

TOWARDS A QUALITY MODEL FOR WEB SITES

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Evaluating web sites quality requires appropriate evaluation criteria. Many of existing criteria are not easy to measure and require methods such as heuristic evaluations, or/and empirical usability tests. This paper aims at defining a quality model and a set of characteristics that can be measured in an automated fashion, relating internal and external quality factors and giving clues about potential problems. The first step in the quality assessment process is an automatic check of the source code, followed by manual evaluation, possibly supported by an appropriate user panel. As many existing tools can perform some analysis (mainly accessibility issues are considered), the general architecture will be based upon a conceptual model of the site/page, and the tools will export their output to a Quality Data Base, which is the basis for subsequent actions (checking, reporting test results, etc.).

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1 Introduction

According to the international standards bodies (IEEE, ISO) there are several points of view to define the software quality. The ISO standard defines three views of quality: *users' view*, *developers' view* and *managers' view*. Users are interested in the quality in use, which is mainly an external characteristic, while developers and managers are more interested in internal quality, which affects maintainability, portability, cost effectiveness, and so on.

Web sites are generally evaluated from the users' standpoint, so mainly considering external quality.

The Web as been the fastest adopted technology, but often the quality of web sites is unsatisfactory, and basic web principles, like interoperability and accessibility, are ignored or scarcely considered by designers. There are several reasons for the scarce quality, in spite of the attention paid to the quality in other sectors like Software Engineering. Among the others we can certainly mention:

- rapid evolution of technologies,
- mix of technologies,
- easy of writing HTML,

- “tolerance” of browsers, which display even non correctly coded pages.

The last two points, and the presence in the development teams of several professionals, not necessarily with a specific background, have certainly been among the reasons of the diffusion of the web. However, as a result, scarce attention has been paid to the internal quality.

The evolution of the Web towards a more complex XML based architecture requires greater attention to the correct usage of technologies and a higher skill. In addition, national regulations are more and more requiring that web sites are accessible and usable (for the Italian case, see [Signore2004]).

This paper aims at investigating on definition and implementation of quality criteria, looking for an approach that can relate external to internal quality, identifying which internal features affect which external characteristics. Quality aspects are therefore considered taking into account what can be objectively measured, by an expert or possibly through a fully automated process. Also an overall methodology to analyze the quality of web sites is suggested, to minimize human intervention.

In the rest of the paper, we firstly discuss general issues about web site quality. Afterwards, we briefly present some approaches, looking for

commonalities and differences. Subsequently, we give a rough description of our approach, which is yet presently at an initial stage.

2 General issues

Evaluating the quality of a web site requires expensive methods such as heuristic evaluations or/and empirical usability tests. In the first case a group of specialists (expert evaluators) apply their experience to conduct independent evaluations and usually it does not permit to find problems related to typical users of the site. In the second case a group of users with different background, age, and skills characteristics are called to browse the web site in order to evaluate their satisfaction in using it.

Until now the explosion of the web has determined the need of measurement criteria to evaluate aspects related to the quality in use, such as usability and accessibility of a web application. The objective is to make a web site useful, profitable, user liking and accessible. The World Wide Web is in fact a universal information space overcoming barriers created by humans towards people with different cultures or physical limitations ([TBL1999]).

One way to point out errors and gaps of a web site in terms of usability and accessibility is to identify possible source of problems, and then perform a check, either by the inspection conducted by an expert, and testing the site with real users. In the following we will analyze which are the characteristics that should be considered.

Finding clues to identify possibly weak points would be a remarkable step towards the development of quality web sites and also for time and money saving, reducing usability tests and expert evaluations.

3 Related work

3.1 Some approaches

We compared approaches defined in different communities (cultural, e-government, research and enterprise environments) looking for similarities and complementarities.

An important initiative towards web site quality in *cultural environment* is MINERVA (**MIN**isterial **NE**twork for **V**alorising **A**ctivities in **D**igitisation) ([Minerva]). The quality criteria have therefore a double objective: on the one hand they represent the quality factors for evaluating the quality of a cultural site on the Web; on the other hand they direct and support the process of design and development of a cultural web site. Quality is defined principally in terms of accessibility and usability (Minerva-qm)).

For *e-government* category we have analyzed the manual of "Quality criteria for a public-user-friendly and secure website" from the University of Bremen, most of all targeted for all e-government coordinators and those involved in implementation of e-government services [Bremen]. The identified criteria are classified as combination of different classification criteria. The model includes some aspects that should be important in web sites that offer services such as buying ticket or information material via web, or wish to support personalized visits using user profiles containing personal data of the user.

[Mich2003] presents an interesting and very flexible approach to evaluate a *generic web site*. The 2QCV3Q, also called 7-loci, is a conceptual model to evaluate web site quality based on seven dimensions: who-what-why-when-where-how, and feasibility (with what means and devices). The 2QCV3Q model takes its name from the initials of the Ciceronian *loci* on which it is based, namely: *Quis* (Identity), *Quid* (Content), *Cur* (Services), *Ubi* (Location), *Quando* (Management), *Quomodo* (Usability), *Quibus Auxiliis* (Feasibility).

A *usability-focused* evaluation method for hypermedia application is MiLE, based on a combination of inspection from expert evaluator and empirical testing through panels of end users [DiBlas2002]. The evaluation model here is based on two heuristic concepts: abstract and concrete tasks.

A more *analytic web site quality model* is proposed by ETNOTEAM ([Etnoteam]).

It is based on six attributes (communication, content, functionality, usability, management, accessibility). The model can be personalized: the sub-attributes are weighted depending on the site category. An evolution of this model is described in [Polillo2004].

A very analytical approach described in [Olsina2001] proposes a Web-site Quality Evaluation Method grounded in a logic multi-attribute decision model and procedures, intended to be a useful tool to evaluate artifact quality in the operational phase of a Web Information System.

Finally, standardization bodies such as ISO (international) or CEN (European) are trying to integrate different approaches to the definition of quality, starting from the awareness that the quality is an attribute that changes on preceptor's perspective and action context, and product's reason and cost. [ISO9241], [ISO9126] and [ISO13407] describe the standards for *usability* aspects, *quality of software*, and *user-centred production*. The ISO/IEC 9126 series standard ([ISO9126]) introduced a hierarchical model with six major quality characteristics, each very broad in nature. They are subdivided into 27 sub-

characteristics which contribute to *external* quality, and 21 sub-characteristics which contribute to *internal* quality.

Conformance to standards is also the basis of W3C quality assurance initiative [W3C-QA].

3.2 Some considerations

Quality evaluation approaches suffer from several limitations.

- They are essentially based on *qualitative criteria*, which can be error prone, or subject to controversial discussions.
- There is a general aim to define very *general criteria*, not addressing the specific type of site or page. There are differences among e-government, information, target specific, large public sites. These differences must be taken into account when measuring the characteristics of the sites, which should be appropriately weighted. For example, a link rich page can be considered a positive element for informative parts of a site, while could disturb in a service specific section/page, where the user should be driven to accomplish his/her task in a linear manner.
- Criteria are *not orthogonal*. Same characteristics are often considered more than once, so contributing to a higher or lower score, depending on they have been fulfilled or not. However, this is unavoidable. For example, appropriate usage of `<hn>` tags must be considered both under the accessibility and the usability (comprehension) aspect.
- Many evaluation criteria are essentially *accessibility or usability biased*. Even if the two areas have some overlap, stressing one of them can lead to wrong results. It may happen that a perfectly usable site is really not accessible, or that a technically accessible site may be scarcely usable.
- There is no clear distinction between page and site quality (*granularity*).
- The perception of the quality changes from *different user perspectives*: the final user is interested in external quality related to the usability and functionality of the site, while the developer is more interested to the internal quality related to software maintainability and portability (interoperability).
- Finally, to define a metrics, we need *measurable characteristics* and a rigorous approach ([Fenton1991])

4 The approach

Our quality model is a five dimensional model, considering: *correctness*, *presentation*, *content*, *navigation* and *interaction*. We deliberately ignore some other relevant aspect like performance.

This classification has been designed to cover a possible automated process for the quality evaluation, using pages and component of pages as elements to evaluate.

Correctness is a technical, internal aspect. The other four dimensions are more strictly related to the user's perspective.

The aim is to identify some user perceived characteristics, and relate them to the internal code. In this way we can identify possible points of weakness, and proceed with a focused user test, so reducing costs and increasing coverage of the critical issues.

The major part of information is gathered through in depth analysis of the source code, including the style sheets. Several tools to perform required analysis and to evaluate some specific aspects of web sites are available. Therefore, the main task is to define a *model of the site* and a *quality database*, where to store results gathered by the tools.

The expert will interact with the database to supply information that can't be derived in an automated fashion. In fact, automated tools can in general just give clues, while human intervention is needed for semantic interpretation.

Just as trivial examples, an alternative text for images (the `alt` attribute in the `` tag) is required for accessibility, and is easily detected by many accessibility evaluation tools, while its semantic correctness must be checked by human inspection of the code.

Other examples are the identification of layout tables, navigation sections, login areas, and so on, that should fulfil some specific requirements, like appropriate positioning, availability of skipping commands, appropriate order to optimize interaction when users read pages using assistive technologies.

In its first approximation the site model is very simple:

- a *site* is made of *pages*
 - a *page* is made of *page components*
 - a *page component* can include some other *page components*
 - a *page* is linked to a *style sheet*
 - a *style sheet* can import another *style sheet* (in this rough sketch we are not considering some additional aspects, like scripts).
- Pages have some properties, as *title* or *metadata*, and can be checked for valid code.
- Page components have some properties, too, like:
- *type* (div, table cell);
 - *purpose* (header, body, index/menu, footer, navigation, etc.);
 - *number of links*, more precisely *inner links* (in the page itself), *outer* (or *intra-site*) *links*, going

to other pages belonging to the same site, and *external links* (going to other sites).

It is easily seen that in some cases these properties can be evaluated by automated tools, while in some other cases it is necessary a direct inspection by the expert, who will update info in the database.

Automated tools will run and produce detailed information that will be imported in the database.

Finally the expert will query the database to identify possible points where an in depth evaluation is needed.

It is worth to point that information stored in the quality database can be useful to reduce maintenance effort, as can help in identifying side effects when something is changed.

In the following section we will briefly discuss the five dimension of the model, pointing as external quality characteristics perceived by users can be related to internal characteristics, identified by an appropriate parsing of the source code (including style sheets). It is quite obvious how these internal characteristics fit in the previously sketched model.

5 The five dimensions

We will here briefly describe the characteristics to analyze. It is worth to remember that the relative importance of some features changes depending on the specific site purpose, and also on the specific page component purpose. Therefore, all the resulting values must be *weighted*.

5.1 Correctness

Correctness is a merely technical aspect, which can be easily checked. Several tools are available to achieve the correctness of code, ranging from editors to repair tools. It is worth to note that even if such tools are available since many years, and are often free, a large number of sites would not pass the check. Positive effects of a clean code are not immediately perceived by the users. However, in many cases inconsistent behaviour with different browsers can be originated by lack of conformance to the published grammars (HTML, XHTML) and the actions taken by the browsers themselves as default.

After all, as writing a correct code or cleaning it is an easy and not costly task, a not valid page is at least an indication that scarce attention is paid to the quality.

5.2 Presentation

Presentation Criteria regard measurements of the whole site and of a single page presentation. More precisely referred to a single page they include:

- page layout

- text presentation (font size, character, etc.)
- multimedia presentation (images, videos, ...)
- links presentation

Layout. The page layout is probably the principal characteristic perceived by the user. Layout must be clean, and the whole content should be well structured. This also helps impaired people (blind or affected by cognitive deficit) as assistive technologies are well aware of paragraphs headings (`<h1>`, `<h2>`, ... tags), and paragraph structure makes content more understandable. Quite obviously, the `<h1>` tags must be used in the correct order, not just to get graphical effects. The correct usage of these tags can be automatically verified.

It is a common practice to use layout tables, as shorthand to compose the page. However, this practice has some drawbacks, especially when accessibility issues are considered. A more correct way to design the page layout is to make use of `<div>` tag, and it is even better when float `div` are used. Text browsers are able to present the page using a correct order of page components.

Layout must be adaptable to different devices. This implies that pages must avoid making reference to specific device settings, like screen resolution or fixed size page components.

An automated analysis of CSS usage and coding can supply information about the layout and the adoption of an organization wide standard. A clue for the existence of such a standard is the presence of a few style sheets, possibly referring (importing) a common basis, with a limited number of different definitions for the same properties (e.g. boldface, italic) or, in case several styles with the same properties are defined, having them identified with semantically significant names.

Text. There are many issues to consider about text presentation.

Used fonts must be suitable for easy reading. This implies several rules about colours and sizes:

- there should be enough contrast between foreground text and background colour (or image);
- it is difficult to distinguish colours differing for only one of the RGB components;
- users have difficulties in reading texts written in blue using small size characters;
- designers should avoid to present long texts written in uppercase or italic;
- fonts must be chosen among the most readable ones;
- font size must be defined as relative size;
- in a single page, the number of different fonts must be limited;

- when using different fonts and/or font sizes, they should have some specific meaning (e.g. notes, links, navigation location).

Needless to say, these characteristics can be detected and measured by parsing both the text and CSS. It is also worthwhile to note that some of these requirements are both accessibility and usability related.

Multimedia. Multimedia is an important component of web sites. However, we must distinguish cases where multimedia components are essential, as they convey an important message, from cases where images or sounds are just enriching the page, to make them more attractive. Some issues to consider are:

- the contrast between foreground image and background (colour or image);
- flickering or flashing (causes repeated reading by screen readers, and some frequencies can be dangerous for people affected by photosensitive epilepsy);
- the number of images in a page and image sizes (to keep download time acceptable, even when using low speed connection);
- image quality (for museum web sites, image quality must be very high, however, the IPR matters have to be considered, so, low quality images can be a design choice, or high quality images could be watermarked);
- every multimedia component must have a text equivalent, that can vary from a simple description or synthesis, up to synchronized media equivalents for time-dependent presentations, depending on the importance of the multimedia component;

Links. Links are an important component that we are considering here only under the aspect of their presentation. Issues to consider are:

- number of links
- number of broken links

Number of links must be carefully evaluated, as some of them can just be menu links, and also their grouping must be considered. Finally, the page purpose can require a high or low number of links.

Forms. At the presentation level, forms must be evaluated considering their accessibility features (labels, field filling with default data, appropriate sequence of fields and possibility of moving using tab key).

5.3 Content

Issues to consider are:

- readability (words for sentences, syllables for words, total of words, number of new lines, titles and subtitle length and so on);

- information architecture (different level of difficulty, summary and stretchable text for widening, customizable information);
- information structure (number of subheading per heading, number of paragraphs per heading, mean length of paragraphs, total length of a paragraph, number of sentences in a paragraph);
- distinction between author and webmaster;
- indication of currency of content (last update date).

As seen in the different approaches one of the general aspects considered about the content is the correctness of the information. This aspect is of greatest importance in some specific cases, like museum web sites, as incorrect wording conveys an image of scarce attention. It includes the usage of language, the articulation of complex concepts, punctuation, absence of duplication and repetition. Incorrect information can completely ruin the web site credibility.

Readability, a concept related to web site usability, is an aspect considered since a long time, and includes the *visual* and *linguistic* readability [Flesh1949]. The first one regards problems of reading through a video (low resolution reduces the readability), as the artificial light of the monitor reduces the reading of 25-30%. The linguistic readability regards the syntax and the usage of the language. Among the others, we recall the *Flesh index* (and its Italian version, the *Flesh-Vacca index*) the *Gunning's Fog Index*, and the *Kinkaid Index*.

Another important aspect to consider is the design of information architecture. This becomes a crucial problem, especially when there is a lot of information related to the entire web site application domain and/or the site is doomed to be used from people with different characteristics (knowledge level, backgrounds, etc.) as for portals. In this case should be useful adaptive or adaptable criteria that personalize the visit of the site for the corresponding user (more easily for casual users and more specific and with more technical information for expert users).

5.4 Navigation

Link topology has a great importance. Some sites are just trees of nodes, with links from a node pointing to children and to ancestors. Some others have a much more complex link topology, with a lot of horizontal or transversal links. Aspects to consider are:

- the site structure (graph of nodes and links);
- horizontal and vertical navigation, mixed navigation;
- navigation bar.

Some links are "*more equal than the others*", as they can implement intentional links that lead to a

concept space ([Signore1995], [Signore1997]). This characteristic requires an expert inspection, which could be supported by automated tools, but remains quite subjective.

5.5 Interaction

The main way of implementing interaction is using forms. Issues to consider are:

- transparency (user is advised of consequences of form filling and submitting);
- recovery (undo is available on the form page or after form submission user is advised of completed action and has an undo possibility);
- Annotation facilities (if the user can contribute to the web site content).

5.6 Additional considerations

Aspects such as brand, charisma, graphical characterization can't be measured through an automated process but require inspective

evaluation. Information stored in the quality database can help in identifying where to perform such an in depth analysis.

Other important aspects to consider in some environments are the professionalism and effectiveness of the web site that could be measured through how many different platforms are supported (mobile phone, PDA, WebTV) and if it supports adaptivity and adaptability for a personalization ([Marucci2000], [Signore2002]).

Finally quality attributes could be the legality that includes the originality of the included materials (artworks, music, manuscripts, and so on), the international copyright laws, the legality of the information and activities.

Table 1 reports a summary of the previously described characteristics, also showing if they must be considered at local or global granularity.

	Local (single page)	Global (entire site)
Presentation	layout: <ul style="list-style-type: none"> ▪ <div> HTML tag ▪ paragraphs structure analysis <h1><h2> HTML tag ▪ layout adaptable to different devices 	Presentation design: uniform layout (CSS usage and analysis)
	text: <ul style="list-style-type: none"> ▪ contrast between text and background or images ▪ colours differing for more than one RGB component ▪ avoid uppercase or italic for long text ▪ avoid blue for small text or images 	
	font: <ul style="list-style-type: none"> ▪ relative size ▪ The number of font must be limited ▪ Different fonts for different meanings 	Font usage coherence in the whole site (CSS usage)
	multimedia: <ul style="list-style-type: none"> ▪ contrast between foreground and background ▪ Flickering of flashing ▪ Number of images and images sizes ▪ Image quality ▪ Text equivalent for each multimedia 	... support different devices
	links: <ul style="list-style-type: none"> ▪ number of links ▪ number of broken links 	
	Forms structure (accessibility criteria)	<ul style="list-style-type: none"> ▪ forms style coherence; ▪ research field even available;
Content	Readability: <ul style="list-style-type: none"> ▪ index conform to the site typology ▪ words for sentences ▪ syllables for words ▪ Number of new line 	Information architecture design: stretch texts, different text for user profiles (conditional text), summary with widening
		Horizontal links for widening (related topics)
Navigation	Navigational bar with link to home page (for each page)	Navigation architecture: horizontal, vertical and mixed navigation, with related number of links
	External links (user is advised when link points to external sites)	
Interaction	Forms: <ul style="list-style-type: none"> ▪ Transparency (user is advised of consequences of form filling and submitting) ▪ Recovery (a undo is available on the form page or after form submission user is advised of complete action and has an undo possibility) 	

Table 1. Summary table of our criteria

6 Discussion and Conclusion

In this paper we have defined web site quality measurement criteria which can help in relating external and internal quality.

Our classification is based on a web site user perspective and has been designed in view of a possible automation of the evaluation process. Attention has been paid to the identification of criteria which can be objectively evaluated and measured.

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