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e-Accessibility: Making the Web Accessible to the Visually Impaired Persons

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ABSTRACT.

Accessibility is the possibility of any person to make use of all the benefits of society, including the use of the Internet. Graphical are an obstacle for visually impaired persons to access the Internet, so they need a support technology capable of capturing interfaces and making them accessible. Interfaces should be designed so that when accessed by support technologies they continue to be friendly. For a site to be accessible to blind persons it is necessary that the information be reproduced by means of an "equivalent" textual description, capable of transmitting the same information as the visual resources. The present study is aimed at identifying and defining usability guidance compliant with accessibility W3C directives that can facilitate the interaction between visually impaired and the Internet and still guarantee sites with understandable navigation content. Towards this end an exploratory study was conducted, comprised of a field study and interviews with various visually disabled people from the *Instituto Benjamin Constant*, reference center in Brazil for the education and re-education of visually impaired persons, in order to get to know visually disabled users better. Through the understanding acquired, different types of impositions and limits that these users are subject to have been identified, enabling a better perception of their needs and special abilities. The impaired user-machine interaction were observed and analyzed, which enabled the identification of aspects that could contribute to the accessibility of sites, with emphasis on facilitating the access of those visually impaired to the Web.

Key Words

Accessibility, Usability, Visually Impaired

INTRODUCTION

Accessibility is the term used to indicate the possibility of any person to make use of all the benefits of society, among which, the use of the Internet (Nicholl, 2001). Digital accessibility is more specific and refers only to access to computer resources; accessibility to the Internet is the right to use the resources in the worldwide computer web and accessibility to the Web, or *e-accessibility*, referring specifically to the Web component (Sales, 2003).

The Web component plays a fundamental role in the innovation that the Internet represents in the daily lives of persons with special needs; it facilitates the lives of these people as it allows them to create new ways of relating to others and performing activities previously unattainable (Takagi, 2004) and (Petrie, 2006). But getting digital accessibility is no simple matter; it requires organizations to adapt their resources in order to make the use of the computer accessible to any person (http_1).

In order to be accessed by visually impaired users, the graphic interface of computer systems should be designed with an "equivalent" textual description. These "equivalent" interfaces should be built in such a way that when accessed by support technology, they continue to provide "friendly" interaction, i.e., an interaction focused on usability. Hence, the present study is aimed at identifying and defining usability guidance compliant with accessibility laws, which may facilitate the interaction between those visually impaired and the Web, guaranteeing sites with understandable navigation content.

ACCESSIBILITY TO THE WEB OR E-ACCESSIBILITY

Digital accessibility refers to access to any Information Technology resource, whereas the term accessibility to the Internet is used, widely speaking, to define universal access to all components of the worldwide computer web, such as chats, e-mail, and so on. The term Web accessibility, or *e-accessibility*, specifically refers to the Web component, which is a set of pages written in HTML language and interconnected by links to the hypertext (Sales, 2003), (Modelo, 2005) and (Nevile, 2005).

The Web plays a fundamental role in the innovation that the Internet represents in the daily lives of those with visual impairment, making their lives easier; it allows them to establish new relationships, find job opportunities and forms of entertainment (Petrie, 2006) and (Queiroz, 2007).

Upon accessing a site, a user with normal eyesight uses a Browser. However, a blind or partially sighted person accessing the Internet would require support technology connected to the Browser, consisting of software called "screen readers", associated to other programs called "voice synthesizers".

Though important, digital accessibility is no simple matter. People with disabilities have sensorial and motor limitations which must be compensated for, one way or another, so as to enable their access to computer resources. With this in mind, organizations need to adapt their systems so that one single computer can be used by any person whatsoever (Harrison, 2005). The problem is that this adaptation requires technical expertise and specialized help, and this is why organizations very often do not make the needed effort to introduce accessibility procedures.

METHODOLOGY

The study, exploratory in nature, was carried out in three stages: (*a*) selection of the category of users; (*b*) bibliographic and documental research; (*c*) field work. These stages were accomplished concurrently. The research work aimed at identifying and defining usability directives that are aligned with accessibility laws and which of these might facilitate the interaction between those visually impaired and the Internet, as well as guaranteeing sites with understandable navigation content.

Stages

a. Selecting the Category of Users: Users with visual impairment were chosen as the object of study of the present work; this decision was made based on the fact that the Internet has done much to contribute to improving the quality of life of those visually impaired, allowing them not only access to information that was previously only attainable with the help of another person, but also providing them with other facilities (Harrison, 2005).

b. Biographical and Documental Research: initially, we sought to understand the principles of accessibility and its implications for Internet sites. During this stage, some institutions provided different software destined for visually impaired users. This software was used to navigate in "common" sites, such as newspapers, and make a deeper observation and analysis of the various aspects brought up in the literature.

c. Field Work: Field work was conducted at the *Instituto Benjamin Constant* (IBC), an agency of the Ministry of Education, founded in Rio de Janeiro in 1854. IBC has become a center of excellence and national reference in matters related to studies of visual impairment. Its main aim is to promote the education and integration of visually impaired persons within a greater framework (http_6). During the field work, which took three months, different sectors of the institute were observed. In addition, several informal interviews and six in-depth interviews were conducted with employees, students and former students at the institution, most of whom are visually impaired and work there nowadays.

MODELS

Mental models are representations existing in the minds of people, which are used to explain, simulate, predict or control objects in the world. These representations are externalized through conceptual models. The elaboration of a user's conceptual model depends on the previous knowledge and experience of each person and is based on the expectations, aims and understanding of the user with regard to the system. Users create models based on "objects" they already know from their daily activities; they try to relate the computer elements to these familiar "objects", in an attempt to understand the machine better (Pressman, 2004).

As the perception of the system is influenced by the experiences of a person, each user creates his/her own conceptual model; since it is highly unlikely that people without special needs undergo similar experiences when surfing the web as those with deficiencies, the models for disabled people tend to be distinct from the models for non-disabled people (Takagi, 2004). For example, according to Prof. Hercen, who was born blind, the window metaphor (Windows), which indicates the visualization of a work area, has no such meaning for a blind person (Hildebrandt, 2005).

When accessing a system, disabled users make use of a very different environment from non-disabled people. They relate the computer elements to "objects" from their day to day lives, developed to supply their needs. In addition, people with disabilities, such as blind persons, develop special skills, *e.g*., excellent hearing; they hardly ever sit passively waiting to hear a spoken exit; they move around Web pages using complex combinations of keys. By means of this process, they create their own models and attempt to surf Web pages in a logical way. As these facts increase the level of difficulty when interacting with sites (Hanson, 2004), this ends up influencing their conceptual models (Takagi, 2004).

In systems geared to usability, the perception the user has of the system should be the closest possible to the system *per se*. This is why the designer should know the final users well enough to understand how they perceive the system, *i.e*., their conceptual models. Thus when dealing with impaired users, it becomes essential to identify what types of impositions and limits they are subject to, in order to understand better their needs and special abilities (Takagi, 2004); an attempt should be made to understand all the hurdles users need to overcome to access information. If these hurdles are understood, it becomes possible to design easy-to-use interfaces for people with special needs as well (Harrison, 2005). The field work for the present study was conducted with this goal in mind.

VISUALLY IMPAIRED-MACHINE INTERACTION

The interface, graphic or otherwise, is the part of the software that users use to communicate with the system in order to perform their tasks; it should be designed to meet the users' expectations, allowing them to direct their attention to the objects they work with, which in turn reflect the real world (Pressman, 2004).

The interface should allow for user-friendly interaction; its design should be aimed at usability, the characteristic that determines whether the handling of a *product* is easy and quickly learned, difficult to forget, does not provoke operational errors, satisfies its users and efficiently resolves the tasks for which it was designed (Ferreira, 2003) and (Nielsen, 2002). If usability guides the system, users feel comfortable and encouraged to make use of it (Shneiderman, 2004). In order to build systems with sound usability, it is important that they be centered on the user (Norman, 1999); towards this end, one should get to know the final users, know how they perform their tasks, and the types of impositions and limits that they are subject to. Because graphic interfaces are a hurdle for visually challenged users, they must interact with the system using support technology capable of capturing interfaces and making them accessible.

USABILITY DIRECTIVES FOCUSED ON ACCESSIBILITY

A usability oriented site is not necessarily accessibility oriented, and *vice versa*; a page may be easy to use for ordinary users, but inaccessible for those with special needs (Hanson, 2004). The directives recommend that site administrators check accessibility by accessing them through a screen reader; the problem is that those visually disabled, besides having special abilities, also use certain combinations of keys that a non-disabled person would not be able to simulate; hence, usability aspects differ from one user profile to that of another.

The authors of the current study agree that accessibility should be verified through a screen reader but that in order to obtain a universal access site geared to usability, it is essential that the difficulties and abilities of users be modeled as well, as these guide the mental model of their interactions. With such modeling, it would be possible to obtain usability directives that, in conjunction with the W3C accessibility directives, would provide for harmonious interaction of those disabled while guaranteeing understandable navigation sites.

Usability issues occur, generally speaking, due to three reasons: the main aim of accessibility evaluation programs is compliance with directives where usability aspects are overlooked; many evaluation programs rely only on syntax verification techniques for sites and so detectable errors are limited to the tag description layer where the users' mental models are not taken into account (Takagi, 2004).

The literature (Ferreira, 2003), (Pressman, 2004) groups human-machine interaction sequences under two categories: *information visualization* and *data entry*. Based on the field work conducted at the *Instituto Benjamin Constant*, the present study proposes that, in interactions between visually impaired humans and machines, these sequences be grouped under three

categories: *information perception*, *navigation* and *data entry*. After observing these interactions it was possible to identify certain usability directives, shown in the following sections (Figure 1).

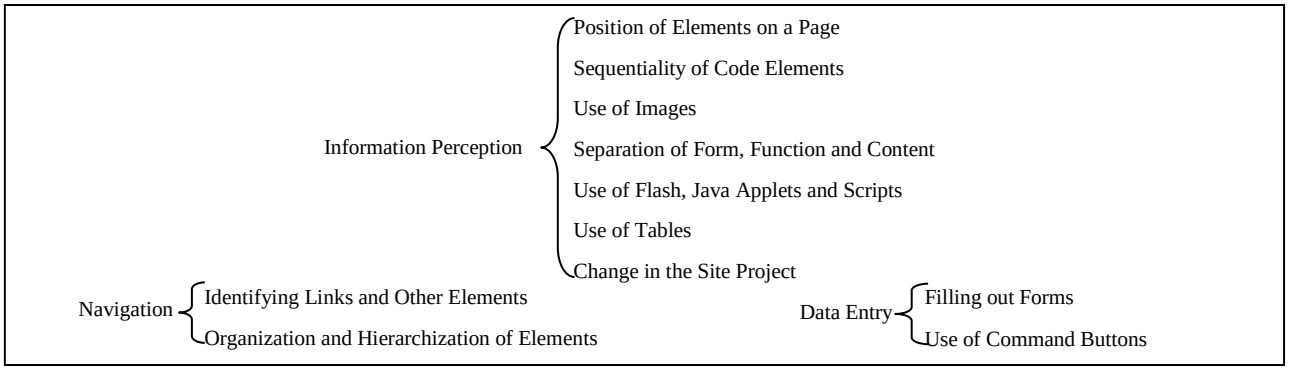

Fig. 1. Usability Directives.

Information Perception

Users accessing the Web by means of screen readers do not need to listen to all the words contained on the page: they only need to hear enough to determine where they want to go from there. It is, therefore, important that the interfaces be simple, because screen readers process the contents of a site differently from a visual reading process; to use them requires training and experience. Screen readers capture the HTML code, analyze the code and line up elements in the same order they appear in the code. As a result, visually impaired users perceive the page as if it were a text that they can read line by line (by means of arrows) or link by link (by means of the tab key) (Nevile,2005).

1. Position of Elements on a Page

The order in which a screen element appears to the user accessing a page by voice reader is not the same order in which it appears visually on a navigator. What determines when it appears on the screen reader is the position it holds in the source code. An important element may very often have a prominent position on the page shown on a navigator, but when analyzed by the screen reader, ends up being one of the last elements users notice, as it is positioned at the end of the code. Aside from losing its prominent position, it will be perceived only after a number of less important information appears (Hildebrandt, 2005).

2. Sequentiality of Code Elements

Sequentiality is one of the barriers found by those visually disabled when browsing a site with a screen reader (or by means of a program that amplifies the interface): the user is only able to access a limited portion of the screen and, thus, loses out on the idea of the general context of the page at hand (Leporini, 2004). This is why HTML language tags that can be identified by the screen reader become an important element in the information perception process of visually impaired users. They allow the reader to provide information about the structure of the site (Leporini, 2004).

Hence, when designing an interface to be accessed by visually impaired users, one should be careful since many visual characteristics, such as bold, underline, italics, font styles, etc. are not detectable to the reader and so become imperceptible; on the other hand, other invisible elements, such as labels, link titles and alt attributes for images can be used to highlight information (Leporini, 2004).

3. Use of Images

The W3C 1.1 directive states that all non-textual information must be accompanied by a text. It is recommended that the alt attribute should always be present so that contents can be read by a screen reader. The alt attribute (alternate text) provides an alternative text associated to an image; in most navigators, the alt textual content is shown to the ordinary user when the mouse passes over the image. When the mouse moves away from the image, this window disappears. Likewise, when the page is being downloaded and an image is still being downloaded, the block with the alt text content appears until the final figure is shown.

If the texts for these image attributes are written appropriately, they can provide useful information for disabled users with respect to the meaning of the images being read by the screen readers (Queiroz, 2007), (Hanson, 2004) and (Harrison, 2005).

When a site contains an image without an alt attribute, this image may be detected or not; it will depend on the screen reader program being used. Some readers don't pick up anything, while others may indicate the existence of an "image" to the visually impaired user, but cannot furnish any information about the nature of the figure (Queiroz, 2007).

For instance, an interviewee reported not being able to register with an Internet provider as the link was hidden, probably because it was represented by an image without alt attribute. In her opinion the descriptive text of an image is only useful if it brings relevant information not available in the text (Livramento, 2005).

Interviewees say they prefer texts without images. What is more, they also state they cannot often find subtitles that might justify the presence of the image on the page. Perhaps bad use of alt attributes is in part responsible for the rejection of images, found to be the case in the current research work (Hildebrandt, 2005; Coube, 2005) (Livramento, 2005).

4. Separation of Form, Function and Content

Although a union of form, function and content are essential to obtain a complete and accessible site, the intersection between these elements may result in inconsistencies among different navigators or even among distinct means of access, as PDAs and cell phones. One should separate these elements, restricting the use of HTML to a description of the content and the use of CSS (Cascading Style Sheets) to the formatting (http_5).

As it offers many more resources for formatting and a more precise control for exhibiting each element in comparison with HTML formatting tags, the CSS standard plays an important role in Web accessibility. When using only CSS to format a page, the HTML code is restricted to the function of gathering and ranking the content, thus enabling navigators that do not depend on formatting – as is the case of screen readers for the visually impaired – to ignore the CSS code and concentrate only on what is contained in the HTML.

5 Use of Flash, Java Applets and Scripts

As HTML is not a programming language, in order to make sites more interesting, solutions were found to allow them to contain programs. Among these solutions, one can find scripts, small programs incorporated in Web pages with a capacity to generate special animated effects, formatting and forms.

As time passed, more powerful technology, like Flash and Java, began to be used to animate sites, and to make them interactive and more attractive. However, most flash and java applet files cannot be deciphered by screen readers. Though recent versions of Flash include resources that enable integration with accessibility support mechanisms, there are still limits to the relationship between flash components and text navigators, as is the case of certain screen readers. One solution would be to create a link for a text version without these resources (Queiroz, 2007).

6. Use of Tables

When a screen reader is used, tables are read horizontally, line by line. As visually impaired users cannot visualize the whole table and so have to rely on their memory to know in which position different columns are to be found, it would be preferable to re-read the heading of each column (the first cell of each column) before reading the data contained in each cell (Livramento, 2005). HTML offers resources that allow distinguishing the heading of the remaining cells, paving the way for this type of reading, as long as this distinction is correctly applied in the font code. It is, therefore, good usability practice to identify the names of each column and line by means of the "th" tag (table header).

7. Change in the Site Project

There are two types of alterations that can be made in sites. The first and more frequent one consists of simply updating the content without modifying the page layout. Newspapers, for example, are updated continually. This does not cause any uneasiness for visually impaired users.

The second and more problematic one occurs when the project of the site is altered. This obliges the visually impaired user to relearn the name and position of all the key elements on the page. Though this was not considered an obstacle, the visually impaired interviewees (Coube, 2005), (Hildebrandt, 2005) and (Livramento, 2005) wished to be notified every time a new version of the site came into effect. One interviewee reported that, when the page of her provider was modified, she and her husband, also blind, had no idea what was going on, unsure of whether it was an error on the part of the program or something they had done wrong (Livramento, 2005). One suggestion to cater to the needs of the visually impaired user is to put some identification inside the page containing the number and date of the current version.

Navigation

Visually disabled users do not use the mouse to navigate, since this device requires visual coordination (aim) (Queiroz, 2007). They mainly use the tab key and combinations of keys, called *shortcut keys*. These keys can also be used by non-disabled users to expedite certain tasks (Leporini, 2004). Using these keys requires learning one more skill, which leads partially sighted users to prefer using their residual sight (Hanson, 2004). This is why one should select a background color that will create a contrast between the background and the text to facilitate reading (Hanson, 2004).

1. Identifying Links and Other Elements

When navigating by means of keys, it is essential that the text describing the link be identified in an informative and useful way (Harrison, 2004); this text will be picked up by the screen reader and it is by this means that the disabled user will know what the link is for. So, simply identifying links with words like "click here" or "next" are an obstacle for users who rely on voice readers, as is the case of the visually impaired (http_1).

2. Organization and Hierarchization of Elements

Screen readers provide functions that enable users to jump directly to the various heading tags, a key element in structuring easy-to-navigate sites. By means of a tag, visually impaired users can navigate using the titles so as to get a general idea of the page (Takagi, 2004).

According to Livramento (2005), sites structured as paragraphs provide more objective navigation. Visually impaired users like to have the option of navigating by jumping from one paragraph to another, only reading through the ones they consider important; experienced users are quickly able to identify if they wish to continue reading a paragraph or skip to another, in this way approximating their method of reading to that of a person with ordinary eyesight (Livramento, 2005).

This is why it is essential to adopt the practice of signaling each paragraph in HTML code by means of a "p" tag instead of a "br" tag, which only enables a line break.

One of the problems in using a screen reader is that navigation on links is sequential (Leporini, 2004). This can slow down navigation. For instance, to return to a link to one's left, one would have to jump over all the links in order to restart reading the page and finally arrive at the desired content. Sites should provide resources that would enable users to jump links repeatedly, accelerating interaction. Hence skip links should be used, speeding up navigation and allowing users to jump links repeatedly and go directly to the desired content (Harrison, 2004). Skip links are not noticeable when a site is exhibited on an ordinary navigator, and are only useful when the site is being accessed by a screen reader (Takagi, 2004).

Data Entry

On entering data, visually impaired users do not use the mouse, but the keyboard, which has become a facilitator capable of being used by any visually disabled user due to an international typing norm: all keyboards produced in conformity with regional technical norms have, on the lower part of the J and F keys (on the alphanumerical side) and 5 (on the numerical side), high-relief to guide blind people when positioning their hands, just as people do when learning to type (Queiroz, 2007).

Relying solely on the keyboard, one could spend a long time choosing commands, typing data and inputting other things. Added measures should be taken to promote accessibility in interfaces dealing with data entry (Ferreira, 2003).

1. Filling out Forms

If filling out forms can be a constraint for just any user, it is much worse for those visually impaired, forcing them at times to abandon the site. The simple fact that many sites have restricted access requiring passwords, which, due to security reasons are not spelled out by screen readers, already hinders user access.

One way people send data over the Internet is by filling out forms. Since the user navigates through forms by using the tab key, in order to facilitate data entry, the fields to be filled out and search buttons, if important, should preferentially be located at the top of the page. (Leporini, 2004).

Some interfaces are made in such a way that very often, when a visually impaired user locates the field to be filled out, no voice indication is made to explain what needs to be done; the user only hears a standard notification from the reader: "edit box." The "label" tag would allow placing a text to be read by the user, giving information on what needs to be filled out (Queiroz, 2007). This tag also permits attributing a rapid access key to each field on the form, in addition to enlarging the click field for *selection box* and *radio box*, which would make filling out forms easier for those with only partial visual

impairment. One should also avoid using a default value in the field, because even when read by the reader, it would require the user to erase the value (Harrison, 2004).

Another error found in forms is the indication of fields where one is required to make use of different color or font formatting. An alternative to this would be to use an asterisk, but screen reader users often disable the punctuation. Ideally this should be indicated by a letter that would represent the word "obligatory" (Harrison, 2004).

2. Use of Command Buttons

Another way of sending data is by means of command buttons, such as the "send" or "submit" button; these do not require a "label," since they can be read by means of the "value" attribute; however, one should avoid using words such as "click here" or "continue" with this attribute, because they indicate nothing about the purpose of the button. If the button has an image instead of a text, it would suffice to use the "alt" attribute (Queiroz, 2007).

CONCLUSIONS

Concern over accessibility at the moment of designing or redesigning a site does not guarantee this accessibility is maintained later when the site is updated. Constant and continual verification of accessibility should be made in order to avoid modifications in content or structure that would compromise the initial accessibility of the project. A new challenge emerges: that of designing, administering and maintaining sites in conformity with accessibility directives that are not only current and easy but also attractive.

Field research was conducted at the Instituto Benjamin Constant, reference center in Brazil for the education of visually impaired, in order to get to know visually disabled users better. The reason for choosing visually disabled people was the fact that the Internet has done much to contribute to the improvement in the quality of their lives, allowing them to engage in new forms of relationships, find work opportunities and alternate forms of entertainment. This research work has prompted the understanding of how these users perceive and interact with sites and has identified certain hurdles that they need to overcome in order to access information. Through the understanding acquired in the field work and based on the literature, different types of impositions and limits that these users are subject to have been identified, enabling a better perception of their needs and special abilities. As a result, impaired user-machine interaction sequences have been grouped together into three categories: *information perception*, *navigation* and *data entry*. These interactions were observed and analyzed, which enabled the identification of certain usability directives that could contribute to the accessibility of sites in alignment with W3C directives, with emphasis on facilitating visually impaired user access to the Web.

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