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"Fine Tuning" Image Accessibility for Museum Web Sites

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Abstract: Accessibility and usability guidelines are available to design web sites accessible to blind users. However, the actual usability of accessible web pages varies depending on the type of information the user is dealing with. Museum web sites, including specimens and hall descriptions, need specific requirements to allow vision-impaired users, who navigate using a screen-reader, to access pieces of information that are mainly based on visual perception. Here we address a methodology to be applied for the proper creation and elaboration of alternative image descriptions in museum web pages. Such methodology has been applied to a gallery of the Museum of Natural History and Territory (University of Pisa). Such indications allow the user: (1) to address indexed contents and to link to information in more details, (2) to calibrate image descriptions (with a command providing alternative explanations for specimens), and (3) to access extra information for the blind (via hidden labels). A multidisciplinary approach is necessary to obtain effective and comprehensive descriptions. In this perspective, a cooperative environment is eventually proposed for team work facilitation.

Keywords: Virtual visit, guidelines, museum, cooperation, accessibility, usability
Categories: H.5.2

1 Introduction and Background

The role of museums has changed during the Information Age. Their role is not limited to conserve and exhibit a set of artifacts, but to communicate and distribute information about these artifacts to visitors [Styliaras 2007].
In this perspective, most museums make part of their content available in their websites, for self-advertisement and for triggering the interest of potential visitors. An online preliminary visit can help planning the real visit and/or provide in-depth and complementary information to be used for educational purposes.

Museums play a significant role as learning contexts especially when they provide interactive experiences, which may or may not be technologically enhanced. The best learning in museums occurs when people are engaged cognitively, physically and emotionally, and this is even more the case when it comes to children or users with special needs. Digital augmentation offers a promising way to enhance and extend the process of learning, especially supporting exploration and reflection

when outside the classroom [Rogers et al 2004]. Mazzone et al. [2004] conducted a study by involving a group of children in order to evaluate museum visit and activities to gather information on missing requirements. The study revealed that the environment presented several biases preventing a fully successful experience for children. Spatial and physical features were of some constraint to children, affecting the accessibility to some of the objects: position of the object in the place, proximity with other distractive objects, chance to touch the object, variety of materials, and so on. Analogous difficulties can occur also to disabled people, who may have similar needs of children. For all these reasons accessibility issues should be considered at different levels, moving from virtual to real visits, in order to allow users to obtain information through a multiple experience.

While the preliminary visit can improve the quality of the visit for "regular" users, it can represent the key of a successful visit for special users, such as blind people. In fact, through an online pre-visit, blind users have the possibility a) to prepare a "mental plan" of the spatial display of museum specimens, exhibitions, and halls; and b) to start dealing the museum contents, in order to avoid information overload during the real visit. The informational gap experienced by blind users (visual display and content location) cannot be properly filled by museum operators, who are constrained by the short time of an average visit. Since time constrains clash with multifaceted information, the visit may eventually result in a simple specimen list or in a sloppy presentation of the overall content.

In order to be really fruitful and effective for disabled users, the virtual visit must be not only well organized and appealing but also accessible. Although a plethora of guidelines, criteria, and suggestions have been proposed to gain or increase web accessibility and usability [Leporini and Paternò 2008, Stephanidis 1998, Theofanos and Redish 2003, W3C 1999, and W3C 2007], a recent international survey of 125 museum Web sites showed that only a minority of them fulfilled the basic accessibility requirements [Petrie et al. 2005]. Consistently, user trials revealed that a non negligible part of visually and cognitively impaired users was not able to recuperate pieces of information or accomplish simple tasks on most of the Web sites included in the survey [Petrie et al. 2005].

Museum web sites need additional accessibility requirements to allow vision-impaired users, who navigate using a screen-reader, to access contents that are largely based on visual perception. A crucial aspect for the suitability of museum web sites is image description, since pictures, figures, and illustrations are an important means for understanding properties and value of scientific specimens, pieces of art, or collections. Of course, comprehensive and effective descriptions (including visual cues, notions, and cultural meaning) can be provided by a combination of experts in different fields (e.g. biology, history, web designer, photography, accessibility).

In this article we address the issue of image description in museum web sites by presenting the case of the Museum of Natural History and Territory of the University of Pisa. Here we propose a multidisciplinary approach, in order to overcome the problem of content accessibility prevented by the imprecise, or even missing, translation of the image content into screen reader language (descriptive text). The article is organized as follows: introduction (present section), theoretical problem (section 2), methodological approach (section 3), case study (section 4), a preliminary test (section 5), and a possible solution via cooperative approach (section 6).

2 Accessibility and Usability: "Fine-Tuning" for Museum Requirements

Accessibility and usability guidelines should allow the creation of web sites suitable for disabled users. However, most guidelines have been created considering accessibility as invariant with respect to content type. Instead, actual usability and accessibility of web pages varies depending on the type of information the user is dealing with. As a consequence, the guidelines are often loose and their successful application is too much dependent on personal interpretation.

For example, the checkpoint 13.1 "Clearly identify the target of each link" reported in the WCAG 1.0 guidelines for accessibility [W3C 2005], states that "Link text should indicate the nature of the link target", providing indications like "more information about sea lions" or "text-only version of this page" rather than "click here" or "more information". Nevertheless, a study conducted on 100 web sites reported that link description is one of the accessibility problems still encountered during web navigation [Petrie et al. 2004].

A further controversial issue is represented by the application of alternative descriptions to non-text elements, as indicated by the checkpoint 1.1 "Provide a text equivalent for every non-text element (e.g., via "alt", "longdesc", or in element content)" [W3C 1999]. Based on this checkpoint, web designers should apply different levels of description, short, more extensive, or alternative. However, the application is controversial since the type of description cannot be univocally predicted basing on the typology of non-text elements, as in the case of images.

For example, no long description needs to be associated to images if they refer to products sold via e-commerce: in this case, the blind customers are more interested in identifying the item they are willing to buy more than in getting an in-depth description of the visual features of the product. In this case, short and clear labels are welcome. On the contrary, the visual features of a scientific specimen or a piece of art are necessary to understand their intrinsic value and properties, thus a detailed and more comprehensive image description is in order here.

Although possible solutions have been proposed to help web designers to create alternative descriptions [Ahn et al. 2006], assigning a proper description remains a difficult task, since web designers must determine, as a first step, the underlying role of an image. In a Museum web site at least three situations are likely to occur. An image can represent a link (e.g. to the home page) and the relative alternative description falls more into checkpoint 13.1 than into checkpoint 1.1 [W3C 1999]. In this case it is more appropriate to label the image function (e.g. "home page") than providing a description of the image itself, which can reported (once for all) in the home page. An image can also be purely ornamental (e.g. pictures of Museum building): in this case a short description is probably enough. Finally, pictures or illustrations can be related to museum specimens and, consequently, the description must be extended since such elements are necessary to understand web page content.

Alternative descriptions can be classically assigned via "alt" attribute (short text), "longdesc" attribute (longer descriptions), or an external link addressing an entire explanatory page. Here we provide a new option to insert longer descriptions without the use of an external link or the "longdesc" attribute. Since description typology

varies according to the type of specimen or piece of art described, a multidisciplinary approach must be considered in order to make such new option effective.

3 Methodological Approach

In order to make the online visit both accessible and usable it is important that image location be well organized. Appropriate descriptions and additional information for users with special needs (like blind people) are required.
Previous work has revealed some important aspects of interface design for vision-impaired users, such as (a) page content serialization, (b) navigation by Tab key and special commands, and (c) the information conveyed through visual layouts differs from that afforded by aural perception. Considering those issues, as well as the accessibility and usability difficulties resulting from the screen reader, we started to identify criteria and guidelines attempt to structure and organize the content and UI elements in order to allow for better interaction through assistive technology.
Eventually, all problems fall into three main issues, which need to be addressed to make a virtual visit more suitable for people with vision impairment:

- A correct location of content, figures and images;
- Appropriate descriptions for gallery and image;
- A cooperative and collaborative team work to gather different expertises in the field.

3.1 Image Location

Often many images and videos, with relative information, are clumped in a single page because they are related to a specific exhibition or hall. Even if such organization can make sense for “regular” users, who are able to detect both the image set and the whole visual layout all at once, vision impaired users can be disoriented because they process the contents in a sequential way, via screen reader [Leporini and Paternò 2004]. Scrolling down all the images is not only time consuming but also confusing and unpractical during information search. Instead, a list of short descriptions of visual items could allow vision impaired users to pick up specific items only on request.

In this view, web pages, each one referring to a hall/gallery, can be organized according to two levels: 1) a summary listing the items exhibited and their location in the hall (index page) and 2) a descriptive page for each items (item detail page), which can be entered on request by linking on each piece listed in the index page.

3.2 Image Information

In relation to the page typology proposed in the previous section, various kinds of labels and descriptions should be used to provide useful information. Such an approach permits to provide various kinds of information: since general information to provide a gallery / image overview, up to specific image details. Consequently, the various types of labels, captions and descriptions herein proposed various according to the page referred: i.e. the "index page", which gives an overview of the gallery, and the "detail page", containing the details of a single picture.

3.2.1 Index page

Here the following information is reported:

"Welcome description" – a summary of the main content of the hall/exhibition.

"Memo description" – a reminder for blind users on how to use the page.

"Spatial description" – a map to help orientation in the hall.

"Inventory description" – List of the items with a link to a new window (item detail page, see below).

3.2.2 Item Detail Page

Here all information about a piece of art or specimen is reported, well separated from any other confounding element. Vision impaired users have the possibility to concentrate on a single item and, if not totally blind, they can use specific software to magnify and navigate the page. The page is organized as following:

Magnified image – a picture with a short description suitable for exploration by low vision users.

Notional Caption – In-depth description for all users. This part provides information on origin, nature, meaning, and cultural relevance of the item.

Visual caption: description of visual cues important for a complete understanding of the presented items. Such information can be read via screen reader only. Colours, shapes, spatial dislocation (if the item is composed by different elements) and other features appearing in the image (e.g. if an animal is hairy or not) need to be included in this description. It should be noticed that this part does not carry any background information on the item itself. As a matter of fact it has nothing to do with the notional caption (necessary to all users). The visual caption only provides visual cues that a blind user would not get otherwise.

Audio caption: sound effects and descriptions can facilitate the users to better identify the typology of a repert (e.g. animal cry). Such an added information could also support learning in the field.

3.3 Team Work

The possibility of inserting the different types of descriptions must be considered by web designers since the beginning, in order to integrate all the pieces of information in a clear and well structured way. However, notional and visual descriptions must be scrupulously prepared by experts in the field, and not by web designers, because details are important for the analysis of scientific specimens (e.g. animal or plant reconstructions) or pieces of art (e.g. a marble statue). Moreover, since a museum can include different disciplinary fields (e.g. paleontology, zoology, botany), several experts can be required to provide appropriate descriptions and information to all the items shown in the museum web site.

In this perspective, the team work for web site realization is needed and it should involve the following people:

I. Web site designer, for the creation and the technical development of the web site.
II. One or more experts in the field, for providing item descriptions.
III. A coordinator, who should gather and integrate the information prepared by the experts.

IV. A sample of final users with special needs, to test the web site via assistive technologies (e.g. screen reader and magnifier).

4 From Theory to Practice: a Web Page Application

When we focus on the web page describing a specific exhibition/hall, the questions to address are:

- how to structure the index page containing the information on the exhibition/hall and the list of specimens that can be "explored" during the visit;
- how to organize the item detail page assigned to each specimen image;
- how to create and insert the additional description to be used by vision impaired users.

In order address such questions, we referred to the web site of the *Museo di Storia Naturale e del Territorio, Università di Pisa* and, specifically, to the page describing the gallery of human evolution and early hominids (*home>esposizioni>zoologia>ominidi*). Such gallery includes only four different dioramas (partially three dimensional models), thus representing an ideal model to implement, for the first time, a new methodology.

Following the methodology proposed in section 3, we structured the index page as follows:

- A "welcome description", a short opening part reporting main subject (a sort of an expanded title); in our case: "*The gallery of human history presents human evolution from early hominids to Homo sapiens*".
- A "memo description", for users navigating through screen reader; this part reminds the users that they can click on each item link (reported below in the page) to open a new window containing an in-depth explanation and a specific hidden description for the blind.
- A "spatial description" reporting hall shape (square), size (20 m x 20m) and the location of the four dioramas (in this case one per each side); this part is important for orientation and can be analysed before the visit. In bigger exhibitions this part can take the form of a map, with its own detail page associated.
- An "inventory description", reporting a list of diorama titles: 1) the study of an anthropologist of XIX century, 2) Laetoli footprints and *Australopithecus afarensis* in the African savannah 3) *Homo neanderthalensis* in an everyday life scene, and 4) drawings by early *Homo sapiens* from the Chauvet cage. Each title is associated with a small image, which can be clicked on to get into a new window page dedicated to the diorama (see Figure 1 below).

Figure 1: List of items in the index page.

Subsequently, we organized the item detail page by including 1) the diorama picture (magnified image), 2) an explanation for all users (notional caption), and 3) a hidden description for vision impaired users (visual caption). We inserted the alternative description for blind users via hidden labels. Normally, when the description is not short the attribute “longdesc” or a descriptive link (“[D]" type) are used. However, when the description is rather complex and multifaceted, the navigation procedure can become confusing and misleading. Consequently, we decided to insert an alternative description that can be read only by the screen reader (thus hidden to “regular” users), so that the vision impaired users can find all the information in the same page. Figure 2 (below) shows an example of item detail page for the exhibition considered here.

Figure 2: An example of a item detail page.

The detail page associated to diorama 1 (Figure 2) can be opened by clicking on the correspondent diorama small image contained in the index page. Such small image is associated to the link text “study of an anthropologist: picture – link to a new window”. The part “link to a new window” is inserted only if Javascript is active, otherwise the detail page will open in the main browser window.

Figure 3 shows the html code used for the visual caption (left) and the information sequence read by the screen reader (right). It should be noticed that the screen reader detects, as first, the presence of the image with the alternative short label, then the hidden description and, eventually, the general explanation appearing on the left side of the window. Such sequence, different from the order that can be detected by the visual layout, is caused by the HTML code flow and by the CSS properties used for page editing. We decided to give priority to the hidden description because the picture itself could contain elements that are important to understand the explanation. In this specific case, it is crucial to know that a clamping metal device is located on the table, in order to understand the general explanation.

//CSS fragment
.hidden-label {position:absolute; left:-1000em; z-index:-1;}
...
//HTML fragment

 <!-- fine foto-->
 	
 Picture alternative description: notes, papers, and research books lie chaotically upon a wood desk...
 This is starting point of our "journey" through human evolution...
 	
	Photo:: The study of an anthropologist
	
	Graphic: **the study of an anthropologist**
	
	Reconstruction of the typical study of an anthropologist of the XIX century.
	
	Picture alternative description:
	notes, papers, and research books lie chaotically upon a wood desk, in front of you… A skull, which seems suspended in the air, is sort of clamped by two arms of a metal device… On the backside, various reproductions of hominid skulls are located on shelves…
	End of alternative description
	
	This is the starting point or our "journey" through human evolution: the working place of a paleo-anthropologist. the particular device upon the table is used in physical anthropology for craniometric measurements…
	
	Link shut the window

Figure 3: HTML and CSS code (on the left, A); Page portion read by the screen reader (on the right, B).

5 Pilot User Testing

5.1 Test Location, sample group, and statistical approach

We conducted a preliminary test in order to evaluate if the application of our criteria was successful in allowing blind users to collect information that they could not obtain otherwise. The test was performed in Tirrenia (Pisa) at the centre "Le due torri" a set of recreational and educational facilities for blind people. The test was performed in a room specifically equipped with computers and software allowing internet navigation to both blind testers (via the screen reader Jaws 7.10). The test involved 16 blind users with similar computer skills and no high-school scientific

education background (they were all participating to the same computer training class, at the intermediate level). To collect information, we used an observational methodology during a Computer Science lesson. They were asked to perform a virtual visit to the gallery of human evolution and early hominids: half of them were asked to navigate an accessible site without our additional criteria whereas the other half used the site including our criteria. After a fixed navigation time (15 minutes) they were asked to answer to five questions included in a multiple choice questionnaire. The questions were relative to basic information that could be obtained by both pictures (with the short alternative description always included) and text. A score of 5 points was assigned for each correct answer. The scores obtained by the individuals of each group were used to perform a statistical tests. The analyses were performed at the individual level comparing the questionnaire results of the two groups (implemented page versus non implemented page navigators). Due to the small sample size ($n<20$) and sample deviation from normality (Kolmogorov-Smirnov test $p<0.05$) we applied non parametric statistics and particularly the Mann-Whitney U test for independent variables. Exact values of probability were chosen according to Mundry and Fischer [1998]. The level of significance was set at 0.05 [Siegel and Castellan 1988].

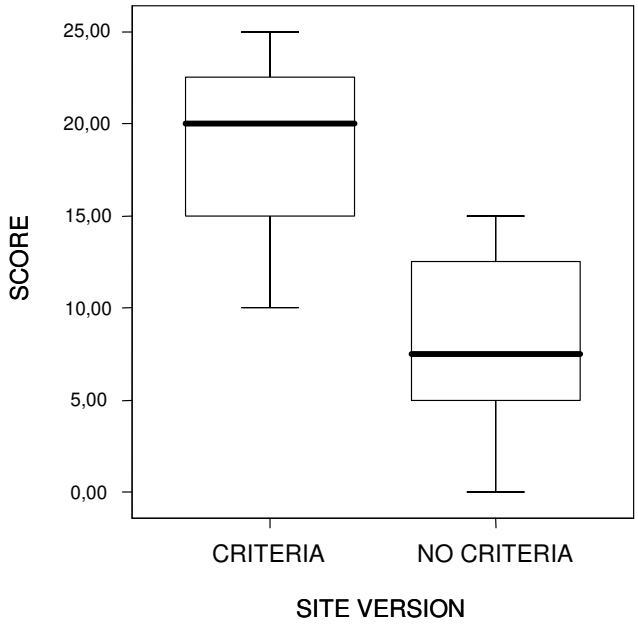

Figure 4: Box plot showing the difference between the scores obtained by the individuals navigating the two versions of the site. The difference is highly significant ($p<0.01$) Black squares: median; box: 25–75%; whiskers: nonoutlier range.

5.2 Results

On average, the users navigating the implemented site obtained much a higher score (mean±standard deviation: 18.75± 5.18) than the users testing the site without additional criteria (mean±standard deviation 8.13±5.30). This is not surprising considering that additional criteria allow to obtain information directly from both text and pictures. For example, one question was: "Did *Homo neanderthalensis* use animal fur for his needs?". The information provided in the description for all user explained that Neanderthal's man was a good hunter and exploited animal parts for his daily needs. The picture shows a Neanderthal's man dealing with meat recovering from an animal corpse and with fur crafting. While the alternative description explained the visual content of the picture in depth, the short one ("alt" description) only reported "Neanderthal's man in his daily life". So in the first case fur crafting was clearly stated in the description whereas in the latter fur use could only be implied by the general description, thus requiring a cognitive mediation and effort, also biased by previous personal experiences and knowledge. We found that the scores obtained by the group navigating with our additional criteria were significantly higher than those obtained by the other group (Exact Mann-Whitney U test, n=16, Z=-2.89 , p<0.01; Figure 4). Even if more in-depth analyses are needed, this preliminary result suggests that our criteria are effective in expanding the background information that a blind user can obtain during the virtual visit of a museum gallery.

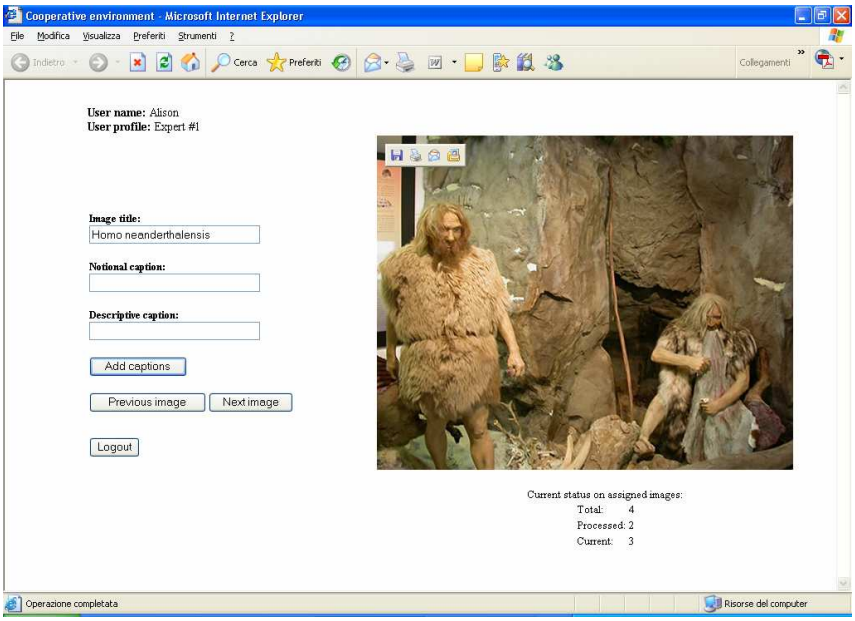

Figure 5: A working page in a cooperative environment.

6 Multidisciplinary Approach in a Cooperative Environment

6.1 Overview

An integrated cooperative environment on the web is important to enhance and improve the team work required to plan, organize, develop, and successfully implement museum web pages (a working page is shown in Figure 5).

Concerning content design, many application frameworks for museums focus on navigation and not on the content structure itself. Usually, content design is too general and doesn't support specific presentation needs. In [Rennick et al. 2004] the main focus is on implementing a web interface for museum collections, but little interest is given on the content design. In [Little et al 2002] it is shown that multimedia authoring should be diverse enough in order to cover specific needs. In [Styliaras 2007] a framework aimed at preparing a multimedia web-based presentation for a museum in a structured and parametric way. The author takes into account several aspects such as content specification, information stations, presentation applications, etc. In particular the framework includes a Content Management System , which can be used to specify and populate the content for the museum. Unfortunately, the framework does not consider accessibility and usability issues for users with special needs. In this context, our proposed environment is aimed at supporting operators in adapting content for virtual visitors who are not able to see figures, pictures, and images. As previously widely discussed, in order to make a virtual visit suitable for people interacting through screen readers, appropriate and suitable captions should be make available for every artwork picture. In preparing such captions experts should be provided of a collaborative environment to gather all information.

It is important to notice that such an environment is not thought to provide an alternative version of the museum Web site for people with disabilities, but it is proposed to help designers and developers in collecting all needed information to produce an accessible and usable Web site. When all information is gathered and stored in databases, the Web site can be developed by using such information.

6.2 Main Features

An environment to support the team work needs to have the following features:

Web-based system. The environment must be created via Web technology and accessible from everywhere. In this way, web site creation is relieved by the necessity of having all team members in geographical proximity. An immediate consequence would be a wider array of options for team members selection. In our case study, the experts in different fields could cooperate from there "home base": Department of Anthropology, C.N.R., Museum of Calci, etc.

User profile differentiation. The environment needs to include different access profiles, following an identification/authentication process, in order to separate system subsets, differing according to the role of each team member. In this case study, a web designer, a Museum expert, a photographer, an anthropologist, and a C.N.R. researcher entered the system via different access profiles.

Collaborative & cooperative interaction. The environment should allow team members to communicate and exchange information with each other, in order to allow proper integration, combination, and connection of all contents.

Collaboration and cooperation are crucial in order for the content i) to remain consistent throughout the site, ii) to be uniformly organized, and iii) to maintain overall homogeneity.

6.3 Technical Properties

Such a collaborative and cooperative environment should be developed so that it is able to allow different typologies of users to access from everywhere they are and independently from their abilities as well. In addition, its interface should permit to obtain the correct information in an appropriate manner (i.e. according to the user experiences and abilities). Thus the main technical properties to be considered when developing this kind of environment can be summarised in:

- *Content-based database*: a database gathering all the pieces of information provided by the team members should be used to store in a central manner all information to be managed. In our case, for example, the Museum expert provided information on the exhibit (spatial organization and dioramas), the anthropologist entered biological information on the early hominids recreated in the hall, and the C.N.R. researcher managed ensure that accessibility criteria were followed.
- *Distributed access*: through a Web-based application the system should allow to access independently from the user location. In our case, the involved experts can use the system everywhere they are (i.e. experts coming from different cities, countries or departments).
- *Adaptable user interface*: based on the typology of the users / experts who access to the system, the system should be able to provide the needed information in an appropriate manner. In our case, the environment provides an editing form for experts who have to input the visual and notion captions, or a list of figures with all information for evaluation by end-users.
- *Accessible and usable UI*: the user interface has to be used easily by each kind of user regardless his/her ability. The system should comply accessibility and usability guidelines for Web sites.

7 Conclusions

In the present work, we addressed the important issue of accessibility and usability of Museum web sites that should allow online visits suitable for vision impaired users navigating through screen reader. In particular, we provided a methodology to create a system of additional and alternative descriptions able to present, appropriately, scientific specimens and art pieces. Such methodology, applied on the web pages of a museum, has been studied and tested to provide complements of information without complicating the web page framework, thus avoiding confusion and disorientation.

We also stressed out the necessity of a team of experts, whose expertise in different topics must be combined to provide effective and useful image descriptions

to web designers, who will integrate in the web site. The problem of scientific image description, requiring precision, competence, and expertise, goes beyond web sites and involve several other fields. A methodology analogous to the one presented here could be applied electronic books and all the scientific material addressed to blind users (tools, specimens, etc). For example, a similar approach could be adapted to off-line materials/tools such as multi-medial CDs, PDAs, mobile devices and/or touch-screens (in this last case for low-vision users) to be used during visits to museums, scientific exhibition, and in any other case scientific contents have to be accessed by blind users. Beyond science, extra accessibility requirements would be necessary for example for architecture, engineering, and art (like sculpture and painting) exhibitions. In fact, every subject dealing with non-textual object (images, technical design, graphs, formulas, etc.) need a similar system of alternative image descriptions and information organization to become really accessible.

The cooperative environment proposed to create Museum web sites could be easily recycled for any type of elaboration involving such subjects.

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