Accessibility and Usability of Search Engine Interfaces: Preliminary Testing

Marina Buzzi[1]*, Patrizia Andronico*[1]*, Barbara Leporini*[2]

CNR, National Research Council
Via Moruzzi, 1 - 56010 Pisa, Italy
050-315{2631, 2090, 2034}, 050-3152593, 050-3152811
{Marina.Buzzi, Patrizia.Andronico}@iit.cnr.it, Barbara.Leporini@isti.cnr.it

Abstract. Due to the enormous amount of information on the Internet today, search engines have become an indispensable tool for finding specific, appropriate information. Therefore, it is essential for search engines to offer user interfaces that are easy to use and accessible to all. In this study we describe the initial steps of a project aimed at evaluating the accessibility and usability of several popular search tools. The analysis is centered on two user categories: sighted and blind users. With this goal in mind, we collected individual feedback in order to determine whether it is possible to improve interface design.

1. INTRODUCTION

The vast amount of data available on the Internet requires the use of search tools in order to retrieve useful information. People wish to find relevant information quickly. Often this is difficult, and the user navigates back and forth among results, which can be frustrating and time-consuming. Even if a user can rapidly distinguish between useful and irrelevant pages, a complete exploration is practically impossible, unless the set of results is quite small. This problem is worse for blind users, who use assistive technologies to navigate, since they usually need more time to complete tasks. New interfaces aimed at simplifying interaction between humans and computers have been proposed recently. For example, Google Labs proposed an interface that automatically shows a sequence of results (summary and cached version) until the user reaches an interesting result and clicks on the mouse to stop the sequence. Although useful for the sighted, these interfaces are often impracticable for blind users.

In order to improve the quality of results, search engines apply functions for assigning importance to a page (i.e. page rank, similarity, back-links and mixed approaches) and give precedence to pages with higher weight, which presumably indicates greater relevance. However, the user may still have difficulty performing web searches. Why? Various reasons include:

- User behaviour/skill. A user is unable to formulate the right query in order to restrict the results set. Using phrases with many words often produces no results; users then prefer to specify only one or two words, which generates large sets of results.
- The interface may be difficult or inaccessible for the unskilled or disabled user.
- Ranking functions are applied statically, i.e. the user is unable to select the criteria most appropriate for him. Some options are present in advanced searches, but are rarely applied even by skilled users.

[1] IIT, Institute for Informatics and Telematics.
[2] ISTI, Institute of Information Science and Technologies.

- Web content design. Information on the Internet is rarely structured and organized for easy retrieval by search engines. Web page authors do not correctly apply meta-tags such as description and keywords and do not use meaningful filenames, titles, link descriptions and alternative texts. On the other hand, an inappropriate use of metadata produces phenomena called "search engine spam", aimed at deviating search engine results. For this reason most search engines ignore or only partially use metadata.

This work describes the initial results of a study regarding search engine accessibility and usability. We began by analyzing the interface of seven search tools, restricting the analysis to features of interest to users. Next, in order to understand user difficulties when interacting with search engines, we performed a survey and analyzed the user feedback.

2. RELATED WORKS

Many studies in the literature focus on user-interface accessibility and usability, but to our knowledge very few involve the study of search engine interfaces. On the other hand, studies regarding search engines mainly address algorithms, strategies and architectures, and focus on increasing the effectiveness and quality of results. Regarding the relevance and precision of results, in [Agichtein 03] the authors introduce a meta-search engine which transforms a question submitted by a user into a set of more effective queries and on-fly re-ranks results, and demonstrate that their system outperforms the underlying search engines. An overview of the variety of possible visualizations for search engine results and a discussion of the main factors for their success is carried out in [Mann 99]. Concerning accessibility, the W3C consortium has a primary role: it investigates the problems of disabled individuals when accessing the web, describes alternative web browsing resources and produces guidelines for accessibility of web contents, authoring tools and user agents. Within the framework of the Web Accessibility Initiative (WAI) the W3 Consortium proposed a set of 14 main guidelines (http://www.w3.org/) In addition, other accessibility guidelines have been defined by section 508 standards (http://www.section508.gov). Detailed usability guidelines have been formulated for user interfaces and Web page design in [Nicolle 01] and [Scapin 00]. A detailed discussion on accessibility and usability requirements for sightless persons is carried out in [Leporini 02] and [Leporini04] since both aspects are crucial for navigation by means of assistive devices. The NOVA project carried out usability experiments on a sample of blind and visually-impaired users who performed four information-seeking tasks, including the use of search engines. Interesting and detailed results are included in [Craven03]. A specific work regarding accessibility of on-line library resources was performed in [Schmetzke 02]. while an auditory search engine prototype, providing vocal output by using real-time text-categorization to organize results into a voice menu format, is proposed in [Ferworn 00]. Last, in [Brajnik 04] the author discusses the limits of Universal Design and analyzes the use of a text-transcoder to furnish a text interface equivalent to the original. In particular, for people using a screen reader (which gives modal access) user bandwidth decreases (e.g. actions take longer) while tasks become more difficult since additional actions are required. Therefore, when designing accessible interfaces it is very important to maximize the "quality of use" for disabled persons.

3. SEARCH ENGINE USER INTERFACES

Accessibility and usability are crucial for those who use assistive technology for navigating the Internet and searching for information. Thus, it is very important to make search engines universally accessible and easy to use for anyone. This work focuses on the needs of sightless

users when accessing search engine user interfaces. Unfortunately, search engines are particularly difficult for a blind person to use, because difficulties in Web navigation add to the complexity of the search engine's interface and functionality.
To understand the obstacles encountered by the blind when dealing with search engines, it is fundamental to know how a screen reader deals with page content and how a user interacts with it. Specifically, navigation via screen reader implies following issues:

- *Lack of context* - The user may lose the overall context of the current page because he/she reads only small portions of texts.
- *Keyboard navigation* – Sightless users are unable to use the mouse functionalities (i.e. pointing, scrolling, selecting, etc.), so they move around the pages by means of the keyboard (Tab key, arrow keys, etc.).
- *Sequencing in reading the information* - Commands for navigating and reading may oblige the user to follow page content sequentially.
- *Information overload* - Portions of the site which do not vary (index, frames, banners) may overload the "reading" since the user hears the same items for every page.

All these drawbacks slow down navigation and annoy the user. In addition, the screen reader deals with page content in a manner that is very different from a visual rendering; it requires considerable expertise in using advanced commands and it takes considerable effort to orient oneself within the page content. Thus, it is important to consider all these problems in the initial design phase. User Centered-Design (UCD) is an effective approach for dealing with the implementation of a user interface. UCD places the person (i.e., his tasks and goals) at the heart of the analysis and focuses on the cognitive processes of interacting with interfaces (i.e. perception, memory, learning, etc). An interface must satisfy graphic requirements, and balance expressive power with simplicity as well as logic: interfaces that are easy to understand and navigate provide substantial advantages in terms of user satisfaction and improved productivity. In the design process several features must be considered including:

- Arrangement of components. This point is very relevant because value-enhancing features are more "visible" when positioned in an area that is rapidly encountered by eye movement and does not require page scrolling. For example, Google's refinement function, which allows searching into results, is not very obvious due to its position and font (size and color): it is found at the end of page results, so inexpert users may not benefit. In order for a sightless user to obtain a similar perception (i.e. visit the most important parts first) most important components (i.e. search box, links to advanced search/preference, etc.) should be located at the beginning of the page; no advertising banner frames, links, and texts should be placed before search fields and results.
- Expressive power: a visual representation can communicate certain kinds of information much more rapidly and effectively than other methods. Keyboard navigation and sequential access to the page content influence the navigation of blind users. Faster navigation and positioning over interface elements can be obtained by assigning access keys and tabindex values (to most relevant components). By means of shortcuts and "priority values" users are able to reach the desired search field or result link more quickly. Moreover, assigning a label to fields is very important in order to facilitate recognition by the screen reader. Labels should be placed over or to the left of the field, and not below, to simplify exploration by using arrow keys. The text used for labels and buttons should be simple and familiar.
- It is very important to design a very simple interface in order for users to navigate the interface easily. Common design errors are unclear mapping of functionalities or positioning too many functions in the same spatial region, which is not intuitive but must be remembered. Web directories are organized according to categories of goods and

services offered but their interfaces are quite complex, and can create confusion in an unskilled user.

- A user typically performs a simple search and specifies one or more words, obtaining a large set of results. Further criteria selection can be specified in order to restrict search on the results. However, although very powerful, search options and commands are rarely used, even by skilled individuals.
- Clustering permits users to explore results grouped by categories so users can navigate a single branch of results more efficiently. If correctly implemented (i.e. accessible), this feature increases interface usability and saves time.

4. ANALYSIS

This work (still in progress) represents the first stage of a study concerning the usability and accessibility of popular search engines:

- Google (http://www.google.com/), and Altavista (http://www.altavista.com/);
- Yahoo (http://www.yahoo.com/) and Excite (http://www.excite.com/) web directories and meta-searches. Yahoo has its own search engine.
- HotBot is a meta-search which permits customizing the user interface (http://www.hotbot.com/);
- Vivisimo is a meta-search which performs on-fly clustering of results (http://vivisimo.com/);
- Kartoo is a meta-search which represents results with a series of interactive maps (http://www.kartoo.net/).

As a first step we verified the conformity of user interfaces to the W3C accessibility guidelines by using automatic tools (validators): Bobby (http://bobby.cast.org/) and Torquemada (http://www.webxtutti.it/). The tests were performed on four types of interface: home page (simple search), advanced search interface, preferences and results pages. Obviously the evaluation of these automatic tools is rough and can generate false positive/negative results so we manually controlled the output and discarded fake errors. Of all the tools analyzed, only Google conformed to priority 1 of WCAG 1.0, meaning that it satisfies a minimal level of accessibility (level A), whereas other search engines, directories and meta-searches presented priority 1 errors, as showed in Table 1 for simple search interfaces (home pages).

Element	Attribute	WCAG Guideline	Present in
Img	Alt	1.1	Altavista, Yahoo, Excite, Vivisimo, Kartoo
Frame	Title	12.1	Hotbot
Object	Title	6.3	Kartoo

Table 1- Validator's output: priority 1 errors

Analogous tables compiled for priority 2 and 3 errors, highlighted 15 different types of errors. In addition 4 of 21 "user checks" warnings reported by Bobby, were also errors by manual control; giving a total of 19 different kinds of errors, present in all the interfaces analyzed.

The analysis showed that errors are also common between different search engines. For instance, tables are frequently used for the layout of page results, ignoring the needs of sightless individuals for whom a sequential reading renders access very difficult. In some interfaces one kind of error is present in one part of the page source but not in another. This clue suggests that various updates have been performed by different tools/persons, resulting in inconsistent attention to accessibility.

When a user interacts via screen reader, there are no standard guidelines for evaluating the interface's usability. On the other hand, even a sighted user may have difficulty using search engines. Thus, testing with different categories of users is necessary in order to discover the source of difficulties.

In order to gather user feedback, we drew up a questionnaire composed of four parts: user characterization; general knowledge of search tools; use of search interface (simple/advanced search and preferences); difficulties encountered. The questionnaire was distributed to 52 individuals. The sample consisted of 75% sighted and 25% sightless users; 33% were women and 67% men; age ranged from 20 – 60+ years, as shown in Fig.1a. In all figures the diagonal-row pattern represents sighted users.

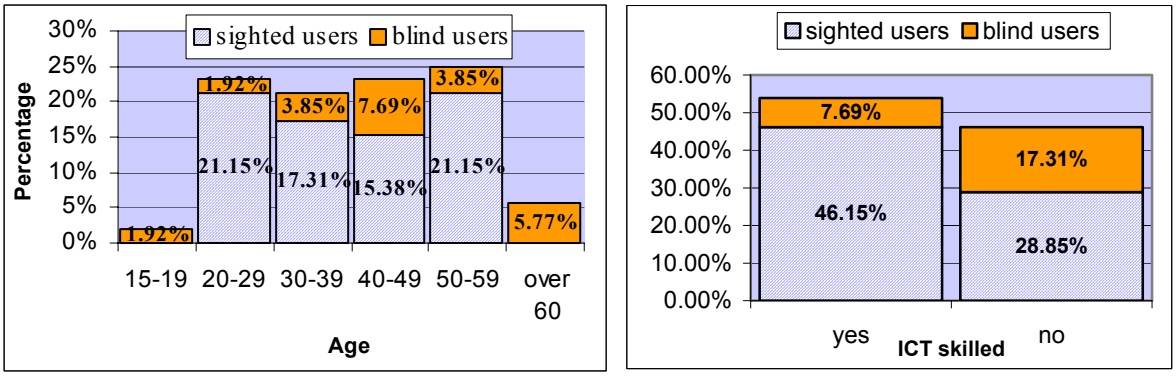

Fig. 1 - Sample characterization a) age b) ICT skill

The 54% of the sample was ICT skilled and 46% was not (Fig.1b); however, all users use the computer: at home (13%), work (44%) or both (43%), as shown in Fig. 2a. The most popular search engine was Google, followed by Altavista and Yahoo (Fig. 2b). The first observation was that sightless users do not use web directories. For the blind in fact, an interface crowded with elements is more difficult due to the increased complexity of the visual layout and structure, and it may become impracticable.

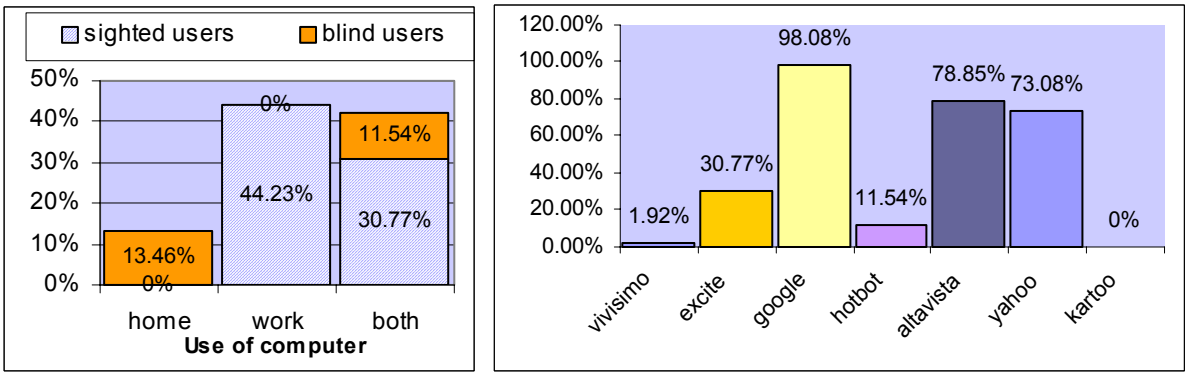

Fig. 2 – a) computer usage b) search tool preferred

Feedback concerning the knowledge of search tools showed that 60% of users always use the same search engine but 79% have tried performing queries with different search product. This value may indicate that the user tries to find better user interfaces. In addition, a total of 58% utilize search engines frequently while 33% do so only when needed.

The third part of the questionnaire was about how users utilize search engines. Only 25% of the total population has attempted to configure the search tool (i.e. the preference page). However 75% have used the advanced search, of which 38% were blind and 87% sighted users. This data confirms that interaction with a more complex interface is more difficult for blind users. About 87% of the total sample (blind and sighted users) agrees that using a search engine is the fastest way to find information on the Internet (Fig. 3a).

Usability renders Internet navigation more effective, efficient and satisfactory. To the question "do you think that search engines are easy to use?" 92% of sighted users answered "yes"; in contrast, 77% of blind users said "not always", as shown in Figure 3b). This result highlights the fact that usability is crucial for disabled persons.

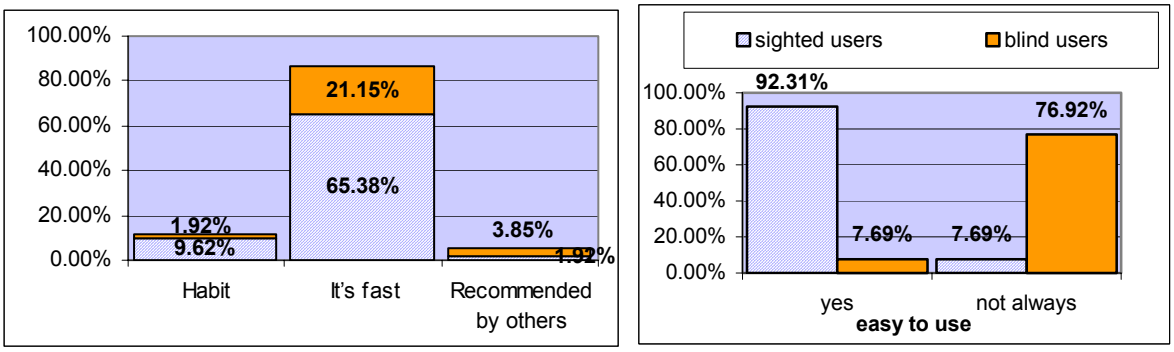

Fig. 3. - a) why search engine is used b) easy to use

Concerning queries, users usually specified more than one keyword (92% of sighted users and 69% of blind users) as shown in Figure 4a. Furthermore, 67% of sighted users had no difficulty choosing the right keywords for the query, whereas only 38% of blind users agreed.

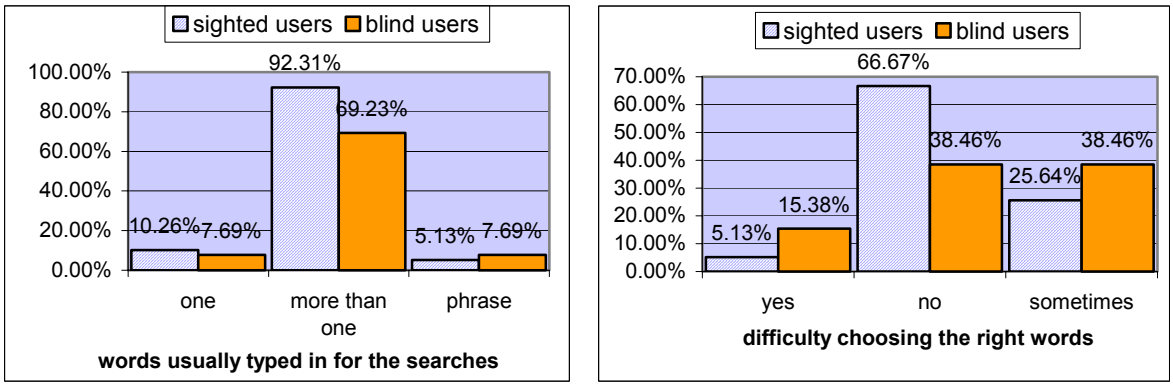

Fig. 4. - a) number of keywords b) difficulty choosing the keywords

Regarding results, 67% of sighted users explored more than two pages compared to 15% of blind users, while 80 % of blind users accessed only the first two (Fig. 5a). Once again these data highlight the difficulties of sightless users. In fact the ability of sighted users to rapidly focus on interesting results or discard irrelevant information is greatly reduced in blind users due to sequential access to the page content. Thus the blind take more time to visit each result page and accessing more than two pages becomes difficult, if features for fast navigation via keyboard are not present (as discussed in § 3.).

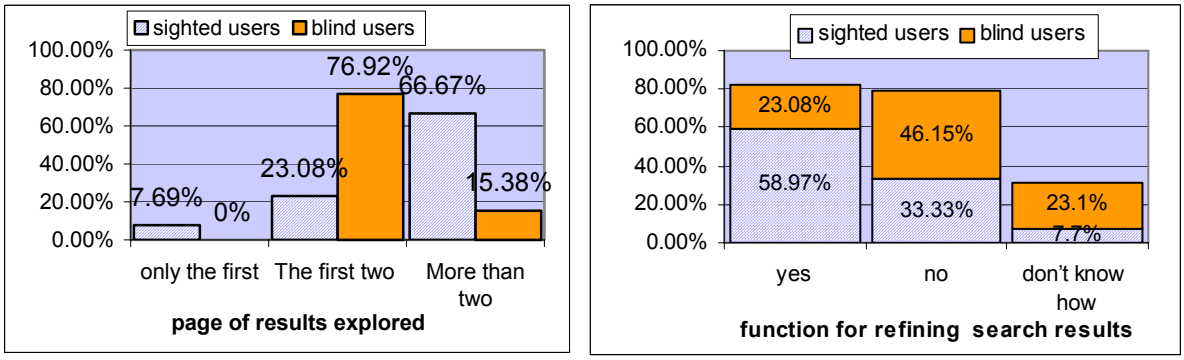

Fig. 5. - a) page of results visited b) searching in results

In addition, only 23% of blind users use the refining function (for searching into results) compared to 59% of sighted users (Fig. 5b). Last, sponsored results were known to 48% of the whole population, but only 25% were able to recognize them among all results.
The last part of the questionnaire attempted to determine where users have the greatest difficulties. This question permitted multiple answers; Figure 6 shows the results. For sighted users the main obstacle is choosing the right keywords (62%) while blind users also have difficulty reading results (46% compared to 15% of sighted users) and accessing interfaces (functions/interfaces unclear): 31% compared to 18% of sighted users. Lastly, 90% of sighted users nearly always find what they are looking for, while 38% of blind users find useful information only sometimes and 8% almost never! (Fig. 6b).

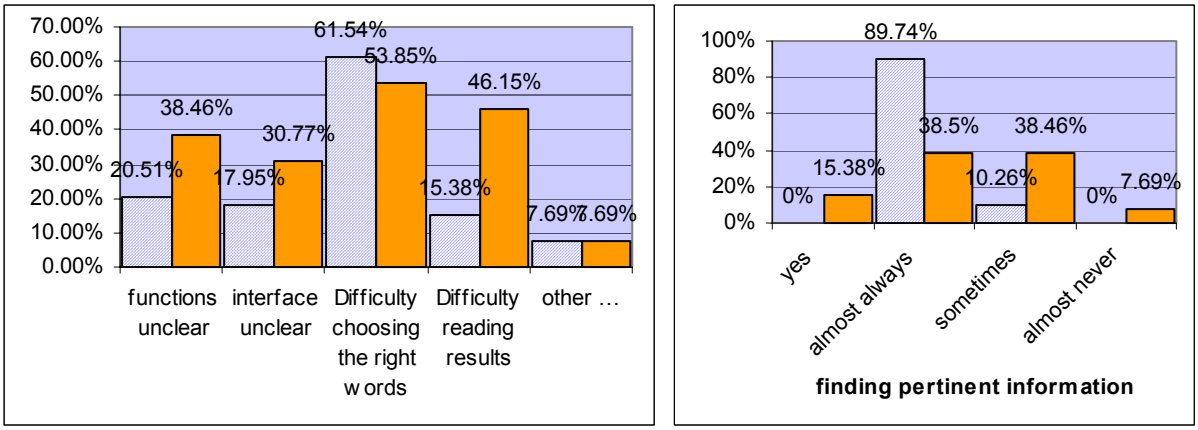

Fig. 6. – a) Difficulties for users b) finding what you are looking for

These data demonstrate that sightless individuals are more sensitive to user interface design. Thus, a crucial aspect is structuring results appropriately, so that blind users can access them quickly and easily. For instance, reaching the result area rapidly, clearly knowing the number of results obtained, reading appropriate links about the results, and so on, are important features for users who access information by means of a voice synthesizer or Braille display. "Next" and "Previous" links are particularly important when navigating by keyboard. To make them truly efficient, they should be assigned an access key (e.g., alt+n and alt+p). In this way, users are able to move more rapidly among the result pages. Furthermore, if numbered links are used to point to result pages, they should be placed at the end of the result list, in a compact format. In fact, when a user moves by Tab key, it is frustrating to hear the voice synthesizer recite all link numbers, before reaching the main results.
However, more detailed studies are necessary to formulate appropriate and specific guidelines for search engines.

5. CONCLUSION

Finding and accessing information is very important for people with disabilities, especially for the blind, who have considerable difficulty accessing printed information. The user interface plays a crucial role in the correct and productive use of a search engine. It is not sufficient for the interface to be accessible - it must also be user-friendly, i.e. easy to use and navigate by all.
This work is a preliminary study regarding the accessibility and usability of search engines. As a first step we used automatic tools for accessibility testing to analyze the interfaces of some search engines, and we then checked the validator output manually, in order to collect reliable data. The results showed that accessibility is greatly neglected: of the seven search

tools analysed, only Google conformed to level A of accessibility as specified by WCAG 1.1, assuring a minimal level of accessibility.
The second step focused on usability. We collected feedback from sighted and blind users by means of a questionnaire. It is remarkable that 92% of sighted users thought that search engines are easy to use but less than 7% of blind users agreed. Furthermore, 38% of sightless users are able to find interesting results only sometimes and 8% rarely. In fact, the sighted can rapidly select interesting results or discard irrelevant information, whereas it takes longer for blind users due to the serial access to web page content. In addition, the population as a whole showed the following difficulties: functions unclear 25.00%; interface unclear 21%; difficulty choosing the right words 60%, difficulty reading results 23%. To facilitate navigation by screen reader and keyboard commands, specific features and an adequate structure should be applied.
In conclusion, usability and accessibility for all are an important and attainable target. Redesigning an existing site can be onerous in the case of large, dynamic sites, but for search engines, which have at most four interfaces (simple search, advanced search, results and preferences) the cost is low and benefits are considerable.

REFERENCES

[Agichtein 03] Agichtein, E., Lawrence, S., Gravano, L., (2003), Learning to Find Answers to Questions. To appear in *ACM Transactions on Internet Technology*.

[Brajnik 04] Brajnik G. (2004) Achieving Universal Web Access through Specialized User Interfaces. In *8th ERCIM UI4ALL Workshop*. Vienna, Austria, 28-29 June 2004.

[Craven03] Craven, J., Brophy, P. Non-visual access to the digital library: the use of digital library interfaces by blind and visually impaired people. Tech. report, Manchester: Centre for Research in Library and Information Management.

[Ferworn 00] Ferworn, A., Bodner, R., Chignell, M. H., Auditory WWW Search Tools. In *Int. Conference on Auditory Display 2002*. Atlanta, USA, April 2-5, 2000. http://www.icad.org/websiteV2.0/Conferences/ICAD2000/ICAD2000.html

[Leporini 02] Leporini, B., Paternò, F. Criteria for Usability of Accessible Web Sites. In User Interfaces for All 2002, Paris (Chantilly), FR, 23-25 Oct 2002, pp. 43-55.

[Leporini 04] Leporini, B., Paternò, F. Increasing Usability when Interacting through Screen Readers, International Journal Universal Access in the Information Society, special Issue on "Guidelines, standards, methods and processes for software accessibility", Springer Verlag, Vol.3, N.1, pp. 57-70.

[Mann 99] Mann, T.M. (1999), Visualization of WWW-Search Results. In *International Workshop on Database & Expert Systems Applications*. pp. 264-268.

[Nicolle 01] Nicolle, C., Abascal J. Inclusive design guidelines for HCI, p. 285, Taylor & Francis, 2001.

[Scapin 00] Scapin, D.L., and al. In *Conf. on Human Factors and the Web*.Austin, Texas, 19 June 2000. http://www.tri.sbc.com/hfweb/scapin/Scapin.html

[Schmetzke 02] Schmetzke, A. The Accessibility of Online Library Resources for People with Print Disabilities: Research and Strategies for Change. In *ICCHP '02*, Linz, Austria, July 15-20 2002, pp. 390-397.