Integrating Universal Design into a Global Approach for Managing Very Large Web Sites

Michael Cooper[1], *Quentin Limbourg*[2], *Céline Mariage*[2] *and Jean Vanderdonckt*[2]

[1]Center for Applied Special Technology (CAST)
39 Cross Street, Suite 201, Peabody, MA 01960 (USA)
Phone: +1-978-531-8555, Fax: +1-978 531-0192
E-mail: mcooper@cast.org, URL: http://www.cast.org

[2]Université catholique de Louvain (UCL), Institut d'Administration et de Gestion (IAG),
Place des Doyens, 1 – B-1348 Louvain-la-Neuve (Belgium)
Phone: +32-10-47.85.25 - Fax : +32-10-47.83.24
E-mail: {limbourg,mariage,vanderdonckt}@qant.ucl.ac.be
URL: http://www.qant.ucl.ac.be/membres/jv/

Abstract. Very Large Web Sites are a particular category of web sites where the potential of traditional evaluation process for ensuring usability is significantly contracted by the size of the web site. Since this kind of web site is authored, designed, evaluated, and maintained by a wide variety of people who have specific information demands over a huge set of web pages, we believe that Universal Design principles should be integrated into the current approach for managing such web sites. We propose to support Universal Design principles by integrating related guidelines into a global approach for managing Very Large Web Sites. This approach is supported by Extended Bobby, an extension of the Bobby tool that provides (i) evaluation on demand ; (ii) a repair tool that proposes to authors of web pages new HTML code fixing usability problems that Extended Bobby itself has merely identified and explained ; (iii) a usability site tracker that keeps track of usability problems of the web sites, automatically sends e-mails to authors with the repair proposal, and helps site managers and webmasters to manage the pages evolving in time.

1. INTRODUCTION

We hereafter refer to Very Large Web Sites (VLWSs) as any large-scale, information abundant, interactively rich web site installed in a distributed environment (e.g., in different physical locations) with heterogeneous software and hardware (e.g., on different servers). A wide range of persons typically maintains a VLWS. It is connected to a large set of databases and contains several thousands of web pages. For example, the Decathlon web site (www.decathlon.fr) is a 10,000 pages VLWS presenting users with a wide variety of information on sports articles and leisure. Similarly, the web site of Université catholique de Louvain (www.ucl.ac.be) contains 40,000 pages on research, courses, and activities on most domains of human sciences and is maintained by a potential range of 1500 persons supervised by 12 local webmasters and a general webmaster. The management of a large university web site is a demanding task as reported in [Nevile96]. Different types of actor typically participate in the design, the implementation, the evaluation and the update of a VLWS:

- *Document author* is any person who is responsible for writing and editing a series of web pages with appropriate tools such as word processor, document manager, HTML editor, converter (for example, a secretary);
- *Document responsible person* is the person guaranteeing the information contents of a document designed by a document author. This person could be a hierarchical supervisor or the document author him/herself (for example, a professor);
- *Site manager* is any person coordinating the web page publishing for any leaf node entity in the organization hierarchy (for example, the site manager of a department);

- *Local webmaster* is a person striving for the utility and the usability of web pages for related entities (for example, a webmaster for all departmental sites in a faculty);
- *Global webmaster* is the person coordinating the utility and the usability of the web pages for the whole VLWS (for example, a webmaster for all faculty sites in a university).

On one hand, document authors and responsible may talk different languages, may have various cognitive profiles and backgrounds and may have separate information demands. Although they do not necessarily have knowledge or experience in usability of web pages, they tend to prefer specific presentation styles and separate dialogue types for their own web pages to be quite different from what the others are designing. On the other hand, site managers, local and global webmasters are responsible for ensuring some form of usability and consistency across these web pages, thus introducing a counter-force. To fulfill their role, site managers, local and global webmasters currently follow a manual approach consisting in the following activities:

1. they regularly evaluate the set of web pages across a defined set of web design guidelines according to a heuristic inspection method;
2. they manually write a usability report where detected usability problems and guidelines discrepancies are documented;
3. they send the usability report to the document author or the document responsible person and ask them to solve the documented problems and to fix the discovered discrepancies;
4. they regularly remind document authors and responsible to take these considerations into account and they iterate the whole process.

These activities lead to the following shortcomings:

- due to the size of a VLWS, it is impossible to manually manage the above activities; therefore, the guidelines should be evaluated as automatically as possible and the usability errors should be reported by appropriate software;
- due to the lack of time or lack of interest, most document authors and document responsible persons devote little or no time to address the documented usability errors; therefore, some proposal should be produced by an interactive repair tool based on the usability errors that have been previously reported;
- due to the progressive appearance of new types of guidelines to be embodied in the evaluation, such as new design rules, guidelines from any custom corporate style guide, and new standards, involved people are rapidly blocked by the currently existing guidelines; therefore, the software should be open and flexible enough to extend the knowledge base of guidelines to be evaluated;
- due to the various types of actors involved, the different information demands, and the population diversity, guidelines from the domain of Universal Design should also be supported; therefore, the software should be able to accommodate this type of guidelines as document authors are rarely aware of them.

In general, Universal Design means designing services and resources for people with a broad range of abilities and disabilities [Stephanidis98,99]. Universal Design promotes equitable use [Coombs99], builds flexibility into the resource so that it can accommodate a wide range of individual preferences and abilities, is simple and intuitive, allows for duplication of information in several formats (e.g. written, spoken), and requires minimal physical effort [Connell97]. In particular, Universal Design for web sites means that a web site should be usable enough to accommodate a wide range of visitors having various information demands, having different cultural backgrounds, and equally important, having disabilities or not, limited computer facilities or not. This last issue is often referred to as the accessibility of web sites [Access98, Bergman95].

The goal of this paper is consequently to present a new global approach for managing a VLWS by integrating Universal Design and supported by appropriate tools. The rest of this paper is structured as follows: section 2 describes into more details the current global approach followed to manually manage a VLWS, its data flow, and reports on the shortcomings of this approach ; section 3 identifies the need for integrating Universal Design principles in this approach ; section 4 exemplifies how the Bobby software enables site managers or webmaster to evaluate a series of web pages across accessibility guidelines ; section 5 describes an extension of this software to support evaluation on demand, automated or computer-aided evaluation of guidelines ; finally, section 6 describes the proposed global approach for managing VLWSs being supported by the extended Bobby tool along with the repair tool and the usability site tracker, and its data flow. Section 7 concludes by presenting the expected benefits of this global approach with some future works.

2. THE CURRENT MANUAL APPROACH

During the maintenance of a VLWS in any organization, one or several methods can be used to evaluate its usability. In order to be concrete, we assume that a heuristic inspection method [Bastien95] based on guidelines will be used throughout the rest of this paper. In this variant, the general heuristics are replaced by a predefined set of criteria of guidelines to be assessed for each considered page of the VLWS [Bastien95,98]. Numerous sources provide such web design guidelines in general [Grose98, IBM97, Ratner96, Usable98, UseIt98, Yale97] and for accessibility and Universal Design in particular [Access98, Lowney96, Washington99].

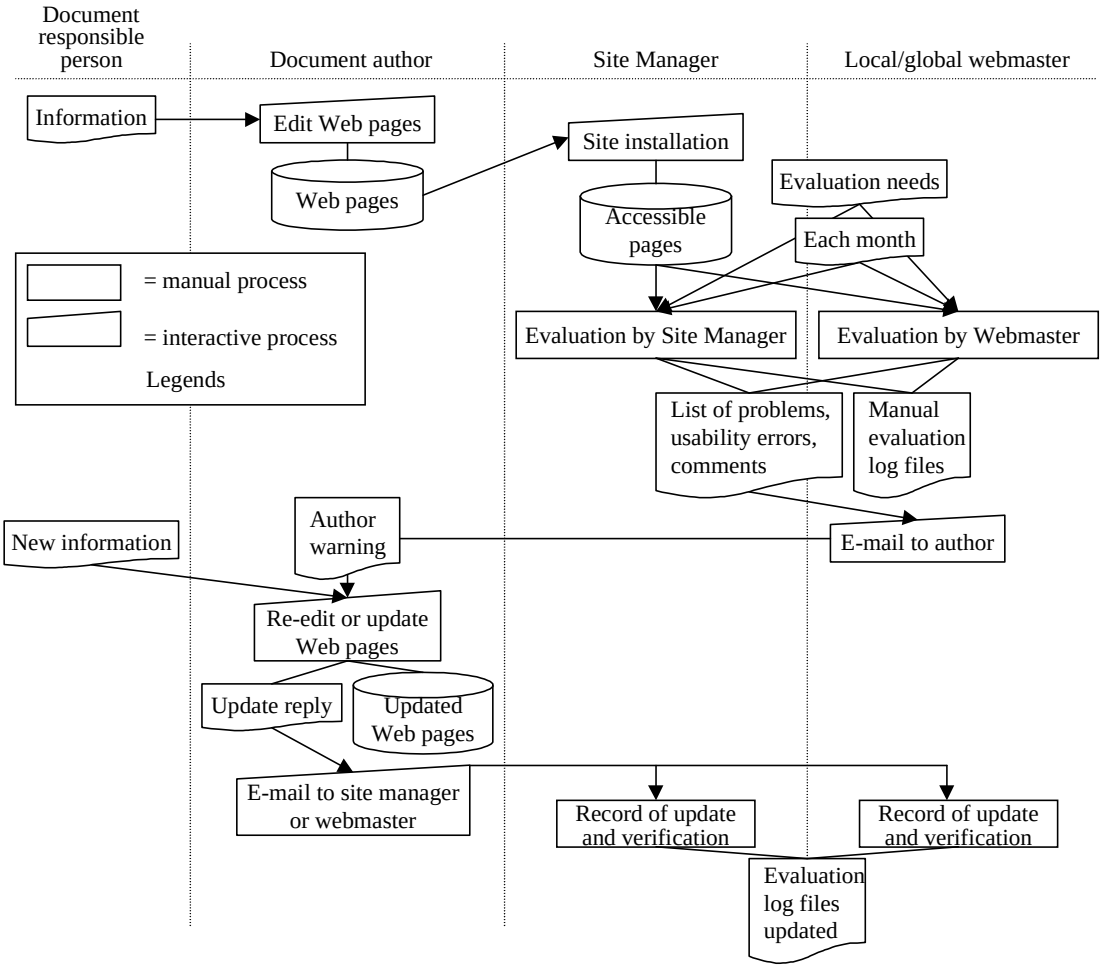

Figure 1. Data flow diagram of the currently existing approach.

The currently existing approach for conducting this VLWS evaluation is illustrated in fig. 1. Although we focused on a particular evaluation method, we believe that this figure will remain similar for any other evaluation method, whether empirical or analytical.

When someone (the document responsible person) would like to publish information on the VLWS, this person provides a document author with the information to be published, e.g., a document, a financial report, an information bulletin, or a list of references. The document author then edits web pages to put this information on line. HTML editors, document converters (e.g., from a word document format to HTML), development environments help the document author for this purpose. Since the pages will be integrated in the VLWS, they cannot be produced randomly : web design guidelines can express the rules that govern the presentation and the navigation of these pages. These guidelines basically come from five types of sources [Scapin90, Vanderdonckt99]:

1. Compilation of guidelines;
2. Style guides, whether they are general or specific;
3. Standards;
4. Design rules, as found for example in screen templates;
5. Ergonomic algorithms that automatically produce usable web pages.

For instance, a design rule can specify that each web page should be terminated with the name of the document responsible person and the clickable name of the document author (fig. 2).

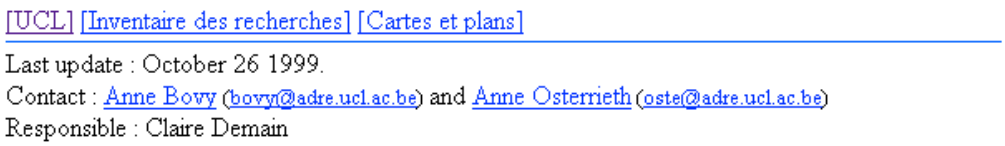

Figure 2. Example of a design rule.

Once designed, the web pages are passed to the site manager who put them on line and insert them in the local hierarchy, thus leading to several link updates. These pages are therefore made accessible to any visitor with a browser.

According to evaluation needs and on a regular basis (for instance,, each week or each month), the site manager, the local or global web master are performing an evaluation of the current VLWS status. This evaluation covers many facets : information consistency, compliance with style guide, respect of design rules, legibility, absence of broken links, verification of recently published pages, checklist of guidelines,… According to the results, they write a list of found problems, usability errors, and comments (fig. 3) to be sent by electronic mail with a warning to the document author by a webmaster having a strong position. If no problem is detected, nothing is sent.

```
14.4.99
To: NYNS CHARLES-HENRI <nyns@bse.ucl.ac.be>
From: Philippe Degand <Degand@sri.ucl.ac.be>
Subject: Corriger <http://www.bse.ucl.ac.be/index2.html>

* Au bas de la page sous rubrique, le message "Depuis le 6 août 1998, cette
  page a été consultée [an error occurred while processing this directive]
  fois" devrait être corrigé.
* L'appel à <http://www.cdess.org/rcompil.htm> (CDESS) n'aboutit pas.
* Le nom d'un responsable devrait être mentionné au bas de certaines pages
  satellites, de même qu'une date de création ou de mise à jour.
* Enfin, certaines balises "NAME=" ont disparu de la page, alors qu'on y
  fait référence au début par
            <LI><A HREF="#train">en train</A></LI>
            <LI><A HREF="#voiture">en voiture</A></LI>
            <LI><A HREF="#avion">en avion</A></LI>
```

```
          <LI><A HREF="#bxl">&agrave; partir de l'UCL-Bruxelles</A></LI>
La page étant relativement courte, je suggère de simplement enlever ces
pointeurs.
```

Figure 3. Example of a message sent by a webmaster.

In parallel, they maintain files recording the position of the VLWS that have been submitted to the evaluation and their results. When such a warning is received or when new information should be added, the document author re-edits or updates web pages of concern. Updated web pages are sent back to the site manager while an update reply is sent to their site manager and to the webmaster. This reply is typically a message stating what have been updated, what problems have been fixed, what usability errors have been solved. The evaluation log files are updated after verification.

This manual approach cause several shortcomings on a VLWS :

- Due to the size, the complexity and the update frequency, site managers and webmasters are often overwhelmed : they cannot evaluate everything on time, they leave some parts unevaluated, they cannot keep track of all performed evaluations, as requested they are more akin to devote more time to put pages on line than to check their usability.
- The quality of web pages basically relies on the document author background, experience and sake for usability. When bad pages are authored, they go on line before any evaluation can take place. The evaluation may come a long time after.
- Site managers and webmasters do not have the time and the resources to make usable every pages submitted by a document author. For instance, a site manager can receive as much as ten on line documents per day, which is more or less 50 web pages to manage.
- The writing of the list of problems, usability errors, comments, and their sending by e-mail requires too much time for such a repetitive task.
- Warnings and lists sent to document authors are infrequently and partially addressed. For example, some statistics for our university showed that only 40% of document authors provided a reply for the first month and 60% for the second month (table 1).
- Once problems are fixed, usability errors are solved, site managers and webmasters still need to verify the updated pages before updating their evaluation log files. This process is highly iterative (for example, up to 4 or 5 loops before final acceptance).
- Document authors have little or no knowledge on how to apply and check web design guidelines. Moreover, they are not especially aware of recently released guidelines. In particular, they are rarely aware of accessibility guidelines required for all kinds of users although they recognize that these concerns should be supported. For instance, on-line courses should be made highly accessible for distance learning purposes.

	First month	Second month	Mean
Reply with a complete correction	20 %	45%	33 %
Reply with a partial correction	20 %	15 %	17 %
Acknowledge but no correction	40 %	30 %	35 %
No acknowledge and no correction	20 %	10 %	15 %
Rate positive reply/no reply	40/60	60/40	50/50

Table 1. Reply statistics.

These two last shortcomings motivate the need for integrating Universal Design in the global approach [Richarson96, Story98].

3. THE NEED FOR INTEGRATING UNIVERSAL DESIGN

Learning requires complex interactions of the recognition, strategic, and affective systems, and no two brains function in exactly the same way. These are the three main dimensions of Universal Design for Learning [Cooper99]. While everyone's brain functions take place in roughly the same areas and work together in roughly the same way, PET scans show that each individual has his or her own activity "signature." Each of us has a different functional allocation of cortex. Some people have larger regions devoted to recognizing patterns, generating strategies, or focusing on particular priorities and these differences seem to be reflected in different configurations of learning style, relative strengths and weaknesses, and varying "kinds" of intelligence. Thinking about individual differences in light of the three brain systems can help us understand the ways in which curriculum must be flexible to reach all learners. Multiple representations of content can adjust to the recognition systems of different learners; multiple options for expression and control can adjust to the strategic and motor systems of different learners; multiple options for engagement can adjust to the affective systems of different learners [Cooper99].

3.1 Multiple Means of Representation

No single representation of information is ideal, or even accessible, to all learners. Some students thrive in lectures; others obtain information effectively from text, while still others learn best through visual media such as diagrams, illustrations, charts, or video. These learning differences reflect variations in neurology, background experiences, and constitution and are manifested along a continuum from slight preferences to profound necessities. For example, one student with a proclivity for art may find an image more comprehensible than a verbal description of an idea; another who is deaf will be shut out completely if only a verbal description is provided. Universally designed materials accommodate this diversity through alternative representations of key information. Students with different preferences and needs can either select the representational medium most suitable for them, or gather information from a variety of representational media simultaneously. Unlike the printed page, computers provide the opportunity to present information in multiple media and to provide settings that permit selecting among the offerings. Additionally, computers can often transform information into a medium most appropriate for the user. However, it is not always a straightforward matter to do so. In some cases a direct translation is possible, as in text-to-speech or spoken dialogue to written caption. In other cases, interpretation is necessary, as in image description or text version of a sound effect. Some content cannot truly cross media in a way that most people would agree on: a poem or music, for example. It is essential, therefore, when providing multiple representations, to consider the purpose of the activity, and the nature of the learners themselves [Cooper99].

3.2 Multiple Means of Expression

Just as no single mode of presentation suits all learners, neither does any single mode of expression. The dominant mode for expressing ideas and demonstrating learning has long been text on the printed page. Work in multiple intelligences [Gardner, 1983] and school reform supports the notion that more options, including artwork, photography, drama, music, animation, and video, open doors for a greater number of students to successfully communicate ideas, knowledge gained, and talents. These ideas apply to students with particular skills and proclivities as well as to students with disabilities that prevent them from using certain media effectively or at all. Universally designed materials offer multiple options for expression and control. Persons with particular preferences or learning needs can find media, supports, and options that enable them to demonstrate their knowledge in the way that is most effective for them [Cooper99].

3.3 Multiple Means of Engagement

Reaching to users' enthusiasm and interests is critically important. The third principle of Universal Design proposes that media should support varied skill levels, preferences, and interests by providing flexible options. For any given user, there must be content that is interesting and provides a clear purpose. Digital materials and electronic networks have the potential to provide the flexibility, and developers, researchers, and educators will have to ensure that sound pedagogy guides the development of new digital curricula [Cooper99].

4. THE BOBBY TOOL

Bobby™ is a computer-based tool that supports Universal Design of a web site. The notion of a universally designed Web challenges society to think about plurality—to consider all individuals, regardless of age, ability, race, or economic or cultural background—when developing new technologies. Yet at this time, though the Web has much potential for broad inclusion, it often excludes some people from participating in much the same way that a staircase prevents a person in a wheelchair from going in a building's door [Cooper99].

4.1 Universal Design Principles for the Web

The World Wide Web is a potentially rich learning environment. The notion of a universally designed Web challenges society to think about plurality—to consider all individuals, regardless of age, ability, race, or economic or cultural background—when developing new technologies. Yet at this time, though the Web has much potential for broad inclusion, it often excludes some people from participating in much the same way that a staircase prevents a person from going in a building's door.

The technology now exists to support inclusion of many different types of people in ways that were previously unconsidered, yet that technology is not always used to its maximum benefit. For individuals with visual disabilities, for example, the Web's highly graphical environment poses serious problems. Even with a screen reader, a tool used by individuals with visual impairments to translate written text into spoken text [Gappa97, Cooper99], web pages can still be inaccessible when screen readers cannot navigate text in columns or recognize images. For individuals who are deaf or hard of hearing, multimedia and audio elements of Web pages are inaccessible without such accommodations as captioning or text descriptions.

In April 1997, the W3C's establishment launched the Web Accessibility Initiative (WAI) to lead the Web to its full potential by promoting a high degree of usability for people with disabilities [WAI98]. In coordination with other organizations worldwide, the WAI is pursuing accessibility through development of technology, guidelines, tools, education and outreach, and through research and development.

An important piece of the WAI's work has been the development of a document called the Web Content Accessibility Guidelines [WAI98] which brings together all of the previous efforts in this area and provides many new ideas. Within this larger international movement, CAST's tool Bobby has identified a critical need to provide practical support to Web developers in implementing the guidelines [Cooper99].

4.2 Supporting the Authoring of Universally Designed Web Sites

Applying the principles of Universal Design to a web site requires awareness of and commitment to the issues. Equally importantly, it requires enough applied understanding of these issues to create effective universally designed web sites. That is, an author must know the design principles that make a web site universally designed, and the author must know techni-

cally how to realize those principles on the web site. To help bring this awareness about, CAST launched Bobby in August, 1996. Bobby is a free interactive tool offered on CAST's web site that analyzes an HTML page with respect to the WAI's Web Content Guidelines, and translates them into instructions for improving its accessibility. After typing in a URL, Bobby delivers a full report within seconds. This report optionally includes the original page, with "Bobby-hat" icons (Figure 4) that visually show the location of errors.

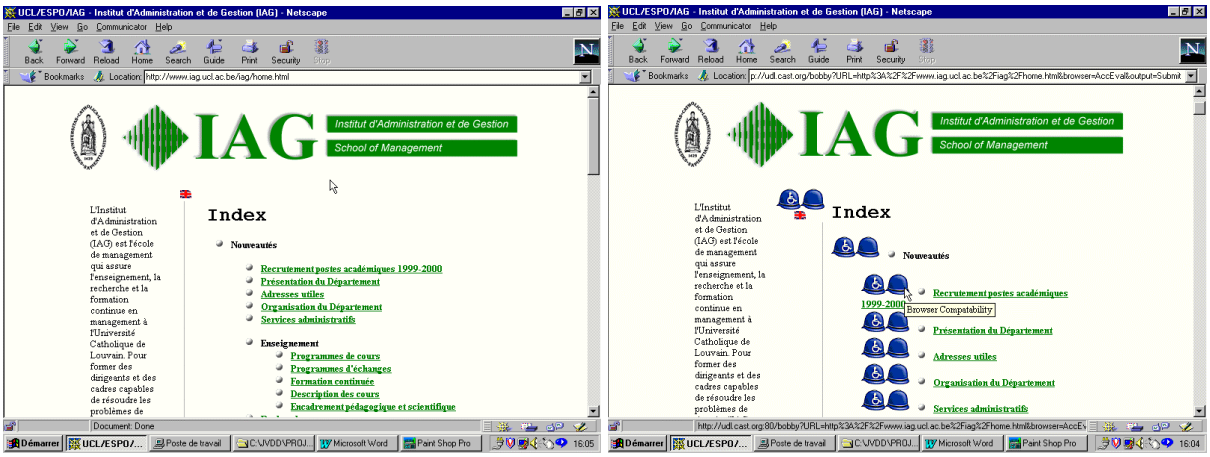

Figure 4. A page evaluated by Bobby. Left: the original page. Right: the page with visual notification of accessibility errors. Clicking on the "hat" provides a more extensive description of the error.

Bobby then explains the factors that limit the site's use and recommends ways to fix those problems. In the report, the factors are presented as a list of error types (fig. 5). For each type, the parts of the page on which it is found is indicated, this time by showing the HTML source. An extended explanation of the cause of the error and means of repairing it is available by clicking on the error title. The errors are organized by three levels of priority—Priority 1 issues are the most important to address for accessibility. Within the priority levels, the report is also grouped into items that it can evaluate automatically, and descriptions of items that require human judgment to determine an appropriate response. While any web page will require an amount of subjective determination, Bobby is able to address many of the most numerous access issues.

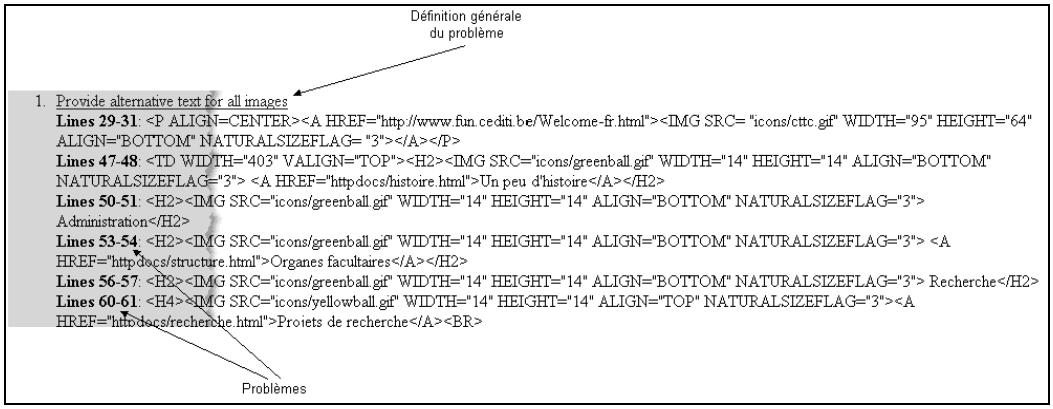

Figure 5. Part of a usability evaluation report.

Now in version 3.1, Bobby has been continually enhanced to provide better support for the guidelines. Many of its recommendations are for alternate representations of media, such as text alternatives and extended descriptions for images; others help authors avoid problems en-

countered by persons using access aids or non-standard browsers. Bobby can test most of these guidelines. In some cases the test involves detecting the presence or absence of certain features e.g., text alternatives that are included with specific HTML constructs like the ALT or `LONGDESC` attribute of media elements. In other cases, Bobby examines the way certain elements are used, such as color, size, or hierarchical organization.

Bobby is designed to be an educational tool that teaches Web designers about Web accessibility. As Web designers use Bobby, they not only learn how to address problems within their own site, they also learn skills that they can apply to site design in the future. Bobby offers concrete design suggestions and is linked to other sites that discuss access issues. The more one uses Bobby, the less likely one is to need it in the future, as accessibility issues and their solutions become integrated into one's Web design at the outset [Cooper99].

In order to serve as an effective model of accessibility and good interface design, Bobby employs the latest technological innovations in its own design. Bobby is now written in 100% Java, and has two forms: the online server, and a downloadable version that uses the same page evaluation code and offers both a graphical and a command-line interface. Since it is written in Java, this version can run on many different hardware platforms. Bobby uses Java's most current accessibility features, which allows the program itself to be accessible to users with disabilities [Glinert92]. Many access aids are built into the interface, and it has the requisite code to allow third party access aids to communicate with it effectively.

The accessibility report will consist of at most seven sections (some sections are not displayed if irrelevant): Priority 1 accessibility errors, Priority 2 errors, Priority 3 errors, browser compatibility, and download time. The online Bobby will redisplay the web page that you asked it to analyze appending an accessibility report to the bottom of the page if the "Text only output" option is not checked [CAST97,Cooper99]:

- The **Priority 1 accessibility errors** section lists problems that seriously affect the page's usability by people with disabilities. A Bobby Approved rating can only be granted to a site in which none of the pages have accessibility errors. Clicking on any of the problems that Bobby reports will produce a more detailed description of how to fix the problem. In addition to items that Bobby can examine automatically, a number of items that require manual examination are presented here. You must be able to answer affirmatively to these questions. The responses to these questions affect your Bobby Approval rating since they are important to ensure your site is accessible in accordance with Priority 1 WAI guidelines. Bobby Approved status is equivalent to Conformance Level A for the Web Content Guidelines.
- **Priority 2 access errors** are access problems which you should try to fix. Although not as vital as Priority 1 access errors, the items in this section are considered important for access. There are items presented here as well that require manual examination. If you can pass all items in this section, your page meets Conformance Level AA for the Web Content Guidelines. This is the preferred minimum conformance level for an accessible site, even though it is not considered part of Bobby Approved.
- **Priority 3 access errors** are third-tier access problems which you should also consider. There are items presented here as well that require manual examination. If you can pass all items in this section, your page meets Conformance Level AAA for the Web Content Guidelines.
- The **browser compatibility** section lists those HTML elements and element attributes that are used on the page which are not valid for particular browsers.
- The **download time** section provides a summary of how long the web page and images would take to download on a slow modem line (assuming the server is not too busy).

4.3 Tool support for WAI guidelines

Bobby 3.1 is an improved implementation of the working draft of the Wide Web Consortium's W3C's Web Access Initiative (WAI) Page Authoring Guidelines [WAI98] as well as reflecting the Page Authoring Guideline Working Group's latest revisions to them. There are, however, some aspects of page design that are important to accessibility but can not be tested automatically by Bobby. Table 2 lists some excerpts of the current WAI guidelines, and the type of support that Bobby provides.

Table 2. WAI guidelines as supported by Bobby (excerpts from http://www.cast.org/bobby/faq.html).

Guideline 1. Provide equivalent alternatives to auditory and visual content.

Tech.#	Guideline	WAI Rating	Bobby Support
1.1	Provide alternative text for all images	p1	full
1.1	Provide alternative text for each APPLET	p1	full
1.1	Provide alternative content for each OBJECT that conveys information	p1	full
1.1	Provide alternative text for all buttons in forms	p1	full
1.1	Use separate buttons or images with ALT text for form controls	p1	full
1.1	ALT text too long, consider providing a separate description	p1	manual
1.1	If any of the images on this page convey important information beyond what is in each image's alternative text, add descriptive (D) links	p1	manual
1.1	If any of the images on this page convey important information beyond what is in each image's alternative text, add a `LONGDESC` attribute	p1	manual
1.1	Do all audio files have transcripts?	p1	manual
1.1	Have you provided audio descriptions for short visuals like animated GIFs?	p1	manual
1.1	Did you provide a synchronized textual transcript for the audio associated with this video?	p1	manual
1.1	Avoid ASCII art if it is important information. Replace it with an image and alternative text	p1	manual
1.2	Provide alternative text for all image map hot-spots	p1	full
1.2	Is this image button being used as a server-side image map?	p1	partial
1.2	Client-side image map contains a link not presented elsewhere on the page	p2	partial
1.2	Provide redundant text links for each active region of a server-side image map.	p3	full
1.3	Does all video information have both a description and a synchronized caption?	p1	manual
1.4	Have you provided visual notification and transcripts of sounds that are played automatically?	p1	partial

Guideline 2. Don't rely on color alone.

Tech.#	Guideline	WAI Rating	Bobby Support
2.2	Use foreground and background color combinations that provide sufficient contrast	p2	partial
2.2	Make sure that document structure is supported by the proper use of structural elements	p2	manual

Guideline 3. Use markup and style sheets properly.

Tech.#	Guideline	WAI Rating	Bobby Support
3.1	Style sheets should be used to control layout and presentation wherever possible	p2	partial
3.1	Where it's possible to mark up content (for example mathematical equations) instead of using images, use a markup language (such as MathML).	p2	manual
3.2	Make sure that headings are nested properly	p2	partial
3.3	Only use list elements for actual lists, not formatting	p2	partial
3.4	Mark up quotations with the Q and BLOCKQUOTE elements	p2	manual
3.7	Use relative sizing and positioning (% values) rather than absolute (pixels)	p2	partial

Guideline 4. Clarify natural language usage.

Tech.#	Guideline	WAI Rating	Bobby Support
4.2	Use the ABBR and ACRONYM elements to denote and expand abbreviations and acronyms.	p3	partial
4.3	Identify the language of the text, and any changes in the language	p3	partial
4.3	If a resource is served in various formats or languages, use content negotiation to determine the format or language preferred by the user.	p1	manual

Guideline 5. Create tables that transform gracefully.

Tech.#	Guideline	WAI Rating	Bobby Support
5.2	If this table contains data in rows and columns (i.e. a spreadsheet), have you identified headers for the table rows and columns?	p2	partial
5.3	If possible, avoid using tables to format text documents in columns.	p2	partial
5.5	If this table is used to display data in rows and columns (i.e. a spreadsheet), have you provided a summary of the table.	p3	partial
5.6	Provide abbreviations for lengthy row or column labels.	p3	partial

Guideline 6. Ensure that pages featuring new technologies transform gracefully.

Tech.#	Guideline	WAI Rating	Bobby Support
6.1	Ensure that pages are readable and usable without frames	p1	full
6.1	Make sure that style sheets transform gracefully	p1	manual
6.2	Ensure that descriptions of dynamic content are updated with changes in content.	p1	manual
6.3	Provide alternative content for each SCRIPT that conveys important information or function	p1	manual
6.3	Is there a more accessible way to implement this applet?	p1	manual
6.4	Make sure event handlers are device independent for programmatic objects.	p2	manual
6.5	Ensure that dynamic content is accessible or provide an alternate presentation or page.	p2	manual

Guideline 7. Ensure user control of time-sensitive content changes.

Tech.#	Guideline	WAI Rating	Bobby Support
7.2	Avoid blinking or scrolling text created with the MARQUEE element	p2	full
7.2	Avoid blinking or scrolling text created with the BLINK element	p2	full
7.3	Did you avoid using movement where possible?	p2	partial
7.3	Did you provide a mechanism to allow users to freeze movement or updating in applets and scripts	p2	manual
7.4	Is there an alternative page where "auto-refreshing" is only done on the users request (manual refreshing only)?	p2	partial

Guideline 8. Ensure direct accessibility of embedded user interfaces.
Guideline 9. Design for device-independence.
Guideline 10. Use interim solutions.
Guideline 11. Use W3C technologies and guidelines.
Guideline 12. Provide context and orientation information.
Guideline 13. Provide clear navigation mechanisms.
Guideline 14. Ensure that documents are clear and simple.

Level \ Support	Manual	Partial	Full	Total
1	16	2	8	26
2	14	18	2	34
3	7	6	1	14
Total	37	26	11	74

Table 3. Level of support for WAI guidelines by Bobby.

The big advantage with web sites is that their HTML code can be downloaded and examined remotely, which is not the case for traditional interactive applications. For these applications, it is reported [Farenc96, 97] that 44% of guidelines relating to interaction objects of a user interface can be evaluated in an automated way. The rest either cannot be automated or can only be processed if more than the resource files are accessible. It is therefore expected that the automated evaluation of web design guidelines will go beyond this barrier thank to the code accessibility. Table 3 shows the different levels of support provided by Bobby for WAI guidelines. If we sum up the partial and full support, we can reach the percentage of 50% of guidelines automatically processed (fig. 6), which is only a little bit beyond the 44% barrier.

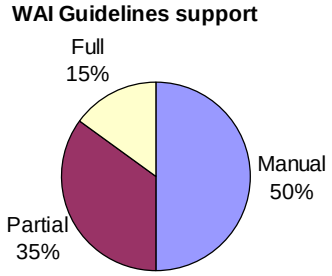

Figure 6. Repartition of support level for WAI guidelines by Bobby.

5. THE EXTENDED BOBBY ENVIRONMENT

In order to overcome the shortcomings discussed in section 2 and to integrate Universal Design as described in section 3 into a global approach for managing VLWSs and in order to support it by Bobby (section 4), we choose to extend the Bobby environment with the following principles and tools (fig. 7) :

- **Evaluation on demand** : up to now, Bobby only evaluates the WAI accessibility guidelines while it could be equally important to see Bobby evaluate when possible other sets of guidelines or any combination of guidelines extracted from several guidelines base. Evaluation on demand promotes the definition of any combination of guidelines extracted from several sources (and potentially conflicting or inconsistent) and the evaluation of this combination. We therefore propose to extend Bobby with Application Programming Interfaces which are able to communicate the HTML code extracted by the Bobby parser to the different combinations of guidelines.
- **Evaluation of custom guidelines** : many companies have developed their own corporate environment style guide containing specific guidelines that may not appear in existing sets of guidelines. Moreover, some guidelines can come from design rules decided by the company. In order to support the evaluation of custom guidelines, we propose a guidelines based editor with which a designer is able to graphically specify guidelines relating to graphical aspects. Guidelines that cannot be expressed graphically should therefore be coded separately, for instance as functions developed in an appropriate programming language. These custom guidelines should be easily incorporated in any combination of guidelines to be evaluated.
- **Computer-aided evaluation of guidelines** : as seen in fig. 6, almost 50% of WAI guidelines can be evaluated automatically by Bobby. It is expected that most of the guidelines that can be processed by an automata are supported by a software that evaluate any web page as automatically as possible. On the other hand, human control over the evaluation process is also a key feature so that the evaluation can be launched in a completely automated way or with human supervision during the evaluation process.

- **Definition of evaluation tasks** : since evaluation tasks are repetitive and can partially be automated, it would be helpful to have an evaluation task editor enabling an evaluator to define parameters of an evaluation task to be performed by Extended Bobby. Such parameters could include :
  - the starting URL, e.g., http://www.qant.ucl.ac.be
  - the maximum link level up to which pages should be evaluated, e.g, up to level 3
  - the need for recursive evaluation, e.g., with all subdirectories
  - the reference to one or many combinations of guidelines that need to be evaluated, e.g., guidelines 1 through 9 from the WAI, Part 12 of the ISO 9241 standard, guidelines 1 through 25 of a custom guidelines base
  - the severity level with which web pages should be evaluated, e.g., with the most important guidelines only
  - the periodicity of the evaluation, e.g., launch this evaluation task every Friday at 5 p.m.
  - the option of re-checking previously evaluated web pages, e.g., re-launch this evaluation task now after it has been processed two times already
  - the option to generate a site map on the fly, e.g., with site map generation linking bad web pages
  - the options for generating a usability report : here, multiple formats and levels of details should be supported
  - the option for sending a user notification by e-mail to the document responsible person
  - the option of considering or forgetting previous evaluations, e.g. forget previous evaluations of this part since it today contains new pages
  - the option for building a proposal for repairing the bad web pages (see next point)
  - the record of the evaluation results into log files

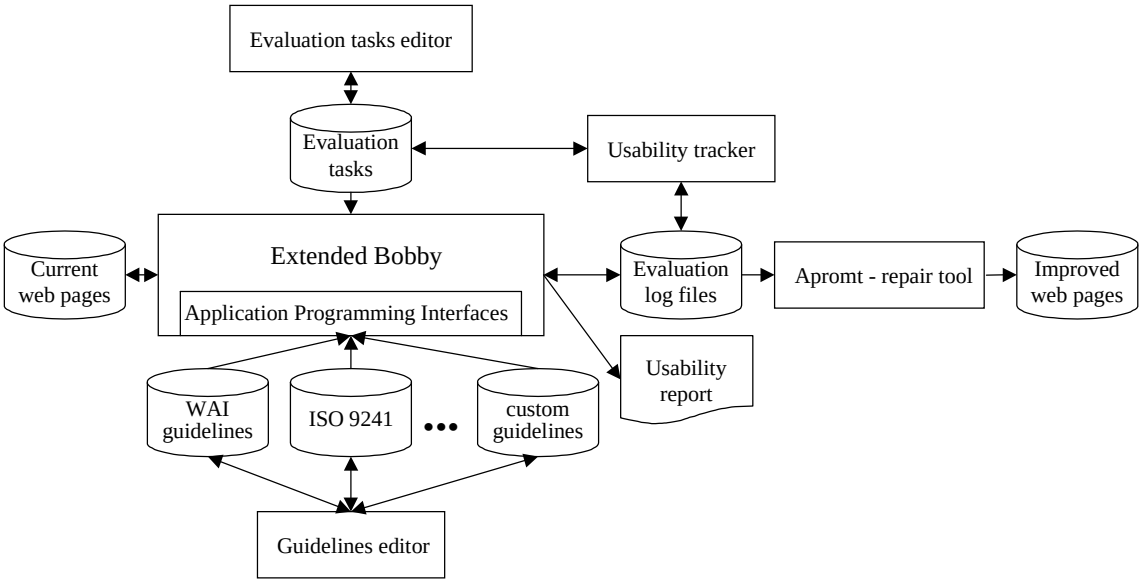

Figure 7. The Extended Bobby environment.

- **Repair support for pages with problems** : the A-Prompt project [Aprompt99] is intended to develop a repair tool that automatically produces a proposal for new HTML code for each page evaluated with problems by Extended Bobby. One or several proposals can be made according to the parameters of the evaluation task. The results of this can be sent with the warning to the document responsible person at the same time.

- **Usability site tracker** : this tool exploits the evaluation tasks defined by the evaluation editor and the evaluation log files produced at evaluation time by Extended Bobby. According to the results, the evaluation frequency or any reply from a document responsible person stating that a new web page has been put on-line, the site tracker should keep track of all detected problems, usability errors and so forth. This feature will guarantee that they will be fixed, solved in a certain amount of time. The main goal of this tool is to release evaluators from repetitively re-evaluating web pages that have been evaluated before, from the management of e-mails with persons (e.g., once updated, a document author can send a predefined message to notify the usability site tracker that a repaired page has replaced an existing page).

6. THE ENVISIONED GLOBAL APPROACH

The envisioned global approach for managing VLWSs with the above tools is outlined in fig. 8.

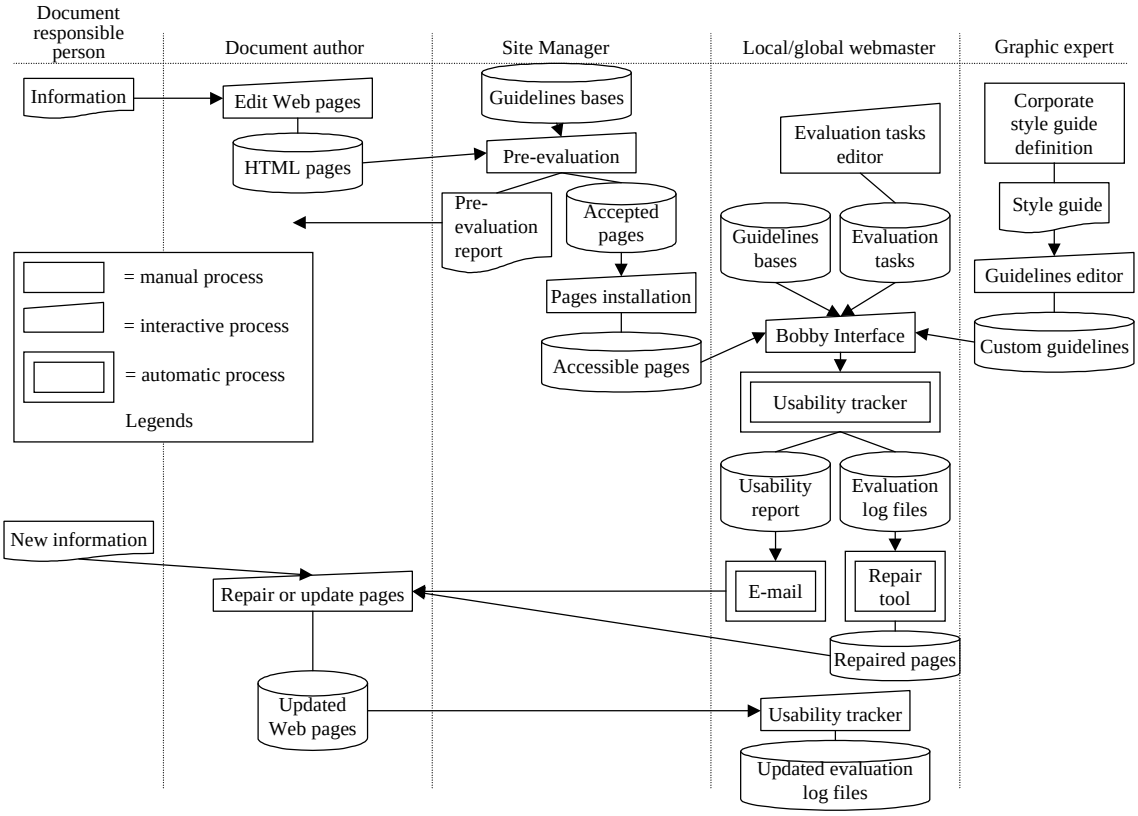

Figure 8. Data flow diagram of the envisioned global approach.

The main differences with respect to fig. 1 are the following :

- In order to prevent document authors to produce web pages with problems, the site manager can perform a pre-evaluation of submitted pages before publishing them on-line. This pre-evaluation can typically consists in a static analysis of each web page, in particular for presentation aspects and individual accessibility issues. Navigation aspects are hard to evaluate off-line. For this purpose, the site manager can define a typical evaluation task of any submitted web page across guidelines contained in guidelines bases. As long as this pre-evaluation is not satisfactory, a pre-evaluation report is sent back to the document author and the web pages remain in the temporary pool.

- The local/global webmaster can define respective evaluation tasks according to their specific needs, for instance the evaluation of some sub-parts of the VLWS with respect to navigation, accessibility, etc. These evaluation tasks can be processed by Extended Bobby either in automatic mode or in computer-aided mode. The usability site tracker is then informed by the evaluation results to record them into evaluation log files. According to parameters, a usability report is produced and sent back and/or proposals for repairing the accused pages.
- If the document author replaces an accused page by an improved one or a repair proposal, s/he can send a predefined message to the usability site tracker to record the modification. The evaluation log files are updated accordingly.
- A graphic expert can independently define the combinations of guidelines that need to be evaluated in any evaluation task. For this purpose, s/he can select subsets of guidelines from different previously defined source and gather them in a specific guidelines base. Moreover, the guidelines that are not part of standards documents such as style guides, standards, can be defined separately and reused at evaluation time. This is specifically intended to support custom guidelines.

7. CONCLUSION

The data flow outlined in fig. 8 is only a vision for a global approach for managing a VLWS while considering Universal Design and keeping the evaluators' work load to a minimum. We are currently working on the mechanization of guidelines contained in guidelines bases. Out of the multiple formats a guideline can take, it is very likely that the final format will be a programming function for each guideline. To identify a guideline that can be calculated, we are looking at the complexity theory and calculability to see if a guideline can be calculated in the sense of the calculability thery.

It is also very likely that such an approach will raise new types of computational questions, organizational questions such as :

- how does the Extended Bobby deal with a very large number of guidelines?
- what will happen if Extended Bobby reports rule violations in 5,000 pages?
- will the repair tool be able to automatically correct most of them?
- how does Extended Bobby will deal with conflicting guidelines?
- how can the guidelines base be updated and by whom?

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