

Web for All: An User-Centred Design Approach for Making More Usable and Accessible Web Sites

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Abstract

The paper presents aspects of design that would improve web accessibility and usability not only for people with disability but for all users. Accessibility means that an information can be reached, used, and understood by any kind of user independently of skill, disability, and hardware or software configuration.

Our experimental methodology which tests web accessibility and usability through several tasks that disabled users should carry out, are discussed. The metrics used are accessibility, site structure comprehension, information reaching through navigation or by using a search engine.

Our experimental results showed critical problems with respect to accessibility, such as structure of pages, quality of colours and scalability of characters, images, clarity of language, navigation aids, search engines, and crucial technologies. Some suggestions for solving these problems are given in the paper.

1. Introduction

Nearly 80% of the population now lives past the age of 65. In addition, more people are now living with disability. These demographic changes result in a population that is older and more disabled than many realize, and these trends will continue.

This new situation requires that online information and services made available through web sites are accessible for all.

Accessibility means that an information can be reached, used, and understood by any kind of user independently of skill, disability, and hardware or software configuration. We could define accessibility as being accessible to people with different needs, including people with different types of disabilities. Accessibility problems fall into several basic categories: browser requirements, user requirements, bandwidth requirements, and simple usability. Different needs and disabilities greatly differ from each other and impose different requirements. The most important difficulties associated with access are:

- Visual impairment: blindness, restricted vision, colour blindness
- Motor skills: inability to use keyboard or mouse
- Hearing impairment: inability to hear audio in multimedia presentation, difficulties in understanding audio information provided in the website
- Cognitive abilities: reading difficulties, dyslexia, memory loss
- Low grade technology: slow connections, old versions of software

The inspiring principle of accessibility is “universal design” or “design for all”, which states that every design activity should take into account the different needs of all potential users.

Universal design has long been an important goal in the design of the built environment. For example, it should be possible to enter a building and move inside it with a wheelchair, or without eyesight, or with limited cognitive abilities. The trend is to emphasize the need to design buildings so that they are equally suitable to all, instead of devising separate arrangements for distinct sub-populations. One of the most important result is that every people, even those with no disabilities, could benefit from more universal designs.

Table I: Operational requirements for disability and situation related

Requirement	Disability Related Need	Situation Related Need
Operable Without Vision	people who are blind	people whose eyes are busy ,e.g., driving a car or phone browsing, or who are in darkness.
Operable With Low Vision	people with visual impairment	people using a small display or in a high glare, dimly lit environment
Operable With No Hearing	people who are deaf	people in very loud environments or whose ears are busy or are in forced silence , e.g. in a library or meeting.
Operable With Limited Hearing	people who are hard of hearing	people in noisy environments
Operable With Limited Manual Dexterity	people with a physical disability	people in a space suit or chemical suit or who are in a bouncing vehicle
Operable with Limited Position or Reach	people who use a wheelchair or have limited reach	people who are out of position or have multiple devices to operate
Operable With Limited Cognition	people with a cognitive disability	people doing a task for the first time, or having to perform multiple tasks at once.
Operable Without Reading	people with a cognitive, language or learning disability	people who just have not learned to read this language, people who are visitors, people who left reading glasses behind.

Web pages often have problems comparable to staircases and narrow doors. For example, if some essential interaction on a web page absolutely requires a pointing device like a mouse, this is a severe obstacle to people who cannot use such a device, or cannot use it with sufficient accuracy. Different software and site design arrangements can be used to solve the problem so that alternative methods, such as keyboard-only access, are possible. A particular

reason to promote web accessibility is that people with disabilities especially benefit from the use of the web, which helps them to overcome physical limitations.

Table I traces operational requirements that are make-or-break issues for people with disabilities to other situations where the capability is also needed [1].

2. Historical Remarks

From an historical perspective, the first approach to accessibility originated from the Trace Research and Development Center (TC) [2]. TC was specifically created in 1971 to address the communication needs of disabled people. With the emergence of the personal computer, TC became involved in making computers universally accessible. The computer design guidelines developed in various research efforts have spread out as principles of Universal Design. Principles of Universal Design can be synthesised in 7 laws, as in Table II [3]:

Table II: the 7 laws of universal design

1. Equitable Use.	The design is useful and marketable to people with diverse abilities.
2. Flexibility in Use.	The design accommodates a wide range of individual preferences and abilities
3. Simple and Intuitive Use.	Use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level
4. Perceptible Information.	The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities.
5. Tolerance for Error.	The design minimizes hazards and the adverse consequences of accidental or unintended actions.
6. Low Physical Effort.	The design can be used efficiently and comfortably and with a minimum of fatigue.
7. Size and Space for Approach and Use.	Appropriate size and space is provided for approach, reach, manipulation, and use regardless of user's body size, posture, or mobility.

The World Wide Web Consortium (W3C) [4] is the forum for promoting the progress of Web technologies and producing recommendations. Within it, there is a range of accessibility related activities, jointly known as Web Accessibility Initiative (WAI) [5], which have resulted in recommendations for Web authors, browser vendors, and other stakeholders. The most well-known WAI recommendations are the *Web Content Accessibility Guidelines (WCAG) 1.0* [6], which were approved in May 1999, and which are translated into several languages other than English [7]. The WCAG 1.0 recommendation divides its rules into three "priority levels" and defines corresponding "conformance levels" (A, AA, AAA).

2003 has been defined as the European Year of People with Disabilities [8]. The European Union is working on the programme "*e-Accessibility*" - *improving the access of people with disabilities to the Knowledge Based Society*.

In the United States much weight is given to "Section 508" [9] of the Rehabilitation Act as amended by the Congress in 1998 to require Federal agencies to make their electronic and

information technology accessible to people with disabilities. Basically "Section 508" rules are very similar to WAI recommendations and based on them.

3. Current Situation

Although there appears to be a growing awareness and concern with accessibility at all levels of society, nowadays most websites are not accessible, and this is primarily due to the fact that web designers aren't really concerned with whether blind people, or people with less than cable-modem bandwidth, can see their page. Instead, the practice of accessibility can lead to better and more effective performance by ordinary web designers by enriching their activity with new stimuli. Accessibility stresses the importance of many aspects of web design that can be critical to design effective web pages: colour perception in visual dysfunctions, theory of colour in its more general aspects, knowledge of W3C standards and their correct implementation, psychological and cognitive aspects of navigation, various types of language deficits, etc. Young web designers who are exposed to the theory and practice of accessibility will be able to enrich their formation with all these aspects.

The accessibility of public web sites is still very limited as indicated by the Fondazione Ugo Bordoni Annual Report on accessibility of Italian public web sites, presented in June 2003. The Annual Report analyzes 102 Italian public web sites with a methodology which assigns a total score based on 29 criteria. Only 20% of the sites (Fig.1) went beyond a minimum quality threshold (a score of 50 out of total 92 points). This means that users can reach information in only 20% of the sites even if with some difficulty. The remaining 80% present difficulties in accessibility for one or more categories of disabled users. Evaluations in 2003 indicate a small improvement with respect to the situation in 2002. (Fig.2)

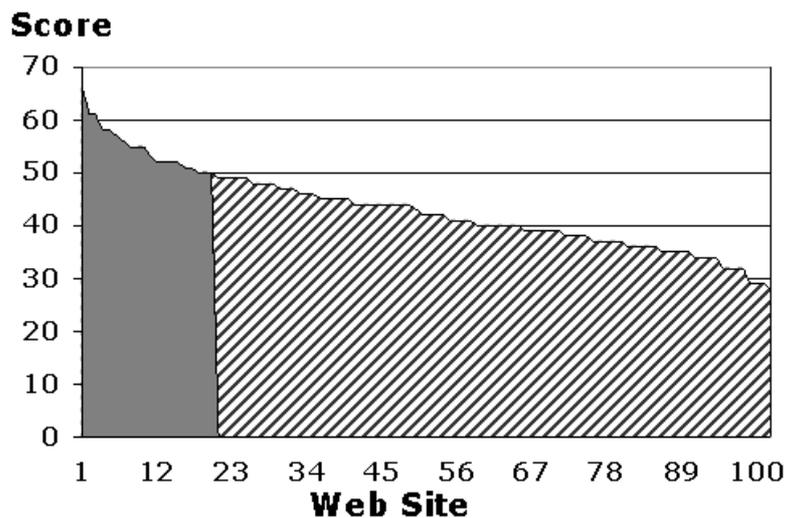


Fig.1: Score distribution of the 2003 report

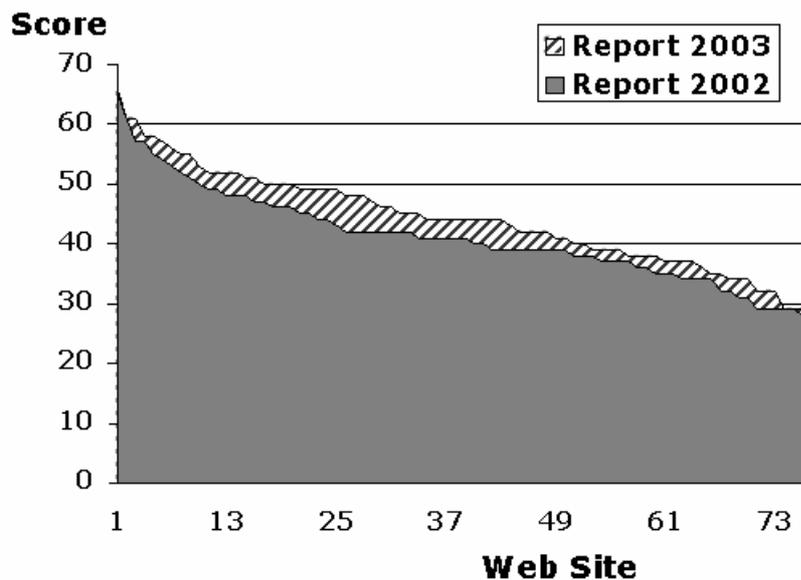


Fig.2: Comparison between 2002-2003 situation

We think that public web sites accessibility will always remain poor until the need of people with disability will be really understood and considered in web design.

In fact, up to now, even in the best conditions, accessibility guidelines are applied and then the site is tested with an automatic tool or through expert evaluation.

Following the guidelines and detecting violations is not always an easy job but it could be made easier by automatic testing tools which check web pages against the accessibility guidelines and report violations. Those tools are very useful since they carry out mostly of the heavy and boring work but they are technologically limited in the violations they can detect (even if the interpretation and correction of the detected problems require deep knowledge of html and accessibility).

Expert evaluation is useful in order to identify problems that require informed human judgement and that cannot therefore be detected by an automated testing tool. An expert may use an automatic tool as a starting point but will then carry out all the suggested manual checks and assess the site against all the remaining guidelines.

Unfortunately, accessibility guidelines often don't take into account the actual needs of impaired users since in these circumstances they should represent all different kinds of accessibility problems. In other words, we think that the main reason for web sites' poor accessibility is the fact that the user-centred design approach is not applied for developing most web sites [10].

In one of our studies [11] evaluation has been conducted in the real context of use, the computer-lab of a school for blind-people. In this case we referred to the model of *Situated action* [12] and *Activity theory* [13]: Interaction occurs in a specific environment, with real people, under specific conditions.

An ethnographic approach was therefore necessary, in order to reach a sound comprehension of accessibility problems related not only to content, software or devices, but to social, cultural and organizational issues related to the environment. Among others:

1. the computer lab of S.Alessio Institute was barely accessible to blind students without guidance by the school staff;

2. in some cases, noise from outside the computer lab, biased the speech reading activity.
3. low effort was taken to deliver students the needed knowledge to operate assistive technologies.

We propose to add structured user tests, involving real users in a real working environment who are required to perform real tasks, to automatic tools and expert evaluations. This method allows to identify real problems with information design, structure and content, visual design and interactive features.

4. Methodology

Our methodology for developing and evaluating accessible web sites includes three different phases:

1. Automated testing tool
2. Expert evaluation
3. Structured user tests

4.1 Automatic Testing Tool

Torquemada is an automatic testing tool for accessibility, developed in the Fondazione Ugo Bordoni. It is the first and only tool for accessibility completely in Italian and its aim is to help the spreading of the accessibility issue also in the Italian reality. Torquemada can be freely used online from the page of the project Webxtutti [14]. Torquemada runs 49 checks of html code, following the WAI guideline and returns a report where the line, the type and the visual appearance of each detected violation are clearly indicated.

4.2 Expert Evaluation

Expert evaluation consists in the application of an analysis protocol made of 29 check points which analyze all web accessibility problems that cannot be automatically verified. An expert, i.e. someone who is familiar with accessibility guidelines, the nature of disabilities, assistive technologies used by disabled people, and the technologies used to create web sites, runs the evaluation giving a score on web pages quality. The aim of expert evaluation is to have a precise picture of problems that a particular site has with respect to accessibility.

4.3 Structured User Tests

We developed an experimental methodology that tests web accessibility and usability through several tasks that disabled users should carry out. The metrics used are accessibility, site structure comprehension, information reaching through navigation or by using a search engine. The evaluation concerns 4 different aspects:

1. whether a page can be reached
2. accessibility of web pages
3. search through navigation
4. search through a search engine

Testing whether a page can be reached

This phase verifies if an user, starting from the home page of a public administration site, can reach some crucial pages such as:

- Page describing search functionality
- Page with news
- Page that describes the specific P.A.
- Page for interaction with the responsible of the site.

The user gives a score using a scale from 1 to 4 (1=worst, 4=best) and possibly a comment.

Accessibility of web pages

The user is asked to give a judgement about the accessibility of given pages. Users are often aware that they cannot reach some information.

Search through navigation

The user is given a scenario asking him/her to reach a particular information by navigating the site starting from the home page. The user gives a score using a scale from 1 to 4 (1=worst, 4=best) and possibly a comment.

Search through a search engine

The user is given a scenario asking him/her to reach a particular information by using a search engine. The user gives a score using a scale from 1 to 4 (1=worst, 4=best) and possibly a comment.

5. User Trials

We ran an experiment with 12 users with different disabilities: 2 blind people, 5 people with restricted vision, and 5 deaf people.

5.1 Findings

The experimental findings emphasize the following critical problems with respect to accessibility:

1. Structure of pages (lack of separation between form and content)
2. Quality of colours and scalability of characters
3. Images
4. Clarity of language
5. Navigation aids
6. Search engines
7. Crucial technologies

5.1.1 Structure of Pages

Web pages are often full of links and information. Such a page complexity may not be a problem for those users who are able to “see” the screen and to process the page “at a glance” in order to understand whether it contains interesting information.

On the other hand, page complexity can represent a severe accessibility problem for blind users since their navigation modality is linear. Using a screen reader or a Braille bar, they scan the page one item at a time, never having an overall picture of the whole page. For blind users navigating a complex page can be a long and boring process since they have to keep into account too much information. This is not a simple accessibility problem but rather a problem of usability of accessibility: information can be reached but how to use the information is not optimized.

In order to improve the navigation of complex pages for blind users it is important to better organize the information and to use correctly the structural html elements. Our proposal is to insert hidden navigational menus which allow the users to ignore such constant features of a page as navigation bars and to go directly to page content. Furthermore we suggest to insert rapid access keys to the fundamentals elements of the sites, such as search engine, site map, and so on.

5.1.2 Quality of Colours and Scalability of Characters

Often in web design aesthetic motivations are more important than functional motivations such as page readability.

To allow user with restricted vision to read a web page, change of colours and scalability of characters are two crucial aspects.

With respect to colours, since one cannot assign a priori a colour pair for indicating foreground/background, users should be able to change colour pairings according to their tastes and exigencies, (e.g. some users prefer green on black.)

The same applies to character dimensions. Each page should allow the enlargement of font size. The use of fixed size is strongly thoughtless.

Given the different devices used for navigating the web (PDA, cellular phones, screens with different resolutions), it is a good practice to guarantee a fluid layout, which generates pages that are able to adapt to every configuration utilized.

5.1.3 Images

An image gives visual information. In order to guarantee images accessibility, a textual description of information communicated by images should always be given (using the ALT attribute).

When a screen reader finds an image without a textual description it reads the URL of that image. In our experiment we noted that blind users were often confused and bored because the screen reader read long URL, and they suspected that they couldn't reach useful information.

5.1.4 Clarity of Language

One of the main problems we noted during our experiment is the difficulty users had in understanding information. Words used in public websites are often too technical and include many acronyms. This is due to the fact that people who insert content in public sites have a rather thorough knowledge of what they are talking about and they tend to assume the same knowledge in the users of the site. Considering that we are talking of public sites which have to goal to communicate information to all kinds of users (citizen), the problem is rather serious. The problem was particularly evident with deaf users: they have difficulty in language comprehension since their mother tongue is a sign language.

In order to solve this problem, public web sites should use a simple language and a focus group should evaluate the quality of content. Furthermore, one might think of adding tools that give some support to the user in content comprehension such as glossaries.

5.1.5 Navigation Aids

Usable web design should provide users with information about their position in the site and various instruments for orienting in the site, as for example “breadcrumbs” (a breadcrumb trail is a navigation tool that allows a user to see where the current page is in relation to the web site's hierarchy).

The site map and the index are also useful instruments since they allow users to have a general view of the site and to better reach the information.

5.1.6 Search Engines

In our experiments we dedicated particular attention to search engines. We noted that users who are not able to navigate a poorly accessible site tend to use a search engine in order to have a direct approach to the information.

The problems we found with search engines belong to two categories:

- Input interface
- Output interface

Input interface

First of all, although the input interface should be eminently accessible, we noted that most search engines in large web sites are not accessible [15].

An example is the web site of the Italian Railways [16]:the form for data insertion it is not accessible by a screen reader. Fig.3 shows the page seen by a user without sight problems (a) and the page “seen “ by a screen reader (b).

Da dove vuoi partire?

Dove vuoi arrivare?

Quando vuoi partire?
22 | 07 | 2003
A che ora?
10 | 17
Ricerca
Aiuto

Fig.3a: Screenshot of the site of the Italian Railways with enabled images

22 | 07 | 2003
10 | 17

Fig.3b: Screenshot of the site of the Italian Railways with not enabled images

One should notice that all the text in the form is an image with no comments. There are no labels that help in discriminating among different parts of the text. Even if the user were able to intuitively fill the form, he/she would be unable to send it because the command “submit” (“Ricerca”) has no comments and therefore it would not be seen by a screen reader.

Output interface

The output interface should be accessible as well. The report page should be well structured in order to allow the users who utilize a screen reader to navigate quickly through the results. The results page should give detailed information, such as title of page, summary of terms, and the page URL.

With respect to deaf users, who have linguistic problems, it is important to have a help modality to make suggestions for correcting potential orthographic mistakes made during query formulation.

5.1.7 Crucial Technologies

One should pay particular attention to the use of JavaScript, Flash animation, Java applets, and the technologies embedded in the html language that are especially critical with respect to accessibility. In many cases these technologies tend to create problems of backward compatibility with not very recent browsers and they tend not to be reproduced appropriately by screen readers. If the problem is intrinsic in the technology, one should also communicate the information in some accessible modality.

6. Conclusions

The experimental results indicate interesting aspects of design that would improve web accessibility and usability not only for people with disability but for all users. In fact, realizing information structures and architectures that are appropriate for disabled users should result in improvement in the perception and retrieval of information also by “normal” users.

Our approach to usable and accessible design emerges from the idea that *there is no average user*, aiming to satisfy the broadest possible range of user capabilities and usage environments. Using no assistive technology, people who were previously unable to navigate a site, to fill a form, to follow a link, or to interact with a Flash animation, are able to perform these tasks, whereas "the rest of us" find these tasks easier as well. Our approach doesn't assume that all users will be able to use all designs, but instead argue that by redefining our definition of the user, a much wider range of users can be accommodated without significant extra effort.

In the following graph (Fig.4), each figure represents a kind of disability with different problems with respect to information retrieval. The circle in the centre represents the level of information comprehension. The radius of the circle can be subdivided into different elements which may improve page comprehension: graphical layout, quality of colours, structure of information, code correctness, and so on. By improving web site accessibility and usability for disable users, general accessibility and usability for all kind of user will improve.

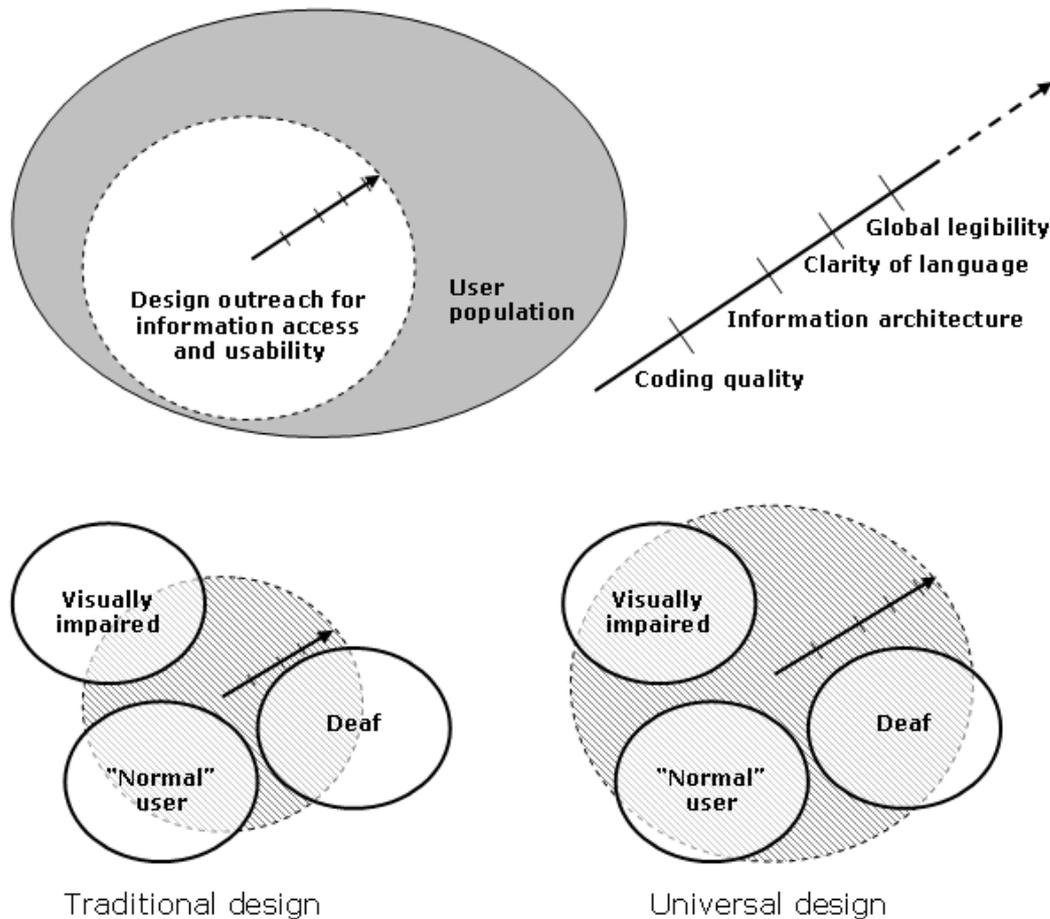


Fig. 4: Information outreach for traditional and for universal design

The results of our experiment demonstrate that an exclusively visual approach which has been privileged in the past is mistaken and that it is better to adopt a multimodal approach. What is crucial is the information to be communicated and used, whereas this information should be represented in a variety and multiplicity of ways.

In our experiments we have observed significant differences in perceived usability depending on the sensory channel used. For example, a blind user which navigates the web using a screen reader (i.e., using auditory input) has an attention threshold very different with respect to a “normal” user (almost entirely visual input). “Standard” usability, in fact, is strongly based on the visual aspect of a page whereas usability for disabled persons involves such factors as technology and the quality of the code behind the page.

A web site which is theoretically accessible is not necessarily easy to use, simple to learn, or able to support efficient job performance. As indicated in a study carried out by Jakob Nielsen [17], web's current usability is about three times better for users without disabilities than it is for users with disabilities. Focusing on usability can significantly improve the user experience for people with disabilities.

Our next works will focus on a better integration of usability and accessibility perspective; the experimental findings will be utilized in order to define new guidelines for web multimodal interaction.

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