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Contextual Web Accessibility -
Maximizing the Benefit of Accessibility Guidelines

David Sloan
Digital Media Access Group
University of Dundee
Dundee, UK
+44 1382 385598
dsloan@computing.dundee.ac.uk

Andy Heath
Axelrod Research and Consulting
51 Paterson Close
Stocksbridge, Sheffield, UK
+44 7881 955997
AndyHeath@axelrod.plus.com

Fraser Hamilton
Designed for All Ltd
109-111 Farringdon Road
London, UK
+44 2078 417417
fraser@designedforall.com

Brian Kelly
UKOLN
University of Bath
Bath, UK
+44 1225 383943
b.kelly@ukoln.ac.uk

Helen Petrie
Department of Computer Science
University of York
York, UK
+44 1904 434336
helen.petrie@cs.york.ac.uk

Lawrie Phipps
JISC Executive
Beacon House, Queens Road
Bristol, UK
+44 117 954 5078
l.phipps@jisc.ac.uk

ABSTRACT

We argue that while work to optimize the accessibility of the World Wide Web through the publication and dissemination of a range of guidelines is of great importance, there is also the need for a more holistic approach to maximizing the role of the Web in enabling disabled people to access information, services and experiences. The persistently disappointingly low levels of usability of Web content for disabled people indicates that focusing on the adoption of accessibility guidelines by content authors, tool developers and policy makers is not sufficient for a truly inclusive Web. This approach fails to acknowledge the role of the Web as an enabler in a broader context and may stifle creative use of Web content and experiences to enhance social inclusion.

Using e-learning as an example, and describing current metadata developments, we present a framework that will guide Web authors and policy makers in addressing accessibility at a higher level, by defining the context in which a Web resource will be used and considering how best existing or new alternatives may be combined to enhance the accessibility of the information and services provided by the site in question. We demonstrate how guidelines such as those produced by the W3C's Web Accessibility Initiative have a role to play within this wider context, along with metadata and user profiling initiatives.

Categories and Subject Descriptors

H.5.2 [**User Interfaces** – Evaluation/methodology]; K.4.2 [**Social Issues** - Assistive technologies for persons with disabilities]

General Terms

Measurement, Documentation, Human Factors, Standardization, Legal Aspects, Verification.

Keywords

Web accessibility, people with disabilities, WAI, WCAG, guidelines, methodologies, metadata, contextual design.

1. INTRODUCTION

Accessibility of the World Wide Web (the Web) to end users, regardless of ability or browsing environment, is widely accepted as a fundamental requirement if the Web is to reach its true potential as an enabler for the widest possible audience. Indeed, the rights of Web users with disabilities are becoming ever more defined in anti-discrimination policy and legislation around the world [49].

Unfortunately studies have regularly shown that the accessibility of Web sites falls short of an acceptable level. This is despite an ever-increasing quantity of work that has gone into:

- developing tools to support Web content providers in authoring accessible material and evaluation of the accessibility of content [46].
- developing assistive technologies for end users, whether hardware or software, adaptations or extensions to browsers, or server-side transformation tools to allow disabled people to overcome or reduce the impact of their impairment when interacting with Web content.
- disseminating the importance of, and best practices in, accessible Web design, e.g.[34],[44].

The reasons behind the continuing disappointing levels of Web content accessibility have been widely discussed (e.g. [13]). What seems clear is that, while still a factor, a lack of awareness of the importance of accessibility amongst Web developers and site commissioners is no longer the predominant issue. A key challenge is effective and appropriate implementation of accessible Web design techniques. Other challenges include the perceived complexity and cost of the task of making a Web site accessible [28], and also the need to unambiguously define what is actually meant by 'accessible', understand what is required to develop a Web site to be considered to have met that definition, and to evaluate it such that once can judge whether it has met the specified level of accessibility [3].

From the disabled Web user's perspective, complicating factors include the browsing and assistive technologies available, the user's ability to use these technologies, and the difference between the technologies available and those most appropriate for the user's needs.

2. W3C, WAI AND WEB ACCESSIBILITY

2.1 The WAI Model of Accessibility

As the body responsible for the coordination of developments to Web standards, the World Wide Web Consortium (W3C) has taken a lead in promoting accessibility of the Web for disabled people, not only as Web users, but also as Web authors. Since 1997, the W3C's Web Accessibility Initiative (WAI) has been extremely active and very successful both in raising awareness of the importance of Web accessibility and in developing a model which can help organizations to develop accessible Web resources. This model provides guidelines which can be used to ensure that Web resources are optimally accessible, as well as influencing the development of other W3C standards for Web technologies.

The WAI promotes a tripartite model of accessibility, with the goal of universal Web accessibility in theory provided by full conformance with each of three components [7]. Of particular relevance to developers of Web resources is the Web Content Accessibility Guidelines (WCAG) [52]. WAI has been successful in promoting the WCAG around the world, the guidelines having been adopted by many organizations, embraced by the Web Standards movement [55], and are increasingly being adopted at a national level [49].

In the WAI model, the WCAG is complemented by accessibility guidelines for browsing and access technologies (the User Agent Accessibility Guidelines, UAAG [51]) and for tools to support creation of Web content (Authoring Tools Accessibility Guidelines, ATAG [46]). 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 towards the provision of accessible Web content.

2.2 Shortcomings of the WAI Model

Although WAI has been very successful at a political level, and to a large extent at a technical level, the authors feel that the model of Web accessibility adopted by WAI is flawed. This is due partly to the nature of the WCAG and also to the overwhelming domination of the role of WCAG with respect to the other guidelines in the accessibility of online information and services.

2.2.1 Limitations of WCAG

Shortcomings of the WCAG have been noted by a number of commentators (e.g. [8], [12]), and documented by the authors [25]. In brief, these include:

- **Theoretical nature of the guidelines**: current guidelines promote the use of open, W3C standards, and ignore widely used proprietary technologies, many of which have made significant improvements in accessibility support in recent years.
- **Dependencies on other WAI guidelines**: conformance of a site to WCAG may not be enough to ensure optimal accessibility if this conformance results in a site that requires use of a UAAG-conformant browser.
- **Ambiguity of the guidelines**: It is well documented that there is a significant degree of subjectivity in applying many WCAG checkpoints; and some are conditional on levels of support for a feature across browsing technologies.
- **Complexity of the guidelines**: The organization of the guidelines (each with constituent checkpoints of varying

priority) means that the WCAG can be difficult to understand and apply to a particular situation. We expect this to be remedied in future versions of WCAG, but interpretation difficulties may be hard to avoid.
- **Logical flaws of the guidelines**: The content of some WCAG checkpoints is such that they are open to quite extreme interpretations.
- **Level of understanding of accessibility issues required:** Given the range in technical abilities of the intended audience (anyone who creates Web content), there may be significant cognitive demand on understanding the principle behind a specific checkpoint, and applying that in a particular situation. Indeed, the format of the WCAG was found several years ago to present developers with problems of interpretation [10].

At this point we must acknowledge the ongoing development of WCAG 2.0 [53]. We have confidence that, when published, WCAG 2.0 will address many of the problems highlighted above. We are less confident that the release of a revised set of guidelines will overcome the wider issues addressed in this paper.

2.2.2 The dominance of WCAG

The WAI model also places significant responsibility on end-users to be aware of the technologies that most suit their needs. The need for improved user awareness, through better training and support, was a point noted by the UK Disability Rights Commission's Formal Investigation into Web site accessibility [13]. It has also been echoed by many developers promoting Web standards (e.g. [29]) who express frustration over the lack of user awareness and uptake of standards-conformant browsers and assistive technologies, of accessibility features of browsers and operating systems, and the resulting impact on the effectiveness of moves to promote adoption of Web standards.

Nevertheless, Web developers remain comparatively powerless to persuade end-users to adopt conformant browsing technologies. The lack of awareness about assistive technology and more capable browsing technology amongst the wider Web-using population has been found to be a significant issue [31]. Developers are limited to attempting to provide bespoke accessibility features such as large-print style sheets [9] or audio-enabled versions of their pages, for example through Readspeaker [37].

Since usage of UAAG-conformant browsing technologies cannot be relied upon, and usage of ATAG-conformant authoring tools can neither be relied upon nor guaranteed to produce WCAG-conformant content, WCAG remains the ultimate standard which developers must meet. Even then, accessibility problems may remain, as discussed further in *Section 3*.

2.3 Alternatives to WCAG

The W3C process of developing its "Recommendations", in the form of specifications is a lengthy, but thorough and robust process, involving domain experts and public consultation. Yet evidence used to support decisions made, for example in formulating the WCAG, is not made explicitly available as part of the guidelines or the supporting documentation, and thus the guidelines have been criticized as lacking empirical evidence [32].

Some sets of guidelines have applied the WCAG to a particular environment, for example the IMS Guidelines for accessible e-learning [18]. In addition, research-based guidelines for Web accessibility and usability for groups who would appear to be

catered for by the WCAG, including disabled and elderly people, have emerged over recent years, (e.g. [11], [27], [32] and [45]).

Some of these guidelines are broadly in agreement with the WCAG; some are more prescriptive, while there are also situations whereby comparison of these guidelines may result in potential conflict between the needs of specific user groups. Even the fact that the research teams producing the above guidelines felt the need to carry out the work indicates a level of dissatisfaction with the nature and content of the WCAG, in particular with respect to lack of published supporting evidence for specific checkpoints.

This situation reinforces the need for guidelines to be perceived to be useful and usable by developers - in terms of being credible, proving sufficient information on the consequences of following (or ignoring) particular checkpoints, and clearly defining the scope of applicability of a particular checkpoint.

3. UNIVERSAL USABILITY OR INCLUSIVE DESIGN?

3.1 Accessibility? Or Usability for Disabled People?

The relationship between accessibility and usability has long been a source of discussion, and as yet no definitive model exists [4]. However, it may be an unnecessary and artificial distinction in practice [1], [44]. This is illustrated by a discussion of the findings of the DRC's Formal Investigation into Web Site Accessibility [13]. The results produced two telling conclusions:

1. Some problems encountered by disabled people could not directly be matched to any single checkpoint of the WCAG. A WAI response [50] argued that many of these problems could be caused by non-conformant user agents and authoring tools. However, an expectation that all disabled people use conformant user agents is, we would argue, hopelessly idealistic at the present time, not least given that if a UAAG-conformant user agent exists, the likelihood that many disabled people would be aware of it, and have the means to obtain it, install it and use it, would be low.

2. Some Web sites were found to perform extremely well in usability evaluations with disabled people, yet did not meet certain WCAG checkpoints. When these sites were announced some commentators (e.g. [54]) criticized the DRC for hailing as examples of best practice sites that did not meet basic conformance levels of the WCAG. Thus, the somewhat strange situation emerged whereby sites that were found to be usable by disabled people were nevertheless rejected by Web developers as being inaccessible!

The WCAG may imply that full conformance will result in a universally accessible Web site, yet the very goal of universal accessibility has been questioned. For example, Newell and Gregor [34] acknowledge the limitations of universal accessibility by proposing a new approach of "user-sensitive inclusive design", while Nevile [33] describes the problems that can face an attempt to create and provide universally accessible resources, noting that:

"…it is not conceivable that even the new guidelines (WCAG 2.0)…will solve all the problems. Perhaps it is just not sensible to expect such guidelines to anticipate every solution and provide for it."

3.2 One Site for All – Always?

The one-site-for-all approach to accessibility has, correctly in the authors' opinion, largely conquered the perception that accessibility can be achieved through a separate stand-alone text-only Web site. Yet advocates of the single-site approach have shown a remarkable intolerance of attempts to use the Web to reach out to neglected groups, in particular people with severe learning difficulties, and who may have requirements quite distinct from most other Web users.

For example, a recent request was made to a Web accessibility email discussion list for feedback on a site designed for children with severe learning disabilities. This request produced feedback that was extremely critical of the appearance and content of the site. Yet while the distinct lack of evidence-based guidelines for Web site design for people with learning disabilities has been pointed out [8], [39] the reaction to the email request indicated an expectation that the resultant site should be equally understandable and usable by the members of the list as well as by the target audience.

We argue that this appears to be a prime example where the Web can be used to enhance the quality of life for a specific group of disabled people through providing information and entertainment, and facilitating communication, yet in a way that may present other people with significant usability problems. Here, the Web is enhancing accessibility for disabled people – but not through a universally accessible Web site.

In fact, there appears to be increasing use of solutions such as text-transcoders, text-to-speech features and alternative style sheets to provide on-the-fly alternative formats of one single site. This could be seen as a realization that designing one WCAG-conformant site for all, and leaving users to adopt UAAG-conformant browsers, is not a realistic approach at the present time.

3.3 Context of Use

Designing digital systems to meet the requirements of the people who will be using it is the classic approach to usability. One can group requirements into several categories, including:

- User characteristics: the abilities (and disabilities) of the target users including perceptual, cognitive, motor, and linguistic abilities.
- Domain requirements: the tasks that need to be supported, group, social and cultural dynamics, communication patterns, environmental factors, and so on.
- Technological requirements: such as availability of hardware and software and the availability of plug-ins.
- Performance requirements: for example, task success rates, task-completion times, satisfaction ratings, and quality of task output (e.g. comprehension outcomes in an e-learning environment).

Taken together these categories of requirements are often called the "context of use" [2]. Ultimately the stakeholders associated with a particular digital system want that system to be "successful". Success, however, can only be identified and measured if requirements such as these are identified and, ideally, specified. The key measure of a digital system is whether it fits its context of use: whether the people for whom it is designed can use it with acceptable levels of usability, for the tasks that they need to do, in the social setting in which these tasks take place, using the technologies they have available.

We argue that only by taking this approach – by considering the context of use – can meaningful and productive discussions be conducted about the accessibility or usability of a system. Using context of use as a benchmark for success also eliminates the illogical situation in which some commentators (e.g. [54]) reject sites that are usable by disabled people (i.e. fit the context of use) but do not meet specific WCAG conformance levels. Appropriate "fit to context of use" should be the goal of developers, with a recognition that guidelines can serve as *means* to this end, but that conformance to guidelines is not itself the end.

4. LEGISLATION AND POLICY

We have introduced our argument for evaluating accessibility based on context of use. However, policy and legislation around the world appears to look favourably on WCAG as a stable, authoritative and unambiguous measure of accessibility. Unfortunately this can lead to problems in terms of assumptions by developers and Web site providers of a 'legal technical minimum' for accessibility, and in terms of the restrictions that such a policy may place on what can be published online. But does legislation introduced to protect the rights of disabled people around the world actually require every Web resource to be universally accessible? It would appear not, at least not in the UK.

The terms of the UK's Disability Discrimination Act 1995 focus on the rights of employees (Part II), the provision of goods, facilities and services (Part III of the Act) and of post-16 education (Part IV). No mention is made of the Web in the terms of the legislation. Commentators have generally agreed that the Web is likely to be covered by the Act, especially given case law that exists in Australia, under similar legislation [39] and we have no reason to question this position. What is increasingly apparent, though, is that while the provision of a service may equally be achieved through the Web or through other means., the key requirement is to ensure that access to that service is not made unreasonably difficult or impossible for someone on account of their disability.

In many cases, an accessible Web site would indeed be the single most appropriate way of providing that service, and under the terms of the UK's DDA, a "reasonable adjustment" for a service provider would be to make their service available through an optimally accessible Web site. But for those who may still have trouble using the site, there would seem to be scope to provide alternative access to the same service, either through an alternative Web interface, or by non-Web means.

While there are accusations within industry that the DDA does not provide Web site developers and commissioners with enough information on what constitutes lawful practice, we suspect that what is needed is a better explanation of what is meant by "reasonable adjustments" – examples, or, in the absence of case law, hypothetical case studies may help.

Ultimately, by not referring to the WCAG or any other technical definition of an 'accessible' – and thus lawful – Web site, we suggest that the UK's DDA is an example of legislation that **encourages** a contextual approach to accessibility. The concept of "reasonable adjustment" as introduced in the legislation is worthy, but could be enhanced by more guidance. Organizations should ideally develop policies that are themselves commensurate with the resources available to them, demonstrating those policies or plans ("reasonable adjustments") the organization had in place to make their services accessible.

This position has been underlined by the publication, in March 2006, of a new UK standard focusing on good practice in the commissioning of accessible web sites [5]. This document advises, but does not specify, minimum conformance levels; crucially, it also emphasizes the need for an accessibility policy to be established for every site, allowing site owners to explain and be accountable for their approach to accessibility in terms of the site's context.

5. A HOLISTIC APPROACH TO ACCESSIBILITY

5.1 A Holistic Model for E-learning Accessibility

In our promotion of a contextual approach to accessibility, we now look to the e-learning field for an example of how a holistic approach to accessibility can be effectively applied.

The development of accessible e-learning resources has additional complexities over the development of conventional informational Web resources. As described by Kelly *et al.* [24] e-learning developers are faced not only with the difficulties of understanding and interpreting WAI guidelines, but also ensuring that the resources implement an appropriate pedagogical approach. With informational resources, the aim is to ensure that the relevant information can be easily accessed. With learning resources, however, this approach could mean learners are provided with answers rather than having to think careful in order to come up with answer for themselves (and it is a legitimate part of the learning process for students to initially arrive at incorrect answers).

The approach to e-learning accessibility developed by Kelly *et al.* argues that the focus should be on the learner's needs and that, rather than mandating that individual *learning resources* must be universally accessible, it is the *learning outcomes* that need to be accessible. In this blended approach, it can be perfectly legitimate for inaccessible digital learning resources to be replaced by learning which makes use of physical resources. This approach is based on regarding the learner with disabilities as an individual with an alternative learning style, rather than the medical model implicit in the WAI approach, which focuses on the disabilities themselves. Within many educational institutions, especially in the UK, **blended learning**, which exploits both digital and physical learning resources to provide a rich educational experience, is growing in popularity. The holistic model for e-learning accessibility reflects a wider approach to learning and therefore is more likely to be embedded within the development of learning resources.

The holistic model for e-learning accessibility also recognizes that other contextual aspects are important. As well as pedagogical issues, factors such as available resources, organization culture, etc. (and usability, as discussed previously) are also relevant factors, as illustrated in **Figure 1**.

5.2 Application of the Holistic Model

The benefit of the holistic approach is demonstrated when considering the importance of multimedia in accessible learning and teaching. While it is important that rich media is provide with appropriate accessibility features to compensate for sensory or physical impairments, it is equally important to take advantage of the potential of the very use of rich media in enhancing the

accessibility of the learning environment to people with specific learning difficulties [39].

Figure 1: Holistic Model for E-Learning Accessibility

As a specific example of an application of the holistic model for e-learning accessibility and a comparison with the WAI approach, we will consider the provision of slide materials supporting a lecture or similar, such as those created by Microsoft PowerPoint.

Microsoft PowerPoint is widely used for presentations in many learning situations. Providing access to PowerPoint presentations after a lecture can help to maximize access to the resource and can provide a useful aid for revision. In many organizations the approach taken may be to simply provide a link to the PowerPoint file - but with this approach, the slides cannot be viewed on platforms which do not support the Microsoft viewer. A better approach is thus to provide access to a HTML version of the slides. As saving as HTML from within PowerPoint creates non-WCAG conformant HTML resources, the WAI approach would encourage use of alternative conversion software to create conformant HTML pages, or alternative presentation software, such as S5 [30]. Although such approaches can enable a better WAI conformance rating to be claimed, it is questionable whether this will always lead to enhanced accessibility benefits for the end user.

A danger with this mechanistic application of WCAG is that it can lose sight of the aims of the presentation. Presentation software such as PowerPoint could be used for a variety of reasons such as:

- an *aide memoire* for the speaker – and therefore of limited use to anyone who was not at the presentation; or
- a content-rich resource possibly containing information not provided in the spoken presentation (such as multimedia content, URLs, etc).

We argue that in the first instance, the presentation file may be of little use to anyone not at the presentation _ perhaps as a limited reference list. Its presence online in HTML format cannot be assumed to provide an equivalent of the information given by the lecturer, and therefore in no way makes the *experience* provided by the lecture 'accessible'.

It should also be noted that although presentational software such as S5 make use of conformant XHTML and CSS, it is questionable as to whether such presentations are as usable as standard PowerPoint presentations. PowerPoint, for example, has an advantage that text can automatically resize to fit the screen display whereas with S5 the viewer needs to manually resize the text (and is not made aware that materials may not be displayed). It should also be noted that handouts from PowerPoint

presentations can be designed to provide useful notes when printed, whereas this option in S5 is poor in comparison. Although both of these issues affect the usability or the learning resource, they are not addressed in WCAG guidelines.

Technological innovations, such as the use of Podcasting to support learning, may have a role to play in enhancing access to such presentations. With the growth in the provision of wireless networks at academic conferences, and the simplicity of creating Podcasts, we are seeing an increase in the numbers of Podcasts of lectures. Such recordings can clearly enhance the accessibility of talks, providing benefits not only for visually impaired users, but also enhancing access to others. Ironically, however the lack of clarity and the dogmatism of the WAI approach can lead to Podcasts being regarded as breaking WAI guidelines: transcripts of Podcasts are not normally provided. If one wishes to pursue the "use W3C technologies" directive to an extreme, there is an additional issue whereby Podcasts typically make use of the proprietary MP3 format rather than, say, an open format such as Ogg.

An application of the holistic model would recognize that enhancing the accessibility of the presentation resources will be dependent on the role they play; that the non-compliance of HTML versions of such resources does not necessarily lead to accessibility problems; that the usability of the presentation is a relevant factor; that the usability of hardcopy printouts is a relevant factor and that it can be beneficial to users if alternative multimedia versions of presentations are provided, even if such enhancements fail to comply fully with WCAG guidelines themselves.

The main point to be made is that it is the experience of listening/seeing the lecturer which should be accessible rather than the emphasis which can be placed on addressing the accessibility of HTML versions of the slides which results from a mechanistic implementation of WCAG guidelines. In such a case, a more appropriate alternative might be an audio or video recording of the lecture plus text transcript or captions and audio descriptions.

Of course, the resources required to create multimedia alternatives and corresponding accessible alternatives may impact on the ability to provide the multimedia. The primary role of this example, though, is to show how the effectiveness of the accessibility solution depends on the context of use of the presentation.

5.3 The Role of Metadata - Personal Needs Profiles, Resource Definitions and Other Standards

A promising approach to the problem shows in the IMS AccessForAll work [19], [20]. This takes the approach that an accessible outcome needs to be provided not by a single universal resource but by a collection of related resources selected and adapted to match the requirements and preferences of that user in that particular context. The basic notion is that each user has a Personal Needs Profile that can contain a number of different personal profiles, each for a different identified context, such as "AtWork", "InTheGym" and "LateAtNight". Each profile consists of a set of "functional" preferences, which contain standardized descriptions of requirements for particular hardware, content or control mechanism that the user requires or prefers in that context.

We stress that the information contained is not medical but is functional. For example a profile may contain information specifying that a user needs to have content where no essential information is encoded with colour alone or the user needs to use a screen reader such as JAWS with specific parameters for speech rate or needs "Sticky Keys" to operate the keyboard. Matching metadata is associated with each piece of content (Web page or Web page component). With this information, and content appropriately labelled it is possible to collect and aggregate resources with alternatives authored to make those resources accessible in the specific context matched to the user's functional profile. The basic components of this approach are shown in **Figure 2.**

Figure 2: Using Personal Profiles and Resources


¹=Learning Object Metadata
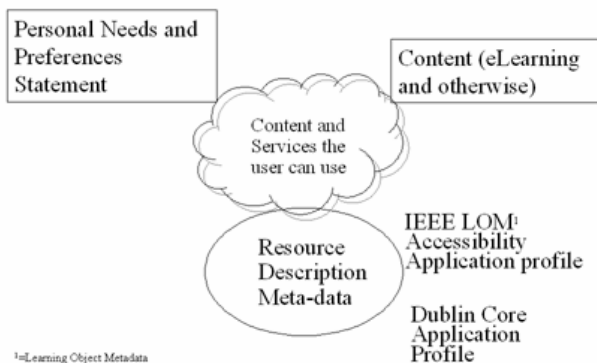
The "Application Profiles" in **Figure 2** are under development and show how Resource Description Metadata can be used in interoperable ways with the two most commonly used e-learning resource metadata schemes. The application profile of the IEEE Learning Objects Metadata standard (LOM) [17] is being developed by CEN-ISSS Learning Technologies Workshop [5] and a Dublin Core Metadata Initiative (DCMI) [14] profile is under development by the Dublin Core Accessibility Working Group [15]. These pieces of work are being developed in close collaboration so that they will interoperate.

Inherent in the Resource Description Metadata model is the concept that an original resource could have adaptations authored separately so as to support the very common use case where resources such as Web pages are authored by a person without specialist accessibility knowledge and are then made accessible for some real context by the provision of alternatives and services by a person or organization with specific accessibility expertise. The metadata provides standard ways to describe the access modalities of a resource (such as "visual", "auditory", "tactile"), adaptations for those (such as specific caption kinds for visual modalities) and ways to refer to and relate the physically separated parts. With this model the requirement that all authors have detailed accessibility knowledge is minimized and accessibility expertise can be drawn from specialists available.

A possible instance of latest versions of the AccessForAll metadata work showing a resource and some alternatives is given in **Figure 3**. In the diagram, the resource "knows" about some of the alternative adaptations that are available because it has URL pointers to them ("hasAlternative"). Sometimes an alternative is known only in its own local context as in the case of the captions alternative for the auditory component. Alternatives can be used as supplementary or replacements and not shown in the figure is

the less common case where a resource can contain alternatives within itself (for example as with a video that has captions that can be switched on or off). Alternatives would be selected from those available to match the preferences and requirements in the Personal Needs profile.

Figure 3: A Possible AccessForAll instance

A possible AccessForAll Instance with alternative adaptions
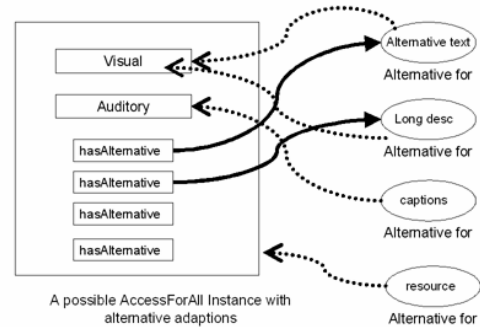
With accessible outcomes provided by collections of resources and services adapted and matched to the user at or close to the time of use, then some of those resources could be online, some offline and some could be (and will need to be) services, such as the provision of a human interpreter.

Despite the deficiencies in the universal accessibility model and the WAI WCAG guidelines some of the guidelines and checkpoints are of some value in this context in ensuring that online content such as Web pages are transformable to meet some Personal Needs Requirements and in providing tests of some properties that can aid in the matching and authoring of digital alternatives. More work is needed here amongst the WCAG tests and tools to determine and document what does and does not work in systems with distributed resources.

Though the work began in IMS, at time of writing it is being developed as a freely available ISO standard [21]. So far the context of this work has extended to digital resource preferences, requirements and descriptions but it is notable that the Framework Document for the ISO SC36 work [21] describes the concept of "blended learning". It is to be hoped that this signals intention to extend the work to provide for description of non-digital preferences and resources, such as railway stations, and non-digital alternatives (including resources and services) to digital resources and services. In the authors' view this is work that needs doing.

Closely related work is underway in IEEE Learning Technology Standards Committee in devising a Resource Aggregation Model for Learning Education and Training (RAMLET) [16]. The aim of this work is to show how different media and aggregation formats can be mapped together so as to technically facilitate dis-aggregation, authoring and re-aggregation of disparate resources and formats.

In the opinion of the authors, it is true that to date a great deal of work in the domain of technical standards for e-learning has had a "hard" edge so that someone is either "doing e-learning" or "not doing e-learning" or they are "using the Web" or "not using the Web". Real practice of learning is much messier and there is a general need within the standards to soften the edge and show how the standards can be used in holistic contexts where some resources and services are digital and some are not. Accessibility

is chief amongst the domains that needs that broadening of context.

6. DEVELOPING THE HOLISTIC FRAMEWORK FOR ACCESSIBILITY

6.1 An Inclusive Approach to Web Accessibility: the Tangram Model

We have argued the practical difficulty of applying the WAI model for Web accessibility. We have described the holistic approach for e-learning and how it can be applied within the context of cultural resources. There can also be a cultural or experiential context to informational resources [22] that is essential to preserve for all users.

We have described our holistic model for e-learning accessibility. This model reflects the wider approaches to learning which underpin current pedagogical approaches. Although this model was developed within an educational context, the approach is being developed to address more general provision of Web resources.

For example, Kelly *et al.* [26] describe the application of the holistic model within the context of cultural resources. The i-Map service [43] developed by the Tate Gallery provided resources on the paintings of Picasso and Matisse aimed specifically at visually impaired users. The approach taken was to focus on the requirements of a specific user community, rather than aiming to provide a universal resource. The i-Map service also makes use of a blended approach, providing access to raised images of the paintings.

Another example of an application of our hybrid approach to accessibility is the recommendation given to a public library in the UK. A presentation on a variety of IT developments within the library was given including an example of a popular Macromedia Flash-based game aimed at children who visited the library. The response to a question of the accessibility of the game was that, although the game had proved popular, it would probably have to be removed, as it did not comply with the organization's commitment to WCAG guidelines. Subsequent discussion explored the purpose of the game. It was found that the game was aimed at parents who visited the library with young children, with the game providing distraction for the children while their parents browsed the library. It was pointed out that, rather than attempting to build an accessible version of the Flash game, an alternative approach could be the provision of building blocks or other types of games.

Our approach therefore emphasizes the importance of the user and on satisfying the user's requirements. Such requirements will have a cultural context to them. We therefore advocate an approach to accessibility which is based on social inclusion rather than on the notion of universal accessibility.

The inclusive approach we advocate should be open and capable of integrating with complementary approaches developed by others, and is neutral on format issues. In addition to technical issues, we argue that the inclusive approach should recognize that alternative ways of providing accessibility can be provided, either through use of accessibility metadata (which can be used to provide resources which are accessible to a user's individual requirements) or through a hybrid approach.

Our initial idea was to develop a jigsaw metaphor. However this approach implies that there is a single, correct solution. We have rejected this notion as we argue the need to recognize the contextual aspects as accessibility and the need for solutions which are appropriate to the particular context. Our proposed model makes use of a Tangram metaphor as an approach for Web developers, based on the Tangram - a seven piece puzzle where the object is to form a shape using all pieces.

Using the WAI model the Web developer has very little flexibility. A series of rules are provided for the developer to follow. Although some of the rules are undoubtedly useful, others are flawed and, as we have seen, alternative approaches, not covered in the guidelines, may also be useful. We feel there is a need to provide a wider set of guidelines, but that the developer needs flexibility in selecting guidelines which are applicable. For example, a Web developer may choose a subset of WCAG guidelines in conjunction with usability guidelines and relevant style guidelines.

The Tangram metaphor makes it clear that there is no single universal solution. Instead the developer can select relevant guidelines in order to implement a solution which is usable to the target audience, and taking into account any access requirements. Web developers will then be expected to make use of a range of guidelines covering best practices in areas of accessibility, usability and interoperability. So for example a simple Web site may make use of well-established guidelines such as WCAG and Nielsen's usability heuristics to develop a simple solution.

Figure 4: The Tangram Model for Web Development
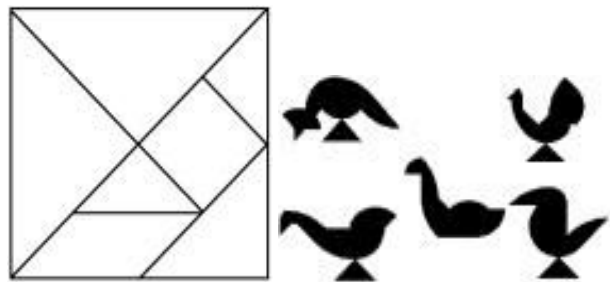
In **Figure 4**, the 7 different pieces of the Tangram puzzle each refer to a set of guidelines. The metaphor is meant to be extensible: as well as WAI guidelines, other guidelines may also be used, such as Nielsen's 10 usability heuristics [35], guidelines for design for specific user groups, such as older people [32], or even guidelines on clarity of written content, for example [37].

A developer of a more sophisticated Web service may require a richer set of guidelines to call upon. This could include organizations guidelines such as use of corporate logos and navigational features, guidelines on writing style. The developer will have flexibility in the approach taken, and may choose a solution most appropriate to the context of the application.

The aim of this approach is to provide a solution which maximizes the usefulness to the end user, as opposed to the current WAI approach which encourages mandatory application of a limited set of guidelines. The metaphor is meant to clarify that the most appropriate solutions can be obtained by engaging with the users rather than simply applying a set of rules.

We can see several advantages with the application of this model:
- The model can be extensible (we can make use of additional 'pieces'). This allows the approach to be extended as, for example, new technologies become available (for example,

guidelines for use of accessible Macromedia Flash or PDF can be incorporated).

- The model can cover general IT accessibility and is not limited to Web accessibility.
- The model can be extended to include real world solutions.
- The model can be extended to include Web accessibility issues which are not covered in WCAG (e.g. the accessibility of hard copy output of Web pages).
- The model is well-suited for use with Web resources which are personalized though use of accessibility metadata (the model emphasizes the service provided to the end user rather than individual components).
- The model can be deployed across a range of different legal systems.
- The model is neutral regarding technologies.

7. APPLYING THE FRAMEWORK

We have described a richer underlying framework for accessibility which is based on the Tangram metaphor. Application of this approach will require a wider framework of activities, including further advice and support for both Web developers and policy makers. Accessibility researchers should also look to how their work can support a contextual approach to accessibility.

7.1 For Web Developers

Using the components of context of use introduced in **Section 3.3**, Web developers can establish context by providing answers to the following:

- **User characteristics:** Who is your target audience? What assumptions can you make as to the level of expertise the target audience have in the subject area of the Web site?
- **Domain requirements:** What is the purpose of the Web site? What sort of tasks do you expect users to be able to perform using the site?
- **Technology requirements:** What assumptions can you make as to the browsing and assistive technology available to the target audience and their knowledge of that technology? What would be the tradeoff in using a non-(X)HTML format to deliver information or experiences along with or instead of (X)HTML?
- **Pre-existing alternatives:** What other ways already exist to provide access to the information or services provided by the Web site in question? What pre-existing assets (e.g. multimedia clips, telephone information line) can you take advantage of to widen access?
- **Quality of alternatives:** What other ways could be created to provide alternative routes to the same goals to which the site is intended to provide access? What are the accessibility (or other) barriers to accessing these alternative means?

Defining this context allows the development team to adopt an appropriate accessibility strategy - one that has the needs of the target users of the site and the purpose of the site at heart. This can then be used to define technical requirements that will allow the most appropriate solution(s) to be created, using appropriate guidelines to inform development.

7.2 For Policy Makers

Using the proposed framework, policymakers can refer to promotion of a holistic approach to accessibility rather than mandate a strict conformance to a technical standard that may not in fact guarantee equality. There is a danger that if policy mandates Single-A WCAG conformance, then this will be all that organizations will consider, to the detriment of the true accessibility and usability of their services.

Policy should encourage information and services provided through a Web site to be made as accessible as possible, and at this point may make reference to the WCAG. However it should also promote the use of other digital content, or even non-Web means along side the Web site, if doing so would enhance the accessibility and usability of the service in question to specific groups.

Policy should also encourage, rather than discourage, the use of multiple routes to achieving the same end goal – whether information, a service or specific experience – where multiple routes might better serve different groups within the target audience.

Perhaps most importantly, policy should require documentation of the process of development – including those attributes of context outlined in **Section 3.3**, and the association of alternative routes to achieving the same end goals. This provides for transparency in decision-making and allows justification of decisions that, without the availability of contextual information, might appear to be discriminatory.

There does remain a role for legislation that more directly refers to minimum technical standards, but we argue this should refer to the production of software and hardware to support creation of and access to Web content. To be more specific, given the blurring of the concepts of Web sites and Web applications, we would qualify this as covering applications under the domain of the UAAG and ATAG. Keates and Clarkson [23] note the positive impact that the amended Section 508 of the Rehabilitation Act has had, on major players in the Web technology sector, in terms of improvements they have made to accessibility of Web authoring software and proprietary Web formats.

7.3 Using the Framework in Evaluation and Benchmarking

One objective of the European Commission-funded Support-EAM project [42] is to develop a 'quality mark' – a pan-Europe accreditation that can be applied to Web sites that have reached a recognized level of accessibility. Given our arguments about the importance of context, and the principle that it is the service or experience that should be the focus of attention, not the Web site, we have serious reservations about the implications of such a scheme on Web content that has been developed as part of a wider strategy to improve the accessibility of information and services.

The framework we propose, on the other hand, provides a more realistic way of assessing accessibility, by considering the Web site in context. By taking a contextual approach to establishing accessibility, it also supports a more task-oriented approach to accessibility evaluation, for example the heuristic walkthrough for accessibility as proposed by Brajnik [4], and is in line with the AccessForAll strategy discussed in **Section 5.3**.

The contextual approach also lends itself to documenting the approach taken by the site providers to accessibility. Documenting decisions taken from an accessibility perspective is a transparent demonstration that accessibility has been considered throughout the design lifecycle. This may also be an important step towards demonstrating that developers have been proactive in taking steps to ensure that unjustified discrimination does not occur.

8. CHALLENGES FOR WAI

In this paper we have outlined an alternative approach for addressing Web accessibility to that provided by WAI. We feel our approach reflects the working practices used by Web developers who do not aim to address usability issues independently of other factors, and who are acutely aware of factors such as resources implications and timescales which they will invariably face. We feel the approach also addresses the needs of the user who wants access to online information, services and experiences, and not simply a WCAG AAA conformant Web site.

It is important to note that our model is not intended to replace the work carried out by WAI, but to provide a context for WAI's activities. There will still be a need for WAI to continue the work of the UAAG and ATAG working groups in order to improve the quality of authoring tools and user agents. Similarly, given WAI's high profile, there is a need for WAI to continue its outreach and educational activities.

We feel, however, that WAI should recognize the limitations of its model for Web accessibility. We feel that WAI should similarly recognize that there can be many approaches to addressing accessibility issues, and that the guidelines developed by WAI groups should be capable of being integrated with other approaches. Acknowledging the diversity of solutions which can benefit end users should also lead to recognition that this diversity needs to be reflected within legal frameworks.

It should be noted that such an approach has been taken by other activities within W3C. When the US government threatened the introduction of the US Communications Decency Act (which addressed the concerns over content which may be inappropriate for children) the response of W3C - an international membership organization - was not to engage in political debate with the US government, but to develop a technical solution (PICS - the Platform for Internet Content Selection) which could be deployed at an appropriate level (its use could be mandated within legislation or could be applied across particular sectors).

At this point, we acknowledge the recent emergence of the 'baseline' concept as part of the work by WAI towards the publication of version 2.0 of the WCAG [46], an encouraging development in this area. It is a welcome acknowledgement by WAI that accessibility can, and should, be measured with contextual factors in mind, such as anticipated browsing technology available to the target audience.

In summary, we feel that the underlying principle to WAI's work should be to *widen participation* rather than to seek *universal accessibility*. Both phrases reflect similar goals, however universal accessibility implies there is a single universal solution whereas widening participation acknowledges that there can be a variety of solutions.

9. CONCLUSIONS

We have argued that a guideline-based approach to accessibility for disabled people has a role to play in the drive towards harnessing the Web as a means of reducing inequality, but it can be harmful if guidelines promote the assumption by both Web site developers and policymakers that, in every case, one fully conformant Web site will be accessible and usable to absolutely everyone. Accessibility guidelines become essential only when the role of a Web site has been defined in a wider context of provision of services, information and experiences.

Taking the approach of the e-learning community as an example, we believe that the goal of universal accessibility on the Web is inappropriate, and instead we should not be afraid to explore multiple routes to equivalent experiences, whether those routes are multimedia alternatives, or tactile alternatives, or whatever might be appropriate. The Tangram Model provides a metaphor for this approach, while the AccessForAll metadata work will give a solid framework for applying contextual accessibility.

We believe that this approach will lead to more effective policy and legislation, will support evaluation and benchmarking of accessibility, will give developers greater freedom to meet the needs of their audience, and will allow disabled people to access information and services in a way that most suits their requirements.

A more holistic approach to Web accessibility – to using the Web as an access technology - is one that will allow the Web to reach its true potential, overcoming the frustrations of conflicting user needs, competing Web technologies, sub-standard browsing technology and users who may never be fully aware of the technologies that can help them most effectively browse the Web.

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