Using the MetroWeb Tool to Improve Usability Quality of Web Sites

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Abstract

This work addresses the question of supporting web designers in considering usability in their work in order to foster user-centered design of web sites. With the MetroWeb tool that is described in this paper, designers can access usability guidelines contained in usability knowledge bases, and use them to design a particular web site based on these usability guidelines. MetroWeb consists of a Java-based application helping usability experts to gather usability guidelines coming from different sources and to organize them in a structured way. It then provides designers with guidance in using these guidelines according to a semantic network of concepts structured around the notion of guideline, such as ergonomic criteria, development phase, bibliographic reference, type of web site, type of web page, etc. A first experiment was conducted with professional web designers in order to evaluate their appreciation of the MetroWeb tool. They had to create two web pages with or without the support of MetroWeb. The main results showed that designers using MetroWeb took into account more usability guidelines and made web pages with less usability errors than designers without MetroWeb.

1. Introduction

Taking into account the usability of a web site is very important nowadays and a very well recognized asset in order to guarantee the quality of web sites [5,8]. Indeed, it is frequent that users leave a web site because the web site suffers from some usability flaws that prevent them to accomplish their interactive task: dead links, poor navigability, lack of guidance, inconsistencies across web pages, difficulty to find out the right link. The vast majority of the designers considers usability as an important quality factor of their applications but do not know really how to respect it [5]. While they usually volunteer to take usability guidelines into account when required, they usually ask what kind of support they could benefit from in order to achieve this mission [7]. To assess the usability of a web site, evaluation methods and tools exist, but are not well-known by web designers [8,13]. To address this shortcoming, a tool named MetroWeb, is presented; it allows accessing knowledge bases of usability guidelines, where these guidelines are linked to useful related concepts like an interface object on which the guideline can be applied, or an evaluation method that is able to assess the guideline. The usability knowledge could be enriched at any time and explicitly used during design and evaluation processes in a continuous way, shared by everyone implied in the web site development. For instance, any usability guideline that has been elicited during the design phase could be further used to assess the usability of the future web site against the same usability guideline.

Although the tool presented can manage usability knowledge about any potential type of interface and a large spectrum of evaluation methods, we focus it on UI for the web with heuristic or expert-based evaluation [1]. The tool is web-distributed to manage usability knowledge in a flexible and autonomous manner that can be run on multiple computing platforms. The tool will respond to design questions with guidelines and resources exploitation.

This paper is organized as follows: Section 2 reports on the most significant pieces of work related to the usability guidelines support. Section 3 presents the semantic framework on which MetroWeb is relying. Section 4 presents the designers' tasks to be supported by MetroWeb. Section 5 shows the implemented tool and explains how to use it during web site design. Section 6 presents a first experiment conducted with web designers, using or not the MetroWeb tool. Section 7 presents the conclusion and the future work.

2. Related Work

Tools appeared to access to usability knowledge, organized in guidelines bases or in a hypertext form [11]. In a first time, usability guides were diffused on paper, but rapidly others appeared on hypertext form. Hyperlinks linked guidelines to resources (e.g., bibliographic references or usability criteria). After that, hypermedia permitted to link usability knowledge to illustrative examples (e.g., screenshots or videos). This supports did not permit to make efficacy research on the information. For that reason software appeared to manage usability knowledge bases, permitting to structure and research the information. Some of this software's are:

- SIERRA [17], which manages usability knowledge bases with an hypermedia system
- Sherlock [11], which manages usability guidelines with an client-server system, evaluating some guidelines or diffusing advices to repair non-usable interface
- GUIDE [12], which links used guidelines to a particular application and records the knowledge to reuse it on cases.
- The TELE-environment [9], which consists of a multimedia learning system for the web, which manages interactive examples and cases linked to guidelines, to support designer to consider usability in the design process.

Unfortunately, these tools manage only one base at a time and for that reason remain too rigid in the development cycle. Moreover, they do not support continue evaluation, except Sherlock [11], which allows accessing guidelines during the whole design cycle. User-centered design is not really supported by these tools and the guidelines contextualisation is poor. Indeed, some design questions are not covered, e.g. "which are the guidelines linked to this context of use or to this ergonomic criteria?". To address the above shortcomings, the MetroWeb tool is presented.

3. The MetroWeb Framework

MetroWeb structures usability knowledge according to a conceptual framework which is composed by the usability knowledge itself and everything that is considered useful towards conducting a user-centered design based on usability guidelines. This framework is therefore appropriate for only this particular method of designing web sites, but may be revealed inappropriate for other types of methods and techniques that also support user-centered design, like user testing, questionnaire-based design, contextual design, participatory design, etc.

3.1. Web Usability Guidelines

The core concept of the MetroWeb framework is the usability guideline. A *guideline* consists of a design and/or evaluation principle to be observed to get and/or to guarantee a usable user interface [7]. Guidelines can be found in many different formats with contents varying both in quality and level of detail, ranging from ill-structured common sense statements to formalized rules ready for automatic guidelines checking [2,13,18]. Certain rules are validated by experimental results provided by user tests, experiments in laboratory or other techniques, and other guidelines are not validated, but provided 'as is'. Guidelines can be classified (Figure 1) by type (ranging from the most general to the most specific: principles, guidelines, and recommendations) and source [13].

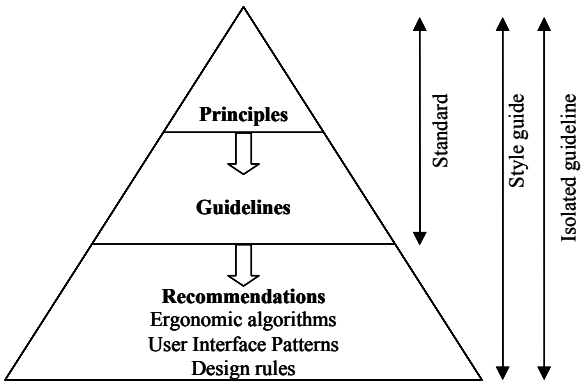

Figure 1. Types of guidelines and sources.

Principles are general objectives guiding conceptual UI decisions. They reflect the knowledge around human perception, learning and behavior, and are generally expressed in generic terms like "Use images and metaphors consistent with real world" so that they can be applied for a wide range of cases.

Guidelines are based on principles specific to a particular design domain. For example, a web design rule can stipulate to "use a consistent look and a visual language inside the site". Some guidelines have to be interpreted more and altered to reflect the needs of a particular organization or a design case.

Recommendations (or *conventions*) univocally determine conceptual decisions specific to a particular domain of application and should reflect the needs and the terminology of a given organization. They are unambiguous statements so that no place for interpretation is left. Recommendations include ergonomic algorithms, UI patterns and design rules. Design rules are functional and/or operational requirements specifying the design of a particular interface, e.g. "Every web page needs an informative title".

Different topics characterize web guidelines [13]. For example, accessibility guidelines present recommendations to transform a web site so it can be used by the widest population possible of users, including users having disabilities and using limited computer resources. An example of an accessibility guideline is "Add an alternative text to each image allowing screen readers to synthesize this text for describing the image". During the user-centered design cycle of the web site, the designer may need to check any web page against particular usability guidelines, e.g. guidelines dedicated to web page title. MetroWeb is aimed at gathering and disseminating such knowledge.

3.2. Resources linked to Guidelines

The web designer can also be interested in which evaluation methods use to assess a set of guidelines. When designer decides to choice an interaction object to put in a web page, she/he can need to access to the guidelines linked to this object. If she/he wants to assess usability criteria in her/his site, like consistency e.g., she/he needs to know which guidelines are linked to these criteria. In parallel, to which criteria is linked such guideline is important to know. In a particular context of use, such as the use of the web site by people with disabilities, specific guidelines (e.g., accessibility guidelines), have to be respected. Moreover, the designer needs access to illustrative examples of the guidelines, references or related guidelines. Figure 2 shows an example of a guideline linked to resources.
An entity-relationship schema exists that structures considered usability concepts into 40 entities and 34 relations between them.

3.3 The semantic network

This section presents the semantic network on which MetroWeb is relying, in order to address typical design questions raised by designers. Actually, it is frequent that, during a user-centered design cycle of the web site, the designer needs to assess particular families guidelines depending on the design goal, e.g. guidelines dedicated to the elaboration of forms. Guidelines can also be related to a development phase, like the specifications. The designer could be interested in which evaluation methods could be used to assess a set of usability guidelines. When a designers chooses which interaction object should be added in a web page, she/he may need to access the guidelines linked to this given widget. If she/he wants to assess ergonomic criteria on the currently being designed site (such criteria include for instance consistency), she/he needs to know which guidelines are linked to these criteria. In this way, a criteria could be assessed through validating the usability guidelines that are attached to this criteria. In parallel, to which criteria are linked such guidelines is important to know. In a particular context of use, like the use of the web site by people with disabilities, particular guidelines (e.g., accessibility guidelines), have to be respected. Moreover, the designer needs to access to illustrative examples of the guidelines, references or related guidelines. The complete structure of concepts that are related to the core concept of a usability guideline is explained and exemplified in Figure 2, where all related concepts are linked around a guideline. The concepts are then defined one by one.

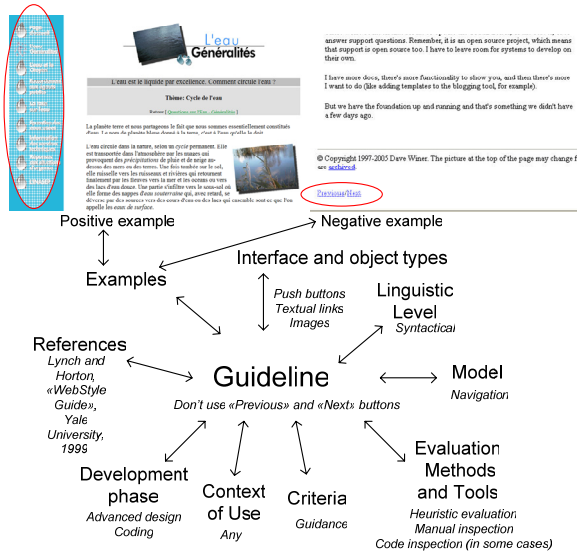

Figure 2. Concepts of the MetroWeb Framework.

Ergonomic criteria lead to an elaborated, efficient, sophisticated, friendly user UI [7]. Nielsen's linguistic model [14] separates human-computer interaction into seven layers ranging from the highest level (the closest of the human world) to the lowest level (the closest to the computer world).

In a guideline evaluation process, other interface information has to be specified: *interface and object types*, *context of use* and *development phase*. Indeed, evaluator needs more information about the guideline than the guideline itself. For example, evaluator needs to know to which types of user, task and environment the guideline applies. This information forms the context of use [12].

The *evaluation methods and tools* must also be specified, in order to illustrate to the evaluator how to resolve the usability problems experienced.

Positive and negative examples and bibliographic references reinforce also the evaluation when presents.

If the evaluator needs to assess a particular interactive object of a particular interface, she/he can

consult all the guidelines linked to that particular point. If an evaluator wants to evaluate a specified guidelines base in the evaluated interface, she/he can consult the evaluation methods and tools permitting guidelines base assessment. Navigation can be made from whatever input point and by direct manipulation. These concepts are structured in a semantic network. This network allows different types of reasoning because it contains several facets [15]:

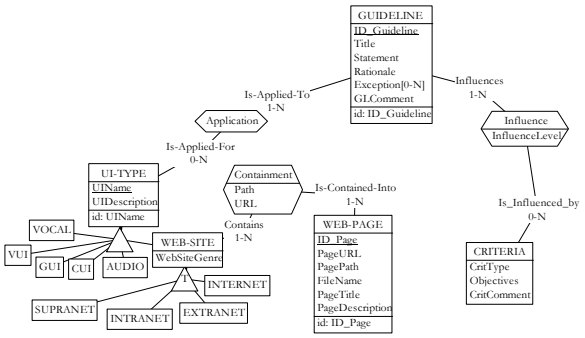

Figure 3. Concepts involved in the implicational reasoning.

- **Definitional**: any entity of interest is described by its own definition in the guidelines base, i.e. by the attributes. Moreover, relationships link entities, e.g., the entity Web-Site is a subtype of the super type UI-type and is the super type of Intranet, Extranet and Internet. Decomposition relation can also link objects to sub-objects, e.g. a Concrete Interaction Object (CIO) [16] can be composed by other CIOs. In this way, usability knowledge is attached to the highest level of application.
- **Assertional**: assertions can be added between guidelines, e.g., the guideline stating that, in a web site, each image should have an alternative text is no more valuable when another image with the same alternative text stays next to the image.
- **Implicational**: implications can be incorporated between contents. For example, if you consider a guideline, then you also need to check if it respects other guideline(s) implied by this one, e.g., a guideline stipulating that web site look must be consistent in the entire application applies to all the objects of the interface. To evaluate this, the consistency has to be assessed in each web page of the web site. For that reason, each guideline part of the consistency criteria must be assessed in each page of the web site to evaluate. The concepts involved in that reasoning are presented in Figure 3. The evaluation of the consistency guideline can be formulated on this way: ((∀ g ∈ Guideline, ∃ c ∈ Criteria | c.CritName = « consistency » ∧ Influence (g, c)) ∧ (∀ u ∈ UI-Type | Type (u) = Web-Site) ∧ Application (g, u) ∧ ∀i ∈ {1, …, n} : containment (pi, u) ∧ pi ∈ WebPage) ⇒ Application (g, {p1, …, pn}). If the evaluation concerns several web sites, we must verify each application page. The consistency evaluation is called inter-application, and no more intra-application.
- **Executable**: in our network, associations between evaluation tools and guidelines are specified so that any usability knowledge content that can be automated is delegated to a tool to be executed [2].
- **Pedagogic**: the usability knowledge managed by MetroWeb, e.g. evaluation methods and tools, can generate tutorial, guided tours, pro's and contra's argumentation of the design cases, and teaching of design through examples. This pedagogic facet is shared by other Tools for Working with Guidelines (TFWWGs) [9].

These five facets permit to support different searching paths linked to user-centered design. Web design based on usability guidelines permits to consider the user in the development. Other user-centered methods are explained in [8].

4. Supporting Web Design based on Usability Guidelines

The MetroWeb tool allows recording structured usability knowledge to be used during the web site development and/or to use this information to guarantee the usability of a web site. The tool diffuses different guidelines bases (e.g., web accessibility, WebTV, etc.) and permits to designers to create her/his own bases from the initial one. The collection of the guidelines depends on the user's needs. Does the user want to use existing usability guides or create her/his own? Designer can also use existing sources to create her/his guide, contextualized to the organizational needs (types of web sites analyzed, development phases to cover, evaluation objectives like code verification of home pages or semantic analysis, etc.). Our tool permits the management of multiple guidelines bases, whatever the source. The organization of the guidelines is the main goal of the tool. The guideline itself is structured as a hierarchy. Each guidelines base created can manage sections and subsections, as deep as needed.

Once a guidelines base is created, it can be used for various evaluation and teaching purposes (e.g., browsing them, searching specific guidelines freely or design question searching, or by teaching, as represented in Figure 3). A typical path consists of carrying out the following actions: browsing through the base to find out relevant guidelines, searching for them, and gathering a set of related guidelines for a particular design question or option to address.

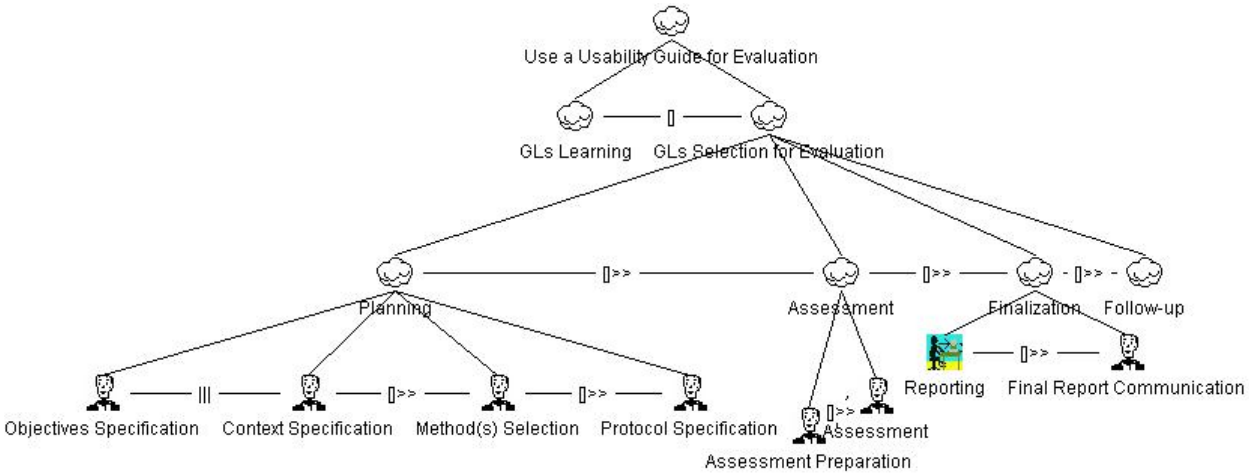

Figure 4. Tasks of Guidelines Use for Evaluation.

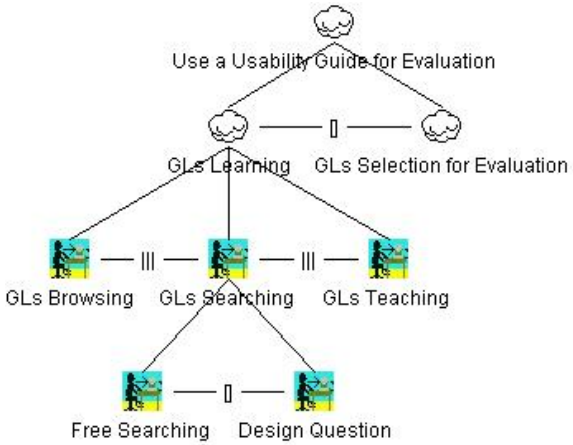

Figure 3. Tasks of Guidelines Learning.

The evaluation reporting task will be totally supported by our tool (Figure 4), by a specific evaluation module, which is currently under development. This module, coupled with an automatic evaluation tool [2,3,18] will allow the evaluator to choose which information should be recorded in the evaluation task (e.g., screen shots, guidelines, scenarios, date, etc.) and to record it when she/he evaluates her site. The tool supports partially the other evaluation tasks (except the follow-up) by providing information helping the evaluator judgments (e.g., information about which methods to use according to the evaluation context).

5. The MetroWeb Tool

5.1 MetroWeb Description

To permit the portability and the low cost of the tool, MetroWeb was developed in Java/Swing, linked to a Borland Interbase database (http://info.borland.com/devsupport/interbase/opensource). This database management system has been selected both for its performances and its free availability on multiple computing platforms. Different views are proposed to the user, corresponding to her/his task (list of guidelines, detailed guideline, detailed resource, etc.). The user (i.e. the designer or the evaluator) can move between views with direct manipulation. The presentation is focused on guideline.

The complete view (Figure 5) presents in one screen the guidelines and resources hierarchy, details and links, thus providing the end user with a complete overview of a guideline and the context in which a particular guideline could be applied. The concepts related to the guidelines (Figure 2), except the interface and objects types, are implemented. Guidelines are contextualized in order to provide complete information about how to apply them in a web development cycle. On the layout, (1) is dedicated to guidelines hierarchy (one base is composed of a hierarchy of sections and subsections), (2) shows the resources hierarchy (example, references, etc.), (3) edits the guideline information (title, comment, exception, etc.), (4) edits the resource information (name of the author, date, etc.), (5) permits to link guidelines to resources (reference, evaluation method, etc.), and (6) permits to link resources to guidelines.

Knowledge manipulation is supported in direct manipulation because the user can switch between views instantly, by moving the slide bars appropriately. Figure 6 shows the different possible views, obtained by direct manipulation of the slide bars, and the relations between these different views. From the complete view, the other views can be produced depending on the focus desired by the end user: more on the guideline itself or more on the resources needed to apply it. For instance, what are the methods that could be applied to ensure the guideline? Positive or negative examples are always welcome to illustrate when and where a guideline could be applied (as exemplified in Fig. 2).

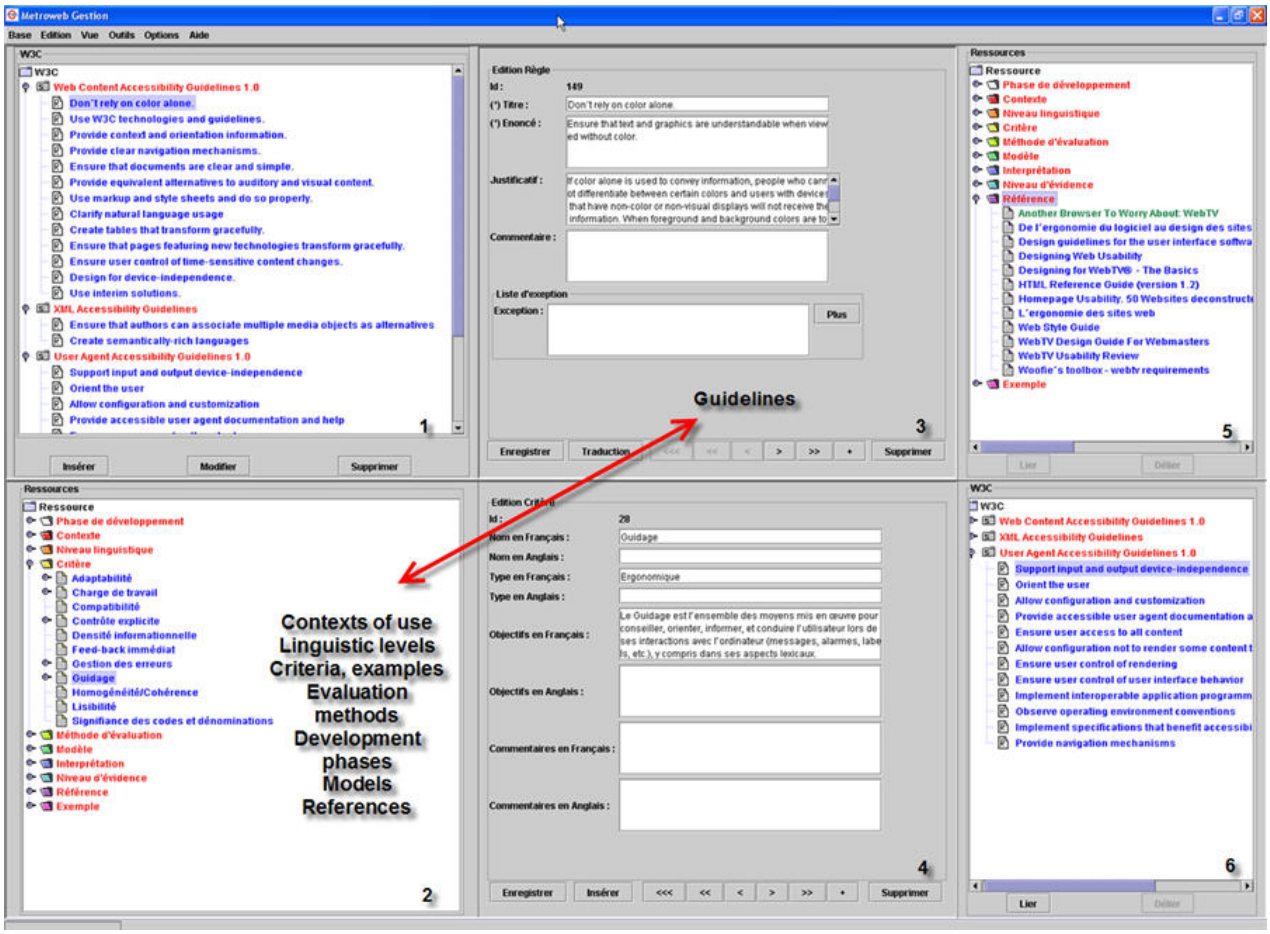

Figure 5. The MetroWeb Tool: complete view.

By moving up or down the horizontal slide bar, the complete view (Figure 6, view 1, Figure 5) is transformed in a detailed view of guidelines or resources (Figure 6, view 2, Figure 7), contextualized by its hierarchy and links. By moving left or right the slide bar, the complete view becomes more detailed for revealing guidelines or resource views (Figure 6, views 3 & 4, Figure 8), keeping either its hierarchy or links. These views can provide the user with a detailed view of guidelines and resources (Figure 6, view 5), without hierarchy and links, by moving vertical slide bars. The last view shown in Figure 6 consists of a detailed view of guidelines or resources without hierarchy and links. These navigation facilities between coordinated views are corresponding to different design questions.

During the design phase in the development life cycle, it is possible to identify usability knowledge required to address questions such as: "for this interactive task, what are the previous UI implementations (examples) that have been recorded with usability qualities?", "what guidelines do I need to consider to design a form in a web page?", "what are the most important design options impacting usability to be decided at design time?", "if I have to design a home page, what are the usability guidelines that I need to consider?", "If a search engine is to be provided, where and how should I locate the widgets implementing it?". Designer can access usability knowledge directly navigating the bases, or using the search engine during the design process.

In order to turn these design questions into an appropriate search through the guidelines bases, it is necessary to interpret the question in terms of the concepts introduced in the semantic network so as to perform a global search. Each search can operate on one or many guidelines bases simultaneously. For this purpose, an extended search engine structures a query in the terms of the semantic network (Figure 9). For instance, the design question "what guidelines do I need to consider to design a form in a web page?" should be interpreted as a search for any guideline related to the object type "form" in any base for the web during the design phase. Figure 9 depicts a global search for usability guidelines related to the presentation of text in a web page. The top part of Figure 9 shows the values of the multi-criteria search and the bottom part lists all guidelines matching the criteria selected in the top part.

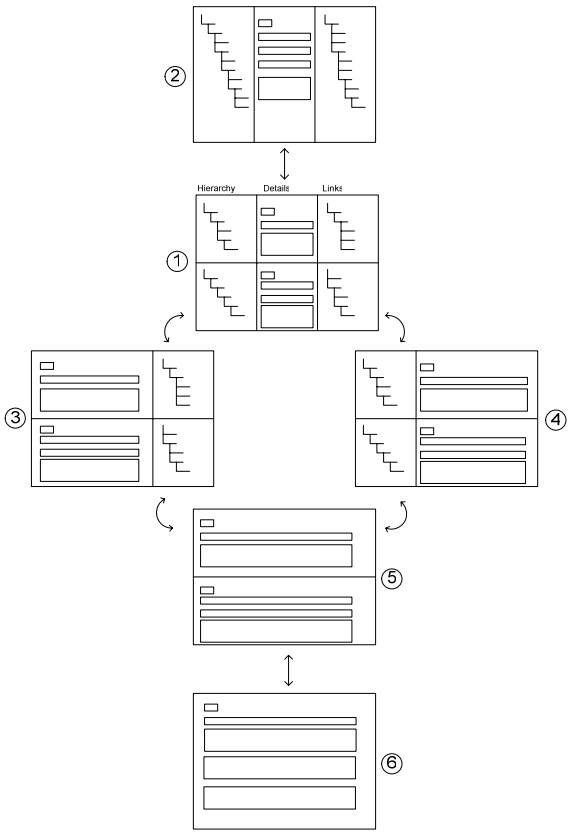

Figure 6. The MetroWeb views and the links between these views.

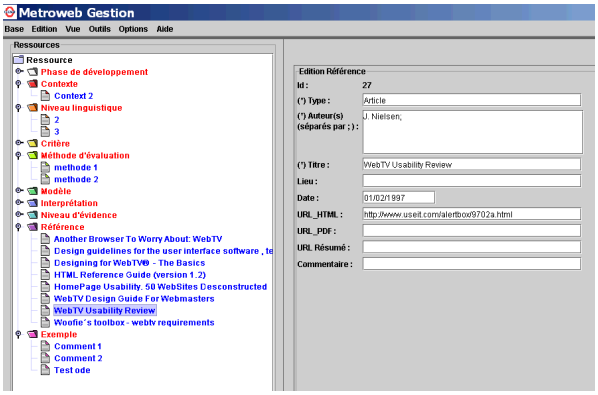

Figure 7. MetroWeb detailed view.

In order to determine if MetroWeb is useful for professional web designers and help them in making web sites easier to use, a first experience was led. The objectives and the main results are presented in the next section.

5.2 Discussion on Using MetroWeb

The first experience gathered while using MetroWeb in various unconstrained contexts allows us summarizing the main advantages and shortcomings of the MetroWeb tool *per se* and with respect to other tools like those reported in the state of the art.

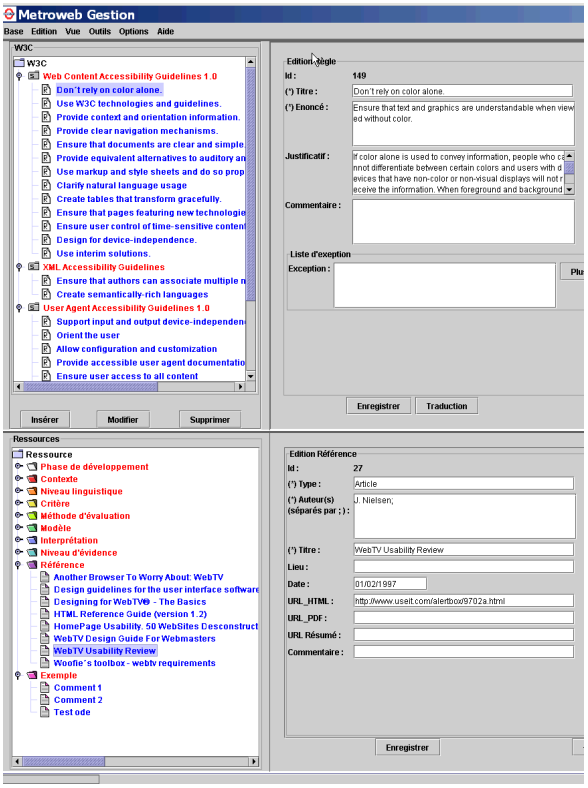

Figure 8. MetroWeb normal view.

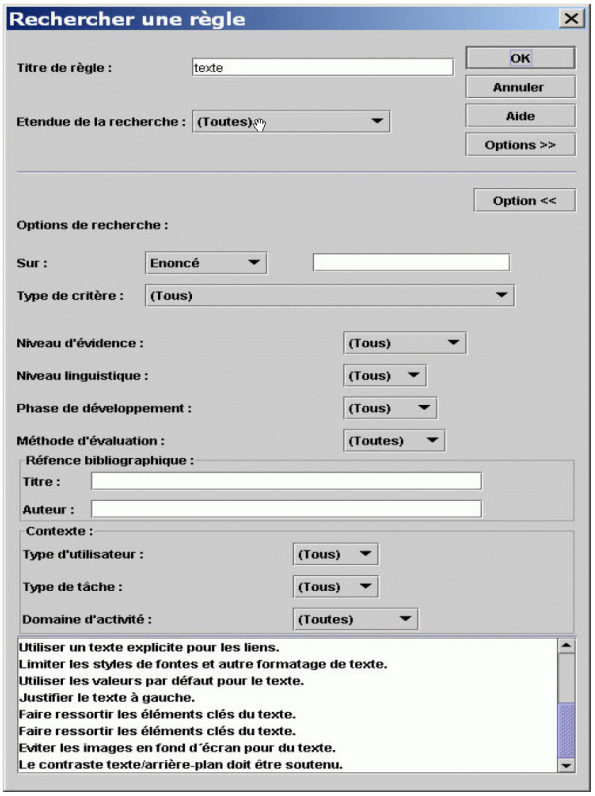

Figure 9. MetroWeb search for guidelines.

- **Advantages**: the tool can support the usability evaluation in web design, by browsing knowledge bases (1) by guideline: all usability problems related to a same guideline can be presented together, and the guidelines themselves can be sorted according to any sorting key present in Figure 2 (e.g., by development phase, by criteria); (2) by screen: all usability problems related to a same screen, a same web page or a suite of screens (as defined in a task scenario) can be presented together to pass to the developer who is responsible to fix the problems; (3) by widget: usability problems can be presented widget by widget or by group of widgets to focus only on parts of the UI that are concerned with the usability flaws; (4) by usability problem: the report can be structured according to the type, the frequency, and the severity of usability problems, e.g., to address the most severe usability problems first; (5) by ergonomic criteria: the report can also be structured by assembling guidelines flaws by related ergonomic criteria, which can be particularly helpful for usability assessment reports.
- **Shortcomings**: (1) Browsing between related guidelines is supported as long as there are any relations between them. For this purpose, different types of relations, like conflicting guidelines, could be defined and introduced but should be entered manually. Therefore, the quality of these links heavily depends on the rigorousness of the usability and human factors experts who entered the usability guidelines in the bases. To avoid such a manual entry, it is possible to apply some automated techniques. For instance, [10] reports on using a information retrieval technique for automatically linking related guidelines as soon as the statistical metric establishes that a reasonably high amount of words are shared by two given guidelines. This technique helps linking guidelines to guidelines, but cannot be used for linking a guideline to the other concepts such as those defined in the MetroWeb framework. (2) The number of guidelines entered may become very large, depending of the source. In that case, the links between guidelines and the search engine should be improved.

6. Using the tool: first experiment

6.1. Participants, design task and objectives

In this first experiment, four professional designers had to create, during about an hour and half, two web pages for presenting a seller of bathrooms (the home page and another from their choices). These professional designers worked within small companies or teaching web design and had created from 3 to 9 web sites (sites composed by in mean than 100 web pages).

All of the designers used an authoring tool, such as Macromedia Dreamweaver® or Adobe GoLive®, to create the two web pages. The half of the designers used MetroWeb (they had access to 40 guidelines) and the others did not use it. While they designed their two web pages, designers had to think aloud [6] in order to determine if MetroWeb helps and incites them to take into account usability recommendations and to respect these usability recommendations in their web pages. More precisely, our objectives were the following:

- To determine the number of usability recommendations articulated by designers according to the design condition (with or without MetroWeb)
- To determine the proportion of articulated usability recommendations from MetroWeb
- To identify among usability recommendations taken into account by designers the quantity effectively implemented in the two web pages according to the design condition (with or without MetroWeb).
- To identify the number of usability errors introduced in their web pages according to the design condition (with or without MetroWeb).

The designers' verbalizations and web sites were recorded with a camera.

6.2. Main results

Designers using MetroWeb articulated more usability guidelines than designers without MetroWeb : in average respectively, 29 *vs* 12 usability guidelines were considered explicitly by designers during the experiment (Figure 10). Among these articulated usability recommendations, an important proportion were from MetroWeb (about 43%). 2/3 of these guidelines were actually respected and implemented in their web pages.

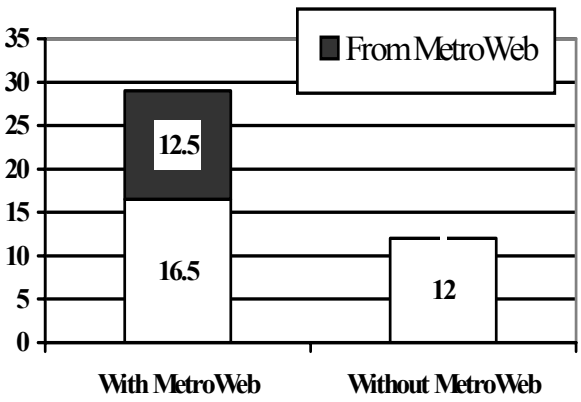

Figure 10. Average number of usability guidelines considered by designers.

We have identified less usability errors in the web pages created by designers using MetroWeb than those developed by designers without MetroWeb (in mean respectively, 10 usability errors *vs* 16 usability errors (Figure 11).

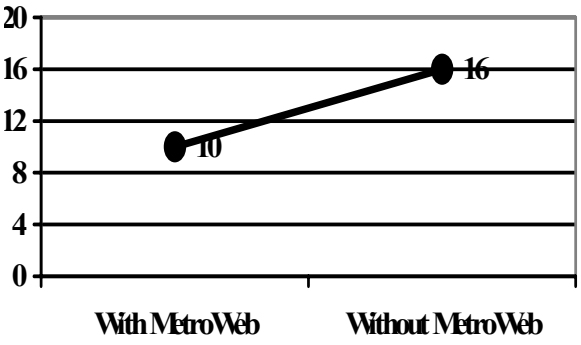

Figure 11. Average number of usability errors introduced in the two web pages.

Moreover, designers using MetroWeb created two web pages more detailed, with hyperlinks, texts, pictures, than the others (Figures 12 and 13).

Figure 12. Home page created by a designer using MetroWeb

Figure 13. Home page created by a designer without MetroWeb

The analysis of the verbalizations shows that MetroWeb is mainly used at different moments of the web design process. However, the tool seems more appropriate to the phase of evaluation than to the design phase.

7. Conclusion and Future Work

The tool presented in this paper permits to support user-centered design, by the creation of multi-bases usability guides, and the use of them during the whole design cycle. The tool, with respect to existing work, is original for the several characteristics: continuity (usability knowledge gathered in the phase of style guide constitution is reused consistently), integration (design and evaluation can be supported simultaneously), multi-bases (multiple knowledge bases can be used at the same time, for instance to evaluate guidelines belonging to different sources), collaboration (since the tool is web-based itself, implemented in Java/Swing, it can be installed and used locally or remotely), level of support (several phases concerning usability in the design life cycle are covered).

Our future work concerns two main points: (1) the implementation of the evaluation module, aimed to support the usability problems reporting, tightly coupled with a system that supports the designer and the evaluator in automating the evaluation of guidelines contained in MetroWeb [2], (2) to continue experimental and quantitative studies, with a higher number of web designers, to confirm the link between using the MetroWeb tool and designing user-centered web sites. More precisely, we will determine the influence of MetroWeb on both (i) the design of ergonomic web pages and (ii) the evaluation and re-design (with modifications) of web pages including usability errors.

Finally, it is expected that the usability knowledge contained in the various knowledge bases will be made accessible to the suite of computer-aided design tools that are developed around UsiXML so as to provide a continuous support based on guidelines across various tools [19]. In this way, any design or development tool could have access to the same usability knowledge independently from where they are needed and accessed.

8. Acknowledgement

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