Editing Wikipedia Content via Screen Reader:

Easier Interaction with ARIA

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Abstract. This study aims to improve Wikipedia usability for the blind and promote the application of standards relating to Web accessibility and usability.

First, accessibility and usability of Wikipedia home, search result and edit pages are analyzed using the Jaws screen reader; next, suggestions for improving interaction are proposed and a new Wikipedia editing interface built. Most of the improvements were obtained using the W3C ARIA suite. Last, a scenario of use compares interaction of the blind with the original and the modified interfaces.

Our study highlights that although all contents are accessible via screen reader, usability issues exist due to the user's difficulties when interacting with the interface. The scenario of use shows how building an editing interface with the W3C WAI-ARIA suite eliminates many obstacles that can prevent blind users from actively contributing to Wikipedia.

The modified Wikipedia editing page is simpler to use via screen reader than the original one since ARIA ensures a page overview, rapid navigation, and total control of what is happening in the interface.

1 Introduction

Wikipedia, the online encyclopedia, is an outstanding example of the power of collective intelligence; there are more than 2,700,000 articles in the English section alone, collaboratively written by people from all over the world [1].

In recent years Wikis have become popular collaborative tools in several areas (social networks, medical environments [2], eLearning systems [3], [4], [5], [6], [7], etc.). As on-line learning continues to expand by leaps and bounds, wiki systems are increasingly used as educational tools and/or are integrated into learning management systems. The effectiveness of Wiki-based systems as learning tools is confirmed by a number of studies. Soo-Hwan et al. [7] found that students learn computer programming more effectively in a community setting than in a content-centered setting, and collaborative learning via Wikis is more valuable when learning requires diverse problem-solving skills or knowledge processing. By analyzing the use of two wikis in two Masters in IT, Bower et al. [4] verified that these collaborative tools can facilitate multi-user asynchronous creation, editing and restructuring information. However, the design and implementation of wiki-based learning tasks can greatly affect their success; thus the authors recommend a set of 12 principles for improving their effectiveness. To remedy the lack of interaction noted in online discussion groups, and stimulate a collaborative environment, Augar et al. [2] adapted a traditional icebreaker exercise used in classrooms for use on a wiki, with good results: in the two-week exercise, the number of wiki pages increased steadily day by day.

Problem solving and shared knowledge building appear to be reinforced by student collaboration and cooperation. eLearning and wiki environments should be friendly and easy to use for everyone, in order to eliminate ‘technical barriers’ and allow students to concentrate on content by reducing any negative effects on the learning process itself. However, current research on usability of wikis is still in its infancy. Soo-Hwan et al. [7] observed that further study on navigation and interfaces is needed for more effective use of wikis. Furthermore, a university-level survey by Carpenter et al. [5] revealed that only 20% of interviewees believed that wikis are easy to use.

Currently, Wiki systems present some limitations on collaboratively enriching media content with new information. Ferretti et al. argue that to really take advantage of the strength of the collective intelligence and to maximize cooperation among users, new solutions are needed for the creation, management and presentation of rich media content [6]. To this end, they developed a wiki-like interface that allows users to enrich multimedia learning objects with additional textual information, such as captioning, annotations and comments. Based on user profiles and technical characteristics of the interaction device, the student receives learning objects in the most appropriate format. Captioning is crucial for the deaf, and also improves usability for foreigners. A mobile user receives a specific version of the lecture that fits the screen size. For a blind user the video lecture is translated into an XHTML document, and all didactic material is presented as a linear sequence, thus reducing cognitive overload. In general, the additional contents may help any student to better understand the lecture [6].

If interaction is easy, rapid and satisfying, wikis and e-Learning systems are a great opportunity for everyone. For the blind, they can save much of the time and effort involved in physically traveling to class, and increase autonomy (e.g. no need to be accompanied to classrooms) as well as facilitate social interaction. However, interacting with a wiki system is more complicated for a blind user who cannot see the screen or use a mouse and who requires the aid of assistive technology, which tends to complicate navigation.

Different approaches to making web navigation more comfortable for blind users have been tackled, such as semantic annotation ([8]), and page transformations/adaptations (client or server side) ([9]). However it requires considerable effort to develop and maintain these systems, with a risk of losing content, or not correctly reflecting user preferences. Other authors have suggested alternative guidelines for the website

designer ([10]). This requires increased awareness of accessibility and usability problems, and knowledge of specific design criteria and techniques. However, in some cases the proposed guidelines attempt to compensate for whatever technology does not provide. For instance, heading levels were used to provide users with a page overview and an additional link to jump to the main content.

Today the Accessible Rich Internet Applications Suite (WAI-ARIA) makes web 2.0 applications more accessible to people with disabilities. ARIA extends the semantics of the (X)HTML language (e.g. roles, states, properties), adding the possibility of communicating UI changes to the screen reader, breaking down the serial announcement of content (defining the reading flow of the UI sections), making navigation via keyboard faster, and so on. Web designers are using ARIA to build a 'clean' code and create efficient solutions to the navigation problems of the blind. With ARIA it is possible to mark regions and define sections of a web UI (such as menus, main content, and sponsored links) providing users with an overview of the page and allowing them to move rapidly around regions/sections via keyboard, instead of pressing the Tab key over and over [11], [12].

The Wikipedia Usability Project aims to make Wikipedia easier for everyone to use. The project comprises six areas: Accessibility, Architecture, Design, Interface, Compatibility and W3C compliance. Since we consider this project's aim to be very useful, we joined the Accessibility group and suggested using WAI-ARIA to improve Wikipedia accessibility and usability.

This paper is an extension of two earlier works ([14], [15]) in which we discussed accessibility and usability issues of Wikipedia for the blind. Specifically we tested the home page, result page (i.e. an article) and the editing pages using the screen reader Jaws for Windows v. 9, and provided some basic suggestions for web designers [14].

Next, based on these guidelines we implemented a modified Wikipedia Editing Page (WEP) which included an ARIA-based toolbar and two combo-boxes to group both alphabets and their associated special chars and symbols [15].

In this paper we integrate the basic guidelines we previously proposed for using ARIA-based features, and discuss a new enhancement of the modified Wikipedia Editing Page: the use of ARIA to define and mark interface logical sections (i.e. regions). Then, using the latest version of Jaws (v.10) which supports ARIA features, we describe a scenario of use to illustrate how interaction changes, with the original and the new ARIA-based interfaces.

The paper is organized in four sections: this introduction, a brief description of Wikipedia usability issues for the blind, basic design guidelines (updated with ARIA), and the scenario of use. Last, conclusions and future work complete the paper.

2 Interacting with Wikipedia

In the first stage of our study (a year ago) the accessibility and usability of Wikipedia was analyzed for the home, search results, and edit pages, using Jaws v. 9.0 ([13]).

We have now repeated this test with Jaws v. 10.0, IE v. 7.0 and Firefox 3.0.5 in order to verify whether any change occurred in the Wikipedia UI or was perceived in the browser interaction.

The test was carried out by both authors independently; afterwards, outcomes were compared and integrated. The different experiences of the two authors (one blind since childhood) when using JAWS allowed us to cover a variety of interaction modalities: i.e. both basic commands, which simulate the ability of novice users, and advanced screen reader functions.

Home Page

Although we tested both the English and Italian versions, in the following we only report the main accessibility and usability problems regarding the English version (Figure 1) since results are very similar. More details are available in [14].

- The first problem concerns links. Jaws provides the list of all links on the page (‘CTRL+F7’ command). If graphical links lack any alternative description, the screen reader extracts (from the <src> element of the <img> tag) and reads the directory/filename, which may be meaningless.
- In the tested UIs several graphical links do not have any alternative description. Links, used for the graphical layout, are perceived via screen reader and make reading confusing and navigation more difficult, so we suggest removing all of them.
- Non-textual links without alternative descriptions or with alt=‘’ (empty) are present, such as: ‘bd/Wiktionary-logo-51px’.
- Links labeled with meaningless names. Links such as ‘more...’ do not give the user any clue to understanding the function of the link itself, so the user must explore the surrounding text via arrow key or follow the link in order to understand its meaning. This is time-consuming, so links should be self-explanatory and not depend on the context.
- Number of links. The page contains too many links -- over 300 in the English version. A more appropriate number of links on a single Web page should be considered.
- Search edit fields. The search edit field is not labeled, so the user needs to understand the purpose of the edit box from the context as well as from the search button labels. However, note that using different browsers changes the code

announced by JAWS. Interacting with the Firefox browser, JAWS reads the labels of push-buttons (i.e. ‘Go’ and ‘Search’), ignoring the ‘title’ attributes. Instead, using the IE browser, Jaws perceives the tool-tip assigned to the two push buttons (i.e. ‘Go to a page with this exact name if one exists’ and 'Search the wiki for this text’). Thus with Firefox the user is unable to understand the type of search since the difference between ‘Go’ and ‘Search’ is not clear. Obviously this depends on the specific implementations of JAWS and the browser version, and will improve in future versions. However, assigning clearer labels to push buttons (for instance ‘Wiki entry’ and ‘Search’) would be useful for everyone.

We also suggest assigning a label to the edit field. For instance a label ‘insert one or more keywords’ could be added either as a hidden label or by using the ‘title’ attribute.

- Content sections. The page contains various areas with different topics. In the visual rendering, each area or topic is surrounded by a colored box. To facilitate navigation via screen reader, several headings have been applied. However, as highlighted by the W3C WAI group, the use of ARIA landmarks (regions) is more appropriate to mark interface logical sections. In this way the screen reader is able to provide a list of available regions, which offer an overview of the page and allow the user to rapidly move from one interface section to another [12].
- Lists. For various groups of links no list has been used (or Links are not grouped in lists). Each item is marked with a ‘.’ instead. An ordered or unordered list is suggested. In this case the user would be able to move from one list to the next, by using a screen reader special command (e.g. for Jaws, the ‘l’ key).
- Tables. Although div blocks are used, the graphical layout is based on tables. A table used as layout should be associated with the ‘presentation’ ARIA role to

indicate to the assistive technology (AT) that this element is used for the graphical layout and does not need to be announced [12].

Search and Results Page

In order to evaluate the results page, we typed ‘podcast’ in the search edit and pressed Enter. As discussed before, two search modalities are available to the user: ‘Go to a page with this exact name if one exists’ or ‘Search the wiki for this text’. The first one is activated when pressing the Enter key; whereas the second must be selected via Tab key. To improve usability for the blind we suggest assigning a clear label (such as a hidden label) to the search edit field(s).

If the search is successful, Jaws announces: ‘Podcast from Wikipedia, the free encyclopedia’, otherwise (no result found) the user hears ‘Search from Wikipedia, the free encyclopedia’. This message might be not be clear for a novice user. Two simple messages such as ‘No result found for...’ or ‘Results for...’ would simplify interaction via screen reader.

Once the article is retrieved, the user understands that the page contains a great deal of information (number of links and headings). Although all main sections are tagged with heading levels (<h1>, <h2>,…), which improve the page perception via screen reader ([16]), the structure is not clear via screen reader. In fact, all main content sections start with ‘[Edit]...’ (Figure 2). In the visual layout the ‘[Edit]’ links are located on the right side, and thus do not impact on the visual reading. When a blind user gets the list of headings (Insert+F6 JAWS command) in order to know the available sections, reading becomes tedious and slow due to the presence of ‘[Edit]’ before the section title (to better understand, try reading aloud each square parenthesis and title). In addition, moving over a specific section by using the first letter of the desired title is not possible.

Editing modality

The Editing modality is the most complicated UI in terms of usability via screen reader. To evaluate the editing modality, we used the 'Sandbox' tool made available by Wikipedia to carry out experiments, shown in Figure 3. Main accessibility problems and usability difficulties are related to:

- The formatting toolbar is difficult to perceive, access and use. To apply formatting styles and to insert elements (such as images, multimedia files and links) a graphical toolbar is shown before the edit box. Graphically each toolbar widget can be selected and clicked via mouse while the edit cursor is on the right point in the edit field. However the widgets of the Wikipedia toolbar are graphic icons, generated by JavaScript, inaccessible via Tab key. In fact, the browser is unable to recognize these widgets as active elements (such as links, buttons, boxes, etc.) so they never receive the focus when the user explores the page via Tab key. Thus, in this kind of navigation the user does not perceive the presence of a toolbar on the page.

  Exploring sequentially (via arrow key) Jaws is able to recognize each graphical icon because alternative descriptions have been assigned, but it does not announce that the widget has indeed an associated JavaScript. Trying to press the Space bar or the Enter key, the script is executed. However, an inexperienced blind user may have difficulty. Since for each graphical symbol a specific textual code is assigned, a possible solution is to learn all the corresponding textual coding. For example, for bold effect the text must be enclosed between triple apostrophes or for italics in double apostrophes. This approach is hardly simple for a beginner. Furthermore, much more effort is required of a blind user than of a sighted person.
- Selecting special characters and symbols. To insert a special character or symbol, a combobox is available to the user for selecting a set and the corresponding

characters are shown as a list of links. For example for the Latin char set more than 150 links are available. Visually, it is quite easy to select one by using the mouse but for a blind user, who reads them sequentially -- via Tab key or by listing all available links (‘Insert+F7’ Jaws command) -- it is not at all simple. A more close-packed structure listing all symbols should be used, for instance a second combo-box [15].

In addition, Jaws does not correctly interpret text associated with uncommon symbols or characters. A more descriptive text should be applied (e.g. ‘e’ with acute accent).

- No flexibility to switch between editing and selecting modality. Using both the mouse and the keyboard to point, select and edit allows the user to operate with ease. A character, symbol or graphical style property can be selected via mouse while typing the content via keyboard, since visually it is easy to control and move the edit cursors. Unfortunately, a blind person must perform both activities via keyboard. An effective way is needed to simply switch between the edit mode and selecting styles/functions. In the original Wikipedia editing page the focus is managed via JavaScript: when one or more words in the text area are selected, all related parameters (focus included) are stored by the script in order to apply the formatting correctly. However, when interacting via screen reader a blind user may not correctly understand how the focus is processed since the screen reader provides a ‘virtual focus’, and this may not coincide with the system focus. If using a previous version of Jaws, to format a portion of text in the original WEP, the user must switch between editing and navigation modalities several times. Fortunately Jaws 10 automatically enables the editing mode when the virtual focus is in a text box (Auto Forms Mode). This simplifies and makes interaction with form fields

more rapid. Furthermore, aural feedback is provided to the user to indicate the editing modality (Forms Mode on). Exiting the control element, the user automatically returns to the navigation modality [13].

3 Basic Suggestions

Based on testing results and thus on the main difficulties observed in navigating via screen reader, we provide some suggestions for Wiki designers to enhance usability for the blind.

Make it easy to identify the content parts.

With Wikipedia, the home page is usually split into several areas (frames) according to different topics. There are several boxes containing links to categories, search tools, the word of the day, and so on. Each area should be clearly identifiable, both visually and via screen reader, allowing the blind user to get a rapid overview of the main macro topics available on the page. Using ARIA roles to define landmarks and regions (corresponding to page logical sections) the screen reader is able to provide a list of all regions of the page, (i.e. the page overview) to which the user can jump easily and rapidly. Previously this overview was obtained with heading levels but this was not consistent with the meaning of heading levels in the websites [12]. Furthermore regions make the main content immediately accessible in aural exploration, as suggested in [17].

Make the search box clearly and quickly identifiable.

The search function is one of the most important features of a portal like Wikipedia so it is essential to find it very easily. Search edit field and buttons should be located at the beginning of the logical flow of the page's main content. Its location early in the content

flow should assure that the screen reader (and thus the user) can identify that important main area almost immediately.

The search box should be easily identifiable. Clear labels should be used for edit field and search buttons in order for the user to appropriately choose the desired kind of search (for instance, use ‘search pages with exact title’ rather than simply ‘search text...’).

Moreover, if the search box is replicated on the same page, the same labels and terms to mark edit fields and buttons should be used for terminological consistency on the page.

Keep the Editing function simple.

The Editing function is very important in a Wiki system as in any collaborative environment. Consequently, the Editing commands as well as the Editing page should be easy for anyone to use, independently from the interaction modality used. We offer several suggestions regarding the Editing function:

- Use a separate page for the Editing function.
- Provide a quick way to use formatting commands. To do this, in addition to clickable graphical symbols, provide an easy way to use the same function via keyboard. For instance, add a shortcut to each symbol, or provide an alternative modality (such as a dropdown menu) listing all formatting options available.
- Provide an alternative textual input. An alternative textual input could facilitate formatting for skilled users. For instance, Wikipedia provides a special syntax to manually add formatting styles to the content (e.g. triple apostrophe for the bold style).

  To facilitate this modality, two possible suggestions are (1) provide a help page listing all commands with their textual alternative input modalities (2) a very similar

HTML syntax could also be allowed. This second modality would facilitate the input process for users who have experience with HTML language.

- Provide a simple way to insert special symbols. In the current version of Wikipedia, to insert a special character a set of over one hundred and fifty links is available on the page. The authors offer two suggestions for improving this operation:

  (1) provide a quicker, more compact way to select a special symbol. Since a great number of links makes interaction via screen reader too difficult, a more effective way should be developed. A list on a separate Web page, or a compact combo-box containing descriptions of all available symbols, are possible solutions.

  (2) associate a clearer symbol description. Many special chars and symbols are not recognized by the screen reader. A descriptive text would overcome this problem; for instance ‘a with circumflex accent’ is clearer than the corresponding character (e.g. ‘â’ is announced by Jaws as ‘a’).

- Control the edit focus. As in the Editing procedure, the focus is very important and it is necessary to ensure that when interacting with formatting commands or choosing special symbols, the focus goes back to the editing cursor. This feature is fundamental for facilitating the Editing process when using a screen reader -- otherwise, the user risks losing the Editing position, which makes the composing process difficult or impossible. For instance, creating the formatting toolbar with ARIA roles, properties, and attributes (i.e. ‘activedescendant’) makes the toolbar navigable via arrow keys. Once the toolbar receives the focus via TAB key, the child elements -- i.e. each formatting widget -- can be accessed by up and down arrows, and the associated formatting function (Bold, Italics, etc.) can be activated by pressing the ENTER key [12], [15].

4 An ARIA-based Wikipedia Interface

As previously mentioned, building an editing interface that conforms to the W3C ARIA standard would overcome accessibility and usability problems that prevent blind users from actively contributing to building Wikipedia contents. From a previous usability study concerning a modified version of Google UI ([17]) we understood that blind users want to immediately hear the main content of the page. Specifically, participants greatly appreciated listening immediately to the result of the query. Indeed, this was only one of the several features we added to the UI for simplifying interaction (headings levels, hidden labels, numbering results, aural feedback, etc.) but surprisingly the page overview was less appreciated than positioning the main content at the beginning. At this time, we physically changed the position of the result in the source code and rearranged the graphical appearance of the UI with the CSS 'positioning' property. In this way, even users who navigate in a sequential way via arrow keys are able to read the results immediately and effortlessly. However this process was time-consuming and difficult to extend to any web page due to the complexity of the graphical layout.

Today ARIA allows the designer of web content to have more control over the flow of content announced by screen reader, by marking main sections (regions) of the UIs with standard xhtml role landmarks or using region ARIA roles [12].

In [15] a modified Wikipedia editing page based on the proposed criteria is described. Specifically, this interface offers an ARIA-based toolbar (that can be reached via keyboard), hidden labels to favor orientation, a different navigation order via Tab key (reflecting the logical pathway the user performs when operating with the interface) and a second combobox for selecting special chars.

In that early phase of our study we only concentrated on the main section of the editing UI: the editing section, excluding navigation menu as well as headers and footers, in order to reduce the complexity of the page and to prepare an environment for testing the proposed features of the UI (toolbar and combobox). The introduction of the navigation menu, headers and footer instead would greatly increase the number of links and headings; thus a user encountering additional difficulties might bias the results of our user test.

Today the awareness of ARIA's full potential and the evolution of Jaws to support this suite, led us to create a new environment for a user test with the complete UI to carry out as soon as Jaws 10 is more spread out in Italy (probably within a few months). Thus as a new step, we enhanced our previous modified WEP by adding ARIA regions. Specifically, we identified and defined the interface regions and associated standard XHTML landmark roles, as shown in Figure 5. With the ARIA 'flowto' property it is possible to change the order of the way page content is announced via screen reader. To this end, we identified three interface logical sections: main, navigation, and search. With Jaws command 'Ctrl+Ins+;' users get an overview of the page (Figure 4). With the ';' command Jaws moves to the next region and with 'Shift+;' to the previous one. If the standard XHTML landmarks (main, navigation, search, banner, contentinfo, etc.) does not appropriately reflect the aim of the region it is possible to personalize the interface logical section using the role 'region' and specifying a 'title' attribute to associate with it [12]. We noticed that Jaws 9.0 is only able to announce the presence of landmarks – i.e. when reading content in a sequential way – but the commands 'Ctrl+Insert+;', 'Shift+;' and ';' are implemented only in the version 10.0. However, at the time of this writing, Jaws is unable to detect the 'title' attribute that can be used to customize a region. This means that, at the moment, the user cannot clearly perceive customized

regions since all are announced by Jaws as ‘Region’. Thus instead of facilitating matters, using a higher granularity of regions might make structure unclear and confuse the user. For this reason, at this time we defined only the three abovementioned regions using the XHTML standard landmarks.

In the next section we describe a scenario of use that highlights differences when a user interacts with the original or an ARIA-based Wikipedia editing page that also includes regions.

A Scenario of Use

In this section we explain how current Wikipedia UIs are explored by a blind user, in order to show how the interface modified according to ARIA specification may provide users with more satisfactory interaction.

This scenario is built based on the real experience of the blind author who explored the environment we are developing for the user test. The online testing environment offers both the original and modified Wikipedia Editing Pages. To show how a blind user interacts with the two Editing Pages we assume a scenario in which the user has to edit a sentence in the Wikipedia Editing Page, using Jaws v.10.

Roberto is a blind boy who is not particularly skilled at using computer applications, but he is an expert in education. He looked up information about distance learning in order to apply a new methodology for blind students. In particular, he wants to explore ‘Podcasting’ as new way to distribute lesson materials. To this end, he would like obtain information on this topic from Wikipedia. He searches for the content ‘podcast’ and finds the content shown in Figure 5. Reading the ‘podcast’ content, and specifically the text with the title ‘Other uses’, he thinks that podcasting may offer new opportunities for blind people and decides to add a sentence.

Search and Result Page

Roberto connects his computer to the Internet, opens Firefox, and types in the Wikipedia URL. As soon as the browser starts loading the Home Page, the screen reader begins to read the page content, from the very first line. Roberto stops it because he wants to quickly reach the edit field and insert his query. He presses the Tab key and the screen reader virtual focus takes him immediately to each link until he finds the 'edit field'. Here Roberto stops, but he is unsure whether he is over the search box and he decides to move up and down with the arrow keys to look for an associated label. Unfortunately there is no associated label, but only a 'Wikipedia Search' button, so Robert guesses that the 'edit field' encountered before was the right place to start his query, after all.

When the virtual cursor is over the edit field, Roberto hears a very short sound indicating that the focus is on the edit field, and the editing modality is now active; then he writes his query: 'podcast'. Again Roberto is not sure that he has written the word correctly and checks again using a special reading command from Jaws (Insert+Up Arrow). Finally, he presses the Enter key to start the search process.

When the results page is loaded, Jaws starts to read the entire contents line by line, from the top to the bottom of the page. Roberto once again halts the process; too much information is provided and it is hard to follow, due to the overload perceived by the user. He moves to the top of the document (via 'Ctrl+Home') and reads the first lines: 'Podcast - Wikipedia, the free encyclopedia Heading level 1 Podcast...'.

He understands the search was successful and then decides to get a page overview by using the Jaws command 'Insert+F6' (See Figure 6). He uses the arrows to read the headings and selects the title 'Other uses' to read that section. After reading it, Roberto is going to add to that paragraph the sentence 'Podcasting can represent a valuable

educational means of providing lessons for blind students.' To this end, from the headings list he selects the '[Edit] Other uses' and presses the Enter key. Afterward he explores with the down arrow and clicks on the link 'Edit' to activate the Editing Wikipedia Page.

Notice that Roberto selected the link 'Edit' (associated with each article section), rather than choosing the link 'Edit this page' available in the tab panel. In fact, for a blind user it is not easy to understand that the four links 'Article', 'Discussion', 'Edit this page' and 'History' are actually the Tab panel labels. These links are not easily detected within the page since they are placed toward the end of the page source code, at about 80% of the total (the 'Alt+Canc', Jaws command announces the element's position in the page). This means the user must proceed a long way down the page. Furthermore, these links are not marked with clear labels to indicate they are links associated with the panels. Otherwise, if the user knows the function of those links (i.e. opening the corresponding panels) – because a sighted person explained it – (s)he can also activate them by searching for a specified link (e.g. 'Edit this page') or by using the associated shortcut (e.g. 'Alt+shift+e'). In brief, it is not comfortable for a blind person to use these Tab panels, unless he/she is a skilled user or is pre-informed regarding the page structure.

Let us now illustrate the different steps Roberto follows when he interacts with the original and modified WEP.

Original WEP

When the Editing Page has been loaded, Roberto has to explore the content. Through the screen reader special command ('Ctrl+Insert+;') a landmark list is not available, so to get a page overview Roberto activates the heading list ('Ctrl+F6'). Roberto notes the 'main' and presses the Enter key to move to this area. Here, after pressing the Tab key many times, Roberto realizes when he finds the text box where he is working to add the

sentence. Indeed Roberto does not hear a label indicating it is a text area to use for editing content; he deduces it from the pre-inserted content (i.e. the existing written sentences). Then, he navigates the pre-edited content via the arrows (line by line or word by word) to move the cursors to the point where the sentence is to be added, types the new phrase and selects by 'Ctrl+Shift+left' arrow the words 'valuable educational means' to which bold will be applied.

At this point, to find the 'Bold' button to use for applying the formatting style, Roberto tries to move by Tab key, without any positive result, since the formatting toolbar cannot receive the focus. To be able to reach the 'Bold' function, Roberto must proceed with some attention. Actually, to apply the formatting styles the user should be experienced in using an advanced interaction modality by screen reader. A possible – but not comfortable – modality for proceeding might be:

- Press the key combination 'Ctrl+Home' to go to the top of page; the exploration mode is automatically activated by Jaws (10.0)
- Select desired widget via arrow keys or find command
- Press the Enter key or Space bar (to apply formatting) and the focus returns to the text box

Now it is possible to continue to write the text (with Jaws 10.0). The modality offered by the original UI requires the user to go up and down along the page. This is uncomfortable, especially for inexperienced users. If previous Jaws versions are employed the process is even more difficult since the user also needs to switch between editing and exploring modalities many times.

Modified WEP

Now let us see how user interaction changes when using the modified interface. When the Editing Page is loaded, the screen reader is about to start reading. Roberto stops

Jaws reading, and he uses the Jaws special command ‘Ctrl+Insert+;’ to get an overview of the page structure (i.e. main areas) based on the defined landmarks. Roberto notes that the list of landmarks now available offers the ‘main’ landmark, so he presses the Enter key on it, to skip directly to that section. At this point, he can immediately move the focus onto the text area by simply pressing the Tab key once; he does not need to switch to the Edit modality with the Enter key since Jaws provides a very short sound to inform the user that the editing modality is now automatically activated. The screen reader now announces the hidden label ‘Write the text here’. Using the arrow keys Roberto moves the cursor to the point where he wishes to insert the text, writes the sentence, and then selects by ‘Ctrl+Shift+left’ arrow the words ‘valuable educational means’ to which to apply the bold. Now, by pressing the Tab key once the focus immediately reaches the Formatting widgets. The screen reader announces ‘Formatting toolbar’ and then ‘Bold button’. The toolbar buttons can be navigated by using the up and down arrows. Roberto presses the Enter key when the screen readers says ‘Bold button’. The result is that the bold style is applied to the selected words and the focus returns to the edit text area in correspondence with the bolded block. Roberto can continue to write without having to reactivate the Edit modality.

Summary

In brief, when interacting with the modified interface, the new page structure makes a user's experience with the application easier and faster. The command sequence is more straightforward and the editing focus is not lost. The new interface allows users to insert/format text without having to switch to navigation modality to find the interface elements (widgets and comboboxes) when using Jaws 9.0 (the user activates the Editing modality and it remains for the entire formatting process). Jaws v. 10 automatically

switches between the two modalities, but the interaction is simplified, due to the immediate recognition of the toolbar as well as for selection of special characters.

To give an idea of the steps involved when using a screen reader and via keyboard, Figure 6 depicts an extract of the content of the Jaws interpretation during the exploration of the original and the ARIA-based Editing Page, as announced by Jaws v. 10.0. Note that to facilitate comparison, the modified interface shows the combobox ‘Select a group’ expanded with the Latin charset.

The part on the left is produced by the original code, while the right-hand part is produced by the modified code. Parts in italics are announced by Jaws but are not ‘explicitly’ rendered on the screen (e.g., link, button, edit, etc.). They are just announced to inform users about features that are perceived from a visual rendering. Parts in bold refer to the content added in the modified interface.

5 Conclusions

Collaborative environments offer a great opportunity for the visually-impaired, provided contents are delivered in a suitable format and interaction is supported in appropriate ways. Wikis are increasingly integrated into Learning Management Systems to improve learning effectiveness in collaborative environments -- thus it is important that they be available to all.

By analyzing the main functions of Wikipedia -- search, results and editing -- we verified that although all contents are accessible via screen reader, there are usability issues, mainly due to difficulty interacting with the interface. Specifically, blind users often encounter difficulties when editing content. We then described a scenario that illustrates how a user's interaction changes when ARIA suite is used to develop a new Wikipedia editing interface.

The use of ARIA for defining landmarks/regions offers a blind user an overview of the page, which permits orientation in a new interface and enables the user to rapidly jump over main contents. Furthermore ARIA allows one to perceive changes in live regions, and make JavaScript and Ajax-based interfaces accessible.

It is important to note that wikis greatly simplify interaction for the sighted user since vision shields users from the complexity of using (X)HTML languages, CSS, and other technological aspects, thus increasing the potential to create shared knowledge and participate in social activities. On the other hand, since wikis automatically translate wiki-syntax based contents in web pages, if both the layout and the translation SW are not appropriately designed, keeping in mind accessibility and usability issues, they might induce problems that may be propagated on each wiki page or entry. This highlights the importance of considering usability issues from the earliest stages of developing wikis and in general, any content or learning management system.

Making wikis suitable for the abilities and skills of all users offers many challenges. When defining the GUI it is fundamental to consider the needs of sighted users but the needs of blind individuals should also be taken into account when writing the UI code. Specifically, the same information should be provided through both visual and auditory channels, the design should be optimized for reading via screen reader, the UIs should be easy to use via keyboard and no additional cognitive effort should be required of the blind user.

As web 2.0 penetrates the Internet, new solutions are created to allow everyone to participate in any collaborative environment, regardless of physical ability or technical skill. The W3C ARIA suite should be incorporated into the creation of any website, to greatly improve interaction via screen reader and allow blind users to fully enjoy the

potential of new Internet technology. This would facilitate the use of Internet applications and help bridge the digital divide resulting from ‘electronic barriers’.

Although this paper focuses on Wikipedia, the problems highlighted are common to other wikis. The accessibility problem of the toolbar is specific for Wikipedia (and Media Wiki derived wikis) while if another wiki only uses (X)HTML standard input element this problem does not exist. However, concepts such as regions (structural roles), keyboard navigation and programmatic focus are valid for any wikis as well as any Learning Management systems that offer complex web UIs. In conclusion, we believe that our findings could have general applications and that implementing ARIA would enhance usability via screen reader in any wiki.

As a future study, a user test with blind users is planned, to quantify benefits of the ARIA-based Wikipedia editing interface, evaluate user satisfaction and collect user feedback.

Figure 1. Wikipedia home page: English version

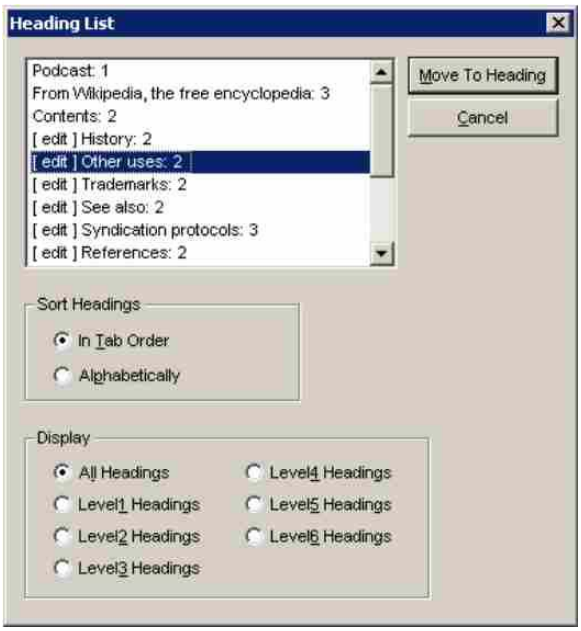

Figure 2. Podcast article: list of headings levels provided by JAWS

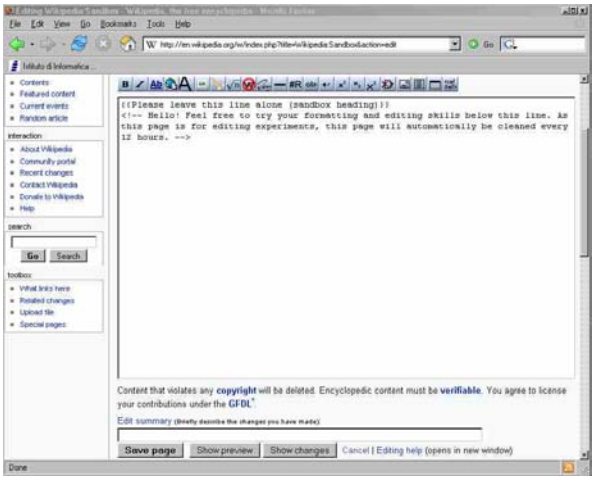

Figure 3. Wikipedia Editing page

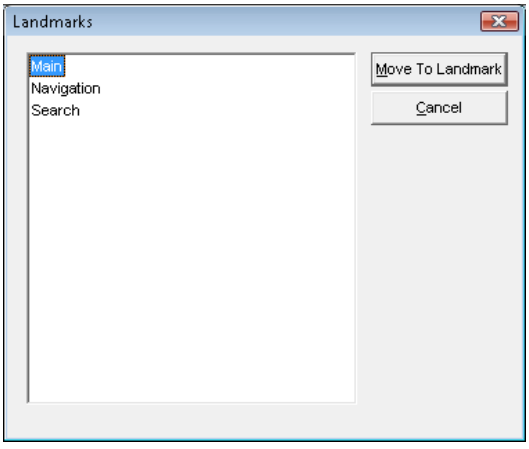

Figure 4. List of page regions

Figure 5. Editing text in the Wikipedia Editing Page

…	…
Editing Podcast (section) - Wikipedia, the free encyclopedia	Modified Wikipedia
Heading level 1 Editing Podcast (section)	***Main landmark***
…	**Heading level 1** Modified Wikipedia
Graphic Bold text	…
Graphic Italic text	***Write here the text***
Graphic Internal link	**Edit**
… [Others 19 elements]	***Formatting Toolbar***
Edit	Bold ***button***
…	Italic ***button***
Link Edit summary	Internal link ***button***
(Briefly describe the changes you have made)	…[Others 19 buttons]
Edit	**Link** Edit summary
…	(Briefly describe the changes you have made)
Save page [**Alt+Shift+s] Button**	**Edit**
Show preview [**Alt+Shift+p] Button**	**…**
…	Save page [**Alt+Shift+s] Button**
Choose character subset	Show Preview [**Alt+Shift+p] Button**
Combobox [collapsed] Latin	…
…	Choose character subset
Link a	**Combobox [collapsed]** Latin
Link a	***To insert a special character select it and press Enter***
…	***Combobox***
	capital a acute

Heading level 5 navigation **list of 5 items** … **list end** search …	***a acute*** … ***navigation landmark*** **Heading level 5** navigation **list of 5 items** … **list end** ***search landmark*** …

Figure 6. Portion of the Original (left) and ARIA-based (right) Wikipedia editing pages announced by Jaws

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