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# Accessibility of Rich Internet Applications for blind people: A study to identify the main problems and solutions

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## ABSTRACT

In this paper, we describe the accessibility problems experienced by blind people using Rich Internet Applications (RIA). RIA are dynamic interfaces where information sharing is done in real time. Due to their greater information density and diversity, making these interfaces accessible for blind people is difficult as the content changes constantly. Our study with blind and sighted people identified the main problems encountered by blind people and the magnitude of the difference of execution time of tasks among these two populations. Analyses also took into account users' expertise. From these results, we suggest recommendations for each problem.

## Categories and Subject Descriptors

H.1.2 [User/Machine Systems]: *Human factors, Human information processing, Software psychology*

H.5.2 [User Interfaces]: *Ergonomics*

## General Terms

Measurement, Design, Human Factors

## Keywords

Accessibility, Rich Internet Applications, Visual impairment, Screen reader, Web browsing.

## 1. INTRODUCTION

Information and communication technologies are widely used in everyday life. On the one hand, they create a new source of exclusion for people with visual impairment. On the other hand, these technologies potentially fill in their disability by offering access to information with computer interfaces such as screen readers. This population is steadily increasing. Despite medical

advances, the longevity of the population growth is the main cause of the increase of visually impaired people, whose number amounts to 284 million worldwide (39 million are blind and 245 have low vision) [1]. In France, visually impaired people are 1.7 million [2]. The number of blind people is expected to double by the year 2030 [3]. Nevertheless, this population is not part of the main concerns of website editors, despite visually impaired people use Internet more frequently and have more computer interfaces than the average French person [4]. Admittedly, advances have been made. World Wide Web Consortium (W3C) has published several sets of technical specifications, including Web Content Accessibility Guidelines (WCAG 2.0) and Web Accessibility Initiative - Accessible Rich Internet Applications (WAI-ARIA), that specifies how to increase the accessibility of dynamic content and user interface components developed with Ajax, HTML, JavaScript and related technologies. Frameworks and guides were created in order to operationalize the standards of W3C, like "Accessiweb" guide from Braillet association or the framework for accessibility of French civil services [5]. Unfortunately, these rules are poorly understood and respected, as we will illustrate in this paper.

## 2. RIA & Accessibility

RIA are filled with rich interactive and dynamic elements, making them difficult to navigate with a screen reader. Indeed, reading a website using a screen reader is serial. This serialisation is problematic with RIA. The auditory modality is brief, depending of time, and creates temporal distance between information samples. The auditory modality prevents to make mental grouping for blind users and inserts distracting elements, not to say dispersive elements, between two associable elements. This phenomenon reduces the ability of disambiguate, omitting or distorting contexts. Thus, it's even more problematic if the content changes constantly. Indeed, screen reader uses the source code of web pages and serializes the content whereas web pages have a parallel browsing with a variety of options (framework, table, drag-and-drop, etc.). Buzzi and colleagues [6] discuss also about these serialization problems in their study with blind people who navigate on one rich website (Ebay). For example, if the table's content is organized in columns, the screen reader (which reads by rows) announces the page contents out of order; consequently the information might be confusing or misleading for the user. Therefore, if the contents are not designed with special attention to their needs, the structure of a web page is

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difficult to understand for blind people. These authors noticed that if the web page is well structured with the help of headings or intrapage links, such as a “skip to main content” link, blind users can easily understand the table of contents or quickly reach the main content. The problem is that the screen reader transcribes simply visual and graphical information into auditory information without taking into account the context. Information can be difficult to understand and the information collecting time is largely increased. Web browsing time for blind users is much longer than for sighted users and this time can vary according to the website accessibility. For example, shopping time with an accessible website is one thirds lower than with a not accessible website for blind users and sighted users [7]. Only 53 % of blind users and 75 % of partially sighted users succeed their web browsing tasks [8]. The main problem is that computer interfaces are designed by sighted people, for sighted people. Our study was designed to observe and understand the blind user’s behavior with computer interfaces such as RIA. User testing was conducted with blind people to highlight the problems encountered with RIA and to suggest recommendations to solve these problems.

### 3. The present research

User testing placed users in a situation as natural as possible of real use. In this way, we observed directly blind user’s use with rich interface to understand their behavior and to identify their problems. We chose 2 websites with rich interfaces: “Facebook”<sup>1</sup> and “Fnac”<sup>2</sup> for their diversity and quantity of information and for their dynamic interaction. We elaborated 3 tasks for the “Fnac” website and 5 tasks for the “Facebook” website. These assignments were standard tasks of search, purchase and listening of music for the “Fnac” website and standard tasks of communication the “Facebook” website. We separated participants into 4 groups according to their visual disability and their level of expertise of RIA.

#### 3.1 Participants

A questionnaire allowed the selection of participants and determined their level of expertise with the “Facebook” and “Fnac” websites. Participants were considered expert when they had daily used social networking websites and/or frequently (at least once a week) shopping websites. The novice participants had never used these websites. Six blind participants had been selected, 3 females and 3 males, aged from 20 to 58 years old (median = 39). They had been congenitally blind or blind for at least twenty years. Three blind participants were experts of the “Fnac” website and three were novices. For the “Facebook” website, there were 2 blind expert participants and 4 blind novice participants. Six sighted participants had been also selected, 3 females and 3 males from 22 to 60 years old (median = 41), with normal or corrected sight. As blind participants, three sighted participants were experts of the “Fnac” website and three were novices. For the “Facebook” website, there were 2 sighted expert participants and 4 sighted novice participants.

#### 3.2 Materials

In order to not unhook the blind user’s habits, each blind participant used his/her own computer with the screen reader “JAWS” and the web browser “Internet explorer”. A camcorder “Handycam HDD” was installed to record all actions made with the keyboard and the software “Morae” was used to calculate the execution time of tasks.

#### 3.3 Procedure

User testing was conducted individually in a non isolated room. The experimenter gave instructions orally, could repeat them and could help participants in case of problems. First, each participant filled a pre-questionnaire in order to know habits and use of computer interfaces. Then, participants performed the tasks for the “Facebook” website and the “Fnac” website. On the “Fnac” website, users were asked to buy a CD of “Jacques Brel”, to listen songs of French singer “Zazie” and to search a digital device. On the “Facebook” website, users had to post a message on their wall, to read and to write a message using the inbox, to search for an artist and to become his/her fan, to add a friend and to search friend’s birthdays. The test time was on average 30 minutes for sighted people and 3h30 for blind people. Finally, in the end of user testing, participants filled in a post-questionnaire “System Usability Scale” in order to know their satisfaction of the use of these RIA [9].

#### 3.4 Results

Many problems were brought to light thanks to our user testing. We list here only the main problems shared with the “Fnac” and “Facebook” websites and recommendations are proposed for each problem.

Firstly, screen reader reads information one after the other. The slightest information is heard. This simplistic oralization, that is an exhaustive oralization, leads to two main problems:

- Inappropriate content for an easy and fast comprehension: For example, « Handheld recorder (5) » is read « handheld recorder opened bracket 5 closed bracket » instead of to be read « 5 handheld recorders available ». Blind users have to do mental operation to put information in the right order. This problem suggests that guidelines of WCAG 2.0 were not correctly applied. For example, the *guideline 1.3 “Adaptable”* advises to create content that can be presented in different ways without losing information or structure. More precisely, the *guideline 1.3.1 “Info and Relationships”* asserts that information, structure, and relationships conveyed through presentation can be programmatically determined or are available in text. As you can notice, the application of this guideline is not obvious.
- The information exhaustiveness of web pages: For example, even an empty space is read. Screen reader may say “empty” between two elements (like links or buttons) during the exploration of webpage. This information is useless but blind users use cognitive resources to process it.

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<sup>1</sup> [www.facebook.fr](http://www.facebook.fr)

<sup>2</sup> [www.fnac.com](http://www.fnac.com)

Therefore, this simplistic oralization increases the number of heard information and thus increases also the execution time. Consequently, this oralization leads to a heavy cognitive load tiring blind users out. Admittedly, the oralization is necessary but not sufficient. One should prefer an adapted oralization – with relevant information for blind people - to a simplistic oralization for a real accessibility.

Secondly, in many cases, links and information irrelevant to the task are read before to reach the required functionalities. In order to prevent the user’s renunciation, the main functionalities should be read at the beginning of the web page according to user’s requirements. The interface should thus be adapted to needs of blind users. However, the web page doesn’t change visually. The source code just orders to read some parts before others orally. In this case, the main functionalities must be read at first so as to blind users reach their objective within a reasonable time.

Thirdly, the active link on which blind users are entered is read again. Blind users are disturbed because they believe that they have not reached the link they choose. They have no feedback as sighted users with a visual feedback. The active link should not be repeated and an auditory feedback should be given for blind users. This problem is also related to webpage refresh. Indeed, the web pages are reloaded for each action of users, resulting the repetitive listening to navigation menus. This mechanism leads to a cognitive strain and time-consuming for blind users. Blind users can be disorientated and lost among their exploration of website. Furthermore, they have to listen too many links and no possibility to skip directly to main content is given. Buzzi and colleagues [6] identified the same problem with the rich website “Ebay”: a blind user has some difficulties to find the relevant links among a high number of oralized links, resulting in disorientation.

The decrease of the number of links, overloading navigation menus, will simplify the websites exploration and the introduction of two links “Skip to content” and “Skip navigation” should reduce the execution time of tasks of blind users significantly, thus lightening their cognitive load. Buzzi and colleagues [6] advised the same recommendations. Koyani and colleagues [10] recommended also to provide a mean for users to skip repetitive navigation links in order to aid those using assistive technologies.

This problem underlines another problem related to the lack of interface adaptation. Each action leads to a new listening of navigation menus whereas each action would have to result directly to associated content. For example, when blind users are searching for a specific compact disc using search engine, they had to listen each link of different navigation menus before to reach the intended content. The solutions might be to listen to the results directly.

Consequently, a search of a few minutes for sighted users may require up to one hour for blind users. Indeed, the difference of execution time of tasks between blind users and sighted users is very large (see Table 1 and Table 2). Blind users had execution time of tasks 8 times longer than sighted users for the “Fnac” website (see Table 1) and had execution time of tasks 4 times longer than sighted users for the “Facebook” website (see Table 2). These differences varied with their expertise level. The difference was more important between blind novice users and sighted novice users for the “Fnac” website whereas the difference was larger between blind expert users and sighted expert users for the “Facebook” website.

For the “Fnac” website, blind novice users had execution time of tasks 10 times longer than sighted novice users whereas blind expert users took 6 times longer than sighted expert users. These results are explained by the fact that blind novice users are lost in the web page because of the excessive number of links, navigation menus and possibilities which are heard several times during their task. Blind novice users don’t know where they can go to reach their goal whereas with a glance, sighted novice users can locate what they are searching. For each link heard, blind users decide if the link is appropriate or not for their task. They can therefore be lost very easily when they choose an inadequate link and had to find one’s way thought the web page. Accordingly, their cognitive load and their execution time of tasks are increased. The difference between blind expert users and sighted expert users is less important than the difference between blind novice users and sighted novice users because blind expert users ignore superfluous links, even if they have to hear these links. Consequently, they take shorter time to perform the tasks than blind novice users.

For the “Facebook” website, blind expert users had execution times of tasks 8 times longer than sighted expert users whereas blind novice users took 3 times longer than sighted novice users to succeed their tasks. These results are explained by the fact that this website uses a specific vocabulary and some links are not correctly entitled. So, even sighted novice users are disturbed and get lost in the website and they take more time to succeed their tasks. The difference between blind novice users and sighted novice users is therefore less considerable than the difference between blind expert users and sighted expert users. However, sighted expert users succeed their tasks with one click or two. It’s very fast whereas blind expert users have to listen all navigation menus to attain the intended element because a link “Skip to content” doesn’t exist.

Therefore, whatever the website and users level of expertise, blind users have execution time of tasks longer than sighted users.

**Table 1. Mean execution time of tasks (minutes) of blind and sighted users depending on the users expertise for the “Fnac” website**

	<b>Novices</b>	<b>Experts</b>	<b>Average</b>
Blind users	36’10	28’02	32’06
Sighted users	3’28	4’50	4’09

**Table 2. Mean execution time of tasks (minutes) of blind and sighted users depending on the users expertise for the “Facebook” website**

	<b>Novices</b>	<b>Experts</b>	<b>Average</b>
Blind users	28’47	17’15	25’17
Sighted users	8’31	2’11	6’25

#### **4. Conclusion and Perspective**

In this study, we noted numerous accessibility problems but also consistency and organizational problems for both blind users than sighted users. In this paper, we selected the main accessibility problems for blind people and suggested recommendations for each problems. Substantial efforts are still to be provided in spite

of the guidelines of W3C. Might it be due to a lack of respect of these guidelines? We assume that the problem is more complex. We showed that guidelines exist for the problems encountered in this study but the actual model of W3C is flawed. These guidelines are ambiguous and complex to understand and to apply in a particular situation. A significant degree of subjectivity plays an important role in the application of guidelines. Ultimately, an accessible website is not always usable [11]. Ergonomics has to answer to user's needs and expectations. In the case of blind people, the role of ergonomist is above all to make the interface usable. The distinction between accessibility and usability for blind people is superficial in practice. In this logical way, blind users should not adapt to interface but interface have to adapt to blind users. Thus, the main recommendation is to reconsider our way to build the computer interface. Sloan and colleagues [12] promoted a contextual approach to accessibility. We concur with this holistic approach to accessibility. As these authors, we reject the approach of a single and correct solution and promote the adaptation according to context. For this purpose, we need to understand that blind users take information auditorily, that is step by step, on the website content and the website organization. They cannot know the organization web page with a glance as sighted people and know where to reach the intended element. A site map could solve this problem, giving an overview of website of blind users. But it is not enough. If it seems obvious, the problematic is not it because the web browsing way is not adapted for blind people. Each link, each button, each element on website is a heard information and so, a consciously processed information. This process generates the cognitive overload for blind users. Therefore, we propose the interfaces adaptation for blind people in order to transform the reasoning of the transcription of visual and graphical information into auditory information because the oralization is admittedly necessary but not sufficient [13]. An adapted interface would offer only main functionalities and pertinent information according to the context for blind users. Therefore, this solution would allow a faster and more fluent navigation and would decrease the cognitive load of blind people. The website might be the same for sighted and blind people but when screen reader is detected, a system sorts the source code and gives relevant information for blind users according to the context and tasks.

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