From Web Accessibility to Web Adaptability

BRIAN KELLY[1], *LIDDY NEVILE*[2], *DAVID SLOAN*[3], *SOTIRIS FANOU*[4], *RUTH ELLISON*[5] *& LISA HERROD*[6]

[1] UKOLN, University of Bath, Bath, UK; [2] School of Engineering and Mathematical Sciences , La Trobe University, Bundoora, Australia; [3] School of Computing, University of Dundee, Dundee, UK' [4] Faculty of Health and Life Sciences, UWE, Stapleton; Bristol, UK; [5] Consultant, Canberra, Australia and [6] User Experience Consultant, Sydney, Australia

Abstract

*Purpose***:** This paper asserts that current approaches to enhancing the accessibility of Web resources fail to provide a solid foundation for the development of a robust and future-proofed framework. In particular, they fail to take advantage of new technologies and technological practices.

The paper introduces a framework for Web *adaptability* which encourages the development of Web-based services which can be resilient to the diversity of uses of such services, the target audience, available resources, technical innovations, organisational policies and relevant definitions of 'accessibility'.

*Method***:** The article refers to a series of author-focussed approaches to accessibility through which the authors and others have struggled to find ways to promote accessibility for people with disabilities. These approaches depend upon the resource author's determination of the anticipated users' needs and their provision. Through approaches labelled as 1.0, 2.0 and 3.0, the authors have widened their focus to account for contexts and individual differences in target audiences. Now, the authors want to recognise the role of users in determining their engagement with resources (including services). To distinguish this new approach, the term 'adaptability' has been used to replace 'accessibility'; new definitions of accessibility have been adopted, and the authors have reviewed their previous work to clarify how it is relevant to the new approach.

Results: Accessibility 1.0 is here characterised as a technical approach in which authors are told how to construct resources for a broadly defined audience. This is known as universal design. Accessibility 2.0 was introduced to point to the need to account for the context in which resources would be used, to help overcome inadequacies identified in the purely technical approach. Accessibility 3.0 moved the focus on users from a homogenised universal definition to recognition of the idiosyncratic needs and preferences of individuals and to cater for them. All of these approaches placed responsibility within the authoring/publishing domain without recognising the role the user might want to play, or the roles that other users in social networks, or even Web services might play.

Conclusions: Adaptability shifts the emphasis and calls for greater freedom for the users to facilitate individual accessibility in the open Web environment.

Keywords: *Accessibility, usability, WAI, WCAG*

1. Introduction

A group of primarily UK-based researchers have, since 2004, investigated limitations of Web accessibility solutions, particularly those proposed by the Web Accessibility Initiative (WAI). The early work described inadequacies of the WAI model in the context of e-learning [1]. Further work exposed limitations in the WAI model itself and the guidelines which comprise the WAI model [2]. An elaborated approach to Web accessibility emerged which included a context for using the WAI model [3] in a more holistic way originally known as Holistic Accessibility. The term Web Accessibility 2.0 (or Accessibility 2.0) has now been adopted to describe this approach.

Subsequent work further explored the definition and needs of users and led to support for work that proposes the automatic composition of components into resources that are suitable for individual users. This was called Web Accessibility 3.0 [4].

This paper reviews the development of these approaches to Web accessibility, explores the various limitations of these distinct approaches and describes a more 'inclusive' approach. The new approach aims to provide a foundation which encompasses the complexity of enhancing access to digital resources for all people, not differentiating those with disabilities that are defined medically. The authors refer to this as Web Adaptability.

The authors have adopted the UN Conventional definition of disabilities and consider that all people are disabled in some circumstances and that disability is a social construct not an attribute of an individual. In particular, resource accessibility is an attribute of the matching, or otherwise, of a resource to a user's individual needs and preferences, not an attribute of a resource [5].

2. Web Accessibility 1.0

2.1 About Web Accessibility 1.0

The term 'Web Accessibility 1.0' is used to described the WAI Web accessibility approach which is based on conformance with the WCAG, ATAG and UAAG specifications developed by W3C's Web Accessibility Initiative (WAI).

2.2 The WAI Web Accessibility Model

The World Wide Web Consortium (W3C) has played a leading role in promoting accessibility of the Web for 'people with disabilities'. People are so described according to a medical model of disability that attributes pathologies to people rather than, for example, a model that attributes functional needs to them, or the more inclusive social definition that considers needs and preferences within contexts for all people.

The W3C's Web Accessibility Initiative (WAI) has a model for developers of accessible Web resources. This is based on the premise that full conformance with the set of technical specifications (guidelines) will achieve the stated goal of universal Web accessibility, meaning accessibility for people with the full range of disabilities (medically defined).

It should be noted here that what is being described as the WAI model is, in fact, what is commonly understood to be their model, whereas WAI itself advocates a broad approach to the problem involving a wide range of players. This confusion arises because in many circumstances, accessibility is assumed to be fully dealt with by adherence to technical specifications. The WAI model, as described here, refers then to the WAI technical specifications model.

In the WAI model, Web Content Accessibility Guidelines [6] are specifications that are coupled with accessibility guidelines for browsing and access technologies, the User Agent Accessibility Guidelines, UAAG [7], and for tools to support creation of Web content, Authoring Tools Accessibility Guidelines, ATAG [8]. This approach acknowledges that in addition to providers of Web content, developers of authoring tools and of browsers, media players and access technologies also have responsibility for the provision of accessible Web content for people with disabilities. It is appropriately a technical approach, because the W3C's mission is technical development of the Web achieved through consensus leading to recommendation of technical specifications.

2.3 Limitations of the WAI Model

Web resource authors have control over their own conformance with WCAG, and with ATAG with respect to interactivity they offer, but they have no control over users' access facilities or practices. In fact, many users cannot benefit from the accessibility features promised by a WCAG conformant Web page, due to limitations of their skills, or their browsing or assistive technology. In addition, not all users have the same functional requirements but they are not offered any way to determine if their individual needs are met, or to find resources that suit their needs, regardless of how those resources may or may not suit the needs of others.

2.4 Limitations of WCAG

WCAG 1.0 was a major achievement of WAI but nevertheless was not perfect. A number of shortcomings of that version have been documented elsewhere [2] [9]. WCAG 2.0 was released in December 2008 [10]. Compared with the HTML-focused WCAG 1.0, WCAG 2.0 is technology-neutral. Its core principles (POUR: perceivable, operable, understandable, robust) and related 'success criteria' aim to be applicable to the widest possible range of present and future technologies used to deliver content on the Web – including non-W3C technologies. WCAG 2.0 is, however, another set of technical specifications. The normative 'guidelines' are complemented by non-normative, technology-specific 'techniques' documents, detailing specific implementation examples and best practices. The specifications are still all about testable technical attributes of resources. There is no problem with this. It is simply that such technical attributes alone cannot, as has been shown, solve all the accessibility problems.

2.5 Limitations of Web Accessibility 1.0

Previously, the authors have shown that the technical approaches do not provide the flexibility needed for a robust infrastructure which supports a diversity of uses of the Web [11].

WCAG 1.0 included a requirement that WCAG 1.0 AA conformant pages must validate as HTML conformant, for instance. Lilley [12] asserted that '99.99999% of the Web was invalid HTML' in 2007 and his estimate is backed up by surveys such as Marincu [13] which reports that 'Only four U.K. sites (less than 0.2 percent) and six German sites (less than 0.4 percent) had completely valid HTML markup'. Similar evidence is provided by more recent surveys [14]. This evidence suggests that the number of Web sites which can be regarded as WCAG 1.0 AA compliant is close to 0%! It is explained by the perceived need of authors to provide resources that are appropriately interpreted by browser software in common usage, and that these are invariably not completely UAAG conformant, so they do not use HTML in a conformant way.

Such examples have led the authors not to the conclusion that the low levels of conformance with WCAG guidelines indicate that more enforcement is needed, but that the evidence can be interpreted as highlighting limitations of the WAI model, which, in this paper, we refer to as 'Web Accessibility 1.0'.

3. Web Accessibility 2.0

3.1 About Web Accessibility 2.0

The term Web Accessibility 2.0 is used to describe a context-focussed and holistic approach to Web accessibility. Unlike the narrow technical approach taken in the original WAI model, with the emphasis on the resource in isolation, this approach advocates a context-sensitive approach, calling for application of the technical specifications as is appropriate for the context.

3.2 A Holistic Approach To Web Accessibility

Although the WCAG 2.0 guidelines are more flexible than the earlier ones, the WAI model still does not seem to allow flexibility for the context of use or the individual user. The lack of context for the application of accessibility guidelines can result in a simplistic and conservative approach being taken, which can fail to take advantage of technological developments, the specific needs of users of a Web service or accessible alternatives to Web resources. The provision for collective users' needs also denies flexibility for individuals.

Kelly *et al* [15] describes a holistic approach to Web accessibility for e-learning which promotes emphasis on accessible learning outcomes rather than accessible resources. This holistic approach is incorporated into the Web Accessibility 2.0 approach. It reflects, in educational contexts, a pedagogical approach that supports a diversity of learning styles and preferences – if a student is uncomfortable with an IT solution to learning, then the student should have the option to choose alternative ways of learning because it is the learning outcome that is sought, not the use of a particular technology. This approach, illustrated in Figure 1, treats the student not as someone who is disabled but as someone with alternative learning preferences. Nevile and Treviranus [16] have argued for what they term 'inclusive' learning environments, again recognizing the contextual goals over the use of particular technologies. The emphasis in such environments is on the learning outcomes and thus the match between resources and users rather than the fixed qualities of the resource.

Now, significantly, the United Nations Convention on the Rights of Persons with Disabilities [5] requires the activities within a context to be inclusive so that all can participate equally. This draws on Oliver's 'social model' of disability [17]: disability is considered to be an artefact of a context rather than a characteristic of a person or resource, and so all participants' functional requirements are to be anticipated and met. The social model of disability thus underpins the Web Accessibility 2.0 approach.

It has been argued that a broad or holistic approach is well suited for use in a Web 2.0 context in which users may exploit a variety of technologies (blogs, wikis, social networking services, RSS feeds, etc.) in both formal and informal ways. In a learning environment, the learner is regarded as an active participant in the learning process, for example, and not just a passive consumer of content. The learner's environment should adapt to her needs and preferences rather than to an arbitrary, generalised standard to which she is expected to adapt.

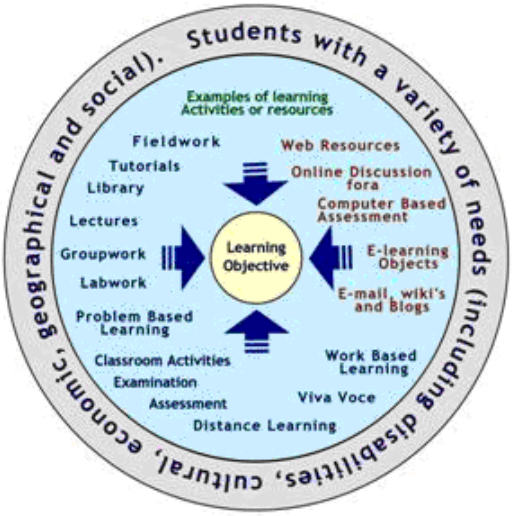

Figure 1: Blended Model For Learning (see [1])

The application of this holistic approach to other areas, such as a cultural context, has been described by Kelly *et al* [18]. Nevile and Ford [19] have pointed to the accessibility problems that arise in location-dependent contexts, asserting that location independence can also be important in many such contexts.

A interesting argument for a holistic approach to accessibility appears in a report titled 'eAccessibility of public sector services in the European Union' [20]. It shows how 'in a multi-channel environment, online services have the clear potential to increase accessibility and inclusiveness of a service to those excluded from traditional forms of interaction with public authorities - and to deliver real benefits to those who use public services the most.' In such an environment, there is a need to (re-)assess the approaches which have traditionally been taken to the development of accessible Web sites and the way in which Web developers can claim 'accessibility' of their resources.

3.3 Accessibility in a Web 2.0 Environment

Although developed before the Web 2.0 term became widely used, a more contextually-sensitive approach to Web accessibility would appear to be relevant in a Web 2.0 environment. The focus on the learning objective, for example, does not require that learning objectives be fulfilled only through passive access to digital resources. Rather, such an objective may be achieved in a variety of ways, including passive interaction with digital resources, but more likely, and in keeping with modern pedagogical models, also including using the resource, discussing the resource and critiquing the resource. And the resource itself need not be only digital: rather there may be a

redundant set of components of learning resources for the user, reflecting different needs, preferences and learning styles. And such learning resources may be digital resources, physical resources, or, indeed, participation or processes.

In the Web 2.0 context, a learner can be empowered to choose their preferred learning route. In a formal course, this will need to relate to satisfying particular learning requirements to particular standards. However, in other contexts such as informal learning, cultural appreciation, etc., the user can have more flexibility in achieving their desired goals.

The authors' initial Web Accessibility 2.0 approach suggested that promoting accessibility as inclusion in a Web 2.0 context might include:

(a) ensuring that the full range of potential disabilities (mismatches between users and resources) within the proposed context is accurately determined for the anticipated target audience;

(b) ensuring that the desired outcomes are available in a range of forms suitable for everyone in the target audience, and

(c) identifying and documenting decisions taken in cases in which the desired outcomes cannot be achieved by some people without having to take excessive measures or unnecessarily disenfranchising other users.

In other words, the context or activity envisaged was a significant determinant of the accessibility requirements. But Web 2.0 encompasses interactivity between users in relatively new ways enabled by new technologies. This meant the Web Accessibility 2.0 approach was later seen by its authors as unnecessarily limited. To explain this, we turn now to a few examples or relevant use cases.

Second Life is a graphically-oriented environment which requires a high-spec PC. It is not universally accessible. In a video entitled Wheeling In Second Life [21], Judith, who has cerebral palsy, describes the pleasure she gains from her use of Second Life and the facility it provides her to meet others. Public sector organisations that are bound too narrowly by technical or even contextual rules and legislation, might feel compelled to shy away from making use of Second Life. In doing so, they might deny users such as Judith the special benefits in terms of engagement that it offers her.

There are accessibility implications related also to the use of social networking services such as Facebook. The traditional approach might be to check whether Facebook conforms to the current WCAG and ATAG guidelines, or even if, in the context of its intended use, it is inclusive. Another approach might be to ask individuals with a range of disabilities to interact with Facebook and then document ease of use for them and accessibility as well as the problems they may encounter when using the environment. But as we have seen in the case of Second Life, a digital environment may provide a valuable experience for some but not all users.

An inclusive activity might offer Facebook and Second Life experiences within a context allowing for choice between them by individual users. Such an approach is being developed by the Fluid project [22] that proposes to offer resources independent of their interface, leaving the choice of interfaces to the users. In other words, the activity can be offered as inclusive of all expected to participate rather than have every single aspect of the context proven accessible to all.

In choosing whether to include Facebook, for example, within a context, developers should take into account a number of factors including how it responds to certain functional needs. There are Facebook groups which are frequently used by people who perpetually encounter auditory and visual disabilities. These include 'Deaf all around the world' with 9,851 users, 'Blind Students on Facebook' (616 users) and 'Deaf and Hard of Hearing' (1,504 users) and there are also groups such as 'STOP facebook discriminating against disabled users' (272 users) that seek to address Facebook's potential accessibility barriers.

The biggest barrier to the use of Facebook by visually impaired users is the CAPTCHA interface (which requires users to type in letters that are displayed as an image in order to register for the service. CAPTCHA acts as a deterrent to automated tools. However, a user campaign has resulted in an audio version of the CAPTCHA being made available [23]; so far 'there is no catch all accessible alternative to CAPTCHA that can be secured from spammers' [24].

An application of the Web Accessibility 2.0 approach would recognise that Facebook can be used to support a variety of user objectives (finding new information, engaging in discussion, etc.) but also that many of these services can be used independently of Facebook. Facebook then, can be regarded as providing an option which users can select for accessing services. An institution could choose to encourage the use of Facebook as an environment for accessing blog posts, uploads of photographs, micro-blogging, etc. If so, the social networking service should be regarded as a resource, as a user agent, and as an authoring tool but the specifications for these should be adapted to the context and, provided users have the ability to make use of alternative interfaces and their assistive technologies, limitations of a particular social networking service need not be a significant barrier to its use.

3.4 Web Accessibility 2.0 Case Study

The University of Dundee has taken a series of steps to promote and support Web accessibility. As an organisation, it has adopted a Web Accessibility 2.0 approach,

The University's School of Computing includes a research centre of excellence focusing on accessible technology [25] and provides consultancy through its Digital Media Access Group.

Until recently, there was no formal mechanism for the School to provide consultancy to the University at an institutional and individual level although Web accessibility was promoted through a variety of activities. In general, these were piecemeal and associated with a variety of initiatives with different foci. This changed with the establishment of the University's Web Accessibility Support service that now provides dedicated accessibility support to University staff.

The original on-demand support mainly for individuals became an institutional responsibility with two major areas of activity:

1. Development of a formal Web accessibility policy and supporting definition of best practice;
2. Evaluation of the extent to which current and potential Web authoring software and tools used by the University support accessible Web content creation.

The standards work acknowledged a need for an internal standard to which staff could refer as a first point of contact for Web accessibility, both for content authoring and for specification where Web content was being created externally. The evaluation of centrally available software focused on identifying weaknesses in software in terms of supporting staff in creating accessible Web content, and forming an action plan to address these weaknesses. W3C ATAG was used as a base for this work [26]. As a side-effect of this work, it was finally recognised that many staff who publish content online are not aware of Web accessibility as an issue, or otherwise, and would not seek the support of the Web Accessibility Service. By ensuring that the tools they use support accessible authoring as far as possible, the University can now assume that at least the content is as accessible as possible 'out-of-the-box'.

While the work of the Web Accessibility Service is ongoing and evaluation of its impact will take place at a later date, it has influenced institutional policy, in particular the central provision of Web authoring software. It demonstrates an organisational move away from an approach to Web accessibility that is fixated on technical measures of the universal accessibility of individual resources towards an integrated process approach to creating and providing an optimally accessible online experience for students and staff.

3.5 Limitations of Web Accessibility 2.0

Web Accessibility 2.0 advocates a contextual approach to the use of technical specifications. The approach is not limited to WAI's guidelines and is not constrained by mandating only technical solutions to Web accessibility. It supports extending responsibility for content authoring beyond the immediate author, as in the case of the university adopting more institutional responsibility, but it retains responsibility within the authoring/publishing domain of an organisation or environment.

Most organisations use some resources from external sources, but they cannot control the production or provision of those resources. The Web Accessibility 2.0 approach leaves the organisation having to choose between excluding resources that do not satisfy their criteria, and thus denying access to what otherwise might be useful resources, or compromising their standards. Somehow, they need to find ways of adapting rogue resources to fit their criteria.

Another major limitation of the Web Accessibility 2.0 approach is that it continues to depend on the authors' provision of resources being suitably formed for the users.

4. Web Accessibility 3.0

4.1 About Web Accessibility 3.0

The term Web Accessibility 3.0 is used to describe access to resources that are personalised to match an individual's needs and preferences [4]. The approach was first developed at the University of Toronto [27]. Instead of aiming to have all resources accessible to all potential users, it aims to provide resources and information about them that enables users, or automation services, to construct resources from components that satisfy the individual user's accessibility needs and preferences. Within the University of Toronto's environment, sufficient forms of components are made available for this to be possible and resources are assembled on-the-fly, dynamically changing as users change their statements of their needs and preferences.

The significant development offered by this approach is from a universal design emphasis to one that engages the user in the resource-design process and considers only individual accessibility or matching of resources, not depending on claims of universal accessibility of resources. This does not mean that components are not authored as universally-accessibly as possible, but rather that the composition of resources is under the control of the users.

4.2 Standards For Web Accessibility 3.0

Web Accessibility 3.0 standards have the potential to provide for the dynamic enhancement of resources that initially do not satisfy inclusive accessibility standards. This means provision for post-production improvement in the accessibility of resources that, in turn, depends upon means for managing the process of continuing improvement of resources' accessibility. Within an environment such at that at the University of Toronto, additional forms of content components can be added to the system and made available for the user. This is possible simply because the user determines the composition of a resource by using technologies that use descriptions of the accessibility characteristics of resource components to create the requested composition. The user determines this by providing a statement of their needs and preferences to which the resource descriptions can be matched. Thus Web Accessibility 3.0 in a closed environment simply requires the use of standard descriptions of users' needs and preferences and matching descriptions of resource components.

The relevant standards for Web Accessibility 3.0 simply extend and adapt the original set:

- Components should be available in all relevant forms depending on the intended audience for resources and the purpose of the engagement with the resources (that is, satisfying relevant technical specifications);
- Users should be able to specify accessibility needs and preferences dynamically, and (in some circumstances) anonymously, and to store multiple versions for later reuse [28];
- Components should be described by accessibility characteristics that can be matched, or otherwise, to users' needs and preferences;
- Resources should be assembled dynamically according to user requirements, and
- Additional forms of components should be accepted and catered for within the system at any time.

4.3 Limitations of Web Accessibility 3.0

The major achievement but also limitation of Web Accessibility 3.0 is that it depends on technology. In a closed or centralized environment, where a database is used to manage the components of resources, it can be implemented relatively simply. In such a case, it is appropriate and relatively easy to manage the process of providing sufficient components and of matching resources to users' needs and preferences. This is not so easily achieved in the open Web with the scale of users and resources although it is here that the strength of the approach is expected to be realized.

4.4 Web Accessibility 3.0 in a Web 3.0 Environment

This work on Web Accessibility 3.0 has been influenced by Kevin Kelly's view of the long-term evolution of the Web [29]. He considers that the Web was first just a network of computers, then of Web pages, now of data and soon of everything. He anticipates a shift from a 'Web' to a 'one' (somewhere after Web 3.0). Kelly describes what we are collectively building as a single, giant system, with lots of smaller gadgets, computers, phones, fridges, etc, all hooking into it – drawing on it for particular needs at any time.

Web Accessibility 3.0 is not yet possible in the open Web. A number of developments will be required:

- Web services should be provided to support the development of alternative formats by users;
- Web services should be developed to allow users to generate needs and preferences profiles and to change them;
- Accessibility metadata terms should be defined in published ontologies which can be shared and their relationships determined;
- Resources and their components should be published with persistent URIs and metadata descriptions (in RDF to make them accessible to the Semantic Web);
- Web services should be provided for users who will tag resources with accessibility metadata;
- Web services should be provided that can match resources to individual user's accessibility needs and preferences;
- Copyright laws should be changed to encourage, not complicate, the sharing of alternative formats of resources;
- More people should publish their resources on the Web with Creative Commons licences so they can be shared.

Nevile [27] describes the development of metadata standards which will provide for a common language with which to describe both users' accessibility needs and preferences and components' and resources' accessibility characteristics. Metadata standards are required to ensure the interoperability of such descriptions across systems.

Work to define metadata for describing accessibility characteristics of resources that are known to be of relevance to users, especially those with dependence on assistive technologies, is currently under development in the eLearning context. So far, some standards for such descriptions have been developed [30], [31] and [32]. Work on specifications for interoperable metadata [33] is currently under development in the same context but can draw upon other work, such as the Dublin Core standards [34].

Expert developers of alternative format resources or resource components understand the characteristics of their alternative formats but need a common way of doing this and are not yet publishing those descriptions. This is partly due to related copyright problems, such as that often the only way to get legal access to the alternative is to be registered as a person with a disability, but also because there is not yet enough demand for such sharing. It is just beginning to dawn on those responsible for alternative formats that they are often duplicating work because they do not know that others have done the same work before them. They are also learning that they can use the same applications to provide information about access rights as they use to provide it about accessibility.

Description that supports discoverability does not guarantee access, or accessibility. On the other hand, as individual accessibility needs and preferences differ, matching of resource accessibility characteristics to individual's needs and preferences both makes for better accessibility and maximises access to the range of suitable resources available for an individual user. In addition, and importantly for resource providers, it maximises re-use of resource components, makes accessibility of resources a cumulative process including by providing for post-production improvement of resources by third parties, and enables the sharing of precious alternative format components.

5. From Web Accessibility To Web Adaptability

5.1 About Web Adaptability

Web Adaptability is a main stream concept as distinguished from those focussed specifically on accessibility for people with disabilities. It encompasses the disabilities that are occasioned by contexts, recognising the inclusive 'social' definition of disability, and adopts the curb-cut approach to accessibility that has something for everyone.

'Mobility' is now a major feature of information technology and ubiquitous access is fast becoming a universal expectation. Web Adaptability envisages a Web of resources and services that can be used by anyone for whom they are intended, anywhere, using appropriate devices and skills. Web Adaptability demands a range of approaches being adopted, in varied circumstances. Like its predecessors Web Accessibility 1.0, 2.0 and 3.0, it requires awareness of the problems for different users and attention to them but is not as prescriptive as they are in terms of solutions.

The range of factors which may need to be considered in a Web Adaptability approach includes:

- Audience: The target audience cannot always be accurately predetermined but it can be informed of the accessibility characteristics of the resource so users and their services can discover and match resources to their individual needs and preferences. Rather than developing for a nebulous global audience, the service could be developed considering the needs of individuals within the specific audience.
- Use: Accessibility considerations should reflect the intended use of the service. Different approaches may be needed for different informational services, including those designed for learning, entertainment, etc.
- Resources: Resource components are better thought of as resources in their own right, and described so that alternate forms can be provided either during production of the original resource or post-production, including by third parties. Design decisions, especially layout and display decisions, should account for user choice of component forms.
- Definitions: Decisions regarding the approaches taken to enhance accessibility will be influenced by the definitions of accessibility and disability being used. The United Nations Conventional definition is recommended for functional purposes although at times, for political reasons, it may be advantageous to use medical and other definitions. It should also be noted that legal definitions of disability are also subject to change, as has happened recently in the case of the Americans with Disabilities Act [35].
- Innovation: A major failing of the technical specification approach to Web accessibility (and organisational, national and international guidance and standards based on the WAI approach) has been its inability to cater for the increasing diversity of ways in which the Web is being used and the variety of technical innovations. The Web Adaptability approach welcomes innovations which enhance the range of services available to users and use of innovations in the technological infrastructure. In particular, it enables the contribution of third parties to the process of continuous improvement of accessibility of resources through social networking and the Semantic Web.
- Policies: In general, local policies will be based on contextual issues including those given above. Such organisational policies could, as is the case in many organisations, focus solely on conformance with WCAG guidelines but they will be more useful, inclusive and main-stream if they also embrace usability issues, focus on organisational priorities which reflect political considerations such as widening participation and social inclusion or address accessibility in a wider sense including real-world accessibility issues.

These areas are illustrated in Figure 2.

Figure 2: Areas for Web Adaptability

5.2 Promotion of the Web Adaptability Framework

It should be noted that the flexibility which underpins the Web Adaptability approach should not be regarded as a licence to avoid responsibilities for enhancing the accessibility of resources. There is a need, for example, to ensure that sites are not designed only to work in a single browser.

As illustrated in Figure 2, the approach taken in the Web Adaptability framework is to recognise that although legislation may be required in some circumstances, it is

too blunt an instrument to provide the only mechanism for promoting the accessibility of Web resources. There are many avenues for promotion that should be taken into account, including the following.

- Legislation: Legislation covering the accessibility and usability of Web services is already in place in many countries [36]. It should be noted, however, that there have been too few publicly reported test cases to establish advisory precedents for determining the scope of such legislation. There is a risk that adverse legal enforcement will simply encourage resource providers to avoid legislatively controlled situations and constrain Web development.
- Peer pressure: It should be recognised that there is widespread recognition of the importance of the WCAG specifications even if they are not always applied. There has been little understanding or recognition of the ATAG and UAAG specifications even though there has been considerable advocacy for them and peer pressure from many involved in Web development activities, as well as the formal channels. Such peer pressure should also be available for embedding the use of a Web Adaptability approach. It is hoped that the single-focus approach on flexibility and adaptability will more closely match the single-focus experience with the WAI guidelines. In adopting a Web Adaptability approach, developers will need to operate in environments that have attended to ATAG and UAAG considerations, but this can happen at an institutional or organisational level, leaving the actual developers to concentrate on adaptable design and production.
- Cultural pressure: Recently Facebook has reversed its previously proposed changes to the terms and conditions covering deletion of user content uploaded to Facebook in response to pressure from users [37]. We might reasonably expect disability organisations to have a role to play in supporting pressure from users to encourage organisations to adopt Web Adaptability principles, perhaps in a way similar to how lobbyists from privacy organisations have supported campaigns against Facebook's terms and conditions.
- Reasonable measures: The requirement for organisations to take 'reasonable measures' and make 'reasonable adjustments' is part of UK disability legislation. The Web Adaptability framework is well-suited to this legal requirement as neither are directly linked to the implementation of any specific set of technical solutions and both approaches call for the application of best practices, presumably tailored to particular contexts rather than arbitrarily being applied universally.
- User engagement: An understanding of what is meant by reasonable measures' and 'reasonable adjustments' can always be gained by ensuring that all users are represented and thus actively engaged in the design processes. This may mean participation from people with medically defined disabilities and reference to comprehensive user requirement literature (such as the ISO/IEC JTC1 Special Working Group on Accessibility documents [38].
- Business opportunities: WAI has argued that enhancing accessibility of Web resources will provide a range of business opportunities for commercial organisations. Web Adaptability increases the management and re-use potential of resource components and facilitates sharing of alternative format components across the board, not just for identified special sectors of the user community, in the same way as do curb-cuts.
- Corporate social responsibility: As defined by Falck and Heblich [39], corporate social responsibility is 'voluntary corporate commitment to exceed the explicit and implicit obligations imposed on a company by society's expectations of conventional corporate behavior'. Such corporate behaviour is more likely to be adopted when there are intrinsic benefits for the corporation as well as the community they serve.
- Reputation management: Failing to take reasonable measures to provide access to Web resources for people with disabilities may undermine the reputation of organisations, especially those with traditions of social responsibility.
- Sharing experiences and evidence: An understanding of what is meant by reasonable measures' and 'reasonable adjustments' in different contexts can be gained by ensuring that mechanisms are in place for sharing experiences of what works, what fails to work and ways in which such solutions can be deployed. The sharing of experiences can be supported by funding agencies if they mandate the publication of documented case studies, for example. The research community has a role to play in gathering evidence that can be used to support or refute theories or various models and approaches for enhancing access.

6. Application of the Adaptability Framework

The adaptability framework can be regarded as a meta-design approach [40] to accessibility. It seeks to identify the broad challenges that need to be addressed at community and organisational level in order to enhance accessibility at the specific implementation level. In order to illustrate how this framework can be applied we provide examples of applications of this approach in a number of different areas, including the need to be adaptable with respect to specific disabilities, legal, cultural and personal definitions of disabilities and available resources and organisational priorities.

The application of this framework should be regarded as seeking to make use of well-established guidelines (such as WCAG) where this can reasonably be expected to be

achieved, but providing a wider range of approaches which can (and, indeed should) be considered in cases in which, due to factors such as immaturity of solutions, excessive costs, conflicts with other policies, etc., such solutions are not feasible.

6.1 Support for Users With Learning Difficulties

In a three-year project at the University of the West of England, Bristol, Fanou is using the Web Adaptability approach described in this paper to develop a Web 2.0 based e-learning system for people with learning disabilities [41]. The focus of the project is on the outcomes of the service with emphasis on the end users who are participating in the design and development. The aim is not to try to create a system and content that are universally accessible, as the WAI guidelines suggest, but rather to try to maximize the usefulness and usability for a specific audience of learning users with particular permanent disabilities. This aim is more realistic and pragmatic than one that tries to develop a universally accessible system which might be unusable in the end.

The system is for people with learning disabilities who are training to act as Health Trainers for other people with similar disabilities. These professionals currently have limited engagement with and use of Web 2.0 technologies in their personal and working lives.

The design and development of the system is influenced by feedback from the users and how they respond to drivers such as the WCAG and other guidelines. This holistic approach offers flexibility by considering the context of use rather than insensitively following a set of guidelines.

The participatory methodology being used should help to address accessibility issues for learning disabilities that are not covered in the WCAG guidelines and answer questions such as 'how can people with learning disabilities be involved in the design and development of software in order to create a system customized to their needs and for their own use?' and 'how can people with learning disabilities use an integrated, Web 2.0 based, e-learning system to help them in their professional duties?'.

The project will provide evidence of the implementation of a holistic stakeholder involvement approach and explore a set of best practices for the building and operation of such systems that hopefully will be transferable.

6.2 Adaptability of Web Content for the Deaf

The inappropriateness of the medical model of disabilities which underpins the Web Accessibility 1.0 approach can be seen if we explore the notion of Deafness. A common misconception about alternative formats for the deaf is that text alternatives for audio content are sufficient. Usually this takes the form of on-screen captioning or written transcripts and ignores the fact that social factors such as culture and education have a significant effect on the preferred access model of the deaf audience [42].

The deaf community itself recognizes both the medical model and the cultural model of Deafness (capital D is used to distinguish them as an ethnic community, just as we would use a capital E for English or a capital A for Australian). Typically, the former group is post-lingually deaf and will be fluent in the dominant language of the region. As such, captioning of audio content in their primary language usually provides equal access to information. Information may also be provided as transcripts, for example, or as printed multimedia presentations in an annotated format.

In contrast to this, the culturally Deaf audience is most likely to use a native sign language as their primary language and may or may not be fluent in the written form of the region's dominant language. Native signed languages are spatial-gestural languages without written form. The grammar and syntax does not usually mirror that of the dominant, spoken language. For example, the signs used by native BSL Deaf (British Sign Language) will not be in the same order (grammar or syntax) as spoken English.

An individual's family background (Deaf or hearing), level of residual hearing, and educational history (Deaf, Oral or mainstream school?) will also influence their learning and information needs. Deaf people from Deaf families often show higher levels of fluency in a second language than Deaf individuals from hearing families. Educational history impacts on literacy and general knowledge where a student has been taught in their second language, or where they have been removed from general classes to attend speech lessons.

As such, not all deaf communicate in the same manner, nor do they have the same needs in accessing information. While some will confidently interact in their first language via a sign-language interpreter, they may for example, struggle with writing or reading captions in their second language. Providing transcriptions of audio will suffice for some individuals, although others may require additional time to translate parts of the document or have it interpreted for them.

Many of the factors identified here as pertaining to members of a deaf community also apply, of course, to others who are not deaf but perhaps operating in contexts based on other than their mother tongue. Technological developments such as access to online interpreters via video streaming are already being used by some deaf individuals in remote areas. In the near future we may also see user generated content where individuals contribute collectively to provide layers of auditory, textual and signed translations in various languages, as well as captioning or subtitles for general use, including by the Deaf and Hearing Impaired.

We feel that this illustrates the point that supporting the needs of the Deaf reinforces the merits of the Web Adaptability approach with the cultural (as opposed to medical) definition of deafness, the user's personal

identification with their Deafness and the expectation that future developments may include the 'crowd-sourcing' of layers of language translations, rather than only targeted translations being provided alongside the publication of the original resource.

6.3 Adaptability in a Government Context

Under the Australian Disabilities Act (1992) [43], Australian Government services must not discriminate against people with disabilities. The Australian Government Information Management Office states that compliance to WCAG 1.0 is mandatory for all Government departments and agencies [44]. In an accessibility project for one particular Australian Government organisation, an accessibility framework was specified for the development of all internal Web and GUI based applications. These applications are used by emergency and law enforcement officers in a variety of situations including emergency response situations, call centres, mobile devices, kiosks, voice recognition systems, and decision making situations which rely on information being entered into and outputted from the internal systems. Applications produced for these situations will be developed under a number of constraints, such as Government policies, budgetary measures, specific deadlines to meet legislative requirements, and availability of staff with the technical expertise required to develop accessible applications.

In light of the constraints, the accessibility framework takes a pragmatic approach to accessibility. It takes into account the employees' day-to-day operational duties (including meeting physical requirements related to emergency response duties), and balances these with the constraints identified above. User research developed a deep understanding of the type of work undertaken within the organisation, the way employees carried out their duties and how accessible design could benefit these employees. It showed the definition of accessibility was a key factor, particularly as it related to the intended use of the resources. Rather than attempting full compliance to WCAG 1.0 or WCAG 2.0 through a checklist methodology, the accessibility framework is flexible to accommodate the different types of operational environments. This was achieved through the adoption of WCAG 2.0's principles-based approach supplemented with contextual guidelines. Due to the operational requirements for the organization, such accessibility features as full alternatives for time-based media (including sign language interpretation and the provision of alternatives for the large number of internal audio and video content) are omitted.

The accessibility framework encourages a holistic and pragmatic approach to accessibility by integrating both usability and accessibility at the start and throughout each project, rather than a checklist conformance process just prior to the release of an application. This contextual approach has helped the organization understand that accessibility is not just about 'stereotypical disabilities' but has unexpected benefits for all employees.

6.4 Adaptability and Institutional Repositories

Increasing numbers of universities are providing institutional repositories in order to maximize access to research publications and to ensure that such publications are preserved to allow continued access in the future. Typically, such repositories offer access to PDF versions of publications as this is the widely accepted format for the submission of papers to peer-reviewed journal publishers.

In the past, consideration of the accessibility of institutional repositories focused primarily on the user interface provided by the repository service rather than the PDF content available from the repository. Such considerations reflected a view held by many that the WCAG 1.0 guidelines applied only to native HTML content. In addition, developers and policy-makers involved in encouraging the establishment of institutional repositories have been concerned that raising awareness of the difficulty of providing accessibility for large numbers of PDFs might inhibit the proliferation of such repositories.

As the WCAG 2.0 guidelines are explicitly format-neutral, any formal requirement that institutional services must conform with WCAG 2.0 would include the PDFs deposited in institutional repositories. So far, advice on creating accessible PDFs appears to be restricted to approaches taken by the authors, such as creating hierarchical structures and providing descriptions of images when using software such as Microsoft Word, a commonly used tool for creating papers published in peer-reviewed journals. Such advice is not suitable for depositing legacy resources, where it could be inappropriate for a librarian, for example, to annotate an image in a research paper as this could undermine the research process by allowing people other than the authors to interpret the meaning of an image.

In the UK, it is not clear if institutions are in a position to formally require researchers to only deposit PDFs that conform to WCAG 2.0 guidelines, as this may be in conflict with academic freedom. On the other hand, failure to deposit such research publications in a managed institutional repository might be in conflict with an institution's requirement to manage its key intellectual assets.

A strict application of the Web Accessibility 1.0 approach would require PDFs to conform with WCAG guidelines and, if this was not possible, for the resources not to be made available. The Web Adaptability approach aims to provide a framework for addressing conflicts of policies and approaches such as those described in this example. An approach which could be applied in this case would be to ensure that new researchers are given training in how to use document creation tools in ways that will enhance accessibility when documents are subsequently made available online. Document templates developed internally should implement best practices, such as providing alternative text on images such as logos, ensuring that tables linearise appropriately and guidelines for a house

style that emphasises the importance of document structure and not just appearance.

As well as applying these approaches, institutions can run automated audits on the content of the repositories. Such audits can produce valuable metadata with respect to resources and resource components and, for example, evaluate the level of use of best practices, such as the provision of structured headings, tagged images, tagged languages, conformance with the PDF standard, etc. Such evidence could be valuable in identifying problems which may need to be addressed in training or in fixing broken workflow processes.

7. Concerns and Limitations

7.1 Criticisms of the Web Adaptability Framework

One of the attractions of the Web Accessibility approaches is that they have provided, particularly Web Accessibility 1.0, clarity of requirements for developers. In practice, however, these have not been implemented in any significant way and so perhaps they actually offer psychological comfort rather than an effective functional value.

A potential objection to the proposed approach is that it offers too many freedoms to developers and leaves the inexperienced or uninformed ill-equipped to support accessibility of the Web. Adopting an inclusive, social, definition of accessibility that disregards medically-defined disabilities may leave those with such disabilities unaccounted for within the target audience. In fact, it imposes on developers greater than usual responsibility with respect to the design of their Web-supported activities with the emphasis on the matching of users to activities rather than the simple evaluation of characteristics of resources.

7.2 Responding To The Criticisms

It should be noted that the Web Adaptability framework is not intended as a replacement for the Web Accessibility 1.0 approached developed by WAI. Rather the framework aims to address limitations of the WAI model, the complex and diverse ways in which the Web is being used, the complexities of legal systems, the mismatch between accessibility guidelines and the ability of organisations to implement such approaches and the rapidly changing technical environment.

We agree, therefore, that WCAG guidelines should be implemented in cases where it is feasible and appropriate to do so. What our framework tries to do is to provide a structure which can be applied in cases in which the simple application of WCAG guidelines cannot be applied, such as, to revisit one of the examples we have described, repositories of a large number of research papers where the original author may no longer be available or where altering the contents of a published research paper may conflict with policies on not amending published resources.

In particular, we are concerned that the accessibility process does not end with the initial publication of a resource. When user needs have not been anticipated or catered for, it is clearly useful to be able to create or discover alternative format components to adjust, or adapt, the original resource and make it accessible to a user.

The framework allows for ‘blended’ solutions in some cases, such as in e-learning, where the inaccessibility of a learning resource may be addressed by the provision of alternative, non-digital resources. This approach also allows providers of Web-based services to address the accessibility of the service by considering the *purpose* of the service, and not just the accessibility of the digital resource itself.

We are careful to not advocate that if a system does not currently have users with particular disabilities they should not be accounted for. We are simply saying that when they are not catered for, there should be an opportunity to fix this problem. And we are saying that individual users, recognised as having some permanent disability or otherwise in a medical sense, will have a wide range of functional requirements in terms of matching their needs with resources. This means the matching of resources to users’ needs and preferences should be flexible and dynamic, not pre-determined and inflexible. In addition, it should provide for cumulative improvement of accessibility.

We also argue that the cost of providing accessible solutions needs to be considered, especially when organisations are facing unexpected economic pressure. The cost of initial provision or retro-fitting of universal accessibility should be compared with the cost of providing infrastructures that support on-going awareness of and improvements in resource-user matching.

8. Standards and Web Adaptability

8.1 What Standards are Needed?

The authors' experience suggests that there is not a single specification, or set of them, that can be prescribed for accessibility. The approach that appeals to the more experienced mind is one that operates on a repertoire of techniques, policies and specifications that are worked upon freshly in each new situation. The results of this expert approach cannot be mandated as the relevant expertise cannot be distilled but the practice of consideration, and exploration can be mandated. The authors are inclined to the view that it is more the processes undertaken by authors or not, that are responsible for many accessibility problems. This suggests a process-oriented approach to accessibility rather than one based on strict technical adherence to technical specifications.

Businesses and other organisations have been able to increase their achievements in terms of quality when they

review their practices against a set of standards for such practices, as specified by the ISO 9000 standards, for example, and claim that they had reached a certain level of quality performance. The anticipated and valued side-effect of following the practices is a better quality product or service, of course. In supporting accessibility, businesses and organisations also need processes that adhere to best practices in this domain.

8.2 BSI PAS 78

The British Standards Institute's PAS 78 "Guide To Good Practice In Commissioning Accessible Websites" [45] helps ensure that commissioning processes for the procurement of Web sites address the accessibility aspects. Although the document highlights the importance of WCAG in this process, the document does not mandate conformance to any particular WCAG priority level. In addition, it recognises that although formats such as PDF and Flash are deprecated by many involved in Web accessibility work, many services make use of such formats. The document provides advice on how to ensure Flash and PDF are used in the most accessible ways.

8.3 BS 8878:2009

The BS 8878:2009 Code of Practice on 'Web accessibility – Building accessible experiences for disabled people' [46] is being reviewed in 2009. Although the review software itself demonstrates the difficulties many organisations have in implementing accessibility guidelines and, ironically, the document itself similarly seems to be inaccessible to a number of the reviewers, the document requires organisations to engage users with disabilities in both the design and testing phases of Web site development and provide accessibility policies in order to conform with best practice.

9. Conclusions

This paper has reviewed a variety of approaches which have been taken to maximise the accessibility of Web resources for people with disabilities. Evidence has been provided which demonstrates that requiring full conformance with WCAG, ATAG and UAAG guidelines has failed to have a significant impact. A review is provided of the approaches previously known as Web Accessibility 1.0, 2.0 and 3.0. Although they provide a pragmatic approach which can be adopted within institutions, it is acknowledged that in a future Web context in which greater use is made of externally hosted Web services, some institutionally-based approaches are inadequate.

The paper argues for the adoption of a Web Adaptability approach which incorporates previous approaches and, perhaps more importantly, embraces the future, including technical innovations, differing perceptions of what is meant by accessibility and real world deployment challenges.

Acknowledgements

The authors wish to acknowledge the contribution made to this paper by an anonymous reviewer.

References

[1] Developing A Holistic Approach For E-Learning Accessibility. Kelly, B., Phipps, L. and Swift, E., Canadian Journal of Learning and Technology, 2004, Vol. 30, Issue 3. Retrieved February 4th 2009: http://www.ukoln.ac.uk/web-focus/papers/cjtl-2004/

[2] Forcing standardization or accommodating diversity? A framework for applying the WCAG in the real world, Kelly B., Sloan D., Phipps L., Petrie H. and Hamilton F., Proceedings of the 2005 International Cross-Disciplinary Workshop on Web Accessibility (W4A) (Chiba, Japan, 10 May 2005). New York: ACM Press, 46-54. Retrieved February 4th 2009: http://www.ukoln.ac.uk/web-focus/papers/w4a-2005/

[3] Contextual Web Accessibility - Maximizing the Benefit of Accessibility Guidelines, Sloan, D, Kelly, B., Heath, A., Petrie, H., Hamilton, F and Phipps, L. WWW 2006 Edinburgh, Scotland 22-26 May 2006. Conference Proceedings, Special Interest Tracks, Posters and Workshops (CD ROM). Retrieved February 4th 2009: http://www.ukoln.ac.uk/web-focus/papers/w4a-2006/

[4] Web Accessibility 3.0: Learning From The Past, Planning For The Future, Nevile, L. and Kelly, B. ADDW08. University of York, 22-24 September 2008. Retrieved February 4th 2009: http://www.ukoln.ac.uk/web-focus/papers/addw08/paper-2/

[5] Convention on the Rights of Persons with Disabilities, United Nations. Retrieved February 4th 2009: http://www.un.org/disabilities/default.asp?navid=12&pid=150

[6] Web Content Accessibility Guidelines 1.0, 5 May 1999, W3C. Retrieved February 4th 2009: http://www.w3.org/TR/WCAG10/

[7] User Agent Accessibility Guidelines 1.0, December 2002, W3C. Retrieved February 4th 2009: http://www.w3.org/TR/WAI-USERAGENT/

[8] Authoring Tool Accessibility Guidelines 1.0, February 2000 W3C. Retrieved February 4th 2009: http://www.w3.org/TR/WAI-AUTOOLS/

[9] The web: Access and inclusion for disabled people, DRC Formal Investigation report, 2004, Disability Rights Commission. Retrieved February 4th 2009: http://www.equalityhumanrights.com/en/publicationsandresources/Pages/webaccess.aspx

[10] Web Content Accessibility Guidelines 2.0, W3C Recommendation 11 December 2007. Retrieved February 4th 2009: http://www.w3.org/TR/WCAG20/

[11] Contextual Web Accessibility - Maximizing the Benefit of Accessibility Guidelines, Sloan, D, Kelly,

B., Heath, A., Petrie, H., Hamilton, F and Phipps, L. WWW 2006 Edinburgh, Scotland 22-26 May 2006. Conference Proceedings, Special Interest Tracks, Posters and Workshops (CD ROM). Retrieved February 4th 2009: http://www.ukoln.ac.uk/web-focus/papers/w4a-2006/

[12] HTML Reloaded, Lilley, C. WWW 2007, Retrieved February 4th 2009: http://www.w3.org/2007/Talks/Banff-WWW2007-HTMLReloaded/index.html#(3)

[13] A Comparative Assessment of Web Accessibility and Technical Standards Conformance in Four EU States, Marincu, C. and McMullin, B., First Monday, 9 (7), 5 July 2004. Retrieved February 4th 2009: http://firstmonday.org/htbin/cgiwrap/bin/ojs/index.php/fm/article/view/1160/1080

[14] Alexa Global Top 500 Validation Research, 4 August 2008, Blooberry. Retrieved February 4th 2009: http://my.opera.com/operaqa/blog/2008/08/04/alexa-global-top-500-validation-research

[15] Holistic Approaches to E-Learning Accessibility, Phipps, L. and Kelly, B. ALT-J: Research In Learning Technology, Vol. 14, No. 1, March 2006, pp. 69-78. DOI: 10.1080/09687760500479860. Retrieved February 4th 2009: http://www.ukoln.ac.uk/web-focus/papers/alt-j-2006/

[16] Interoperability for Individual Learner Centred Accessibility for Web-based Educational Systems, Nevile, L. and Treviranus, J., IEEE TCLT's Journal of Educational Technology & Society, Volume 9, Issue 4, pp. 215-227, 2006. Retrieved February 4th 2009: http://www.ifets.info/issues.php?id=33

[17] The politics of disablement. Critical texts in social work and the welfare state, Oliver, M. London: Macmillan Education.

[18] Accessibility 2.0: People, Policies and Processes, Kelly, B., Sloan, D., Brown, S., Seale, J, Petrie, H., Lauke, P. and Ball, S., WWW 2007 Banff, Canada, 7-11 May 2007. Retrieved February 4th 2009: http http://www.ukoln.ac.uk/web-focus/papers/w4a-2007

[19] Location and Access: Issues Enabling Accessibility of Information, Nevile, L., and Ford, M., in Multimedia Cartography (2nd Edition) Eds. Cartwright, W. Peterson M. & Gartner G. (2007) ISBN 3-540-36650-4 Springer-Verlag – Heidelberg.

[20] eAccessibility is an issue for all of us, Cabinet Office, 24 November 2005. Retrieved February 4th 2009: http://www.cabinetoffice.gov.uk/newsroom/news_releases/2005/051124_eaccessibility.aspx

[21] Wheeling in Second Life, YouTube. Retrieved February 4th 2009: http://www.youtube.com/watch?v=CBlaiBV_yJs

[22] About Us, FLUID Project, Retrieved February 4th 2009: http://fluidproject.org/about-us/our-mission/

[23] Thanks Facebook, AFB Blog, 29 January 2009. Retrieved February 4th 2008: http://www.afb.org/blog/blog_comments.asp?TopicID=3371

[24] CAPTCHA - if your name's not down you're not coming in, Web Access Centre Blog, 30 October 2007. Retrieved February 4th 2009: http://www.rnib.org.uk/wacblog/images/captcha-if-youre-names-not-down-youre-not-coming-in/

[25] HCI for older and disabled people, Newell, A., Gregor, P. and Alm, N. in the Queen Mother Research Centre at Dundee University, Scotland. Proceedings of CHI 2006, Montreal, Quebec, Canada, 22-27 April. New York: ACM Press, 299-303.

[26] Evaluating the Accessibility to Disabled People of E-Assessment Tools, Sloan, D. and Walker, D. Proceedings of the 12th International Conference on Computer Aided Assessment (CAAC). Loughborough, UK, 8-9 July 2008.

[27] Adaptability And Accessibility: A New Framework, Nevile, L. Proceedings of OZCHI 2005, Canberra, Australia. November 23 - 25, 2005. ACM (the Association for Computing Machinery) Digital Library. Retrieved February 4th 2009: http://portal.acm.org/citation.cfm?id=1108368.1108413&coll=ACM&dl=ACM&CFID=24041543

[28] Anonymous Dublin Core Profiles for Accessible User Relationships with Resources and Services, Nevile, L. Presented at DC 2005 Conference. Retrieved February 4th 2009: http://purl.oclc.org/dcpapers/2005/paper09. (Later, republished as 2006 "Anonymous Dublin Core Profiles for Accessible User Relationships with Resources and Services" in New Technology of Library and Information Service, Vol. 1/2006 Serial No.132, pp. 17-24).

[29] Four Stages in the Internet of Things. The Technium Online, Kelly, K. Retrieved February 4th 2009: http://www.kk.org/thetechnium/archives/2007/11/four_stages_in.php

[30] ISO/IEC 24751-1 Information technology -- Individualized adaptability and accessibility in e-learning, education and training -- Part 1: Framework and reference model. ISO/IEC 24751-1:2008. Treviranus, J., Nevile, L. & Heath, A. (Eds.). http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=41521

[31] Information technology -- Individualized adaptability and accessibility in e-learning, education and training -- Part 2: "Access for all" personal needs and preferences for digital delivery. ISO/IEC 24751-2:2008. Treviranus, J., Nevile, L. & Heath, A. (Eds.). http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=43603

[32] Information technology -- Individualized adaptability and accessibility in e-learning, education and training -- Part 3: "Access for all" digital resource description. ISO/IEC 24751-3:2008. Treviranus, J., Nevile, L. & Heath, A. (Eds.).

http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=43604

[33] ISO/IEC 19788-1 Information technology -- Learning, education and training --Metadata for learning resources -- Part 1: Framework (under development), Bourda Y, Li Z.

[34] DC Terms (DCMI Metadata Terms) DCMI Usage Board, (2008). http://dublincore.org/documents/dcmi-terms/

[35] ADA Changes: The New Definition of Disability, Fred's Head blog, 25 February 2009. . Retrieved February 20th 2009: http://www.fredshead.info/2009/02/ada-changes-new-definition-of.html

[36] Policies Relating to Web Accessibility, W3C. Retrieved February 20th 2009: http://www.w3.org/WAI/Policy/

[37] Facebook's turnaround on data-retention policy, Silicon Republic, 18 February 2009. Retrieved February 20th 2009: http://siliconrepublic.com/news/article/12307/digital-life/facebooks-turnaround-on-data-retention-policy

[38] ISO/IEC JTC1 Special Working Group on Accessibility, Retrieved February 20th 2009: http://www.jtc1access.org/base.htm

[39] Corporate Social Responsibility: Doing Well by Doing Good, Falk, O. & Heblich, S. Business Horizons, Vol. 50, 3, (2007) pp. 247-254.

[40] Fischer, G. & Giaccardi, E. (2006). Meta-Design: A Framework for the Future of End User Development in H. Lieberman, F. Paterno & V. Wulf (Eds.), End User Development: Empowering people to flexibly employ advanced information and communication technology, pp. 427-458. Dordrecht, The Netherlands: Kluwer Academic Publishers

[41] Web 2.0: Engaging those with learning disabilities, Fanou, S. Proceedings of the 7th European Conference on e-Learning - Agia Napa, Cyprus, 6-7 November 2009, Academic Publishing Limited, Reading, UK pp 354.

[42] Deafness and the User Experience, Herrod, L., A List Apart, 12 August 2008. Retrieved February 20th 2009: http://www.alistapart.com/articles/deafnessandtheuserexperience

[43] Disability Discrimination Act 1992, Attorney-General's Department, Australian Government. Retrieved February 4th 2009: http://www.comlaw.gov.au/ComLaw/Legislation/ActCompilation1.nsf/0/FC69105BAF504384CA2571400006FD7F?OpenDocument

[44] Accessibility, Department of Finance and Dereregulation, Australian Government. Retrieved February 4th 2009: http://webpublishing.agimo.gov.au/Accessibility

[45] Guide to good practice in commissioning accessible websites, BSI PAS 78. Retrieved February 4th 2009: http://www.bsi-global.com/en/Shop/Publication-Detail/?pid=000000000030129227

[46] DRAFT Web accessibility – Building accessible experiences for disabled people – Code of practice, BSI. Retrieved February 4th 2009: http://drafts.bsigroup.com/?i=245