

Integrating HCI in a Web Accessibility Engineering Approach

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Abstract. The treatment of Web accessibility is not only following the Web Content Accessibility Guidelines (WCAG) to strictly comply with technical aspects. The development processes of web applications are very much centred in the architecture, which are normally very distant to the user. This requires integrating usability and accessibility in software engineering processes incorporating a User-Centered Design (UCD) and Inclusive Design. In this paper, an integration of usability techniques in the whole life cycle of a web application is shown. This work is part of AWA framework (Accessibility for Web Applications) that provides a methodological support for the development of accessible web applications.

Keywords: Web accessibility, Human Computer Interaction (HCI), usability, User Centred-Design (UCD), Inclusive Design, Web engineering methods.

1 Introduction

Lack of accessibility in web environments is a problem which affects to everybody in the current context of digital society: the increasing number of affected users by inaccessibility produces the so-called digital divide; we ourselves meet with web accessibility obstacles as a result of a specific personal context or a technological incompatibly. Therefore, a very aged population would be using the web in the following decades and this requires being careful with accessibility issues, rethinking whether to consider web accessibility as just a social responsibility or also as a legal obligation, because there are economical and business factors which are to be reconsidered.

Currently, companies and organizations are also facing a crisis in the development of web sites, where there is a tendency towards ad-hoc designs which, in most of the cases, do not follow any method or standard. This view complicates the establishment of procedures on how to include accessibility criteria from the initial stages of the development process. From an engineering perspective, the solution should be guided towards the training of those professionals who develop web sites with Web Engineering Methods which help and guide the processes in order to achieve the objective of accessibility. Accessible development implies some difficulties such as cost previsions and the selection of adequate methods to include accessibility criteria;

incorporating accessibility criteria entails higher costs or an impossibility to carry it out. These difficulties, amongst others, make accessibility development a complex task.

From this perspective we propose to integrate accessibility issues into the software development process following Web Engineering methodologies. With this motivation, AWA¹ (Accessibility for Web Applications) providing a methodological framework for the accessible web applications development with a web engineering support. Accessibility is understood as the fulfilment of the Web Content Accessibility Guidelines (WCAG) standard including the user web experience.

The objective of AWA is to define specific accessibility mechanisms to be included in a methodology for web applications development, i.e. in analysis, design, implementation and maintenance phases. This paper describes only accessibility mechanisms of AWA related to usability, specifically (a) how to follow a User-Centered Design (UCD) methodology with inclusion, using usability techniques such as Surveys, Interviews, User Profile, Person, Scenarios, Card Sorting, Prototyping and Heuristic Evaluations, and (b) how to integrate the results of these techniques on the different models, steps, artefacts in a process according to AWA. This proposal has been validated in several case studies and one of them is introduced in this paper.

This paper is organized as follows, in section two a brief related work is shown; section three describes the AWA methodological approach, section four introduces the accessibility mechanisms relating to Human Computer Interaction (HCI) and finally some conclusions are given..

2 Related Work

In the development processes, technological, human and legislative aspects must be considered in order to manage accessibility issues, and consequently, related work from numerous disciplines must be considered. In the standardization field, the W3C must be highlighted along with the Web Accessibility Initiative (WAI). The Web Content Accessibility Guidelines (WCAG) [1] is one of the most important components, and is considered to be the official standard.

There are several peculiarities in the area of accessibility, closely related to usability, which lead us to consider some methods from the Human-Computer Interaction (HCI) Discipline. Along these lines there are studies which demonstrate the relationship between usability and accessibility [2] [3], others establish a framework for taking into account accessibility in the User Centered-Design (UCD) and Inclusive Design methodologies [4] and applying methods of usability [5] [6].

In the area of Web Engineering [7], there is a poor support to capture user requirements [8]. The accessibility is referred to in literature [9], sometimes considered as part of usability [10]. There are also works that consider accessibility [11] [12] but not how to carry out the accessibility model according to the WCAG standard which covers important and necessary technical aspects to avoid access barriers. From a research perspective, some areas of engineering are recently starting to include usability and accessibility in web engineering.

¹ [http:// basesdatos.uc3m.es/AWA/](http://basesdatos.uc3m.es/AWA/)

3 AWA Framework

AWA proposes an extension of the engineering web methods to offer a methodological support to develop accessible web applications following the WCAG standard, offering Accessibility Mechanisms that have to be included in the process.

The methodological support identifies Accessibility Mechanisms attending to configurable criteria (WCAG 1.0 and WCAG 2.0 guidelines) such as standard levels and access Type.

The user experience must be taken into account from the beginning of the process (requirements elicitation) using these extended Web Engineering Methods with accessibility aspects. To achieve this purpose, AWA has a specific Accessibility Mechanism called AWA **Interaction** introduced in section four. In addition, there are other Accessibility Mechanisms related to:

- **Accessibility plan in the organization** which would include: Elaboration of an initial report of advisement, creation of a multidiscipline group of accessibility as well as the design of a training plan and specifications for providers.
- **Quality**, which is understood as the sustainability of accessibility in the overall application life. These quality mechanisms should be translated into including Functional Requirements which manage the accessibility in the processes related to edition of accessible contents, monitoring of accessibility, management of suggestions from the users, etc.
- **Modeling techniques**. The Web Engineering Methods provide a systematic and structured process of software production. Accessibility Mechanisms which include accessibility aspects have been defined, so that when using modeling techniques, the final web code could be automatically offered with a high level of accessibility. In this way, conceptual abstractions of the WCAG standard have been identified to allow the extension of modelling primitives and constrains used in Web Engineering Methods. AWA is being validated in OOWS (a model-based web engineering method) [13].

With these mechanisms the web application should guide designers in their work and should force to collect accessibility requirements according to WCAG, for example, an alternative text for an image, subtitle in a video, semantics of a link, etc. But there is a dependency of designers due to they could to insert an alternative text that has no correspondence with the image or to represent an inadequate semantics of a link. In order to assure high level of accessibility, a monitoring of accessibility mechanisms over AWA framework is required.

4 AWA Interaction

As we have noticed, web accessibility is more than the WCAG guidelines, and consequently, other Accessibility Mechanisms relating Human Computer Interaction (HCI) techniques should be included during the process.

The web accessibility and usability are concepts very much related to each other because both aspects converge towards the same objective: that all users can access the web in a pleasant way. With this objective, designing products following methods

that integrate usability and accessibility will make possible and easier the access to those users with and without disabilities. The UCD controlled by multidisciplinary teams, using techniques which guarantee the participation of every user, is required. This is the peculiarity that User Sensitive Inclusive Design has [14]. In the development process although designers have explicit definition of concepts, project requirements, etc., it is not usually enough, as the designer cannot adopt several roles. It considers an iterative process that allows evaluating the design during the development cycle and not only to evaluate the web site at the end of the process.

AWA Interaction focuses on defining Accessibility Mechanisms to include user interaction into design, and improves the user experience for Web accessible applications that agree with WCAG. To achieve these goals, this work proposes to use usability techniques in requirements elicitation and analysis phases. Moreover, how to use the knowledge resulting from these techniques will be shown. With this aim we want to design better conceptual models (data, navigational and presentation ones) following UCD approach in addition to consider web accessibility. These mechanisms are mainly offered in the requirements elicitation, analysis, design and evaluation phases (see Figure 1).

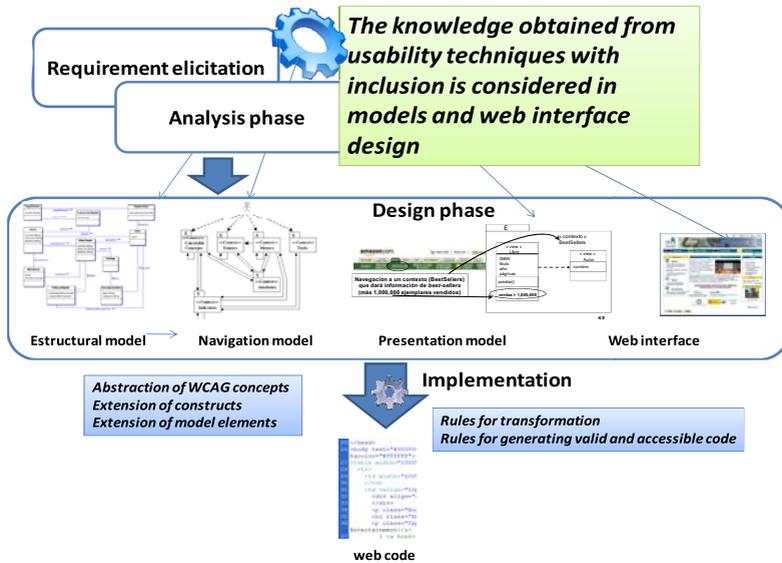


Fig. 1. Integration of usability techniques in AWA framework

Current Web Engineering Methods propose structuring the development process in several phases. Different methods include different phases, but a study of them shows that conceptual, navigational and presentation modelling and implementation phases are always present. The aim of conceptual modeling is to obtain a model of the problem domain. A Navigational Model shows the logical structure as views from a source data model which reflects the reachable information by a user, and the routes and structures of paths, considering a generic structure like a graph of nodes and navigational links. With this navigational structure, the structural markup and labeling

of web contents as well as the purpose of each navigational link must be inferred. Commonly, presentation design is based on the construction of the interface which shows the navigational elements to the user, and it is performed via abstract user interfaces. Presentation model does not usually deal with the concrete presentation or web interface. Web interface concerns interface style and it is implemented by other techniques such as CSS (Cascading Style Sheets). This approach has been based in the use of navigation, abstract presentation models and concrete presentation (web interface styles) in design phase, as is shown in figure 1.

4.1 Case Study

In order to show how usability techniques has been used, we describe the development of the web application of CESyA ², a public reference institution dependent on the Royal Board on Disability – Ministry of Education, Social Affairs and Sport. This case study is used to show and validate the accessibility mechanism of AWA interaction. The experiments have consisted of applying a UCD approach with inclusion incorporating usability techniques in the development process. Once the website was created, an extensive evaluation with experts and survey methods was made with users with or without disabilities with successful results and the website received the TAW³ award for the public more accessible website in 2008.

Among available usability techniques, the work described in [6] helped us to select the most appropriate ones. In requirements phase, inquiry methods such as Ethnographic Studies, Interviews and Focus Groups to capture the accessibility and usability requirements were proposed. With the output of these techniques, second step concerns modeling the user. The user model is based on defining the User Profile [15] with the aim to satisfy the necessities of each group of users.

In this point, we face the problem of extension and wide coverage of every user, which could make the total categorization of the audience not possible or too expensive. In these cases, it is convenient to make use of the focus of Person [16]. Defining people following an inclusive design requires the designer to have in mind potential users, knowing always which type of design will be needed. In this line, Scenarios technique has been used [17]. With Scenarios to obtain information on how the user interacts with the web.

Related to the analysis and design phase, it is useful to use low cost prototypes [18], Card Sorting technique [19] and Visual Brainstorming [20]. The objective of these techniques is to facilitate the contents to be included in the web application when defining information architecture of the web (or conceptual structural model) and presentation of web contents into web interface.

Finally, in evaluation phase (see figure 1) the inquiry methods (Questionnaires, Interviews) [21], Inspection Methods as Heuristic Evaluation [22] [15] and Walkthrough [22] [23] have been used.

The experiments applying a UCD approach with inclusion incorporating usability techniques show that valuable knowledge for the modeling phase is obtained. The designer becomes familiar with users and their characteristics, for instance, keeping in

² www.cesy.es

³ <http://www.tawdis.net/taw3/cms/es/premio/premiados.html>

mind factors such as the use of magnifiers, screen readers, etc. The relationship between the accessibility barriers and the definition of information architecture is not explicitly indicated in guidelines of standard WCAG, while the Web Engineering Methods are usually centered in the architecture of the application. However, with the use of Card Sorting Technique and Interviews with users, some problems have been detected and corrected.

Table 1 outlines the relationships among usability techniques, phases and models in which the results of such techniques have been incorporated following an iterative process.

Table 1. Summary table of usability techniques to be integrated into web modeling

Usability techniques		Requirements elicitation	NAVIGATIONAL MODEL		PRESENTATION MODEL		WEB INTERFACE STYLES	
			Design	Evaluation	Design	Evaluation	Design	Evaluation
Inquiry Methods	Ethnographic Stu.	X						
	Interviews	X		X		X	X	X
	Questionnaires	X		X		X		X
	Focus Groups	X						
	User Profile	X	X		X		X	
	Focus Person	X	X		X			
	Scenarios	X	X		X		X	
	Card Sorting	X	X	X	X			
	Brainstorming	X	X	X	X	X	X	X
Prototyping Methods	Prototypes	X	X	X	X	X	X	X
Inspection Methods	Heuristic Evaluation			X		X		X
	Walkthrough			X		X		X

Some guidelines are given below to illustrate how to integrate the results of these techniques on Navigational and Presentation models as two of the most important artefacts in design of web applications (see figures 2 y 3)

1. The data resulting from Card Sorting such as concepts classified in each category and their labeling (category names), etc. provides a structural markup and labeling of web contents according to the mental model of users. The initial logical structure of the Navigational Model is designed. Each category is a node in a Navigational Model. For instance, an abstraction in the example application domain is "legislation related to CESyA" concept, the data resulting from Card

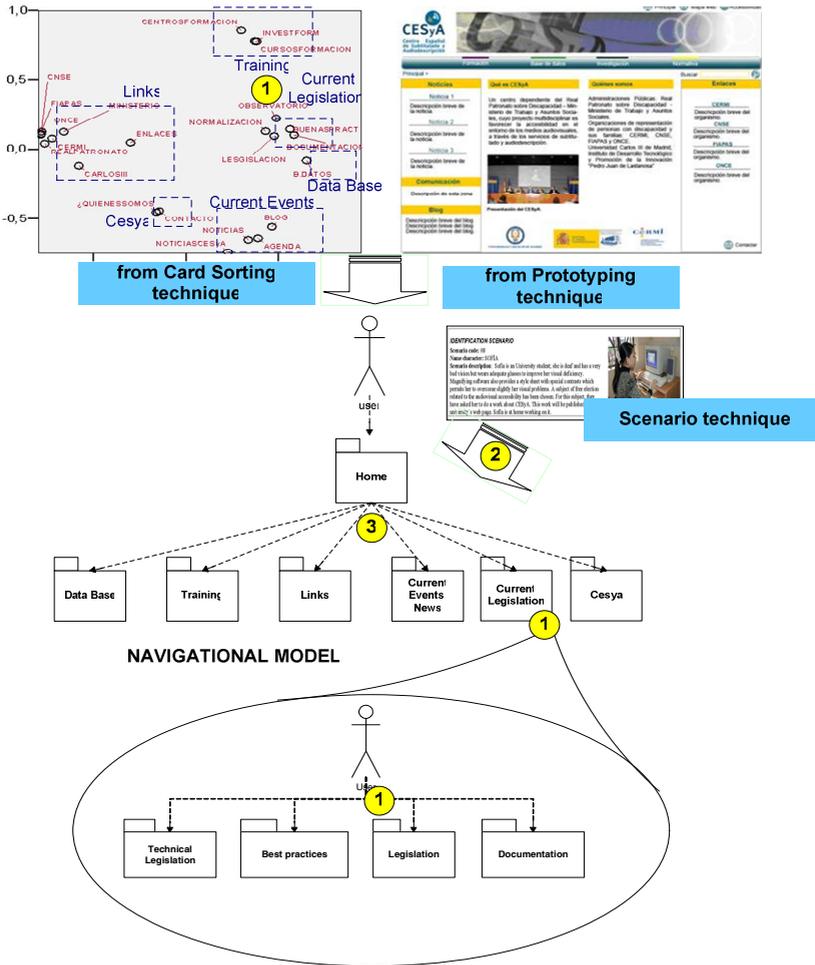


Fig. 2. Output from usability techniques included in the “Navigational Model”

Sorting technique indicates that this concept is a category that groups others, and this category is a structural element (node) of the Navigational Model.

Also, the name “Current Legislation” of this category is the label of a node. This node groups nodes labeled with “Technical legislation”, “Best practices”, “Legislation” and “Documentation” as is shown in figure 2 with label (1)

2. With this logical structure and data resulting from Scenarios Technique, the routes and structures of paths (nodes and navigational links) of Navigational Model can be inferred from them (as is displayed in figure 2 with label (2)).
3. With data resulting from Card Sorting, the labeling of web contents and the purpose of each navigational link must be included into structural markup of web page. The revised labeling of the classified concepts and categories performed by

users will be used. The Navigational Model will be designed according to how the user perceives content structure.(as is shown with the label (3) in figure 2).

This approach helps to comply with the WCAG. If we like to comply with WCAG Level of Conformance "AA" in the web page, it is necessary to comply with the guideline 3.5, that says "Use header elements to convey document structure"; with this approach this structure and labeling of web contents marked with header will be according to the opinion of users. This header is also used to optimize SEO (Search Engine Optimizer).

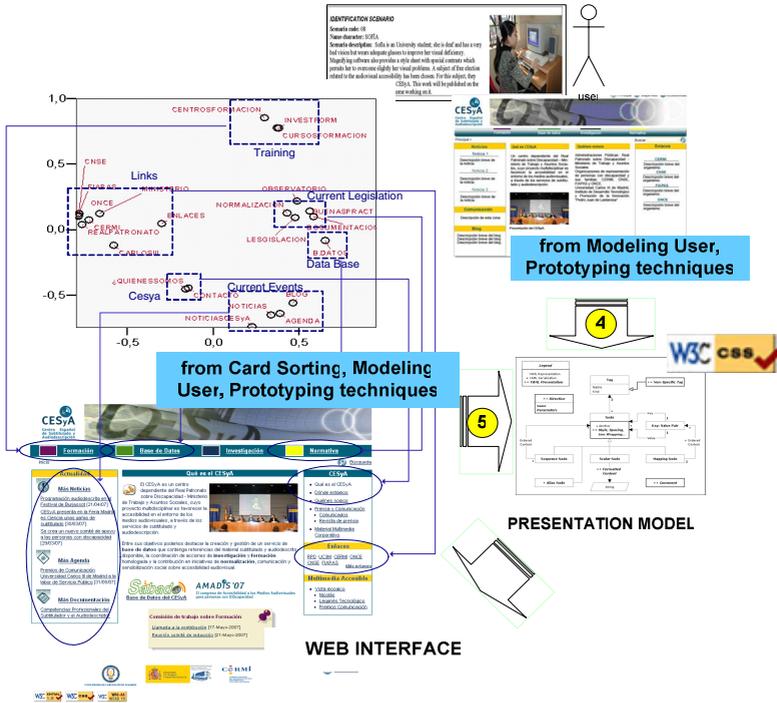


Fig. 3. Output from usability techniques included in the "Presentation Model"

4. All knowledge gained resulting from modeling user (User Profile, Person and Scenarios) will be taken into account when designing the "Presentation Model" to include abstracted characteristics into the "Presentation Model" and precise styles through Cascading Style Sheets following standards (WCAG, CSS) for the web interface. With the prototyping and Visual brainstorming techniques these design decisions must be validated (as is shown with label (4) in figure 3)
5. The abstract Presentation Model can be inferred from the output from Prototyping and User Profile techniques, together with structural elements (Nodes of Navigational Model) as is shown in label (5) in figure 3.

5 Conclusions

To follow accessibility standards does not guarantee complete accessible web applications. There are difficulties in web application development due to not consider accessibility in the overall software life cycle together to forget important aspects concerning user interaction. In this work, we introduce the AWA framework, an extension of a web engineering method to provide a methodological guide for designing accessible web applications. One of its components is AWA Interaction devoted to cover the integration of usability techniques by following a User-Centered Design (UCD) and Inclusive Design in the development process. This approach allows us to be closer to the user in software design. A group of usability techniques and how to use them have been outlined and a case study has been shown.

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