furthermore the Web can serve as a platform for expressing democracy and human rights and to implement freedom of speech [Birdsall, 2007]. For example, the Web could be used to make it possible for the public to become involved in legislation processes at an early stage by commenting on current proposals online. However, to make it possible for online commenting systems to mirror society it is necessary to allow all people, independent of their physical or mental capabilities or other accessibility related parameters to participate on equal terms.

2.3.2. Commercial reasons

Firstly, disabled people or other groups which benefit from accessible Web sites are an important target audience. Therefore it might be considered to be strategically clever to adapt Web sites to the needs of this vast number of potential customers. However, regard must be taken of the fact that disabled people or those with other kind of impairments, in relative terms, use the Web more than other customers [Schmitz, 2002], which means that it is even more important for a company Web site to be easy to use for the target audience. In addition, the eCommerce market share is rapidly increasing [Hirsh, 2002] and depends on accessible and easy to use Web sites.

Secondly, there is a potentially huge increase in the number of older people because of demographic changes [Czaja, 2006]. Thus it is becoming ever more important to address the needs of older people. Accessible Web sites make it possible to adjust to the decreasing capabilities of older people by using bigger fonts and stronger contrasts to compensate for sight impairments, for instance. As, at present, older people do not form the target audience for the majority of companies there is a

potential niche market available for the creation of usable Web sites to attract older people [Roe, 2001].

Furthermore the Web is becoming ever more important. The Web site of a company does in fact represent that company and many people utilise this to provide them with information regarding their products. As a consequence, a positive or negative impression can make a great difference with regards to consumer behaviour. This also underpins the importance of online reputation management [Walsh, 2003]. Since accessible Web sites are becoming a common requirement and are "trendy", failing Web accessibility tests can have negative effects on a company's reputation on a scale that should not be underestimated.

2.3.3. Governmental reasons

In addition to commercial and ethical reasons, governmental ones also require consideration.

The Web Content Accessibility Guidelines (WCAG) are not governmental regulations but are recommendations from W3C, the World Wide Web Consortium. WCAG 1.0 [W3C, 1999] forms the basis for most governmental regulations, such as U.S. Section 508 [ITAW, 1998], German BITV [Deutsches Bundesministerium des Innern, 2002] or Swiss P028 [Kohler, 2005] / eCH-0059 [Lindenmeyer and Riesch, 2007]. WCAG 1.0 (cf. Section 2.4.1 later in this article) not only formulates functional requirements, but also contains a checklist and concrete instructions for Web design. Thus, most governmental regulations refer to those checklists to illustrate their intentions and to deliver a verifiable set of requirements.

Section 508 of the U.S. Rehabilitation Act is probably one of the most well known regulations in the context of eAccessibility. According to ITAW [1998] Section 508 of the U.S. Rehabilitation Act defines the minimum requirements for information technology products regarding accessibility. Because of its early publication date, Section 508 has more general but weaker requirements than WCAG 1.0, which was released in 1999 and which specializes in Web accessibility. Section 508 Standards [ATBCB, 2000] implements Section 508 of the above mentioned Rehabilitation Act and defines concrete definitions with regards to the design, structure and behaviour of IT systems within the context of eAccessibility and applies to the following technological domains:

- Software applications and operating systems
- Telecommunication systems
- Video and multimedia systems
- Electronic devices (e.g. scanner)
- Desktop computers and portable computers
- Web-based intranet and internet information and applications

According to ITAW Section 508 applies in an obligatory manner to all U.S. federal agencies and to all companies working on behalf of the governmental administration with some minor exceptions. If an undue burden were to be imposed on the agency it is also possible to forego the relevant requirements [ITAW, 1998].

Because the requirements are relatively weak and conform to priority 1 of WCAG 1.0 and many companies would prefer not to rule out the possibility of trading software with the government, it is important for them to implement the challenging accessibility requirements.

In Europe there is no common law or guideline that specifies detailed (technical) requirements for implementing Web accessibility. However, there are national regulations and laws such as the German Barrierefreie Informationstechnik-Verordnung (BITV) [Deutsches Bundesministerium des Innern, 2002], which can be translated into "regulation for accessible information technology". Within Germany, there are regional implementations of this federal republic law, such as the Bayerische BITV (BayBITV) in Bavaria which means Bavarian BITV.

Germany's Web accessibility related laws are some of the most restrictive. BITV introduces two levels (priorities) which map to WCAG 1.0 priorities for example. Even the lowest must-priority 1 means that WCAG 1.0 priority 1 and 2 have to be implemented. BITV priority 2 corresponds to WCAG 1.0 priority 3. This means that compared to Section 508, BITV enforces not only WCAG 1.0 priority 1 but also priority 2. This law and its regional implementations apply to all federal agencies, but only to Web sites and Web applications and not to desktop applications.

In summation, in most countries it is not necessary for private companies to make accessible Web sites but it is often a requisite if they would like to sell Web based products to the government. Usually implementing Web accessibility in federal agencies is essential because of (local) accessibility laws.

2.4. Implementation guidelines

There are various guidelines and tools to enable Web accessibility to be put into practice. This section aims at showing the most relevant ones from W3C.

2.4.1. WCAG 1.0

Even though there are many guidelines and tools within the context of Web accessibility, WCAG 1.0 is probably the most important guideline. This can be verified by taking into account that nearly all governmental regulations are based on WCAG 1.0 [W3C, 1999] (cf. Section 2.3.3 earlier in this article). This is a result of the practical relevance of WCAG 1.0 which describes requirements in a way that is understandable to a Web developer. WCAG is developed by W3C, the World Wide Web Consortium, which emphasizes the fact that WCAG is country independent and possesses problem oriented, neutral characteristics. As mentioned above, most governmental regulations refer to WCAG 1.0 or include slightly modified checklists based on WCAG 1.0 requirements. WCAG 1.0 consists of 3 priorities:

- Priority 1: All requirements classified with this priority are mandatory. They are minimal demands to ensure basic accessibility.
- Priority 2: All priority 2 requirements are "should" demands. Their implementation would vastly improve accessibility. Ignoring these requirements can result in the exclusion of some groups of people.
- Priority 3: Requirements annotated with this priority are optional. Their application can help to optimize accessibility.

More important than the priorities themselves, the conformance levels express the fulfilment of the priority categorized requirements. According to [W3C, 1999], there are three levels of WCAG 1.0 conformance:

- Conformance Level "A": all Priority 1 checkpoints are satisfied
- Conformance Level "Double-A": all Priority 1 and 2 checkpoints are satisfied

- Conformance Level "Triple-A": all Priority 1, 2, and 3 checkpoints are satisfied

Currently, WCAG 2.0 [W3C, 2008b], the predestinated successor of WCAG 1.0, is in reconcilement. Even though WCAG 1.0 will be replaced by its successor in the mid-term or long-term, it will take even longer for WCAG 2.0 to prevail, since governmental regulations are not able to be adapted immediately.

2.4.2. WCAG 2.0

Without a doubt, the final result will be that WCAG 2.0 will follow in the steps of WCAG 1.0. Thus, the main intentions and differences between the two versions [W3C, 2008c] of WCAG should be analyzed. Unlike WCAG 1.0, WCAG 2.0 (available as working draft) does not target a specific technology such as CSS and HTML. On the contrary, WCAG 2.0 attempts to formulate accessibility principles and criteria which are independent of current and future technology. However, this does not mean the complete abandonment of WCAG 1.0. Classic WCAG 1.0 requirements will be generally retained and associated to one of four common principles which describe the way Web content should be:

- Perceivable
- Operable
- Understandable
- Robust

The principle ”Perceivable” means, users should be able to perceive the Web site content. As a consequence the content of a Web site has to be visible for at least one working sense of a person. “Operable” asks for user interfaces that can be handled by the user. The aspect “Understandable” means that the Web site should be developed in such a way that its content and usage are comprehensible to the user. The term “Robust” is used to describe the requirement that a Web site or Web application should be useable by its original user interface or, in a likewise manner, by assistive technologies.

2.4.3. ATAG1

The Authoring Tool Accessibility Guidelines 1.0 (ATAG1) [W3C, 2000] is a specification for Web authoring tool developers. Its purpose is to assist developers in the design of authoring tools that produce accessible Web content. Furthermore it can be used as an orientation for the development of accessible authoring tool interfaces.

In a similar manner to WCAG 1.0, ATAG1 introduces three priority and three conformance levels. Priority 1 is essential, Priority 2 is important and Priority 3 is beneficial for meeting the goals. There is also a relative priority which references WCAG 1.0 requirements. The conformance levels are defined analogously to WCAG 1.0 conformance levels which means that they refer in a similar manner to those for the fulfilment of the priorities 1 to 3.

2.4.4. WAI-ARIA

According to [W3C, 2008e] WAI-ARIA [W3C, 2008d], the Accessible Rich Internet Applications Suite, describes and provides mechanisms to increase the accessibility of Web sites and Web applications with the focus on rich Web applications, dynamic

content and advanced user interface controls. WAI-ARIA currently consists of four documents:

- WAI-ARIA technical specification
- WAI-ARIA Primer
- WAI-ARIA Best Practices
- WAI-ARIA Roadmap

The technical specification is a planned W3C Recommendation Web standard and is intended to be used by developers of Web browsers, assistive technologies and other user agents. It is mainly based on declarative ways to decorate (even custom and composite) Web page components or regions with descriptive roles which can be used by assistive technologies, e.g. role ”slider” for a custom component that serves as a slider control [W3C, 2008e]. Therefore it provides a means of specifiying semantics which Web 2.0 currently lacks [Cooper, 2007]. Futhermore, WAI-ARIA supports describing the state of Web page components or areas, e.g. ”checked” for a checkbox. WAI-ARIA also provides properties to define live regions of a Web page that are likely to be updated and policies to control the update behaviour. Additionally WAI-ARIA makes it possible to describe drag and drop related information and to provide keyboard navigation for Web objects and events.

WAI-ARIA Primer is a planned W3C Working Group Note and introduces developers to accessibility related problems.

WAI-ARIA Best Practices also targets Web developers and provides detailed advice and examples in order to develop accessible rich internet applications.

Last but not least, according to [W3C, 2008e] WAI-ARIA Roadmap defines the path to enrich rich Web content with accessibility aspects.

3. Web 2.0

3.1. Definition

The term Web 2.0 was originally coined by Dale Dougherty and Craig Cline of O’Reilly as a catchword for a conference. After the conference Tim O’Reilly made an attempt to clarify the meaning of Web 2.0 by formulating core competences of Web 2.0 companies [O'Reilly, 2005]:

- Offering services (with advantages such as cost effective scalability) in contrast to software packages, e.g. Software as a service paradigm [Chou and Chou, 2007]
- Control over unique data sources that can hardly be recreated by business competitors, e.g. Wikipedia [Ayers et al., 2008]
- Treat users as co-developers [Beaudouin-Lafon, 1990; Xiao et al., 2007] and arrange, with the underlying open source development, practices including very early, partially working, releases
- Harnessing collective intelligence [Weiss, 2005; Heylighen, 1999], e.g. folksonomy based services such as del.icio.us or Flickr
- Make profit from long tail effects of the Web which means that special products that could not be traded locally due to a low demand can be profitable because of the larger virtual sales area of the Web [Anderson, 2006].

- Lightweight business, user interface and development models, e.g. RSS, REST services and Web services that can be combined to create composite applications
- Distributed computing

O'Reilly also mentions the aspect "Rich User Experiences" and highlights AJAX technology [Garrett, 2005; Zhang et al., 2007] to create rich and responsive user interfaces by combining several technologies including XHTML, XML, CSS and JavaScript and enabling asynchronous Web page updates [O'Reilly, 2005]. According to O'Reilly AJAX is a key component of Web 2.0 applications such as Flickr.

In contrast to Web 2.0, Web 1.0, a retronym for the state of the Web before the advent of Web 2.0, is primarily a flat, two-dimensional target with offerings of predefined static information [Jazayeri, 2007]. This definition mainly excludes typical Web 2.0 characteristics such as user generated content and Web sites with rich internet application behaviour.

The current definitions of Web 2.0 are mostly aimed at functional aspects, technical issues or both. According to Treese primary aspects of Web 2.0 are [Treese, 2006]:

- Interactivity: through technologies such AJAX or Flash
- Social networks: e.g. linked Web sites, blogs, navigation to Web sites of friends
- Tagging [Halpin et al., 2007]: annotation of Web resources with keywords to search for them instead of using inconvenient navigation through a hierarchical order
- Web services [Yee, 2008]: via Web or intranet accessible application programming interfaces which are mostly stateless and provide reusable functionality

Gibson defines Web 2.0 in a similar manner to that of Treese but additionally explains the underlying technology and emphasises the central points of Web 2.0 including the AJAX technology and dynamic page updates [Gibson, 2007]. Gibson also touches upon the usage of Web 2.0 to create visually appealing rich internet applications.

From a technical point of view, AJAX stands for Asynchronous JavaScript and XML and enables the creation of Web applications which have the ability to communicate with the server side without full submits [Zhang et al., 2007]. This is achieved by a client side JavaScript that triggers the browsers XMLHttpRequest object which enables asynchronous communication with the backend [Garrett, 2005; Stamey and Richardson, 2006]. The result of such asynchronous requests can be represented by modifying the document object model of the current Web page via JavaScript. As a result, parts or components of the Web page can be visually updated. This technique of asynchronous partial Web page content updates acts as the foundation for responsive and rich Web applications that mimic desktop application user interface features.

Other definitions of Web 2.0 concentrate on user generated content, e.g. in the form of videos (YouTube.com), news articles (Digg.com), photos (Flickr.com) or encyclopaedia articles (Wikipedia.com). By definition, user generated content [Obrist et al., 2008] is content provided by the users. In the context of Web 2.0, users can use Web 2.0 applications such as YouTube.com to act as a consumer, but also as an

author. This is in contrast to the Web 1.0 based Web sites which mainly provide static "readonly" information.

3.2. Importance

According to Forrester Research Inc. investments in Web 2.0 technologies will increase by approximately 43 percent per annum for the next 5 years [Forrester Research Inc., 2008]. It is predicted that in 2013 companies will invest 4.6 billion dollars in the Web 2.0 domain. Forrester further specifies that social networks, blogs, mashups, rss, podcasting, widgets and wikis will become primary applications.

The "ARD/ZDF Online Studie 2006" [Trump et al., 2007], a study on online usage, states that 11 percent of all online people in Germany use a Web 2.0 application at least once a week and 9 percent on a daily basis. Additionally Web 2.0 applications are mainly used by people with higher education, e.g. "Abitur" certificate. It is also important to remark that 43 percent of Web 2.0 usage is passive and 57 percent active. This means that one of the main aspects of Web 2.0, the interactivity, is perceived at a high rate.

According to an empirical study of Web use by Weinreich et al. [2008] a strong growth in the proportion of submit events indicates an increase in dynamic Web pages and Web applications.

In summation, Web 2.0 applications are already important but are predicted to increase in usage even further during the next few years. The next section will explain the different reasons for the popularity of Web 2.0.

3.3. Reasons to implement Web 2.0

There are a variety of reasons to implement Web 2.0 applications. This section aims to detail some of the above mentioned characteristics of and reasons for Web 2.0.

One main reason for Web 2.0 is the creation of rich internet applications (RIAs) [W3C, 2008a; Linaje et al., 2007]. AJAX which forms the basis for Web 2.0 application's interactivity makes it possible to create rich user interfaces that appear and behave in a similar manner to their desktop application equivalents. This technology and paradigm enables the implementation of Web based systems with the convenience and ease associated with the use of desktop applications and the advantages of Web based applications such as universal access and central administration. In addition, Web based applications make software rollouts to clients and client based update management obsolete [Zucker, 2007]. This central deployment can also minimize distribution and maintenance costs.

In addition to better management, distribution and maintenance, rich Web 2.0 user interfaces can provide opportunities to increase usability [Pilgrim, 2008] and user efficiency, even if usability has possibly to be redefined for Web 2.0 applications [Silva and Dix, 2007]. These opportunities also include usability potentials in the lifecycle of digital art projects [Christodoulou and Styliaras, 2008].

Moreover Web 2.0 is used as a marketing device in the advertising industry. Because Web 2.0 techniques can be used to create visually attractive Web content it is assumed that great potentials exist for Web 2.0 based advertising, which is called Advertising 2.0 [Parise and Guinan, 2008; Beelen, 2006]. Web 2.0 also supports bidirectional asynchronous communication via blogs and comments attached to Web site items. Thus it would be possible to allow consumers to offer feedback on certain products in order to improve the offerings and finally to maximize profits.

Last but not least, Web 2.0 supports harnessing collective intelligence potentials [Weiss, 2005]. This includes the following topics:

- The Web user as reader and author
- Cooperative developing knowledge
- Social networks [Reinhardt, 2003]
- Semantic Web [Horrocks, 2007]
- Mashups, Blogs and information aggregation [Zang et al., 2008; Chin and Chignell, 2006]

According to Pastore [2008], the scientific community, in particular, is able to benefit from Web 2.0 driven platforms and social networks, since discussion and information exchange can be conducted while research is in progress rather then after its completion. As mentioned above, Web 2.0 can also assist in both the learning and research into cooperative knowledge development. This is achieved by social learning, active participation and the simplicity of eLearning application prototyping by using Web 2.0 technologies [Ullrich et al., 2008].

3.4. Implementation guidelines

In Web 2.0 context, as yet, there are no relevant official or standard, non-accessibility related guidelines. Consequently, this section offers some less than scientific guidelines. Basically there are various types of guidelines.

Because rich Web applications are, in general, implemented by Web application frameworks in order to reduce complexity, development guidelines are, in the main, specific to the corresponding technology and domain, e.g. Security Guidelines for ASP.NET 2.0 [Meier et al., 2005]. Software development process models or software development process guidelines are generally independent of the implementation technology. Although there are many process models including Rational Unified Process (RUP) [Kruchten, 2003], there are only a few guidelines that target Web 2.0 development or translate existing process models to Web 2.0, e.g. Petrasch [2007].

As well as the technological aspects, business guidelines in the form of business models for Web 2.0 are also researched [Högg et al., 2006]. Högg et al. [2006] are, in the main, attempting to discover what the fundamentals of Web 2.0 communities are and what business models exist for Web 2.0 communities.

However, most Web 2.0 guidelines are available in the field of Web usability, which can be defined by the five main attributes Learnability, Efficiency, Memorability, Errors and Satisfaction [Shneiderman, 1992] and describe how usable a system is from the perspective of a user [Cato, 2001]. ISO [1998] provides a more technical definition (cf. section 2.1 earlier in this article). The following guidelines can, in the main, be categorized as design rules and style guides which are variants of the Web usability guidelines [Scapin et al., 2000].

Torab's guideline [Torab, 2007] is mainly concentrated on design. It demonstrates modern Web design with screenshot based samples of other Web sites and highlights the use of large fonts, AJAX process indicators, bright colours, RSS support, light boxes, round corners and reflections. The guideline is more a style guide than a "real" Web 2.0 guideline which results in a vast non-compliance of accessibility and Usability, since no special attention is paid to accessibility or usability details.

Kroski [2007] wrote another guideline, which she called "Information Design Principles For Web 2.0 Design: Simple & Social". This guideline describes visual aspects but, in contrast to Torab's guideline, social aspects, the kiss principle and navigation mechanisms are also discussed. Furthermore, Kroski mentions evolvement,

being nimble and being open as new Web philosophies. In the context of navigation techniques, mechanisms such as tag clouds, related information, widgets and mashups are also considered. In the field of social aspects, features such as user driven commenting, rating, reviewing, online resource sharing, personal expression and communication are mentioned. Regarding Web 2.0 technologies, mechanisms such as AJAX, Drag & Drop and AutoComplete are mentioned. This is completed by WYSIWYG online Web content manipulation support, previews and maps.

Furthermore, it is possible that Web 1.0 usability guidelines or even desktop usability guidelines may be partly applied to Web 2.0. For example, Nielsen [1994] defined ten usability heuristics with the focus on user interface design. These guidelines were originally aimed at desktop applications, but turned out to be also applicable to the field of Web usability. According to McMullin and Skinner [2003] they are also adaptable to Rich Internet Applications. However, this correlation cannot be generalized. Ratner et al. [1996], for instance, show that there is only, approximately, a 20 percent overlap between desktop guidelines and Web guidelines.

4. Symbiosis of Web 2.0 and accessibility

4.1. Motivation

There are various reasons for combining Web 2.0 and accessibility. Generally speaking, the motivation behind this is the result of the desire to simultaneously profit from the advantages of Web 2.0 and accessibility.

Firstly, in the context of eGovernment, accessibility is mainly an inalienable requirement because of governmental regulations. In addition, there is the desire to provide a modern, easy to use and rich user interface as the front-end for the implementation of functional requirements. This desire can be fulfilled by using the dynamic aspects of Web 2.0 technology, namely AJAX technology [Garrett, 2005; Zhang et al., 2007], which supports the creation of responsive and rich Web applications that mimic features of desktop application user interfaces without imposing any special (and exclusive) requirements on the client, e.g. browser plugins.

Secondly, rich Web based user interfaces, which mimic desktop application interfaces, can be used to optimize usability. As Web 2.0 applications support a great deal more design flexibility than the regular Web 1.0 applications, proven usability guidelines, e.g. in the field of desktop application usability, can be, at least partly, implemented. Because usability problems can be seen as being a subset of accessibility [Petrie and Kheir, 2007] in the context of Shneiderman's concept of universal usability [Shneiderman, 2000] and vice versa [Thatcher et al., 2002], the combination of Web 2.0 and accessibility would appear to be a logical and synergistic choice.

Web 2.0 based applications or its generalization RIA, can provide the basis for collective intelligence. Reinhardt [2003] illustrates this with a case study that investigates the building of communities with rich internet applications. In the case where accessibility is considered, it is possible to increase the range of users because all users, including disabled users, can participate in the communities and attend on equal terms in the Information Society. The same arguments for the implementation of accessibility are also true for other mechanisms of collective intelligence, because all mechanisms are based on cooperative efforts. The consequence of this is that user interfaces have to be able to be operated by people, independent of their mental and physical conditions.

4.2. Current problems

In this section the focus is now on current main accessibility related problems with regards to Web 2.0.

Firstly, there has been an enormous increase in video content based Web sites. This is a major problem for blind or deaf/blind people and can only be partially compensated for by providing alternative texts [Crichton, 2007]. In general, Web sites are becoming more and more graphical [Zajicek, 2007], which makes it difficult for assistive technologies to extract the relevant Web page content.

Secondly, people who have impairments associated with sight, e.g. older or disabled people, probably depend on assistive technologies such as screen readers which read out the content of Web pages. However, most screen readers have problems with asynchronous page updates which are a main feature of AJAX technology [WebAIM, 2008]. Asynchronous or dynamic page updates make it possible to replace parts of a Web site without the necessity for full page submits. However, most screen readers do not realise client side modifications of the html document object model (DOM) which means that screen reader users are not provided with information regarding user interface changes. This is also dependent on the browser used on the client side.

In addition, users are not completely accustomed to the behaviour of AJAX based Web applications. Usually, there is no visual progress indication on AJAX requests in contrast to regular page submits which contravenes Norman's Principle which states that an interface should provide inherent clues to currently available actions, the current state of the system and results of available actions [Norman, 1988]. Response times are so fast that users might not recognize them because they do not anticipate such behaviour from Web sites. In general, there is the risk that Web 2.0 applications are less predictable and easy to use as compared to simple old fashioned html forms, which is an infraction against an important principle of Human Computer Interaction [Shneiderman, 1992]. Additionally, there is the risk of adding too much complexity by using AJAX and creating rich internet user interfaces [Nielsen, 2007].

According to Zajicek [2007], a Web 2.0 based Web site is only accessible if it includes users in its group and if it makes people keen on being members of the group. Zajicek also mentions that it is important for Web sites to make their benefits apparent. For example, this is an important issue for older people who frequently suffer from a lack of technological knowledge and an understanding of its benefits. In summation, true Web accessibility must not only eliminate technological barriers; it also has to make the people want to use Web 2.0 applications and Web 2.0 content.

Furthermore, many Web 2.0 applications require broadband connections [Zajicek, 2007]; mostly because of large client side libraries or embedded videos. This can be a problem for people on low incomes in case of dialups without a flat rate. It also excludes people who live in areas which only provide slow connections to the internet. Additionally, because of slow application loading, the user acceptance of these applications can diminish for the affected groups of people.

In respect of user generated content [Obrist et al., 2008], there are three main barriers to user participation, according to [Brandtzaeg and Heim, 2007]. In addition to the shortage of interesting people or friends participating and low content quality, low usability is a possible reason for low participation in user generated content based social community platforms [Brandtzaeg and Heim, 2007]. As mentioned above, usability problems can be considered as being a subset of accessibility and vice versa (cf. section 4.1 earlier in this article). As a consequence, low accessibility and for this reason low usability are the main drivers for low participation in user generated

content. Because the provider of a user generated content hosting platform is not the main content producer, the accessibility of user provided content cannot be ensured.

In the widest sense, Web accessibility relates to the support of online access that is independent of client parameters or client capabilities. Since location can be seen as a client parameter, location based censorship can be regarded as an accessibility barrier. Because formerly independent social network platforms are increasingly being bought by large companies and companies are generally aiming to make a profit, they tend to censor the content provided by social network platform users to fit in with the requirements of a government or other powerful players. For example, Google, as the owner of Youtube [Cha et al., 2007] adheres to the Internet censorship policies of China which means that Google has agreed to filter content that the Chinease government does not want to be published [BBC NEWS, 2006]. Another example is the suspension of the YouTube account of an Egyptian anti-torture activist who showed pictures and videos depicting police brutality, anti-government demonstrations and voting irregularities [Johnston, 2007]. This behaviour from the social network operators works directly against efforts with regards to democracy and freedom of speech [Birdsall, 2007] and excludes Chinease users from Web 2.0 and other content. As a consequence censored Web content is no longer accessible to the affected people.

In addition, there are legal [Kienle et al., 2008] and responsibility related problems regarding Web accessibility and Web 2.0. On traditional Web 1.0 sites content, in the majority of cases, is provided by the owner or someone who acts on behalf of the owner. Even if the content is supplied by a customer of the owner, the owner is still responsible for the content but can make contracts to delegate responsibility. Since user generated content is completely created by (anonymous) users and because of the huge number of social network platform users there is only a minimal chance that the provider of the particular social network platform can check all user contributions regarding the adequacy of content or consideration of accessibility related aspects. This also has legal implications and the question arises as to how statutory accessibility requirements can be ensured if the content originates from different users who are beyond the provider's control.

Last but not least, there is a major technical problem resulting from Web 2.0 applications dependence on AJAX and JavaScript support. As mentioned in section 3.1, all AJAX based communication is based on asynchronous communication between the client side and server side. This data exchange is implemented by using the browsers XMLHttpRequest object which is triggered by JavaScript code. In the context of Web accessibility this is a significant problem. Web accessibility means that a Web application has to work independently from the browsing technology on the client side [W3C, 1999]. However, if the client does not support JavaScript (e.g. older browser, browser of smart device) or has JavaScript disabled (e.g. because of security reasons) client side script and as a consequence AJAX is no longer working. This will often result in a fatal malfunction of the JavaScript and AJAX depending Web application.

4.3. Approaches to a solution

This section deals with current approaches to a solution and unresolved issues. The first depicted problem regarding the increase of video content can be handled by restricting its usage to optional enhancements. This means that content should always be presented in text form and graphical and auditory information should only be used as an optional enhancement which enables screen readers and other assistive

technologies to reliably transform and provide the content in an accessible form. Additionally, according to [Crichton, 2007] text representations should be provided as a whole instead of temporary restricted visibility.

The next aspect, the problem of screen readers with asynchronous page updates, can be solved by adapting current screen reader technologies to recognize DOM modifications. Additionally, browser vendors can improve screen reader support by firing defined events which can be traced by screen reader applications. Furthermore the implementation of WAI-ARIA (cf. section 2.4.4 earlier in this article) can assist in the provision of additional metadata concerning Web page components and their states. WAI-ARIA [W3C, 2008d] also supports descriptions for live regions and the specification of dynamic update behaviour which could be used by assistive technologies to inform the client about the state of and changes the graphical user interface. However, WAI-ARIA is not yet in its final form and it will also take some time for Web 2.0 developers and assistive technology vendors to implement WAI-ARIA. In addition, it is unlikely that WAI-ARIA will prevail until Web development framework integrated WAI-ARIA tools are available.

As mentioned above, there is also an issue with regards to the context of Web application behaviour that clients are used to which contravenes Norman's Principle [Norman, 1988]. AJAX applications should, for instance, visualize the progress of long lasting actions with regards to informing the user about the status and finally to improve user acceptance. Most applications only show an animation which is meaningless to the user apart from the simple information that a process is currently running. Real status information becomes much more complex and requires the continuous return of status information from the server to the client. Therefore this option is rarely implemented in production systems but is described in concepts and even illustrated in sample code [Esposito, 2007]. However, this approach does rely on JavaScript and also requires the Web developer to write custom visualization code. There is also ongoing research into augmenting the XMLHttpRequest object to support progress events [W3C, 2007] which could be used in combination with JavaScript to incrementally update the progress visualization on the client. Generally, a more generic and obvious solution other than HTML based animations would be the native support of browsers to visualize AJAX requests in a similar manner as for regular requests. This would also come closer to Norman's Principle because there is no functional reason for browsers to deal with synchronous and asynchronous submits in a completely different manner with regards to visualization.

According to Zajicek [2007], Web accessibility has to make people want to use Web 2.0 applications and Web 2.0 content because technological Web accessibility has no effect if there is no interest in the corresponding Web applications or Web sites. Excluded groups, e.g. older people, generally have no technological knowledge or interest at the same level as that of the younger generation who has grown up with such technology. Hence, ways must be found to increase the interest for and technological knowledge of Web 2.0 regarding this excluded groups.

Free and locally based presence courses sponsored by the local authority or companies aiming to find new potential online customers could be a first step to introduce older people to Web 2.0. However, an enduring interest is unlikely if no important advantages are apparent to older people. Therefore these types of courses could deal with different aspects such as the financial benefits, e.g. using Skype to make cheap telephone calls, and social advantages, e.g. chatting or video telephony. Because older people do not, generally, have many online contacts it would be very useful if the participants were to take their relatives of a similar age group or

technological knowledge with them in order to build up a stable personal online community. As a fallback option, course participants could form work groups. This would allow people to get to know each other and to build up a circle of online friends. Additionally, it is unknown if this will still be a problem in the future as future older generations will already possess knowledge regarding computers.

Another problem mentioned above is the increasing requirements for broadband connections in order to use certain Web applications [Zajicek, 2007]. On the one side, this problem can be somewhat reduced by disabling flash or other video enabling plugins to prevent the automatic download of contained videos. On the other side, Web applications could be developed which load their JavaScript libraries only if JavaScript is enabled on the client side. This would allow for a reduction in traffic and would enable the user to decide what is actually required. Within the field of videos, streaming [Li et al., 2005] can be an adequate replacement for full downloads. Another common solution is the offering of an alternative representation of a website for small band users. However, this involves twice the cost regarding further development, support and management.

In view of user generated content [Obrist et al., 2008] and accessibility, classic Web 1.0 accessibility guidelines such as WCAG 1.0 [W3C, 1999] can be applied to provide an accessible basis. Because users cannot be forced to be interested in accessibility, different approaches must be invented. Firstly, the user should not be allowed to enter raw (x)html. Instead a Web based WYSWYG (acronym for What You See Is What You Get paradigm) frontend which only supports valid xhtml or a subset of predefined structural elements, e.g. some header and content types, can be provided. Although this method cannot prevent all accessibility pitfalls, it can help to enforce a minimum of accessibility. Another idea is community member or community provider based rewarding of accessible contributions to increase the motivation of participating users. This can be implemented by using user based reviews or rating mechanisms [Ozakca and Lim, 2006].

Regarding online censorship and filtering, there are different approaches to a solution. On the technological level, foreign proxies, whose IP addresses are not filtered by the authorized body can be used to bypass its local filtering and, as a result, to access arbitrary Web sites. However, this solution requires the availability of unfiltered proxies and some technological knowledge and skill. As a result this method excludes people and counteracts the original aim of improving accessibility. Furthermore, the suggested method could be considered as illegal by the government of the respective country. Therefore it would appear to be more prudent to attempt to solve the problem on a political level. However, the success of this suggestion is highly dependent on the dedication of other countries to apply pressure on the censoring country. In summation, there are a number of approaches in providing a solution, but, as yet, there is no definitive answer.

As mentioned in the previous section, there are legal [Kienle et al., 2008] and responsibility related problems regarding Web accessibility and Web 2.0. Because in Web 2.0 user generated content is often used instead of static information provided by the owner of the Web site the consideration of accessibility cannot be ensured. Hence, this situation could have serious legal consequences for the owners of Web 2.0 sites which are based on user generated content. Solutions for this problem must be based on juridical actions or definitions. For example, in the U.S. this topic is primarily treated in Section 512(c) of the Digital Millenium Copyright Act [U.S. Copyright Office, 1998] and Section 230 of the Communications Decency Act which is part of

the U.S. Telecommunications Act of 1996 [U.S. Federal Communications Commission, 1996].

According to Fayle [2007] Section 512(c) eliminates a website provider's liability for copyright infringement if the websites support mechanisms that allow copyright owners to request the removal of infringing content. Additionally, the Web sites are not allowed to make financial benefits from infringing content, even in case where it is user provided content. On the other hand, Section 230 of the Communications Decency Act removes liability resulting from the publication of information provided by other Web sites. This means a Web site provider cannot be held responsible if a user posts defamatory or otherwise illegal content [Fayle, 2007]. Although this laws are not aimed at accessibility, they can be regarded as models for future accessibility related laws.

One of the most critical technological problems mentioned above is the dependency of Web 2.0 applications on JavaScript. Current solutions suggest

- abandoning Web 2.0 applications interactivity and sticking to basic html application design,
- building an accessible alternative website for each application with only basic functionality
- or simply ignoring accessibility issues.

The suggested solutions are far from optimal or economically acceptable because they either require throwing away all the benefits associated with Web 2.0 applications or by creating massive overheads in developing, testing, managing and supporting two completely different user interfaces for each application.

Another and new alternative to the problem mentioned above is currently being researched in a doctoral thesis being conducted at the University of Regensburg. Its aim is to identify basic and complex Web interaction patterns that support AJAX and JavaScript based Web 2.0 applications that work independently of the availability of JavaScript on the client side. This is mainly achieved by restricting the usage of action triggering entities to submit buttons which means that client side events that are not attached to a submit button are no longer valid. As depicted in Figure 1, in this scenario JavaScript functionality only improves responsiveness and is regarded as optional. If JavaScript is available, regular submit actions will be cancelled on the client side and processed solely on the client if possible. Otherwise JavaScript statements are not processed and regular page submits occur.

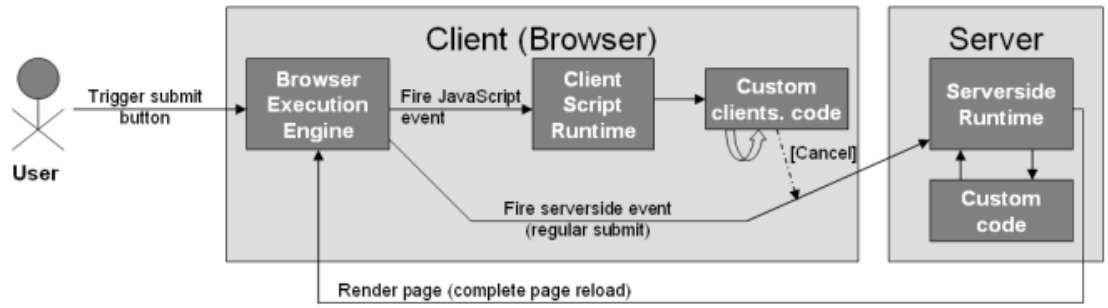

Figure 1: Basic "JavaScript availability robust" Web interaction pattern

A simple example to this approach would be a web based tab control that allows for tab related content to be shown by clicking a tab (Figure 2). If a user clicks on the second tab and JavaScript is available on the client, the content of tab 2 is displayed

and the contents of the other tabs are, for instance, hidden. This can be conducted completely on the client because the content for all tabs is already rendered in html, but made invisible by using CSS. JavaScript can now be used to show the selected tab by changing the style sheet attributes of the tabs. If no client script support is available on the client, the tab button, a submit button, does not process the attached JavaScript handlers, but fires a full page submit. On the server side, this has to be handled by returning an html response to the client which still includes the complete tab control but with different CSS style assignments to show the triggered tab and hide the others.

In the context of Web 2.0, this concept has to be adapted to AJAX which basically means that an AJAX based asynchronous submit has to be transformed to a regular full page submit if the client script and, as a result AJAX, is unavailable.

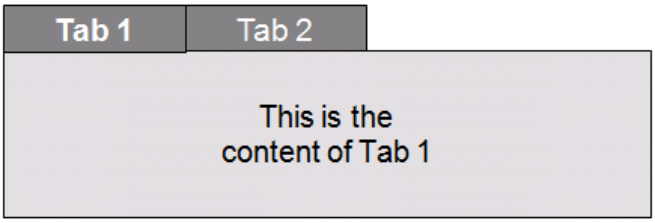

Figure 2: Simple tab control

The solution depicted in Figure 1 appears to be somewhat trivial at first glance, but consideration must be given to the fact that this approach only shows the most basic interaction without giving any thought to any side effects such as client side and server side Web page state persistence. However, omitting such kinds of side effects can lead to inconsistent Web page component states and will most probably make the Web application useless. As a consequence, thorough research is necessary to deliver a consistent and viable solution. In summation, the aim of this research is to finally provide a framework that allows for the development of rich Web 2.0 based applications which work independently of the availability of JavaScript and AJAX on the client to make it possible to create Web applications which provide, simultaneously, rich features and Web accessibility.

5. Conclusion and Perspective

On the one hand, it is not merely a nice option to have Web accessibility. It is an essential altruistic, commercial and statutory requirement. It enables all people, regardless of their mental or physical restrictions and independently of technical limitations, to use Web sites and Web applications in a comfortable and inclusive way. On the other hand, Web 2.0 technologies are used to create powerful and desktop like, rich Web applications. The main intentions of Web 2.0 applications are to provide powerful, flexible and rich user interfaces, harnessing collective intelligence and optimizing online advertising by providing more interactive and visually appealing banners and promotion in general.

Currently, the combination of accessibility and Web 2.0 results in many problems. Most problems depicted above can be at least partially solved or there are ideas which could provide a potential solution. One of the main identified technical problems is Web 2.0's dependency on AJAX and JavaScript. At the present time there is no acceptable and permenent solution available in the scientific community. As mentioned above research in this topic is currently being conducted at the University of Regensburg. Our studies have already identified some basic Web interaction

paradigms and concepts that enable Web 2.0 behaviour without the dependency on JavaScript. These encouraging concepts are currently being refined, modularized and put into practice with conceptional results and an implementation prototype expected for 2009.

References

Abecasis, H. and Fernandes, J. (2001). "The national initiative for people with special needs in the information society: the elderly, people with disabilities and long-term bed-ridden", in *WUAUC'01: Proceedings of the 2001 EC/NSF workshop on Universal accessibility of ubiquitous computing*, New York, NY, USA : ACM, pp. 19–23.

Anderson, C. (2006). *The Long Tail: Why the Future of Business Is Selling Less of More*. Hyperion.

Architectural and Transportation Barriers Compliance Board (ATBCB) (Ed., 2000). "Electronic and Information Technology accessibility Standards", in *Federal Register* 65, December 21, No. 246, pp. 80500–80528.

Ayers, P., Matthews, C., and Yates, B. (2008). *How Wikipedia Works: And How You Can Be a Part of It*, No Starch Press.

BBC NEWS (Ed., 2006). *Google China Censorship*. January 2006. – URL http://news.bbc.co.uk/2/hi/technology/4645596.stm – Last accessed at 16.10.2008.

Beaudouin-Lafon, M. (1990). "Collaborative development of software", in *Proceedings of the IFIP WG 8.4 conference on Multi-user interfaces and applications*. Amsterdam : Elsevier North-Holland Inc., pp. 103–114

Beelen, P. (2006). *Advertising 2.0: What everybody in advertising, marketing and media should know about the technologies that are reshaping their business*. 2006. – URL http://www.paulbeelen.com/whitepaper/Advertising20.pdf – 16.06.2008.

Birdsall, W. F. (2007). "Web 2.0 as a Social Movement", in *Webology* 4, June, No. 2.

Brandtzaeg, P. B. and Heim, J. (2007). "User loyalty and online communities: why members of online communities are not faithful", in: *INTETAIN '08: Proceedings of the 2nd international conference on INtelligent TEchnologies for interactive enterTAINment*. ICST, Brussels, Belgium, Belgium : ICST (Institute for Computer Sciences, Social-Informatics and Telecommunications Engineering), pp. 1–10.

Cato, J. (2001). *User-Centered Web Design*. 1st. ed., Addison Wesley Longman.

Cha, M., Kwak, H., Rodriguez, P., Ahn, Y.-Y., and Moon, S. (2007). "I tube, you tube, everybody tubes: analyzing the world's largest user generated content video system", in: *IMC '07: Proceedings of the 7th ACM SIGCOMM conference on Internet measurement*. New York, NY, USA : ACM, pp. 1–14.

Chin, A. and Chignell, M. (2006). "A social hypertext model for finding community in blogs", in *HYPERTEXT '06: Proceedings of the seventeenth conference on Hypertext and hypermedia*. New York, NY, USA : ACM, pp. 11–22.

Chou, D. C. and Chou, A. Y. (2007). "Analysis of a new information systems outsourcing practice: software-as-a-service business model", in *International Journal of Information Systems and Change Management*, Vol. 2, No. 4, pp. 392–405.

Christodoulou, S. P. and Styliaras, G. D. (2008). "Digital art 2.0: art meets web 2.0 trend", in *DIMEA '08: Proceedings of the 3rd international conference on Digital Interactive Media in Entertainment and Arts*. New York, NY, USA : ACM, pp. 158–165.

Cooper, M. (2007) "Accessibility of emerging rich web technologies: web 2.0 and the semantic web", in *W4A '07: Proceedings of the 2007 international cross-disciplinary conference on Web accessibility (W4A)*. New York, NY, USA : ACM, pp. 93–98.

Crichton, P. (2007). "The Access 2.0 interview", http://www.bbc.co.uk/blogs/access20/2007/01/post_2.shtml – Last accessed at 13.07.2008.

Czaja, S. J. (2006). “Technology and older adults:: designing for accessibility and usability”, in *Assets '06: Proceedings of the 8th international ACM SIGACCESS conference on Computers and accessibility*. New York, NY, USA : ACM, pp. 1–1.

Deutsches Bundesministerium des Innern (Ed., 2002). *Barrierefreie Informationstechnik-Verordnung (BITV)*. July 2002. http://bundesrecht.juris.de/bundesrecht/bitv/gesamt.pdf

Esposito, D. (2007). “CUTTING EDGE: Context-Sensitive Feedback with AJAX”, in *MSDN Magazine* 07.

European Commission (Ed., 2005). *Communication from the Commission to the Council, the European Parliament and European Economic and Social Committee and the Committee of the Regions: eaccessibility*, Brussels, 005. COM(2005)425 final – URL http://ec.europa.eu/information_society/activities/einclusion/docs/access/comm_ea_2005/com_2005-0425-f_en_acte.pdf – Last accessed at 08.10.2008

European Commission (Ed., 2007). *eInclusion@EU - Strengthening eInclusion and eAccessibilityacross Europe: Final Project Report*, http://www.einclusion-eu.org/files/D6_3_final.pdf – Last accessed at 29.10.2007

European Interactive Advertising Association (Ed., 2007). *EIAA Silver Surfers Executive Summary*, – http://www.adeurope.com/fileadmin/user_upload_adeurope/Presentation/Research/EIAA_Silver_Surfers_-_Executive_Summary.pdf – Last accessed at 09.07.2008

Fayle, K. (2007). *Understanding the Legal Issues for Social Networking Sites and Their Users*, http://technology.findlaw.com/resources/scripts/printer_friendly.pl?page=//articles/00006/010966.html – Last accessed at 19.10.2008

Forrester Research Inc. (Ed., 2008). *Forrester: Global Enterprise Web 2.0 Market To Reach $4.6 Billion By 2013*. 2008, http://www.forrester.com/ER/Press/Release/0,1769,1207,00.html – Last accessed at 14.06.2008

Garrett, J. and Ajax, J. (2005). *A New Approach to Web Applications*. http://www.adaptivepath.com/ideas/essays/archives/000385.php – Last accessed at 11.10.2008

Gibson, B. (2007). “Enabling an accessible Web 2.0”, in *W4A '07: Proceedings of the 2007 international cross-disciplinary conference on Web accessibility (W4A)*, New York, NY, USA : ACM, pp. 1–6.

Halpin, H., Robu, V., and Shepherd, H. (2007). “The complex dynamics of collaborative tagging”, in *WWW '07: Proceedings of the 16th international conference on World Wide Web*. New York, NY, USA : ACM, pp. 211–220.

Harris Interactive Inc. (Ed., 2004). *2004 N.O.D./Harris Survey of Americans with Disabilities*, http://www.nod.org/Resources/ harris2004/harris2004_data.pdf

Henry, S. L. et al. (Ed., 2005). *Introduction to Web accessibility*, http://www.w3.org/WAI/intro/accessibility.php – Last accessed at 13.06.2008

Heylighen, F. (1999). “Collective Intelligence and its Implementation on the Web: Algorithms to Develop a Collective Mental Map”, in *Computational &. Mathematical. Organization Theory*, vol. 5, no. 3, pp. 253–280.

Hirsh, L. (2002). “How Big Is E-Commerce?”, in *E-Commerce Times*, http://www.ecommercetimes.com/story/18403.html – Last accessed at 12.07.2008

Högg, R., Meckel, M., Stanoevska-Slabeva, K., and Martignoni, R. (2006). ”Overview of business models for Web 2.0 communities”, in: *Proceedings of GeNeMe 2006*. Dresden, pp. 23–37.

Horrocks, I. (2007). “Semantic web: the story so far”, in *W4A '07: Proceedings of the 2007 international cross-disciplinary conference on Web accessibility (W4A)*. New York, NY, USA : ACM, pp. 120–125.

IDG Business Media GmbH (Ed., 2005). *Mobile Dienstleistungen werden sich bis 2010 verdoppeln*, http://www.channelpartner.de/_misc/article/__print/index.cfm?pid=143&pk=225255&op=prn – Last accessed at 02.05.2008

International Organization for Standardization (ISO) (Ed., 1998). *Ergonomic requirements for office work with visual display terminals (VDTs) - Part 11: Guidance on usability (ISO 9241-11:1998)*.

International Organization for Standardization (ISO) (Ed., 2008). *Ergonomics of human-system interaction - Part 171: Guidance on software accessibility (ISO 9241-171:2008)*.

IT accessibility & Workforce Division (ITAW) (Ed., 1998). *1998 Amendment to Section 508 of the Rehabilitation Act*., http://www.section508.gov/index.cfm? FuseAction=Content&ID=14 – Last accessed at 11.07.2008

Jazayeri, M. (2007) "Some Trends in Web Application Development", in *FOSE '07: 2007 Future of Software Engineering*. Washington, DC, USA : IEEE Computer Society, pp. 199–213.

Johnston, C. (2007). *YouTube stops account of Egypt anti-torture activist*. Reuters. November 2007. http://africa.reuters.com/wire/news/usnL27590430.html – Last accessed at 16.10.2008

Kienle, H., German, D., Tilley, S., and Muller, H. (2008). "Managing legal risks associated with intellectual property on the web", in *International Journal of Business Information Systems*, vol. 3, no. 1, pp. 86–106.

Kohler, T. (2005). *P028 – Richtlinien des Bundes für die Gestaltung von barrierefreien Internetangeboten – Version 1.0*. http://www.isb.admin.ch/themen/ standards/alle/03237/index.html?lang=de – Last accessed at 11.07.2008

Kroski, E. (2007). *Information Design Principles For Web 2.0 Design. Simple & Social*, http://www.masternewmedia.org/information_design/information-design-principles/web-20-design-simple-social-design-components-20071017.htm – Last accessed at 19.07.2008

Kruchten, P. (2003). *The Rational Unified Process: An Introduction,* 3rd Ed., Addison-Wesley Professional.

Küpper, A. (2005). *Location-Based Services: Fundamentals and Operation*, Wiley.

Li, M,, Claypool, M., Kinicki, R., and Nichols, J. (2005). "Characteristics of streaming media stored on the Web", in *ACM Transactions on Internet Technology*, vol. 5, no. 4, pp. 601–626.

Linaje, M., Preciado, J. C., and Sánchez-Figueroa, F. (2007). "Engineering Rich Internet Application User Interfaces over Legacy Web Models", in *IEEE Internet Computing*, vol. 11, no. 6, pp. 53–59.

Lindenmeyer, J. and Riesch, M. (2007). *eCH-0059 accessibility-Standard. V 1.0,* http://www.access-for-all.ch/download/eCH-0059=DEF1-0=eCH-0059_STAN_d_Acce_accessibility%20Standard.pdf – Last accessed at 11.07.2008

Martin, B. (2005). "Information society revisited from vision to reality", in *Journal of Information Science*, vol. 31, no. 1, pp. 4–12.

McMullin, J. and Skinner, G. (2003). *Usability Heuristics for Rich Internet Applications*. http://www.boxesandarrows.com/view/ – Last accessed at 13.10.2008

Meier, J. D., Mackman, A., Wastell, B., Bansode, P., Wigley, A., and Gopalan, K. (2005). *Security Guidelines: ASP.NET 2.0*, http://msdn.microsoft.com/en-us/library/ms998258(printer).aspx – Last accessed at 12.10.2008

Ministerial Conference "ICT for an inclusive society" (Ed., 2006). *Declaration of Riga. Ministerial Declaration*, http://ec.europa.eu/information_society/events/ict_riga_2006/doc/declaration_riga.pdf – Last accessed at 01.11.2007

Nielsen, J. (1994). *Ten Usability Heuristics*, http://www.useit.com/papers/heuristic/heuristic_list.html – Last accessed at 13.10.2008

Nielsen, J. (2007). *Jakob Nielsen's Alertbox. Web 2.0 Can Be Dangerous...* http://www.useit.com/alertbox/web-2.html – Last accessed at 19.07.2008

Norman, D. A. (1988). *The Design of Everyday Things*, N.Y., Doubleday.

O'Reilly, T. (2005). *What Is Web 2.0? Design Patterns and Business Models for the Next Generation of Software*, http://www.oreilly.de/artikel/web20.html – Last accessed at 14.06.2008

Obrist, M., Geerts, D., Brandtz, P. B., and Tscheligi, M. (2008). "Design for creating, uploading and sharing user generated content", in *CHI '08: CHI '08 extended abstracts on Human factors in computing systems*, New York, NY, ACM, pp. 2391–2394.

Ozakca, M. and Lim, Y. –K. (2006). "A study of reviews and ratings on the internet", in *CHI '06: CHI '06 extended abstracts on Human factors in computing systems*. New York, NY, ACM, pp. 1181–1186.

Parise, S. and Guinan, P. J. (2008). "Marketing Using Web 2.0", in *HICSS '08: Proceedings of the Proceedings of the 41st Annual Hawaii International Conference on System Sciences,* Washington DC, IEEE Computer Society, pp. 281.

Pastore, S. (2008). "Social networks, collaboration and groupware software for the scientific research process in the web 2.0 world", in *AIKED'08: Proceedings of the 7th WSEAS International Conference on Artificial intelligence, knowledge engineering and data bases*, Stevens Point, Wisconsin, World Scientific and Engineering Academy and Society (WSEAS), pp. 403–408.

Petrasch, R. (2007). "Modellbasierte Entwicklung von Web 2.0 Anwendungen mit MDA", in *i-com* 2007, pp. 28–32.

Petrie, H. and Kheir, O. (2007). "The relationship between accessibility and usability of websites", in *CHI '07: Proceedings of the SIGCHI conference on Human factors in computing systems*, New York, NY, ACM, pp. 397–406.

Pilgrim, C. J. (2008). "Improving the usability of web 2.0 applications", in *HT '08: Proceedings of the nineteenth ACM conference on Hypertext and hypermedia*. New York, NY, pp. 239–240.

Ratner, J. A., Grose, E., and Forsythe, C. (1996). "Traditional vs. Web Style Guides: How Do They Differ", in *Human Factors and Ergonomics Society Annual Meeting Proceedings*, vol. 40, pp. 365–369(5).

Reinhardt, R. (2003). "Building communities with rich Internet applications", in *SIGGRAPH '03: ACM SIGGRAPH 2003 Web Graphics*. New York, NY, ACM, p. 1.

Roe, P. (Ed., 2001). *Bridging the gap? Access to telecommunications for all*. Zurich, Commission of European Communities.

Scapin, D. L., Leulier, C., Bastien, C., Vanderdonckt, J., Mariage, C., Farenc, C., Palanque, P., and Bastide, R. (2000). "A Framework for Organizing Web Usability Guidelines", in *6th. Conference on Human Factors and the Web*. Austin, Texas.

Schmitz, C. (2002). *Ein Netz voller Scheren, Barrieren und Chancen*, www.einfach-fuer-alle.de/artikel/barrieren – Last accessed at 14.06.2008

Shneiderman, B. (1992). *Designing the User Interface: Strategies for Effective Human-Computer Interaction. 2nd ed.* Addison-Wesley.

Shneiderman, B. (2000). "Universal usability", in *Communications of the ACM*, vol. 43, pp. 85–91.

Silva, P. A. and Dix, A. J. (2007). "Usability – Not as we know it!", in *Proceedings of the HCI07 Conference on People and Computers XXI*, http://www.bcs.org/server.php?show=ConWebDoc.13413 , p. 26.

Stamey, J. and Richardson, T. (2006). "Middleware development with AJAX", in *Journal of Computing Sciences in Colleges*, vol. 22, no. 2, pp. 281–287.

Thatcher, J., Waddell, C. D., Henry, S. L., Swierenga, S., Urban, M. D., Burks, M., Regan, B., and Bohman, P. (2002). *Constructing accessible web sites*. UK : glasshaus.

Torab, H. (2007). *Web 2.0 Magazine. Your Web 2.0 Guidelines*, http://web2magazine.blogspot.com/2007/01/your-web-20-guidelines.html – Last accessed at 22.07.2008

Treese, W. (2006). "Web 2.0: is it really different?", in *netWorker*, vol. 10, no. 2, pp. 15–17.

Trump, T., Klingler, W., and Gerhards, M. (2007). „Web 2.0": *Begriffsdefinition und eine Analyse der Auswirkungen auf das allgemeine Mediennutzungsverhalten*, http://www.wissen.dsft-

berlin.de/%E2%80%9EWeb_2.0%E2%80%9C_%E2%80%93_Begriffsdefinition_und_eine_Analyse_de/Info-15-675-4-4.10.html - Last accessed at 19.10.2008

U.S. Copyright Office (Ed., 1998). "The Digital Millennium Copyright Act of 1998", *U.S. Copyright Office Summary*. http://www.copyright.gov/legislation/dmca.pdf – Last accessed at 19.10.2008

U.S. Federal Communications Commission (Ed., 1996). "Telecommunications Act of 1996",http://www.fcc.gov/Reports/tcom1996.txt – Last accessed at 19.10.2008

Ullrich, C., Borau, K., Luo, H., Tan, X., Shen, L., and Shen, R. (2008). "Why web 2.0 is good for learning and for research: principles and prototypes", in *WWW '08: Proceeding of the 17th international conference on World Wide Web*. New York, NY, ACM, pp. 705–714.

W3C (Ed., 1999). *Web Content accessibility Guidelines 1.0*, http://www.w3.org/TR/WAI-WEBCONTENT/ – Last accessed at 14.06.2008

W3C (Ed., 2000). *Authoring Tool Accessibility Guidelines 1.0*, http://www.w3.org/TR/WAI-AUTOOLS/ – Last accessed at 20.10.2008

W3C (Ed., 2007). *Progress Events 1.0. W3C Working Draft*, http://www.w3.org/TR/2007/WD-progress-events-20071023/ – Last accessed at 19.10.2008

W3C (Ed., 2008a). *Rich Web Clients Activity Statement*, http://www.w3.org/2006/rwc/Activity.html – Last accessed at 16.06.2008

W3C (Ed., 2008b). *Web Content accessibility Guidelines 2.0*, http://www.w3.org/TR/WCAG20/ – Last accessed at 19.07.2008

W3C (Ed., 2008c). *[DRAFT] Comparison of WCAG 1.0 Checkpoints to WCAG 2.0, Grouped by Priorities*, http://www.w3.org/WAI/WCAG20/from10/comparison-priorities/ – Last accessed at 19.07.2008

W3C (Ed., 2008d). *Accessible Rich Internet Applications (WAI-ARIA) Version 1.0*, http://www.w3.org/TR/wai-aria/ – Last accessed at 19.07.2008

W3C (Ed., 2008e). *WAI-ARIA Overview*, http://www.w3.org/WAI/intro/aria.php – Last accessed at 19.10.2008

Waldrop, J. and Stern, S. M. (2003). *Census 2000 Brief: Disability Status 2000*. http://www.census.gov/prod/2003pubs/c2kbr-17.pdf – Last accessed at 14.06.2008

Walsh, T. (2003). *The Reputation Vortex: Online Reputation Management (Spiro Business Guides)*. Spiro Press, no. 9.

WebAIM (Ed., 2008). *Accessibility of AJAX Applications*, http://www.webaim.org/techniques/ajax/ – Last accessed at 16.06.2008

Webster, F. (1995). *Theories of the Information Society*. New York, NY, 10001 : Routledge.

Weinreich, H., Obendorf, H., Herder, E., and Mayer, M. (2008). "Not quite the average: An empirical study of Web use", in *ACM Transactions on the Web*, vol. 2 , no. 1, pp. 1–31.

Weiss, A. (2005). "The power of collective intelligence", in *networker*, vol. 9, no. 3, pp. 16–23.

Xiao, W.., Chi, C., and Yang, M. (2007). "On-line collaborative software development via wiki", in *WikiSym '07: Proceedings of the 2007 international symposium on Wikis*. New York, NY, ACM, pp. 177–183.

Yee, R. (2008). *Pro Web 2.0 Mashups: Remixing Data and Web Services (Proffesional Reference Series)*. APress.

Zajicek, M. (2007). "Web 2.0: hype or happiness?", in *W4A '07: Proceedings of the 2007 international cross-disciplinary conference on Web accessibility (W4A)*. New York, NY, ACM, pp. 35–39.

Zang, N., Rosson, M. B., and Nasser, V. (2008). "Mashups: Who? What? Why?" in *CHI '08: CHI '08 extended abstracts on Human factors in computing systems*. New York, NY, ACM, pp. 3171–3176.

Zhang, X., Zhang, Y., and Wu, J. (2007). "Research and Analysis of Ajax Technology Effect on Information System Operating Efficiency", in *CONFENIS*, vol. 1, pp. 641–649.

Zucker, D. F. (2007). “What does AJAX mean for you?”, in *interactions*, vol. 14, no. 5, pp. 10–12.