Contextualised Travel Support for the Visually Impaired Web Users Continuation Report

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Abstract

Visually impaired people have difficulties accessing the Web, either because of the inappropriately designed web pages or the insufficiency of the currently available technological advances. The main focus of the currently available technology is on providing sensory translation rather than supporting mobility. As a consequence of limited mobility support, visually impaired people are less able to browse and travel on the Web. Furthermore, Hypertext design and usability traditionally concentrates upon navigation and/or orientation and neglects the importance of mobility and travel [30].

Harper introduced the notion of travel on the Web and proposes the inclusion of travel and mobility in the usability metrics of web design [32]. The notion of travel extends navigation and orientation to include environment, mobility and the purpose of the travel task. Travel in the virtual, web world is likened to travel in the real, physical world. In consequence, the extensive work undertaken in the mobility of visually impaired people in the physical world can be transferred and adapted to the web-based world [30].

The notion of travel on the Web is also the foundation of this PhD project. Our goal is to improve travel upon the Web by improving the design of web pages and sites – moving the travel component from a craft towards an engineering paradigm. In order to achieve our goal, we are aiming to support travel on the Web by providing a tool that analyses travel support offered within a page and consequently, semi-automatically transforming the page to increase the travel support provided. We are proposing a framework for analysing travel support offered within a web page. This framework forms the basis of the tool that will be created, which aims to increase the provided mobility within a web page. This continuation report presents the context of the research, the work done in the first year of this PhD project, including an evaluation of the framework's effectiveness, and proposes a work plan for the forthcoming years.

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Chapter 1

Introduction

This report explains the PhD project, where the aim is to improve the mobility of the visually impaired users on the Web by providing tool support for the provision of mobility. In this chapter, we will explain the context of this project, the main hypothesis, aims and objectives, the phases of the project, and finally the structure of the remainder of the report.

Nowadays, the Internet, particularly the Web, plays an important role in our daily life. Various types of information are being made available via the Web, ranging from international news to local restaurant menus. The amount of information on the Web is overwhelming. However, although the Web is evolving rapidly, the focus is still on visual interaction, and thus causes difficulties to visually impaired people.

Visually impaired people usually access hypermedia environments, particularly the Web, by using screen readers [34, 75] or specialist browsers [11, 66, 90]. For these access technologies to work properly, web pages must be appropriately designed and must be encoded in valid HTML that conforms to its DTD (Document Type Definition) and various guidelines for accessibility. Unfortunately, many pages are not appropriately designed, thus causing difficulties for visually impaired users. Additionally, these access technologies themselves may also cause problems because they have focused on supporting the sensory translation of visual content to either audio or touch (through braille) rather than enhancing movement on the Web.

Some organisations, particularly the W3C Web Accessibility Initiative, recognise these difficulties and provide guidelines to promote accessibility on the Web. Although the guidelines provided are sensible and important, designers rarely follow these guidelines. Moreover, the main focus of these guidelines also supports the sensory translation rather than providing mobility on the Web.

This PhD project builds on work previously undertaken by Simon Harper during the TOWEL project [32]. TOWEL is a research project which proposes using the notion of travel and mobility on the Web to improve the accessibility for visually impaired and other travellers. The main hypothesis of the TOWEL project is that travelling and mobility on the Web mirrors travelling and mobility in the physical environment. **Travel** is the confident navigation and orientation with purpose, ease and accuracy within the environment. **Mobility** is defined as the confident ease of movement within the environment and the accuracy of navigation. In consequence, the extensive work undertaken in the mobility of visually impaired people in the physical world can be transferred and adapted to the web-based world.

Harper also proposes the inclusion of travel into the Web design and usability metrics [32]. Hypertext design and usability has traditionally concentrated upon navigation and/ or orientation. **Navigation** is the process whereby people determine where they are, where everything else is, and how to get to particular objects or places [41]. **Orientation** is the knowledge of the basic spatial relationships between objects within the environment, and the objects and the traveller [48]. However, the notion of travel extends navigation and orientation to include environment, mobility and purpose of the travel task.

The notion of travel on the Web [32] is also the foundation of this PhD project. We will also continue investigating the work undertaken in the mobility and travel of visually impaired people, as well as sighted people in the physical world. Our main goal is to improve travel upon the Web by improving the design of web pages and sites. An initial task is to discover the flaws in travel support in existing web pages and sites. In order to achieve this goal, we created the travel analysis framework for extracting travel objects from a web page and discovering their roles. Although Harper has provided a framework for analysing mobility support offered by a page [32], the focus of the framework is providing a mobility rating. Moreover, it is 'craft based' and a tool cannot be build on craft; we need to move beyond the craft and create an engineering based framework (see Chapter 4). The main aim is to provide tool support for travel on the Web, by extracting travel objects from a page, discovering their roles and transforming a page into another form so that travel objects can fulfill their intended purpose. In the following sections, first, we will state the research hypothesis. Second, we will indicate the aims and objectives of the project. Third, we will explain the phases of this project to achieve the main goal - improving the mobility of visually impaired users around the Web. Finally, we will present the structure of the remainder of the report.

1.1 Research Hypothesis

The research hypothesis that underlies this project can be phrased as follows:

> A semi-automated process can be captured in a software tool to extract travel objects and determine their roles. As a consequence, the original web page can be transformed such that travel objects can play their intended roles. In order to achieve this goal, the tool will allow semi-automated annotation of the extracted travel objects. The transformation of a web page to augment travel support will improve the travel and mobility support offered within that page.

In the following sections, we will explain the procedure that will be followed to demonstrate this hypothesis and how a success will be declared at the end of this project.

1.2 Aims and Objectives of the Project

The overall aim of the project is to develop a semi-automated tool to support visually impaired people travel on the Web. This tool is aimed to comprise of the knowledge acquired from the physical world studies undertaken in the mobility of visually impaired people as well as sighted people. The objectives of this project are:

- To develop a framework for analysing travel support offered within a web page or a site by using the knowledge from the physical world travel acquired by investigating the real world studies on mobility and travel;
  - To extract travel objects from a page and create a travel object inventory,
  - To discover the roles of extracted travel objects in the process of travel,
  - To conduct an evaluation to test the applicability of the framework,
- To Design and implement a tool for travel analysis which will include automatic and third party travel analysis;
- To conduct evaluations to test the success of the travel analysis tool;
- Transforming the page into another form so that travel objects can play their intended roles;
- Evaluating the overall system to test the main hypothesis of this project.

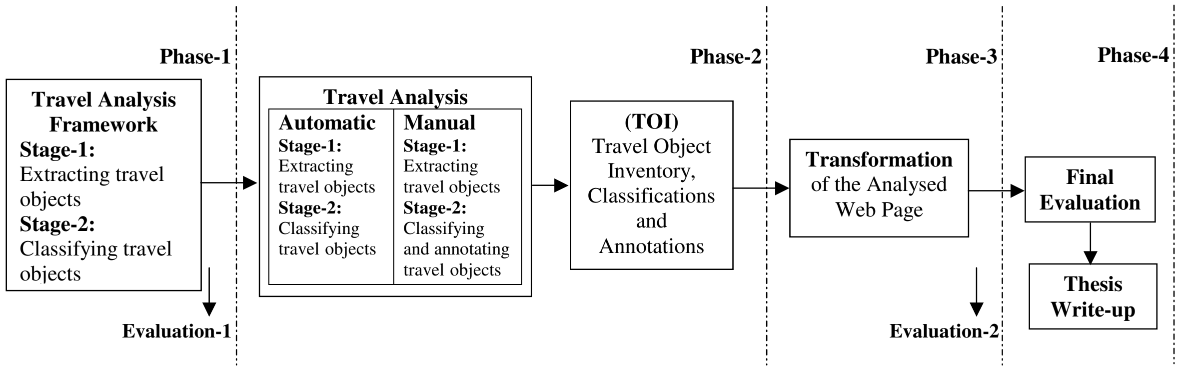


Figure 1.1: The project phases.

1.3 The Project Phases

This PhD project will consist of the following four phases (illustrated in Figure 1.1):

- **Phase one:** This phase has been completed in the first year of this PhD project. In this phase, we identified the problem domain (see Chapter 2), studied the TOWEL project (see Chapters 2 and 4) and investigated the work undertaken in the mobility of visually impaired as well as sighted people (see Chapter 5). Additionally, we have investigated the literature concerning the browsing activity in order to understand the activity and extend the notion of travel on the Web (see Chapter 3). The aim of both investigations was to acquire the necessary knowledge to analyse travel support offered within a web page. Then a framework was created that encapsulates the findings and solutions from real world mobility and travel (see Chapter 5). This framework is for analysing travel support offered within a web page. This framework has two stages: first identifying travel objects on a web page and second classifying them. We have also conducted an evaluation to test the applicability of the framework (see Chapter 5). This framework is the basis of the further phases of this project.

- **Phase two:** This phase aims to design and implement a tool that will be the implementation of the framework. The tool is aimed to be semi-automated: the framework will be applied in two ways:

  1. *Automatic:* The tool will automatically extract the travel objects and classify them based on the heuristics, that it is to say, a travel object inventory will be created (TOI).
  2. *Manual:* Then the TOI will be provided to the manual part as suggestions. In the manual part, an analyst will be able to accept or reject the suggested TOI. He(she) will be able to extend or modify the suggested TOI of the automatic part.

  The reasons for aiming to build a semi-automated tool can be summarised as follows:

  1. the travel analysis is a subjective process, therefore cannot be fully automated;
  2. automatic tool cannot identify the layout of the information, the navigation structure, the value of information and various aesthetic aspects;
  3. the automatic analysis part can speed up the process of analysis;
  4. an analyst can deal with visual effects and add further description to original content;

  Consequently, in order to benefit both of their advantages, we will integrate both of them into a single travel analysis tool. The main outcome of this phase will be a TOI (travel object inventory), classifications of travel objects in the TOI and the annotations. At the end of this phase, we will also conduct an evaluation to test the success of the travel analysis part.

- **Phase three:** The analysed page from the previous stage, will be transformed into another form in this stage. As a result, the travel objects can fulfill their intended role. The TOI from the previous phase, the annotations and a set of heuristics will be used to transform the page.

- **Phase four:** This will be the last stage, a final evaluation will be done concerning the travel analysis and transformation of the page. This evaluation will include the comparison of the mobility support and accessibility of the page before and after the travel analysis and transformation, in order to be able to declare the success or failure of improving the accessibility and mobility. The final part of this phase is writing up the thesis.

1.4 Contents of the Report

The remainder of this report is organised as follows:

- **Chapter 2** presents the state of the art in the published literature related to web accessibility and the TOWEL project, which is the basis of this PhD project.

- **Chapter 3** investigates the literature on browsing activity and how this activity can be used to contextualise travel on the Web.

- **Chapter 4** discusses the mobility analysis framework proposed by Harper and states the problems of the framework.

- **Chapter 5** explains the new travel analysis framework as well as the modifications and extensions of the real world travel model introduced by Goble *et al.* [30].

- **Chapter 6** presents the evaluation conducted to test the applicability of the new framework.

- **Chapter 7** first summarises the report and the work done in the first year, then proposes a work plan for the remainder of the project.

Chapter 2

Accessibility Issues

2.1 Introduction

This chapter presents a review of the published literature related to web accessibility. By reviewing this work it will be possible to characterise the nature of visually disabled user's interaction with web pages. It will also be possible, having characterised the nature of interaction, to spot the problems with the style of interaction and the support offered by tools. It will be seen that most tools simply offer a 'sensory translation' of web page content and that this offers inadequate support for using the Web. The introduction of travel as a metaphor in web use offers a way to enhance the design of web pages and sites for all users, especially those with visual disabilities. This review ends with a summary of the state of the art in this field and describes the problems that need to be addressed.

Figure 2.1 summarizes the content of this chapter. Section 2.2 reviews some of the Web access technologies for visually impaired people, including screen readers and special browsers. Section 2.3 covers and discusses some research projects related to accessibility. Section 2.4 discusses some published accessibility guidelines for making the Web accessible to visually impaired users. In addition to web access technologies, some tools that are used by web content developers and users to make the Web more accessible are introduced. Section 2.5 covers some of these tools. Finally, the foundation of this project which is the notion of travel, is introduced in Section 2.7.

2.2 Web Access Technologies for Visually Impaired People

There are several assistive technologies for visually impaired people for accessing the Web. These include screen readers such as JAWS [34], Window-Eyes [81], outSPOKEN [80], LookOUT [15] and special web browsers such as pwWebSpeak [63], BrookesTalk [38], EmacSpeak [66], HPR [11]. We will present a review of these assistive technologies within this section.

2.2.1 Screen Readers

Screen readers are software applications combined with a synthetic voice that read the content from top left to the bottom right of a page, line by line [56]. They can be used with conventional Internet browsers such as Netscape or Internet Explorer (IE) for accessing web pages. Some screen readers have relied on the visual representations of web pages as the basis for audio rendering, for example, outSPOKEN [80], LookOUT [15] and Window-Eyes [81]. So it is the conventional browsers (Netscape or Internet Explorer) that do the visual rendering of web pages (visual presentation of HTML files). Then it is the screen readers that do the audio rendering from this screen rendering. Although the potential functional utilities of these browsers can be accessed, full interaction with the HTML is lost. They cannot recognise and differentiate HTML elements such as tables, headings or frames.

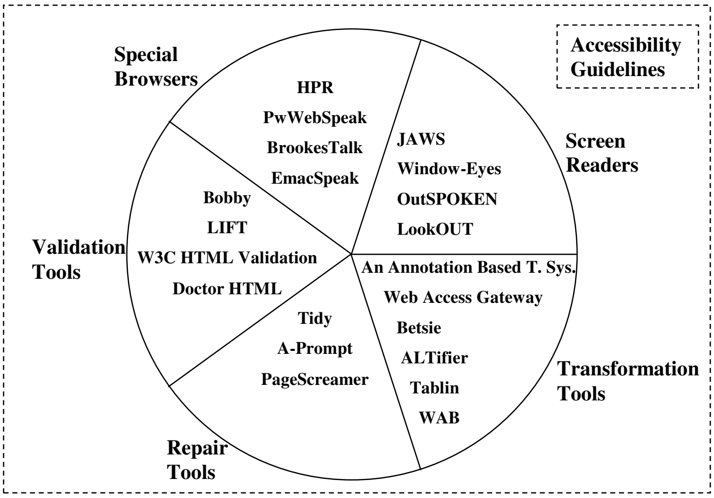


Figure 2.1: Schematic representation of the literature review.

LookOUT is a commercially available screen reader designed by Blenkhorn and Evans [15]. They stress the importance of *maximum information and minimum speech* and provide two modes of operation: standard for experienced users and verbose for novice users. They have used musical tones to indicate in which direction the user is moving the cursor; a musical tone goes higher as the user ’cursors up’ and different musical tone goes higher as the user ’cursors right’. They provide ”where am I” keys for obtaining the position on the screen in X and Y coordinates. Similarly, outSPOKEN and Window-Eyes are also commercially available screen readers: the former is from ALVA Access Group [80] which was originally designed for accessing the Machintosh [29] and the latter is from GW Micro, inc.

We can illustrate the problem that screen readers have with Web pages by using the *Virgin Trains* web site (`http://www.virgin.com`). Figure 2.2 shows the top navigation bar of the site entry page. Since it has a simple visual layout, the sighted readers can easily orientate themselves quickly. On the other hand, all the visually impaired people hear in such a short time are the words in the Figure 2.3 by IE and JAWS screen reader. The problems can be summarized as follows:

- It is almost impossible to differentiate items in the page.
- They do not provide or maintain an overall picture of the page.
- They focus on providing ’sensory translation’ of a page which is called ’screen scraping’, rather than enhancing web navigation [30].
- They produce superficial information about the page; all layout which is often a key for understanding the content of a page, style, font, or nature of information is lost.
- All the visual navigational cues are missing so navigation is almost impossible.

Consequently, there is no question about the ignorance of supporting the mobility.

There are also some specialist screen readers for visually disabled users, which can read the web content directly following the tag order. For example, JAWS 4.2 used within Internet Explorer. While this can be seen as an improvement on traditional screen readers which can only access the visual rendering of a page, it is still not a complete solution. The contents should be laid out according to the tags in a logical and meaningful way. Most of the designers, however, are not aware of this. An important advantage of being able to access the HTML source code, is being able to provide interaction with the HTML. For example, JAWS 4.2 when used with Internet Explorer, provides heading index based on

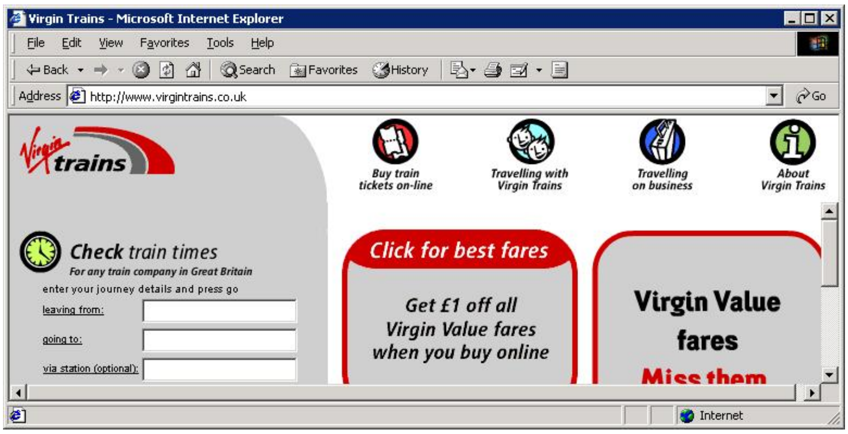


Figure 2.2: The *Virgin Trains* home page (21-Feb-2002).

Graphic Virgin Trains link Virgin Trains Link Virgin Trains Link Virgin Trains Link about Virgin Trains

Figure 2.3: The audio rendering of the *Virgin Trains* home page.

the heading tag set(<H1>···<H2>) and supports navigation of web pages by headings. Thus, the hierarchy of headings levels may help to aid understanding of how the page is structured. For this to work properly, however, the HTML source code should be compliant with the HTML 4.0 standard and the provided accessibility guidelines. However, not many pages are designed by following the HTML 4.0 standard or the guidelines.

JAWS also recognises and provides some functionalities for complex structures, in particular, tables. However, the provided functionalities are limited and every table is rendered row by row without considering the semantic structure of the table. Figure 2.4 shows the visual rendering of a table in the *Cornerhouse* home page and Figure 2.5 shows the audio rendering of that table. It is almost impossible to understand the content of the table and since it is an important part of the page, it is almost impossible to understand the entire content of the page.

2.2.2 Alternative (Special) Browsers

These are specialised browsers which provide speech output. IBM home page reader [11], pwWebSpeak [63], BrookesTalk [38] and Emacspeak [66] are some examples of these browsers.

IBM Home Page Reader (HPR)

IBM's Home Page Reader is a web browser for visually impaired users. It converts the web page contents (HTML source) into text and synthesized speech. The numeric keypad can be used to navigate web pages, and individual keys and combinations of keys represent control commands [11].

HPR provides Netscape Navigator synchronization: while it reads a web page, the same page can be rendered by Netscape at the same time [46]. It also provides multiple voices for reading the page, for example a female voice to read links and male voice to read text. It provides several reading modes which are different choices of how to read a web page. There are ten reading modes including table navigation mode, frame navigation mode, items reading mode [82]. Although these reading modes may reduce the number of key combinations and simplify the command language, it may be confusing because the user always needs to maintain which mode he(she) is in. HPR also addresses the issues

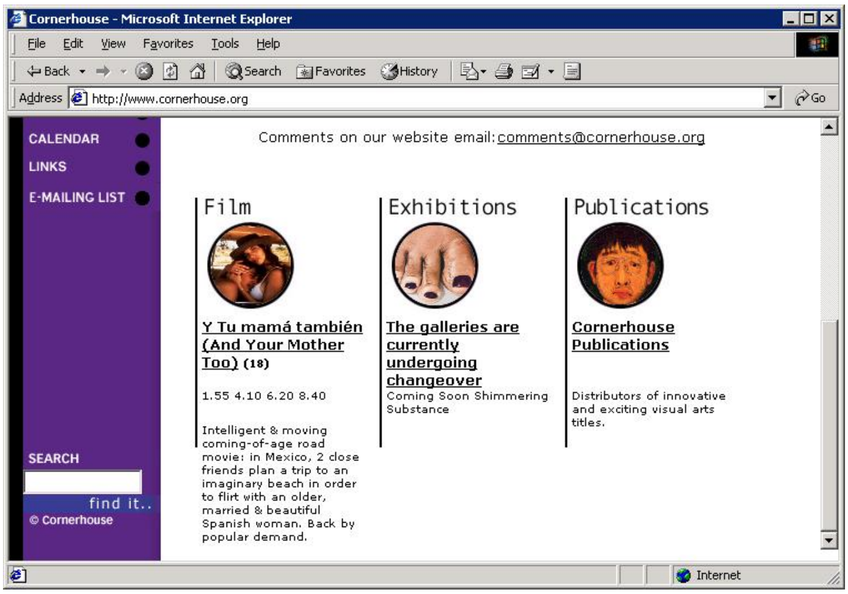


Figure 2.4: The *Cornerhouse* home page (20-Feb-2002).

Link graphic headers/film_mini link graphics headers/exhibition_mini link graphic headers/publication_mini link graphic pictures/y tu mam link graphic pictures/ssubmainssmallweb(1) link Y Tu mama tambien (And Your Mother Too) (18) link the galleries are currently undergoing changeover link Cornerhouse Publications 1.55 4.10 6.20 8.40 Intelligent & moving coming-of-age road movie: in Mexico, 2 close friends plan a trip to an imaginary beach in order to flirt with an older, married & beautiful Spanish woman. Back by popular demand Coming Soon Shimmering Substance Distributors of innovative and exciting visual arts titles.

Figure 2.5: The audio rendering of the *Cornerhouse* home page.

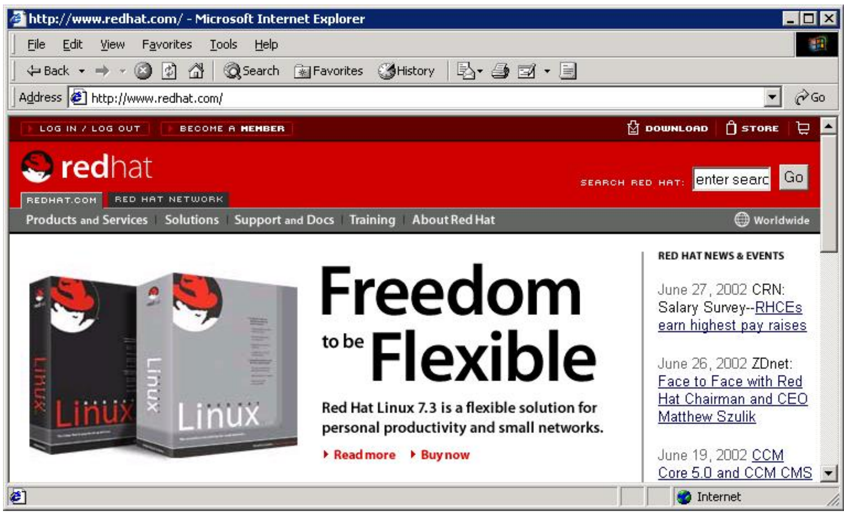


Figure 2.6: The *Redhat* home page (2-Jul-2002).

(Start of map with 5 items).(End of Map.)Red Hat Linux 7.3 box shots.Freedom to be Flexible.Red Hat Linux 7.3 is a flexible solution for personal productivity and small networks.Read more.Buy now.

Figure 2.7: The audio rendering of the *Redhat* home page by IBM Home Page Reader.

Redhat– linux, embedded Linux and open Source solutions image link image Login/logout image link image become a member link image download image link image store image link image cart image image image image image redhat logo data entry form image search redhat text submit end of data entry form image image image redhat.com image link image redhat network image image image map menu link image image image image link image Redhat linux 7.3 box shots

Figure 2.8: The audio rendering of the *Redhat* home page by pwWebSpeak.

Webcast: Red Hat training - Webcast: Red Hat Linux advanced server - A RedHat network how-to - More Red Hat news - Ask Shadowman: Red Hat Linux applications - More Red Hat speaks - Copyright@2002 Red Hat, inc.

Figure 2.9: The generated abstract of the *Redhat* home page by BrookesTalk.

concerning orientation and provides two important functionalities which are 'Where am I?' and 'page summary'. The former function gives a simple description about the current location, for example; Figure 2.6), if a user currently reading the link 'Read more', requests current location then HPR gives the following information: *Link 16. [Red Hat Linux 7.3 box shots]. Table 4. At 29% of page*. The user is not able to access the page layout so the given information may be confusing and may not be sufficient to understand the current position. For instance, in the previous example, it reports table 4 but it does not say anything about the location of the table in the page and about the nature of the table such as whether it is nested or not. The latter function provides a summary of the page which includes the title and the number of links, items, forms, frames and tables, but it does not mention how they are related to each other and how the layout of the page is, which may be the key for being able to navigate in the page.

The World Wide Web Consortium(W3C) provides a list of guidelines for 'user agents' (tools for viewing web pages) [31], which will be discussed in Section 2.4. Although, HPR implements many of these guidelines [86][1], the focus is still on serializing the page content. This can be demonstrated with Figure 2.6 which shows its visual rendering of the *Redhat* home page and the Figure 2.7 which shows the audio rendering. The Top navigation bar is not rendered (see Figure 2.7) and the structure of the page is lost. It reads the Web content directly by reading the HTML source code, so it is required that the contents are laid out according to the tags in a logical and meaningful way. Additionally, some provided functionalities requires the HTML source to be compliant with the HTML 4.0 standard and the provided accessibility guidelines. For example, when a user tries to navigate the page on Figure 2.6, HPR says "No heading on this page" because headings on this page are not specified by heading tag set(H1-H6).

pwWebSpeak

pwWebSpeak [63] is a non-visual Internet browser, which can be used to access information and services in a non-visual or dual mode manner. It is built by isSound corporation(Productivity works) and provides both speech and large character interpretation of the page. It provides a keyboard command interface and the 'Command Menu' which refers to the menu interface.

pwWebSpeak retrieves the content of the specified URL by analysing the HTML source code. It is suggested that the system has a kind of 'intelligence' that can differentiate the HTML constructs that define the pages from the constructs that have no relation to the information content of a document and automatically bypass those constructs [64]. It can be seen from the audio rendering (see Figure 2.8) of the *Redhat* home page, pwWebSpeak cannot even recognize and bypass images that are only used for leaving space on the visual layout (see Figure 2.6). pwWebSpeak also provides summary and 'where am I' functionalities concerning orientation. The summary includes the title, number of headings, number of links, number of data entry forms, and the total number of tags on the page. Although provided information may give an idea about the size of the page, it may not be enough to gain an understanding of the page content and the layout. The 'where am I?' function only provides the element number of the active item, for instance if the user is currently reading 'redhat logo' (see Figure 2.6) and requests the cursor position, then pwWebSpeak gives the position as 'at element 20 over 126'. The given information is at abstract level and far from enabling the user to understand his(her) position on the page.

The system also supports several ways for navigating in the page such as navigation by headings and link navigation. It is also necessary that, the HTML source code is compliant with the HTML standards and the provided accessibility guidelines. In addition, the problems of handling complex structures in pages such as tables and frames have not been fully addressed. For instance, the supported functionalities for navigation and orientation in tables are limited and since they are usually important constructs in pages, the overall navigation and orientation is limited. It is also difficult to differentiate between tables used for structuring data and those used for web page layout.

[1] They have implemented many of the checkpoints in version 3 that had not been implemented in version 2.5

BrookesTalk

BrookesTalk is a web browser for visually impaired users developed as part of the speech project at Oxford Brookes University [38]. It is a function key driven web browser and provides keyboard only accessibility using the function keys. Information retrieval and language processing techniques are used for providing different views of web pages.

Brookestalk mainly concentrates on summarizing pages and provides several functions including heading list, link list and extracted keyword lists. Heading lists can be considered as a good indicator of page content, however, headings are often represented as images or eye-catching objects rather than standard heading elements. Therefore, BrookesTalk considers extracted keyword lists as an alternative to headings list to provide an overview of pages. Keywords are extracted from pages by using Information Retrieval techniques based on word frequency together with Natural language Processing techniques such as relationships and anaphora resolution [89]. BrookesTalk uses similar techniques to provide an abstract of the page, which is usually 25% of pages. The Figure 2.9 which shows the generated abstract of *RedHat* home page (see Figure 2.6), demonstrates that the abstraction needs to be improved and made more efficient. Beside the abstract, BrookesTalk also provides a summary of pages which includes title, number of words, links, headings, images, extracted keywords and meta keywords. While the summary provides an overview of the page content, it does not include information about the layout or other information that is important to enable the user to navigate in the page.

In addition, BrookesTalk provides a search facility that a user can input a text string and choose a search engine [88]. However, the challenge is not accessing a search engine and inputting the text, the challenge is enabling the user to understand the retrieved search results. As a conclusion, although BrookesTalk is successful in addressing the issues concerning scanning and providing different views of pages, e.g. summary, abstract, it pays little attention to navigation, orientation and in particular mobility within a page.

EmacSpeak

Emacspeak is a speech output interface to Emacs (a text editor) and is claimed to be the first speech access interface to a Unix system [66]. It is a subsystem of the Emacs, hence it will always have the shortcoming of working only under Emacs. Unlike traditional screen readers, which reads the final display produced by individual applications, Emacspeak provides speech output directly from individual applications [66]. It integrates spoken feedback into the application itself [67].

The two important features of Emacspeak are *Voice Lock mode* and *auditory icons*. The former feature provides facility to use distinct speech characteristics for aural highlighting of specific textual constructs, such as comments in program code [67]. The latter feature provides short sound cues which are called *auditory icons* as a supplement to the spoken interface; they alert the user to significant events such as the arrival of an e-mail [67].

In the case of accessing the Web, Emacspeak can be used with Emacs/W3 which is a full-featured web browser written for Emacs [56]. This browser first parses a web page, then displays it and Emacspeak provides speech rendering from this internal representation [67]. Emacspeak provides a primitive form of the Document Object Model (DOM) [5] based navigation; the user is able to move through nodes in the underlying DOM tree [68]. However, this may also not always work, since the HTML pages are usually not compliant with the standards, the generated DOM tree often reflects the visual presentation rather than the semantic structure. Emacspeak provides two navigation capabilities through the page; by headings and hypertext links. As a conclusion, while Emacspeak is successful in addressing the issues such as audio formatting or importance of DOM, efforts have focused on audio rendering and little attention is paid to orientation and navigation. Furthermore, it only works under Emacs.

Conclusions

In this section, we have discussed some special browsers. These browsers render web pages by directly examining the underlying HTML source. Therefore, they make more use of HTML, for example using headings to form an index. While they have some obvious advantages over screen readers, they are flawed in the following aspects:

- They do not provide as many features as conventional web browsers.
- They are usually behind the current state of browsers for sighted people.
- Some of the functionalities they provide require the HTML source code to be compliant with the standards and accessibility guidelines.
- They also usually have problems in handling complex HTML structures such as tables and frames.
- They usually do not provide information about the layout and the structure of the page.

2.3 Access to Electronic Information

In this section, we will review some of the research projects related to accessibility. These projects broaden the context of web accessibility; they provide several approaches to enable visually impaired people to access electronic information.

The E.U. funded TIDE ACCESS project has proposed an approach to solve accessibility and usability problems of disabled and elderly people [73]. This project has focused on the concept of *User Interfaces for All* which follows the principle of *design for all in HCI (or universal access)*. Stephanidis [72] defines the concept of *design for all* as ”the conscious and systematic effort to proactively apply principles, methods and tools, in order to develop user interfaces for IT&T products and services which ensure universal access and quality in use to users, thus avoiding the need for a posteriori adaptations or specialised design”.

This project has also produced tools to aid the creation of user interfaces adaptable to the needs of different user groups, particularly visually impaired users [73]. The hypermedia system with non-visual user interface named DAHNI (**D**emonstrator of the **A**CCESS **H**ypermedia **N**on-visual **I**nterface)is an example system that was developed with these tools [61]. A series of user requirements studies form the basis of this non-visual user interface. DAHNI was used to investigate the fundamental issues of non-visual access to, and navigation of, hypermedia systems [51]. Although it is successful in addressing those issues, it is a stand alone system and provides one static interface that may not be appropriate for different kinds of data. This project has also addressed the importance of non-speech sounds, which refer to any non-verbal auditory signals, in the non-visual interfaces [52].

Similarly, a framework called AHA (Audio HTML Access) has been developed for the use of non-speech audio in HTML interfaces (for understanding how to represent document structure in audio) and focused on the audio rendering from the HTML representation of the document rather than generating it from the visual representation [39]. Although, accessing directly HTML source is a sensible approach to the problem of losing structure of the documents, it may not be a complete solution because not all pages are designed according to standards. For instance the headings may be specified by using different typeface instead of heading tag set(<H1>· · ·<H6>). This framework provides a set of principles and guidelines for different techniques to represent document structure (for choosing sounds to represent documents structure), for example, using multiple voices, and non-speech audio cues [40]. Principally, this work is an expansion of the previous work by T.V. Raman that has been done on the audio formatting of text for blind computer users in the area of access to mathematics and TEXdocuments [40].

ASTER is an audio system that implements the notion of audio formatting which is rendering information structure orally by using non-speech sound cues [69]. This project addresses the importance of making a listener active in oral communication. In the visual communication, while the rendering is passive, reader is active because of the eye's ability to actively access the parts of the page. On the other hand, in oral communication, information flow is active and the listener is passive which does not allow the listener to obtain a high-level view and then "look" at the portions of the information in detail [69]. [74] also addresses issues of designing user interfaces that enable visually impaired users to read complex information by listening. This stresses the importance of control of information flow and the lack of external memory, and proposes a set of guidelines to transform the passive listener to an active reader.

There are also some projects which focus on some complex structures in HTML pages that traditional rendering systems cannot handle properly, such as tables [62, 87]. EVITA (Enabling Visually impaired people table accessing) has been developed to enable visually impaired people to browse tables. This system is based on the analysis of the tasks undertaken by visually impaired people when browsing and reading tables.

Pontelli *et al.* [62] also proposes a framework for representing and navigating tables in web pages. This framework is based on semantic representation of the HTML tables' structure and a domain specific language for navigation and manipulation of tables [62]. They consider semantic representation of tables, which they refer to as additional knowledge about the table (either provided by a third party or the creator of the document). However, they do not consider how visually impaired people navigate and browse tables and how different tables need to be handled. Finally, Oogane and Asakawa [55] propose a method for converting a single table into several HTML files corresponding to each cell in the table. This may work for simple tables, but it may be an expensive process for complex tables. In such a system, it is difficult to establish a context and travel using the structure as a whole. Although all of these projects are substantial, we need to go one step further and look at the entire structure and content of a page.

2.4 Web Accessibility Guidelines

As it can be seen from the previous section (Section 2.2) where we have presented reviews of some web access technologies, visually impaired people have several difficulties accessing the Web. This is not only because of technological advances, it is also because of inappropriately designed web pages. The World Wide Web Consortium (W3C) recognises these difficulties and provides guidelines to promote accessibility on the Web. There are also other organisations that provide accessibility guidelines, including the following:

- The Royal National Institute for the Blind (RNIB)
- The American Foundation for the Blind (AFB)
- WebABLE
- Trace Research and Development Center
- Access Board of the U.S. Federal Government

While these organisations point out some of the important accessibility issues, the W3C accessibility guidelines are more complete and cover key points of all others. Moreover, the W3C not only provide guidelines for creating accessible content, but they also provide guidelines for user agents[2] and authoring tools[3]. Each of them includes a set of guidelines with several checkpoints and these checkpoints are

[2] An application that retrieves and renders web content [31].
[3] An application that is used for creating web content [77].

prioritised into three levels regarding to their seriousness (priority 1: essential; priority 2: important; priority 3: beneficial).

The Web content accessibility guidelines [23] promote improving the overall design of web pages. They are presented in two themes: graceful transformation (of content, structure and presentation), and making content understandable and navigable. The specifications provide 14 guidelines, but unfortunately only three of them are in the second theme; the rest such as creating tables that transform gracefully, is really oriented to support sensory translation. The Nielson Norman Group has also published guidelines to assist designers to create accessible and usable web pages [25]. This report is different from other guidelines as it is based on a series of usability tests of several different web sites. However, the guidelines themselves are not different from others and the usability tests performed just confirmed that the visually impaired people have several difficulties when accessing the Web.

The user agent accessibility guidelines [31] provide key issues to assist in designing an accessible user agent interface and to assist designing user agents that render web pages appropriately. The specification emphasises the importance of accessibility of the user interface, enabling the user to have access to the content and helping the user orient. Similarly, the authoring tool accessibility guidelines [77] provide key issues to assist in designing authoring tools that produce accessible web content and to assist in creating an accessible authoring interface. Most of the guidelines in this specification focus on the creation of standard and accessible markup, but they pay little attention to how authoring tools can assist web designers to create understandable and navigable web pages (including how to include different orientation mechanisms).

Although the overall vision of these guidelines is good, many designers rarely follow these guidelines. They usually view these guidelines as irrelevant, too restrictive or too time-consuming to implement. Web pages are usually created in a very short time and designers focus on creating visually attractive web pages to attract as many web surfers as possible.

2.5 Tools for Web Content Accessibility

In this section, we will cover and discuss some Validation, Repair, and Transformation Tools which are developed to be used by web content developers and users to make the Web more accessible.

2.5.1 Validation Tools (Evaluation Tools)

Validation (evaluation) tools analyze pages or sites with respect to their accessibility, and return a report or a rating. They are important for web accessibility as they provide medium for designers or authors to validate their page against published accessibility guidelines without reading them. While these tools encourage markup that conforms to the specifications and accessibility guidelines, no one except the Web page designer can really enforce it [56].

We will review some of the validation tools under two categories: accessibility validation tools and HTML validation tools. The first validates pages against accessibility guidelines and the second validates pages against the HTML specifications.

1. Accessibility validation tools:

   Bobby WorldWide: (was created by the Center for Applied Special Technology (CAST)) It is a web-based tool that evaluates web pages for accessibility [21]. The Bobby WorldWide is the latest version and supports analysis of web pages for web content accessibility guidelines from W3C [23] and Section 508 guidelines from Access Board of the U.S. Federal Government [21]. After Bobby analyses a page, it provides a report on the analysis. This report includes accessibility errors and proposed manual checks, which can be grouped into three:

(a) The accessibility errors that Bobby detects automatically, such as missing ALT text for images.
(b) The errors that cannot be fully automatically checked by Bobby and need further manual examination, such as checking if the color is used to convey information, if yes, is that information also represented in alternative form.
(c) The accessibility checks that require manual examination, such as checking that all link phrases make sense when read out of context.

The main problem with Bobby is that it may not correctly parse the Web page if the underlying HTML source is not well-structured. In addition, Bobby may rate a web page as approved even though it is inaccessible.

LIFT Online: A tool for testing web pages using the accessibility guidelines, including Section 508 and W3C. It provides several features, for instance, rule prioritisation which allows user to prioritize or disable rules used in a particular test. LIFT reviews the site based on some rules derived from accessibility guidelines [84]. Checking that keywords are provided, images include ALT text and image map links have textual version are some examples for the rules applied during a test. Although LIFT provides a report which is easier to understand compared to the Bobby's report, it does not provide the depth of the accessibility review that Bobby provides.

2. HTML validation tools:

W3C HTML Validation Service: Introduced by World Wide Web Consortium (W3C) [83], this service can be used to validate web pages against one of the HTML specifications such as XHTML or HTML 4 specification. It also provides several reporting characteristics that can be specified including showing the parse tree and the outline of the current page.

Doctor HTML: This is a commercially available web site analysis tool [36]. Doctor HTML can be used to analyse either a single web page or an entire web site. It provides a variety of tests including a document structure test which for example, looks for unclosed HTML tags, and image syntax which checks image commands for HEIGHT, WIDTH and ALT tag. Although Doctor HTML is not an accessibility validation tool, some checks are important for accessibility, for instance, checking whether ALT tag exists or not.

As a conclusion, while these automatic validation (evaluation) tools provide a quick reference to the web site's accessibility, they cannot still provide a complete automatic evaluation. Kurniawan *et al.*, analysed several pages by using Bobby [21] and LIFT [84], and specified some of the limitations of using automatic evaluation tools as follows:

1. Automatic evaluation tools cannot evaluate some of the important elements including the layout of the information, the navigation structure, the value of information and various aesthetic aspects.

2. They can check the existence of ALT text, but not the meaning or significance of the provided ALT text.

3. They cannot evaluate the appearance or content of graphics.

4. Automatic tools usually give high ranking to text only pages without considering the quality of information or the readability of fonts [44].

In addition to these limitations, we need to address that, there are many subjective issues that need human analysis and cannot be computer verified, for example, if a link phrase makes sense when read out of context. These issues need to be either considered during the design phase or checked manually afterwards.

2.5.2 Repair Tools

Repair tools identify potential accessibility problems and provide either automatic correction or guide the author to correct them interactively. In this section, we will review the following repair tools:

Tidy: is designed by Raggett. It is a tool which identifies a number of common HTML errors and fixes them. If it cannot fix the problems by itself, it prints warnings for those problems [65]. After all the problems are fixed, Tidy can pretty-print the HTML according to a chosen layout style. It also offers advice on accessibility problems, such as, suggesting to add summary attribute to table elements.

A-Prompt: is a tool for checking and repairing HTML. It was developed by the collaboration between the Toronto's Adaptive Technology Research Center(ATRC) and TRACE center at the University of Wisconsin [78]. It includes a validator that evaluates pages for accessibility based on the Web content accessibility guidelines. If the validator detects an accessibility problem, then A-prompt displays necessary dialogs and guides the user to fix the problem [78]. It allows a user to set the level of accessibility check regarding the priorities provided by the Web content accessibility guidelines and Section 508 guidelines. According to the selected level of accessibility, A-prompt automatically repairs some problems. However, the number of automatically fixed problems are limited; usually A-prompt displays necessary dialogs which require input from the user to fix the problem.

PageScreamer: verifies and corrects web pages that are not compliant against Section 508 standards [1]. It identifies some of the violations and allows the user to fix them interactively. For example, if row and column headers are not specified for a table, it allows the user to interactively enter appropriate data. The tool also identifies any potential 508 violations for manual verification, for example applets are identified since alternative content should be supplied for them and PageScreamer cannot check this automatically [26].

These reviewed repair tools also have limitations that were specified for validation tools (see section 2.5.1).

2.5.3 Transformation (Filter) Tools

In the previous sections, we have discussed validation tools (see Section 2.5.1) and repair tools (see Section 2.5.2). Fundamentally these tools focus on assisting the authors to modify or correct their pages, whereas, transformation tools focus on assisting web users to modify pages. Transformation tools mainly transform pages into another form by using different techniques. We will discuss some transformation tools based on the following techniques:

- Creating text version: Betsie [53].
- Transformation based on some user preferences: Web Access Gateway [18], Tablin [2].
- Transformation based on rules and heuristics: WAB [43], ALTifier [85].
- Transformation based on annotations: an Annotation-based transcoding System [12].

Betsie

The BBC Education Text to Speech Internet Enhancer (Betsie) is a simple Perl script written by Wayne Myers. It is used by the British Broadcasting Corporation (BBC) to create an automatic text only version of its web site [53]. Betsie takes a web page and makes various changes in the HTML code and then displays the page. The changes include removing all the images, moving the BBC's navigation bar to the bottom, removing all Javascripts, making frames horizontal and deleting any Java. Betsie has the shortcoming that it only works with BBC sites. Sometimes, it may not even work with BBC sites, for example, in case of syntactically incorrect Javascript or non-standard implementation of BBC's navigation bar.

Web Access Gateway

Access Gateway is a script created by Silas Brown that transforms the existing web pages [17]. There is an HTML form that the user can enter the URL of the page to be processed and the preferences. The Gateway then retrieves the Web page, transforms and renders it according to the specified preferences. The preferences include options regarding to frames, tables, style and images. Fundamentally, Gateway tries to serialize most of the HTML elements such as frames by inserting one after the another, tables by linearising row by row, images by replacing with the provided ALT text and so on. Although Gateway does serialisation on the server side, it has already been implemented by screen readers [34] and special browsers [11] on the client side. It can be considered as an unsophisticated tool because it serializes web pages without considering the reading order and layout of the pages.

Tablin: an HTML Table Lineariser

There are some transformers that transform some particularly complex structures in web pages and Tablin is one of them. Tablin is a filter program developed by WAI Evaluation & Repair (ER) group, that can linearise HTML tables and presents them according to preferences [2]. There is an online form which the user can fill in preferences, such as the cell or header separator. Essentially, in order to fill in this form and obtain linearised table properly, the user needs to have a prior knowledge about the table structure, but if the user already knows the structure, then he (she) does not need to linearise table and can read the table as it is. Additionally, the linearization prevents the user to navigate or browse tables because it loses it's structure or dimensions that are important for navigation and browsing.

WAB

World Wide Web Access for Blind (WAB) is an HTTP proxy server that transforms the page into another form to assist visually impaired users [43]. The WAB-proxy-server is located between the Web server and the browser, and when a user requests a page, this proxy server reads the page from the original server, modifies it according to the given rules and then passes it to the browser. The WAB-proxy-server does the following four modifications. First, it adds the word 'link' before each link in the page. Second, it adds a title list and a link list at the end of the page. Third, it adds two links referring to added lists at the top of the page. Fourth, it adds keywords such as 'Checkbox' or 'Button' before each of those form elements [43]. All of these modifications that WAB does, are not needed anymore because currently available technologies provide them. However WAB is still important in demonstrating the applicability of the transformation.

ALTifier

ALTifier is a tool designed by Michael Vorburger for generating alternative text (ALT attribute) to images and other graphical HTML elements such as image maps. ALTifier is comprised of a toolkit with various modules, including guessing missing ALT text by using heuristics. Fundamentally, ALTifier scans web pages for HTML elements such as IMG and checks for the presence of associated text descriptions. In case of missing of alternative texts, ALTifier inserts new alternative texts, which tries to guess by using heuristics.

An Annotation-based transcoding System

This system is designed to transcode[4] already-existing web pages based on annotations [12]. The annotations are classified into two components; structural and commentary annotations. Structural annotations are used to identify visually fragmented groupings, their roles and importance. Commentary annotations are used to provide description about groupings. The notion of visually fragmented groupings is not defined properly, the only information given is that, the page is fragmented into groupings by using various types of visual effects such as layout tables.

The WYSIWYG tool is provided to specify a grouping, its roles, importance and a description. The nine proposed roles are proper content, updated index, heading, footer, delete, advertisement, norole and layout table. They are mainly at the abstract level, specific to some special sites and so are not generic enough to be used with various types of web pages. The system transforms pages by presenting groupings in descending order of their importance. If a role is not assigned to a group, the importance will be default value which will make it be placed in the middle of the page. Therefore, the transformation may result in a more inaccessible page than before. Additionally, the acquired annotations are liable to become obsolete by site redesign.

2.6 Summary and Conclusion

In the above sections, we have presented the conducted literature review about the Web accessibility. The literature review can be summarized and concluded as follows:

- The focus of screen readers and special browsers is providing sensory translation of visual textual content to audio or touch rather than enhancing web navigation. While the sensory translation is needed, the navigation, orientation, browsing and mobility should be supported as well.
- Screen readers and special browsers do not directly address the issues of mobility and browsing.
- While the overall vision of web accessibility guidelines is good, they also are focused on providing sensory translation and, not on providing navigation and orientation mechanisms. Moreover, the concept of mobility is missing.
- While the approach of validation and repair tools is sensible, they validate pages against published accessibility guidelines, therefore like accessibility guidelines, their main focus is validating or repairing the page to support sensory translation rather than navigation. Additionally, automatic validation and repair tools cannot evaluate some of the important elements including the layout of the information, the navigation structure and the value of information. Consequently, this confirms the importance of our aim to built a semi-automated tool, rather than fully automated.
- Most of the reviewed transformation tools are focused on serializing the page content by such as linearizing tables or inserting frames one after the other. Although serialization may be a good way to support sensory translation, the navigation structure of the page can be lost, furthermore reading order and layout should be considered to provide proper serialization.
- The transformation system proposed by Asakawa *et al.* [12] demonstrated the importance of third party annotations in dealing with visual effects and adding further description to the original content. In consequence, we are aiming to have third party travel analysis and annotations of travel objects in the tool that will be built.

[4]The process of transforming information from one form to another is called transcoding [3].

As a summary, the conducted literature review shows that there is lack in addressing the concept of mobility and travel on the Web. In the next section, we will discuss the basis of the notion of travel and mobility on the Web proposed by Harper [32].

2.7 Travel on the Web

As it can be seen from the previous sections, visually impaired people have several kinds of difficulties accessing the Web and there are various approaches to solve these difficulties. Fundamentally, work on accessibility concentrates on supporting the sensory translation of visual content to alternative forms (e.g audio or touch (through braille). When the problem may in fact be much deeper. There is very little research on understanding what the overall task undertaken by visually impaired or sighted people is when they access the Web: what kind of activities they engage in, what kind of information they need in order to access the Web easily, the importance of purpose. That is to say, there is very little research that provides a deeper understanding of the whole process of accessing the Web.

The work presented in this report builds on work previously undertaken by Simon Harper during the TOWEL project [32]. TOWEL is a research project which proposes using the notion of travel and mobility on the Web to improve the accessibility for visually impaired and other travellers. The main hypothesis is that travelling and mobility on the Web mirrors travelling and mobility in the physical environment. In consequence, the extensive work undertaken in the mobility of visually impaired people in the physical world can be transferred and adapted to the web-based world.

Hypertext design and usability has traditionally concentrated upon navigation and/or orientation. The notion of travel extends navigation and orientation to include environment, mobility and purpose of the travel task. Goble *et al*. [30] define travel as confident **navigation** and **orientation** with **purpose**, ease and accuracy within an **environment**. In other words, travel is the whole experience of moving from one place to another, regardless of whether the destination is known at the start of travel or if the journey is aimless. **Navigation** suggests an opportunity of movement within the local environment [32]. **Orientation** is the knowledge of the basic spatial relationships between objects within the environment, and the objects and the traveller. **Mobility** is defined as the confident ease of movement within the environment and the accuracy of navigation. **Environment** is the context that the traveller travels through and includes the way the landscape is rendered and perceived.

2.7.1 Real world and the Web world travel

Knowledge about real world travel suggests that there are differences between how sighted people and visually impaired people travel during a journey. Goble *et al.* [30], highlights some key points from real world and parallel observations from the Web world as follows;

Information flow: Sighted people usually ignore the details when they navigate in physical space; they usually do not inspect each obstruction. However, it is not easy to assimilate too much complex information by non-visual means. Thereby, visually impaired people use complex information less often than simple information.

The Web World Sighted users do not read web pages, they scan them, whereas, visually impaired users may have to listen to the whole text or undertake cursor based exploration of a window.

Granularity: Visually impaired travellers orient themselves more frequently than sighted people do. There are also differences in route description; when visually impaired people describe a route, it is broken into a greater number of more complex stages.

The Web World Visually impaired people use explicitly more environmental cues such as landmarks, paths, borders and boundaries.

Egocentricity: Many visually impaired people tend to think the real world in *egocentric* manner; the traveller associates journey, route and survey knowledge to himself (herself) and not to the environment.

The Web World The notion of *egocentricity* suggests that an unmodified direct translation of a sighted way of orienting and navigating may be inappropriate on the Web.

External memory and mental maps: Visually impaired travellers have a tendency to create egocentric and exact maps, divided into smaller and more manageable steps and with many more landmark points.

The Web World External memory is not efficiently used. Visually impaired users rely less on external memory sources such as history list than sighted users, since access is slow.

Regularity and familiarity of the environment: Visually impaired people would normally only travel unassisted in areas that were familiar to them. This can be considered as the issue of predictability.

The Web World There are some canonical navigation elements such as home-page site logos in the upper left corner that sighted users are familiar with. Few of them are available to visually impaired people since graphics are commonly used.

Spatial awareness: Previous visual experience may affect spatial awareness. Many adventitiously visually impaired (had previous visual experience) people, are better at decoding spatial information than many congenitally visually impaired people.

The Web World Spatial information is technically difficult to convey and rely on, even if visually impaired users can assimilate it.

2.7.2 A model of travel

A model of travel has been proposed to apply physical world metaphors to moving around the Web [30]. The traveller uses landmarks and memory objects while travelling a journey (see Table 2.1). The traveller navigates and orientates by consulting memory objects, and detecting and identifying landmarks. Travel objects are supplied by the page design and the browser [30]. If an object obstructs the progress of a traveller to a specific destination, it is an obstacle. In contrast, if an object or series of objects in combination orientates and encourages onward navigation, it is a cue. The design intention is to have no objects that are obstacles and a large number of objects that are cues, by recognising and transforming obstacles to become cues.

The proposed model of travel was then extended to a framework for assessing the mobility support given to visually impaired users. This framework was proposed to identify travel objects and register them as either cues to aid travel or obstacles that hinder travel for visually impaired users [32]. This framework will be discussed in detail in the next chapter.

	Object	**Physical**	**Web**	
	Memory (M)	Route Plan	History List	Memory
Landmark	Alert (A)	Traffic light	Download Progress	Memory
Landmark	Information point (IP)	Street	Web site map, hyperlink to a history list	Memory
Landmark	Identification point (ID)	Sign	Frame title	Memory
Landmark	Way point (WP)	road junction	Menu item	
Landmark	Way edge (WE)	A wall or pavement	A guided tour or text border	

Table 2.1: Travel objects proposed by Goble *et al.* [30].

Chapter 3

Contextualising Travel by Using Browsing

3.1 Introduction

As we have described in the previous chapter, travel is the accomplishment of a journey in either the real world or the virtual world. Another view upon travel is movement, with purpose, orientation and navigation etc. through a space. In this chapter, we investigate a related activity – browsing, which can be characterised as movement through an information space. This applies to activities as diverse as reading to picking vegetables from a market stall. As both travel and browsing involve movement, knowledge about the latter might well inform the promotion of travel in the virtual world.

Browsing is an activity that a traveller may engage in while travelling a journey. As it can be seen from the accessibility review (see Chapter 2), most of the assistive technologies are focused on providing sensory translation of web pages, rather than supporting mobility. As a consequence of limited mobility support, visually impaired people are less able to browse the Web. Before discussing what can be done to enable visually impaired people to browse the Web, we need to understand the browsing activity. Because of this we have conducted a literature review concerning browsing and Section 3.2 presents this review. The review suggests that there are different browsing strategies and typologies. Therefore in order to enable visually impaired people to browse the Web, these different strategies and typologies should be supported. Section 3.3 and Section 3.4 discusses these typologies and strategies, respectively.

3.2 Browsing

Browsing is an activity that is difficult to define [20], but as Chang and Rice [22] state ”we all browse in various context to make sense of the world around us”. It is a very common exploration strategy that hypertext users commonly engage in [20]. Cove and Walsh describe it as a process of ”picking out bits and pieces$\cdots$selecting worthwhile information need or interest” [24].

Different disciplines look at browsing from different perspectives [22]. Chang and Rice, in their review of browsing, consider how the following six disciplines treat browsing [22]:

1. *Library and Information science:* A kind of searching, in which initial search criteria or goals are only partly defined or known in advance. Browsing involves scanning, which has been previously described as looking, examining, or sampling, during which the person's body or eyes move smoothly at will.

2. *End user information retrieval and system design:* Browsing has been proposed as an alternative approach to IR that does not use Boolean operations or require specific search queries. It is an interactive and exploratory process.

3. *Consumer Behaviour:* Distinct consumer shopping behaviour that is related but not equated with buying behaviour. Methodologically, eye movement can be a useful indicator of browsing and has been used to test the effect of different page layout or catalogues on browsers' attention.

4. *Mass Media Audiences:* The notion of browsing is implicit in the media audiences behaviour and known as "zapping".

5. *Organizational communication:* Environmental scanning and informal communication (social browsing) are the two phenomena that can be considered as browsing in this discipline.

6. *Wayfinding and environmental design:* Browsing is fundamentally scanning and has been related to environmental perception and cognition. For example, sightseeing is environmental browsing as perceptual experience.

Although all of these disciplines have various approaches to browsing and provide different definitions, there seems to be an agreement on the essential characteristic of browsing which is the movement. This notion of movement is the link between browsing and travel. Browsing can be thought of as travel in information space.

Jul and Furnas [41] describe browsing and searching as two tasks and, querying and, navigation as two tactics for accomplishing those tasks. They describe these tasks and tactics as follows [41]:

- *Searching* is the task of looking for a known target.

- *Browsing* is the task of looking to see what is available in the world.

- *Querying* is using a search engine to submit a description of the object being sought and receiving relevant content of information.

- *Navigation* is moving oneself sequentially around an environment, deciding at which step where to go.

In the most general sense, travel is the overall process which querying and navigation tactics are used for accomplishing browsing and searching tasks.

In investigating the nature of browsing, several researchers have attempted to establish different types of browsing. Fundamentally, these types have been established by considering the goal, purpose or the information need. Some of the proposed browsing types and the importance of supporting them on the Web will be discussed in Section 3.3.

Browsing has been also proposed as an alternative approach to information retrieval which does not require specific search queries. A distinction has been made between the analytical search strategies and browsing search strategies. Marchionini [50] defines a search strategy as "a set of ordered tactics or behavioural moves that are consciously selected, applied and monitored to solve the problem". Analytical search strategies are formal, discrete and deterministic, in contrast, browsing search strategies are informal, continuous and heuristic. Marchionini distinguishes four browsing strategies:

1. Scanning,

2. Observing,

3. Monitoring and

4. Navigating.

He then describes browsing as the general behaviour exhibited by people when they use one of these strategies for information seeking [50]. Like Marchionini, some other researchers also propose browsing strategies and Section 3.4 reviews these strategies in detail.

There are many factors which influence the way people browse including system features, user's knowledge, tasks and purposes [19]. In a study of hypertext learning support system, Alison and Hammond found that four major navigation tools were used differently for various types of users' tasks [8]:

1. *The tour* was mostly used for studying unfamiliar material.

2. *The map* was used mostly for browsing and studying somewhat familiar materials.

3. *Hypertext links* were mostly used for studying familiar material.

4. *The index* was mostly used for information searching and for seeking references.

This particular study confirms the importance of providing different navigation tools and confirming their accessibility. As Kwasnik [45] states "browsing is not a passive activity$\cdots$the user is in charge of the direction, pace and depth of the search". Different navigation tools should be provided and the user should be able to choose which one to use according to his(her) purpose or task. Furthermore, they should be accessible to provide the same opportunity to visually impaired people. For example, if the map is rendered graphically then its contents cannot be deciphered by visually impaired people.

Another important feature of browsing which has been discussed in the literature is feedback. Thompson and Croft [76] emphasise that browsing as a feedback process, is incremental and under the user's control. The user examines only one item at a time and it is the user who determines which items will be examined, not the system. However, most of the assistive technologies (see Chapter 2) do not take this into consideration, they usually read a web page from the top left corner to the bottom right. Visually impaired people are not able to choose what to read with these assistive technologies. Although, some of them provide features to access parts of the page such as headings or links, they are not enough to support required movement for browsing. By the way that the conventional screen readers render web pages, it is the system who determines which item will be examined, not the visually impaired users.

Finally, Chang and Rice indicate five dimensions that can be used to distinguish browsing from other information seeking behaviours and to characterize types of browsing [22]. The five dimensions and the aspects included in these dimensions are as follows:

1. *Context:* Organisation (how resources are organised and presented), Interface (the display perceived by the user), Feedback (relevance or content related, and orientation feedback), Economics (access costs, resources available such as time).

2. *Behavioural:* Scanning (orientation or exploratory scanning) and movement.

3. *Motivation:* Purpose (why people engage in browsing) and goal (what they intend to accomplish).

4. *Cognitive:* Plan (accomplishing a goal can be planned or unplanned) and knowledge/experience (content or structure knowledge).

5. *Resource:* Form (object or representation) and focus (content or path) of resource.

As a summary, browsing is movement in the information space and the user is in control of what to read or examine. Many studies have addressed different browsing types and strategies. They may be considered as the key to support browsing, thus, we will discuss them in detail in the following sections.

Levine [47]	Herner [35]	Apted [9]	Cove and Walsh [24]	Marchionini [50]	Characteristics
Semi-deterministic	Directed	Specific	Search	Systematic	Specific goal or target, focused, structured, systematic
Quasi-random	Semi-directed	Generally purposeful	General purpose	Opportunistic	Predictive, less definite target, less systematic
Random	Undirected	General	Serendipity	Casual	Purely random, unstructured, very little focus, no real goal, not systematic

Table 3.1: Browsing typologies from different investigators.

3.3 Browsing Types

The literature contains many attempts to distinguish different types of browsing. Chang and Rice cite different typologies from different investigators in their reviews of browsing [22]. As Marchionini states ”although there are differences in how the types are named, there seems to be an agreement on three general types of browsing that are differentiated by the object of search (the information needed) and systematicity of tactics used” [50]. Table 3.1 shows the summary of these five different types of browsing from different investigators and their characteristics [9, 24, 35, 47, 50].

In a single information-seeking episode, the user can move from one type of browsing to another or he (she) can engage in multiple types of browsing at the same time [22]. Therefore it is important to support different types of browsing capabilities in order to enable users to browse the Web. The importance could be obvious with some of the complex structures on the Web. The table is a good example of this. It is a complex structure that can be accessed in multiple ways depending on the purpose of the user and the structure and the content of the table itself. Visually impaired people are not able to browse tables with most of the assistive technologies (see Chapter 2). Assistive technologies usually read tables row by row without considering the structure and the content of the table. Moreover, they do not provide different types of browsing capabilities in order to enable visually impaired people browse the tables. For example, visually impaired people cannot access directly a specific cell; they need to listen to the whole table in order to access the content of that cell.

The entire table structure forms a network of cells, which forms a network of columns and rows. There are several ways of accessing tables and three of them are as follows [87]:

- Intersection (the cell contents can be accessed through the intersection of rows and columns))
- Row by row and column by column
- Accessing individual cell contents

A visually impaired reader should be able to access a table by using all of these three ways. In the following paragraphs, we will explain the relationship between these three different ways of accessing tables and the proposed three different types of browsing (see Table 3.1).

Accessing a cell as an intersection of a column and a row can be considered as the first type of browsing. It is systematic; the user needs to select a row and a column, and usually the user has a specific or well-defined goal when he (she) wants to access a table in this way. For instance, if the user wants to learn the value of Cos 60 (specific goal) (see Table 3.2), then he (she) can access the value as intersection of second row that is CosΘ and fifth column that is 60 and read the intersection cell.

	0^o	30^o	45^o	60^o	90^o
SinΘ	0	0.5	0.7	0.86	1
CosΘ	1	0.86	0.7	0.5	0

Table 3.2: Trigonometric ratios for the special angles.

Product description	Tesco price (Stg.)	Boots Price (Stg.)
Elvive 200 ml	1.49	2.39
Fructis Shampoo 200 ml	1.59	2.19

Table 3.3: Shampoo price comparison table.

Accessing a table as row by row and column by column, can be considered as the second type of browsing. They are not as systematic as intersection and there may not be a specific target or goal. The user may access a table in this way because as Cove and Walsh [24] state, it is highly probable that the source, in this case a row or a column, contains items of interest [24]. For example, the user may look for a shampoo but not be sure about the brand. Chang and Rice [22] state that finding an item in a category is semi-defined goal, in this particular case category is shampoo (see Table 3.3). Table 3.3 can be accessed row by row in order to learn prices of different brands from different companies.

Accessing a table, cell by cell, can be considered as the third type of browsing. A user may access individual cell contents and move from one to another without any systematicity or randomly (without following any specific path). For example, Table 3.4 from Chang and Rice shows dimensions that are explicitly discussed (x) and dimensions that are implicitly assumed (y) [22]. The user may want to have a look at this table to find out which dimensions are explicitly discussed in which disciplines and which ones are assumed implicitly. Hence, the table needs to be accessed as cell by cell, because individual cell contents are important. In this case, there is neither a specific goal nor a systematicity and there is very little focus.

In this section, we have demonstrated the importance of supporting different browsing types for tables. These typologies are not only important for the tables, but they are also important for the entire web page content. For example, the following three scenarios can happen regarding the browsing types:

- If a user has a specific or well-defined goal (object sought is well-defined and specific), he(she) may use the search box provided in the Web page.
- If he(she) has less definite target (object sought is not that well defined), he(she) may scan the menu provided in the Web page rather than using the search box.
- If he(she) does not have a specific goal, he(she) may only read the advertisements on the page.

These three scenarios do not have to happen in different journeys. As it was stated at the beginning of this section, the user can move from one type of browsing to another or he(she) can engage in multiple types of browsing at the same time [22]. As a conclusion, all these different browsing types should be

Factors	Library	IR	Consumer	Media	Organization	Design
Purpose/ Motive	-	-	x	x	x	-
Goal	x	x	-	-	x	x
Plan	y	-	x	x	-	-

Table 3.4: Factors influencing browsing in each discipline.

supported and the user should be able to implement any of these types at any time during their journey in a web page.

3.4 Browsing Strategies

In the literature, several browsing strategies have been identified. These strategies may help to understand the process of browsing and may guide to provide support to browsing on the Web. This section explains the functional components of browsing proposed by Kwasnik [45], and browsing strategies proposed by Bates [13] and Marchionini [50], respectively.

Kwasnik [45] defines browsing as the movement in the connected space. She also emphasises that a set of certain actions are undertaken by people to achieve this movement. These actions are grouped into six functions. These functional components of browsing are defined as follows [45]:

Orientation Learning the structure and content of the browsing environment.

Place marking Making a view for the potential second consideration (a way to allow the user remember salient objects).

Identification Identification or recognition of potentially interesting or disinteresting items.

Resolution of anomalies Browsers attempt to understand objects that were not clearly identified, even though sometimes they do not need to.

Comparison Browsers make comparisons at all levels, structures, environments, and items. They compare one item with another.

Transition Is the movement from one view to another. Two kinds of transitions are identified. First, a movement can be towards something in anticipation of a goal. Second, a movement can be away from something because of sufficient or exhaustion information, or identification and a rejection of a view.

These functional components of browsing are closely related to aspects that are important for travel. For example, orientation is a must for both of them or transition suggests mobility. Consequently, all these components should be supported to enable visually impaired people to browse the Web.

Bates proposes a model named as 'Berry-Picking' which integrates browsing with searching. She describes six widely used search strategies that should be supported by bibliographic search systems [13]:

Footnote Chasing Browse through article or book that generates the references as well as through the list of references.

Citation Searching Browse the set of references that cite a given starter reference, or read any of the citing article.

Journal Run Identifying a central journal in the area and scanning relevant volumes of that journal.

Area Scanning Browsing the materials that are physically collocated with materials located earlier in a search.

Subject Searching Browsing classified arrangements and subject indexes.

Author Searching Searching by author.

Bates also indicates that because of the nature of the 'Berry-Picking', people adapt the strategy to the particular need at the moment [13]. Although the browsing strategies proposed by Bates are specific to bibliographic search systems, they confirm the importance of movement. For example, footnote chasing or citation searching needs navigation capability.

Marchionini defines browsing strategies as informal and interactive strategies that information seekers use [50]. He identifies four browsing strategies and describes them as follows:

Scanning is an activity that compares sets of well-defined objects with an object that is clearly represented in the information seeker's mind. For example, information seekers may scan section headings in a book or a title lists to identify potentially relevant information. It benefits from highly organized environments.

Observing can be used when the information seeker assumes that he(she) is in a promising neighborhood and react the stimuli from the neighborhood. For example, advertisements in newspapers and magazines and proactive titles of books on shelves attract the browser's attention as he(she) applies observational tactics. Observations may lead to interesting discoveries but yield initiation control to the environment.

Navigating is the activity that users engage in as they follow links in hypertext.

Monitoring focuses on attributes of interest to the information seeker. For example, while reading a text related to a specific topic, a monitoring strategy "listens" for concepts related to another topic of interest.

Browsing is defined as general behaviour that people exhibit when they use one of these strategies for information seeking [50]. Any of the browsing strategies can be applied to any browsing situation, thus any of the strategies may be used during any type of browsing (systematic, opportunistic or casual browsing, see Table 3.1). The notion of travel on the Web provides the context to support these strategies. As it was stated before travel objects are used for orientation, navigation, route planning and survey knowledge. This could be extended by saying that travel objects are also used for browsing, thus for browsing strategies. The travel objects that encourage scanning, observing, navigating and monitoring are cues, but those that hinder are obstacles. This could be explained by using an example web page. Although the home page of *ACM hypertext 2001* conference is a simple page, it provides many travel objects which may enable sighted users to apply any of the browsing strategies (scanning, navigating, observing and monitoring). However, because of the assistive technologies, visually impaired users may not be able to apply the same strategies. Figure 3.5 shows the travel objects on the page and Table 3.5 lists those travel objects. The following list shows the analyses of some of the travel objects according to these browsing strategies.

- KBL (keynotes bulleted list) and NBL (News bulleted list) travel objects may be considered as cues for sighted people since they aid scanning. However, conventional screen readers do not read the bullets and it becomes a single paragraph for visually impaired people. Hence, KBL and NBL objects become scanning obstacles because they do not fulfill their roles with the screen readers.

- SL (Sponsors Link) travel object is an animation that shows the name of the sponsors with ALT text as "Sponsors". It is an observing cue to sighted people (like advertisements in newspapers that attract our attention as we passively apply observational tactics [50]). On the other hand, it is an observing obstacle to the visually impaired people, since screen readers read it as "Sponsors" without the names of sponsors which hinder them applying observing strategies.

- MM travel object may be considered as a scanning obstacle for visually impaired people since they cannot access the parts of the menu. They need to listen to the whole menu in order to find

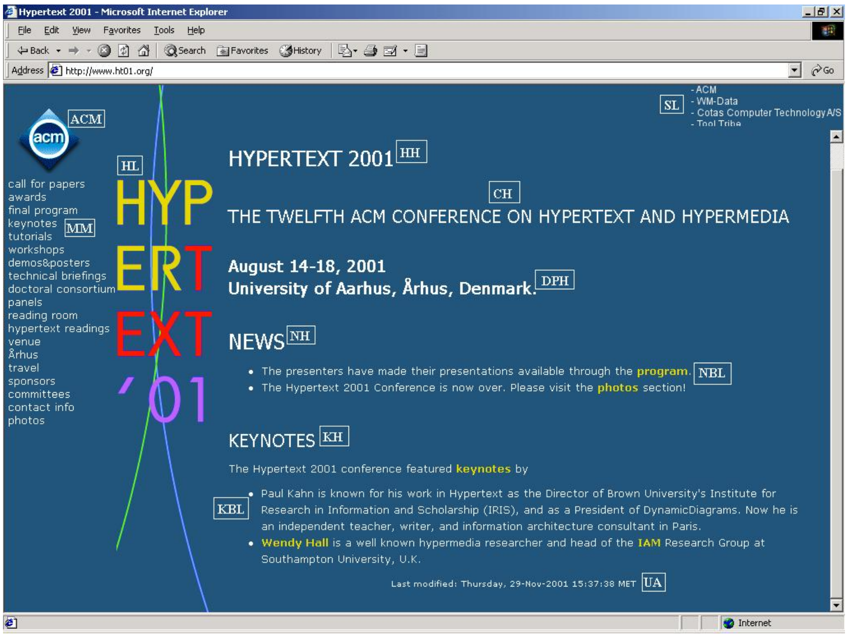


Figure 3.1: The home page of *Hypertext 2001 Conference* (24-Jan-2002).

the item they would like to follow, in other words, they are not able to scan through the menu options.

- There are four links in the third frame of the page, two of them are within NBL object and other two are within KBL object. They are highlighted with different colors, so they are scanning cue to the sighted people, but scanning obstacle to visually impaired users since they cannot directly access the highlights in a web page.

- ACM (ACM logo) is a monitoring cue (while reading text related to a specific topic, a monitor browsing strategy 'listens' for the concepts related to another topic) to both sighted and visually impaired groups.

As it can be seen from the analysis of the example web page, travel and browsing are closely related to each other. Therefore, offering travel support may enable visually impaired people to implement different browsing strategies.

3.5 Conclusion

As a summary, the following aspects of browsing emerge from the conducted literature review:

- Browsing is movement through information space [45] or movement is the essential characteristic of browsing [13].

- Behavioural characteristics of browsing which are scanning and movement are necessary [22].

- Browsing in a manual environment is a physical activity, involving body or eye movements of a fairly random character [13].

- Browsing is not a passive activity, the browser is in the control of process (browsing is dynamic) [45].

Id	**Object**	**Presentation**	**Description**
ACM	ACM logo	Graphic-Link	Link to the ACM site with Alt tag
MM	Main Menu	Text-Link	
HL	Hypertext'01 logo	Graphic-Link	Link to the main page with Alt tag
SL	Sponsors link	Animation-Link	Link to the sponsors page with Alt tag
HH	Hypertext 2001 heading	Text H1 Tag	"Hypertext 2001" heading
CH	Conference heading	Text H2 Tag	"The twelfth ACM conference on hypertext and hypermedia" heading
DPH	Date & place heading	Text H3 Tag	This heading shows the date and place that the conference was held
NH	News heading	Text H1 Tag	The heading for the news section
NBL	News bulleted list	Bulleted List-Link	Bulleted list for the news section
KH	Keynotes heading	Text H1 Tag	Heading for the keynotes section
KBL	Keynotes bulleted list	Bulleted List-Link	Bulleted list for the keynotes section
UI	Update information	Text	It shows when this page was last modified

Table 3.5: *ACM Hypertext 2001* home page- mobility object inventory.

- Feedback or interactivity during browsing is an important feature in human-computer interaction [22]
- Different browsing types are established, which were discussed in Section 3.3.
- There is no generally accepted definition of browsing, but it is agreed that browsing refers to a spectrum of activity, rather than a single narrowly defined behaviour [79]
- Different browsing strategies are proposed, which are discussed in Section 3.4
- Browsing is described as an approach to information seeking that is informal, opportunistic, heuristic and unplanned [50].
- As Levine states vision is not the only sense used for browsing in the physical world, browsers also use hearing, smelling and sense of touch to examine the room, the pages and etc. [47]. Chang and Rice also emphasise the aural browsing of radio channels [22].
- The true purpose of hypertext is to provide an open, exploratory [browsing] information space to the user [20].
- Browsing capabilities have been recognized as one of the central features of the hypertext systems [22]

All these aspects should be considered in any attempt to support browsing. In addition to these aspects, the dimensions that influence browsing should also be considered (see Section 3.2). As a conclusion, we propose providing travel support which covers most of the browsing aspects, particularly the mobility, will enable visually impaired users to browse the Web.

Chapter 4

Critique of the Mobility Analysis Framework

4.1 Introduction

As described in Chapter 2, Harper [32] introduced the notion of travel on the Web, that is the starting point of this work. Travel on the Web has been likened to travel in the real world. Travel is defined as confident navigation and orientation with purpose, ease and accuracy within an environment. That is to say, the notion of travel extends navigation and orientation to include environment, mobility and purpose of the travel task [32]. A model of travel was proposed in order to apply physical travelling metaphor to moving around the Web. This model was then extended to a mobility analysis framework [32] which will be reviewed in this chapter. The framework has many problems and this chapter discusses them in detail. To overcome these problems, we propose a new framework for extracting travel objects from a web page and discovering their roles. The new framework will be explained in Chapter 5 and this current chapter explains in detail why we have introduced the new framework.

Harper [32] proposes a framework to provide the ground work for including travel into web design and usability metrics. This framework is for identifying travel objects and registering them as cues, obstacles or ”out-of-view”:

- Cues are the travel objects that orientate and encourage onward navigation.
- Obstacles are the travel objects that obstruct the progress of a traveller.
- A travel object may also be classified as out-of-view; it is not an obstacle because it does not inhibit travel but it is not a cue either because it does not facilitate travel until it comes into view [33].

Harper [32] indicates that the design intention is to have no objects that are obstacles and a larger number of objects that are cues, by recognising and transforming obstacles to become cues. The framework proposed by Harper *et al.* was designed to find these objects and allow the transformation of obstacles to cues.

The framework is based upon a model of real world travel. The traveller uses landmark and memory objects to reassure themselves that they are safe to proceed and going the right way (see Table 2.1). The classifications are dynamic and can overlap. A travel object may have many roles, for instance, it may be an information point, a way point, as well as a memory object [30]. This model is important in applying the physical travelling metaphor to moving around the Web. However, the framework derived from this model has many problems. These can be divided into three main areas:

1. It is craft based rather than engineering.

2. It is highly subjective.

3. It is not transferable; only the creator of the framework can use it. There is no substantial evaluation of this framework which shows its applicability. Although some analysis results are provided to show the applicability of the framework, they are analysis results from different pages analysed by the same person, who was the creator of the framework.

In the following sections, we will explain the framework in detail and discuss all the problems of the framework.

4.2 A Mobility Analysis Framework

Harper [32] divides the area of analysis into four groups, that can be analysed based on the level of detail (or granularity) the analyst needs to consider. These groups are as follows;

- *The browser (Client interface)* is mainly concerned with mobility support provided by the browser.
- *Inter-page* is mainly concerned with navigational links from the current page to other pages.
- *Intra-page* is concerned with travel information that supports movement around the page, but not on to different pages. Therefore these are mainly concerned with travel information embedded in the information content.
- *Site-Wide* (Items like maps and guided tours that relate to the entire site): are concerned with providing an overview and memory of the site so that navigation and orientation at a site wide level are enhanced.

The analyst needs to decide on the level of granularity at which to analyse the site. He (she) should decide which of the four mobility support groups to use. Some guidelines are provided to decide which group to consider according to the expected end results. It is clear when to use Client and Site-wide mobility groups, however, it is not clear when to use Intra and Inter-page mobility support groups. Furthermore, the distinction between Inter and Intra-page mobility support groups is not clear, because some travel objects may be concerned with both Inter-page mobility group (travelling from a page to other resources) and Intra-page mobility group (travelling within a page).

The four proposed mobility support groups are interlinked. During the Intra-page, Inter-page and Site-wide mobility support analysis, actually the analyst is analyzing the client interface support as well as these groups (Intra-page, Inter-page and Site-wide). Some objects may be considered as obstacles in the Intra-page or Inter-page mobility support group. It may be because of the agent but this framework does not recognise that the main problem is with the mobility support provided by the agent and not because of the mobility support provided by the page content. For example, if the user agent does not render the provided ALT text of an image, it may become an obstacle for visually impaired people. The image may be important for the page content and considered as an obstacle for Intra-page, but it is actually an obstacle because of the agent, not because of the mobility support provided by the page content. The mobility support should not be considered partially, the mobility support should be considered for the whole landscape, which is defined in terms of the page and the user agent [30].

The framework comprises of six stages which are as follows:

1. *Give an overview of the site and any additional unbounded information.* The analyst is required to provide an overview of the site that will be analysed.

2. *Decide on the context of the user.* The analyst should decide which user group (sighted or visually impaired people) he(she) will consider during the analyses.

3. *Decide on the granularity; which of the four mobility groups should be used.*
4. *Take an inventory of items effecting mobility.* This stage is for creating an inventory of mobility objects and can be considered as the key part of the analysis.
5. *Apply the framework.* There are a series of questions regarding each mobility support group. The results of these questions should be placed in the table of templates provided for each of the mobility support groups.
6. *Combine and plot the results.* All the result tables from mobility support groups are combined into a single table.

The first two stages are for orienting the analyst to the framework and need no discussion. We have already discussed the third stage at the beginning of this section. Therefore, in the following sections we will discuss the last three stages, that are the principal parts of the framework.

4.2.1 Stage 4: Taking an Inventory

In this stage, the analyst should extract travel objects from the page and create an inventory. The Mobility objects that support travel are supplied by the page design and the browser. Potentially every single thing on the screen is a landmark to visually impaired people. Objects that are perceived as intended to be travel objects by the page or site design or those that can be actively used for mobility are considered as travel objects [32].

The definition of mobility object is not clear in the framework. The analyst will not be able to extract mobility objects from pages without understanding what he (she) is supposed to extract.

The taking of an inventory is the central part of the framework, the analysis will be done based on this inventory. However, there is no explanation or set of guidelines that explains how to do it. Therefore, even though creating an inventory is a subjective process, not guiding the analyst to create the inventory makes it even more subjective. A systematic approach is not defined that facilitates the discovery of mobility objects on the page. The process depends on the analysts understanding of travel.

We tried to analyse the home page of *EBI (European Bioinformatics Institute)* by applying the framework. Extracting mobility objects from the page was very difficult, because there was no explanation of how to do it. The only provided information was that "mobility objects are provided by the page or the browser" [32]. In order to create a mobility object inventory, we referred to provided examples and created the inventory shown on Figure 4.1 (see also Table 4.1). Therefore, this inventory completely depended on our understanding of travel. So if different analysts have a different understanding of the model, and analyse the same page, the results cannot be expected to be consistent.

In addition, there is also an important issue related to mobility objects which is not addressed by this framework: a mobility object may be composed of one or more objects. For example, the SS (Site search) object (see Figure 4.1) is composed of the text label, a search box and the go button. The whole object (SS) provides a single functionality which is site search, but they also individually have different roles (it does not have to be different), for example, the text 'site search' is used as an identifier of the search box and the go button.

Creating a travel object inventory is subjective and this cannot be eliminated completely as it exists in the nature of travel objects. However, in this framework, no effort has been spent to minimise the subjectivity. A set of guidelines or a systematic approach must be provided if we are going to semi-automate the process.

4.2.2 Stage 5: Apply the Framework

In this stage, the analyst should answer a series of questions which are separated into the four mobility support groups (Client, Intra-page, Inter-page and Site-wide mobility groups). Due to the grouping, the

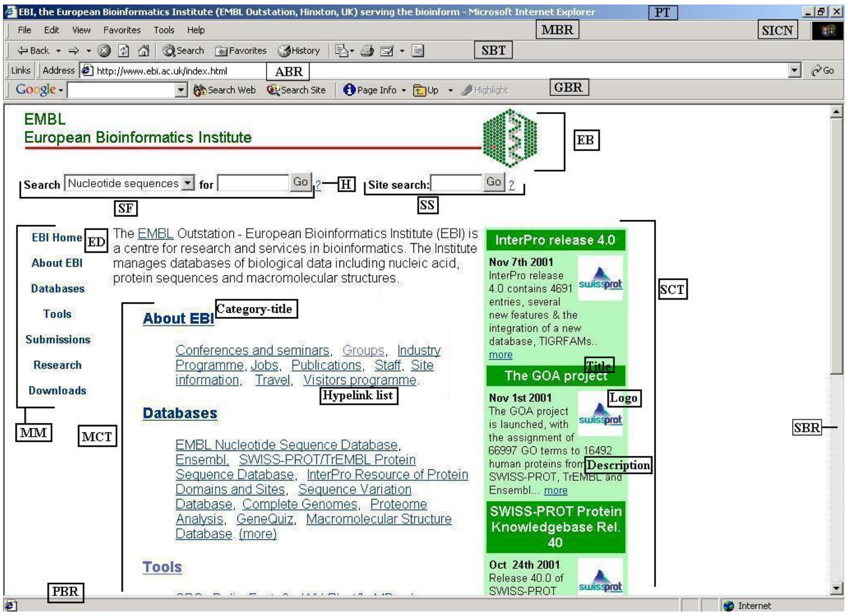


Figure 4.1: The home page of *EBI (European Bioinformatics Institute)* (14-Nov-2001).

analyst should decide which objects in the created inventory will be analysed in which group, but again, the analyst is not guided to make the decision; only the definitions of these groupings are provided. Moreover, as it was stated before, these groupings are not distinct from each other, which makes decision making even more complicated. There may be:

- A mobility object in a page that helps the user travel within the page (Intra-page), as well as the site (Site-wide)

- A mobility object in a page that helps the user travel to other pages (Inter-page), as well as inside the page (Intra-page).

A good example of this choice between groups is the EBI banner (see Figure 4.1); it is an image which includes the logo and the heading, and has a link to the home page. This object can be considered as:

1. An Inter-page mobility object since, it has a link and is important for travelling to other pages.

2. An Intra-page mobility object since it contains the heading of the page and it is important for travelling inside the page.

An analyst should be able to consider an object in more than one mobility support group. This aspect is not supported by the framework.

In the current framework, each question is presented with the type of answer required, a comment about the question and a justification for asking the question (see Figure 4.2 for an example). The required answers are usually *yes* or *no*, but sometimes it may be difficult to answer strictly as *yes* or *no*. For example, there is a question in the Intra-page part as *if there are group sections and titles, do the titles accurately describe the sections?*; the answer for this question may not be strictly *yes* or *no*, because the title may describe the section but not sufficiently enough. This will depend on the user's knowledge of the subject and the purpose of reading the page. Most of the questions have this same problem. We will use two more questions and the *EBI* home page (see Figure 4.1) to illustrate the problem. The first question is *Is the content description easy to access?*; the answer may be yes because sighted users

Id	Object	Description
		Browser- Mobility Objects
PT	Page title	
MBR	Menu bar	Includes; File, Edit, View Favorites, Tools, Help
SBT	Standard Buttons	Includes; Back, Forward, Stop, Refresh, Home, Search, Favorites, History, Mail, Print
ABR	Address bar	Includes; Address (label), history list
GBR	Google bar	Menu, search box, search web button, search site button, page info menu, up button, highlight button
PBR	Progress bar	
SBR	Scroll bar	
SICN	Status icon	
		Page- Mobility Objects
EB	EBI banner	Graphic-link
SF	*(Composite Object)*	Table
	Combo box	Form combo box
	Search box	Form
	Go button	Image button
SS	*(Composite Object)*	Table
	label	Text
	Search box	Form
	Go	Image button
H	Symbol	Symbol-link
ED	EBI description	Text-link
MM	Main menu	Image menu
MCT	*(Composite Object)*	Table
	Category title	Text-link
	Hypertext link list	Text-link
SCT	*(Composite Object)*	Table
	Title	Text
	Description	Text-Link
	Logo	Graphic
EMT	E-mail address	Mail To

Table 4.1: The *EBI (European Bioinformatics Institute)* mobility object inventory (see Figure 4.1).

can scan the page and get the content description but on the other hand answer is no because they need to scroll up and down. The second question is *Do the intra page inventory items accurately describe the content they point to?* and one of the inventory objects considered for this question is ED (EBI description) (see Figure 4.1). The text 'EMBL' in this paragraph has a link to the European Molecular Biology Laboratory home page; the answer is yes if the user knows what EMBL stands for but the answer is no, if he(she) does not.

During this stage of the framework, Harper [32] describes a case study. This case study is built step by step along with each part of the mobility support groups to aid understanding, however, most of the answers for the case study are justified by considering if the knowledge is implicit or explicit to the user. For example, the answer for the question *Does this page have an accurate and adequate content description?* regarding to case study is given as "the description is implicitly accurate and adequate to sighted users, but is inaccessible to visually impaired users as no explicit information about the page is provided" [32](see Figure 4.2 for another example). It may not be right to say that the description is implicitly accurate and adequate to sighted users because if the users do not have knowledge in the subject provided by the page, it may not be implicit and they may need explicit description in order to understand the page content. As a consequence, the traveller brings knowledge and interpretation to a page or site, for instance, a bioinformatician can more easily move around the *EBI* page (see Figure 4.1) than a non-bioinformatician.

Question: Does this page have an accurate and adequate layout description?
Answer: Yes or No.
Comment: This description should be either explicitly or implicitly to the target user group.
Justification: Layout information is also critical for orientation within the page.
Case study: It does for sighted users as the information is visual and implicit, not for visually impaired users as the information is explicitly available.

Figure 4.2: Third Intra-page question in the mobility analysis framework [32].

Object	Environment				Memory			
	Cue		Obstacle	Out of View	Cue		Obstacle	Out of View
	Nav	Ori			Nav	Ori		
IP-1						Y	N	
IP-2	Y		N					
IP-3						Y	N	
IP-4	Y		N					
IP-5		Y	N					

Table 4.2: Part of the Intra-page Template [32].

The framework is supposed to be based on the provided model of real world travel. This model shows that the traveller uses landmarks and memory objects. A mobility object may have more than one role, it may be an information point as well as a way point and Goble *et al.* [30] indicate that ”if an object is rendered in a form that, given the available instruments, it is able to fulfill its role then it is a cue. If not it is an obstacle”. However, the framework does not consider this, it only focuses on two higher level roles of travel objects which are environments and memory, but does not consider the roles including information point, identification point, way point and way edge, and whether the available instruments are provided to fulfill their roles.

The analyst is supposed to place the given answers in the relevant locations within a provided table template (see Table 4.2 for an example template). This template shows the question number and the location corresponding to the expected answers[1]. Expected answers are provided to guide the user to place the given answers in the template table. However, it may not be correct to provide expected results, because as it was stated earlier, a mobility object may be a cue or an obstacle depending on the combination of all the following five things:

1. The current travel purpose; information seeking, surveying, orientation, and navigation.
2. The user: sighted or visually impaired.
3. The presentation form.
4. The timeliness of access and feedback.
5. The user agent.

While the framework considers different user groups and partly the purpose (only navigation and orientation), it does not systematically encompass purpose and account for current focus of activity.

Finally, Table 4.3 summarizes the questions asked for the Intra-page, Inter-page and Site-wide mobility support analysis groups. The summary confirms that the questions are not addressing the mobility issues; they are specific questions which are mainly focused on content and layout. Additionally, some

[1]Expected answers are indicated as Y and N in the template tables.

Intra-Page	**Site-Wide**	**Inter-Page**
		1.Items description accessible
		2.Item preview
1.Content description	1.Content description	
2.Content description accessible	2.Content description accessible	
3.Layout description	3.Layout description	
4.Layout description accessible	4.Layout description accessible	
5.Layout accessible		
6.Items describe destination		3.Items describe destination
7.Items accessible		4.Items accessible
8.Group titles		
9.Group title describe section		
10.Sections previewed		
11.Page preview	5.Site preview	

Table 4.3: Summary of the Intra-page, Inter-page and Site-wide mobility support analysis questions.

<table>
<tr><th rowspan="3">Object</th><th colspan="4">Environment</th><th colspan="4">Memory</th></tr>
<tr><th colspan="2">Cue</th><th rowspan="2">Obstacle</th><th rowspan="2">Out of View</th><th colspan="2">Cue</th><th rowspan="2">Obstacle</th><th rowspan="2">Out of View</th></tr>
<tr><th>Nav</th><th>Ori</th><th>Nav</th><th>Ori</th></tr>
<tr><td>Totals</td><td>22</td><td>25</td><td>5</td><td>2</td><td>16</td><td>15</td><td>6</td><td>0</td></tr>
<tr><td>Target</td><td>23</td><td>31</td><td>0</td><td>0</td><td>19</td><td>18</td><td>0</td><td>0</td></tr>
<tr><td>Diff.</td><td>-1</td><td>-6</td><td>5</td><td>2</td><td>-3</td><td>-3</td><td>6</td><td>0</td></tr>
</table>

Table 4.4: An example mobility analysis summary table [32].

questions can be considered more as usability checking questions rather than mobility checking, for example, the question *Do the intra-page inventory items accurately describe the content they point to?*(summarized in Table 4.3 as items *describe the destination*), is a well known usability issue in the usability community [54, 71].

As a conclusion, these questions are specific and not focused enough on the mobility and travel processes.

4.2.3 Stage 6: Combine and Plot the Results

In this stage, the analyst is supposed to combine all the tables corresponding to mobility support groups into a single table in order to give a final mobility rating to the analysed page. It is a very complicated process. The final combined table shows the totals from the analysis, a target (shows the best case) and a difference between the two. As it can be seen from the example (see Table 4.4), the whole analysis is reduced into a set of numbers; it is not clear which objects in the created inventory are obstacles and which objects are cues. It just shows the total number of cues and obstacles, but this may not help in achieving the main goal which is indicated as ”having no objects that are obstacles and a large number of cues by recognising and transforming obstacles to become cue” [32]. In order to do a transformation, the mobility objects should be precisely specified.

4.3 Conclusion

As a conclusion, the focus of this framework is to provide a mobility rating which shows the provided mobility support of the underlying analysed page. However, we need a framework that focuses on extracting travel objects from the page and discovering their intended roles in the page. The mobility analysis framework proposed by Harper [32] has many problems. The major problems of this framework ca be summarized as follows:

- *Not transferable*: There is no substantial evaluation which shows the applicability of this framework (Section 4.1). Moreover it is too complex to understand and use (Section 4.2.3).
- *Simplified and omission*: How to extract mobility objects from the page is not explained (Section 4.2.1). It does not systematically encompass purpose and consider all travel object classes (way point, information point and etc. (see Table 2.1) (Section 4.2.2).
- *Too subjective*: Creating an inventory is subjective but not guiding the analyst to create the inventory makes it even more subjective (Section 4.2.1).
- *Implicit assumptions*: Some expected results are used to provide final mobility rating to the analysed page (Section 4.2.2).
- *Focused on mobility rating*: Although this is not a problem of the framework, we need the focus to be on extracting travel objects, because in order to do a transformation, the mobility objects should be precisely specified.
- *Usability check*: Some questions suggest usability check rather than mobility check (Section 4.2.2).
- *Questions* The questions are not generalised; focused on content and layout. It is difficult to understand and answer them, particularly, it is difficult to give answer as *yes* or *no* (Section 4.2.2).
- *Real world travel model*: This framework do not completely cover real world travel model (Section 4.2.2).
- *Implicit of the knowledge*: Mobility support groups are not defined precisely (Section 4.2).

Our goal is to semi-automate the process of extracting travel objects and discovering their roles by devising a tool. Although this framework addresses creating travel object inventory and analyzing extracted objects for mobility support, it is a craft based framework and a tool cannot be built on craft. We need to move beyond the craft, eliminate subjectivity and create a systematic approach to extract travel objects in order to be able to semi-automate it. Therefore, we propose a new framework for extracting travel objects and discovering their roles. The new framework forms the basis of this report and first years work, and will be explained in Chapter 5. A semi-automated tool for extracting travel objects and discovering their roles will be devised based on the new proposed framework in the forthcoming work of the PhD.

Chapter 5

Travel Analysis Framework

5.1 Introduction

Our goal is to provide tool support for the travel on the Web. The aim of this tool is to semi-automate the process of extracting travel objects and discovering their roles. After extracting travel objects from a page and discovering their roles, the page will be transformed into another form so that the travel objects can fulfill their intended roles.

Although Harper's framework addresses the creation of a travel object inventory and analysing the extracted objects for mobility support, it has many problems (see Chapter 4). It is a craft based framework and a tool cannot be built on craft. We need to move beyond the craft, eliminate subjectivity and create a systematic approach to extract travel objects in order to be able to semi-automate it. Furthermore, the focus of Harper's framework is to provide a mobility support metric to the underlying analysed page, not to transform the page's mobility. Therefore we propose a new framework whose focus is extracting travel objects and discovering their roles.

The new framework is also based upon a model of real world travel by both sighted and visually impaired people, as proposed by Goble *et al.* [30] (see Chapter 2). In this model, traveller uses landmarks and memory objects to reassure themselves that they are safe to proceed and going the right way (see Table 2.1). Landmarks and memory are two main classes of travel objects, and these classes also include sub-classes. While these classes of travel objects provide an overview of what kind of objects a traveller can use during a journey, the distinction between these classifications is not clear. They are not defined finely enough. Moreover, these classifications do not identify all the travel objects that a traveller uses or may need to use during a journey. Therefore we have modified and extended the classifications of travel objects proposed by Goble *et al.*. Section 5.2 presents the new proposed classifications of travel objects.

The new framework is comprised of two stages:

1. Extracting travel objects from a web page and creating a travel object inventory: The first stage is to inspect a web page in order to create a travel object inventory. Section 5.3 explains this first stage.

2. Classification of each travel object in the inventory (Discovering the role travel objects play in the travel process): The second stage is to classify each travel object in the inventory according to the role it plays in the travel process. We have prepared a questionnaire for this stage; an analyst will be asked to answer the questionnaire for each travel object in the inventory. Section 5.5 explains this second stage.

We have also evaluated the new framework and Section 5.6 explains the evaluation process and the results of this evaluation.

5.2 Travel Objects

In the model of real world travel proposed by Goble *et al.* [30], classifications of travel objects that may be used by a traveller during a journey, are proposed. Travel objects are mainly classified into two; memory and landmark objects. These main classes include sub-classes which are as follows (see Table 2.1):

- *Landmarks:* Alert, information point, identification point, way point and way edge.
- *Memory:* Memory, alert, information point, identification point.

These classifications are dynamic and can overlap. An identification point is both a landmark and a memory object. A landmark may be classified as an information point and a way point at a closer inspection [30]. Although these classes provide an overview of what types of travel objects travellers can use during a journey, the distinction between classes is not clear. For example, it is not clear what is the difference between memory and information point. Memory object is defined as ”an external memory aid to supplement internal memory” and information point is defined as ”a mechanism that allows access to memory information within a journey”. They are not defined finely enough. Furthermore, these are not the only objects or environmental features that traveller use or may need to use during a journey. Therefore we have modified and extended the proposed classifications of travel objects.

In order to modify and extend classifications of travel objects, we have studied the research on the mobility of the visually impaired people in the physical world, wayfinding, spatial orientation, and urban and architectural design studies. As it is defined before, *Mobility* means moving safely, gracefully and comfortably [14]. The spatial orientation and the wayfinding are the foundations of the mobility and Passini *et al.* [57] describe them as:

Spatial Orientation A person’s ability to mentally represent the environment (cognitive mapping) and situate himself(herself) within that environment.

Wayfinding A person’s ability, both cognitive and behavioural, to reach destinations.

This study suggests that, visually impaired or sighted people use a variety of sources of information during a journey. In this section, we will highlight the key environmental features or elements, which we call travel objects, that travellers use or need to use in order to travel a successful journey. Table 5.1 summarizes all the classifications that will be explained in this section, and includes examples from the real world and web world for each class of travel objects. The new classifications are dynamic and can overlap. Reference points or landmarks are both way point or orientation object. Figure 5.1 demonstrates the relationship between these classifications.

5.2.1 Way Points

These are the points within a journey at which a decision may be made that directly facilitates onward movement. Although we have explicitly indicated four sub-classes for way points which will be discussed in the following paragraphs, other classifications may also be considered as way points depending upon the undertaken journey.

Decision points These are the choice points where alternative paths of travel are possible [48]. As Long and Hill state [48], at the choice points, the travellers recall the direction they must travel to reach their destination and they change their direction of travel if necessary. At decision points people have to choose from different paths [70]. The number of decision points directly influences the difficulty of performing a wayfinding task [10].

	Role	Real World	Web	
	Decision Points	Junction, corridor intersections.	Menu, Check boxes, and combo box.	
	Way edge	Wall, shorelines, hedges, fences, cliffs, railroad tracks [49].	Colour boundaries, frame borders, horizontal rule (HR tag).	
WayPoint	**Navigation Points**	Streets, walkways, canals, railroad [49], corridors and some examples specific to buildings: stairs, escalators, elevators [59].	Hyperlinks, mail to, search box.	
	Reference Points	Big Ben, Precinct centre bridge on Oxford road, indoor examples [59]: sculptures, structural or decorative elements, information booths, particular shops and etc.	Logo, title banner, some aspect of style.	
	Location & Position	”You are here” signs, signs that show the current position, reassurance signs on the motorway.	Hyperlink menus highlight the active page, some sites show the active page (e.g home>products).	**Orientation**
	Direction	Signs that show the direction to cities, towns, signs with arrows.	Scrollbar direction, Back and Forward button.	
	Distance	Signs that show the distance to cities or towns.	Scrollbar shows the distance from the top and bottom of the page.	
	Identification points	Building name, house number, street name, campus entrance identification, floor number, room identifiers.	Heading, title, URL, frame title.	
	Alert	Traffic lights, signs that identify hazards, bridges, stops, and curves.	Progress bar, a search field icon can change the color and appearance to indicate that the search is in progress, displaying or animating an hour glass, animated progress indicator.	
	Attention	Advertisements.	Animation, advertisement, banner.	
	Information Points	Information or help desk, police, friends.	Search Box.	
Travel Assistants	**Travel Aid**	Map, tactile map, road list, attraction list, floor plan.	Site index, table of contents, site map, outline.	
	Travel Memory	Route plan, journey plan.	Previously visited links change colour, history list, bookmark.	
	Travel Support	Guided tour, visually impaired individuals may learn new routes by guiding them.	Guided tour.	

Table 5.1: Travel objects and examples from real world and web world.

Way Edges These are the environmental elements that are linear or continuous. Lynch [49], in *The image of the City*, identifies five primary components which are critical to our understanding of an urban environment. These components are landmarks, edges, nodes, districts and paths. Passini [59] confirms that five basic elements identified by Lynch also applied to buildings. Lynch [49] defines *edges* as linear elements that act as boundaries between two areas [49]. Edwards *et al.* also indicate that visually impaired children, in their route description, made exclusive references to ”following edges (FE)” in the environment such as walls and the edge of lawn.

Navigation Points They provide a possible route and the traveller exercises some control by choosing to follow or not to follow it. They can also be considered as decision points in wayfinding but this time the traveller is not choosing from a set of options; the traveller needs to decide to follow or not to follow it. They relate directly to the *paths* which is one of the elements identified by Lynch [49]. He defines *Paths* as the channels along which people potentially move.

Reference Points or Landmarks They are some aspects of the environment that are unique and memorable [49]. They are conceptually and perceptually distinct locations [41]. Darken *et al.* [27]

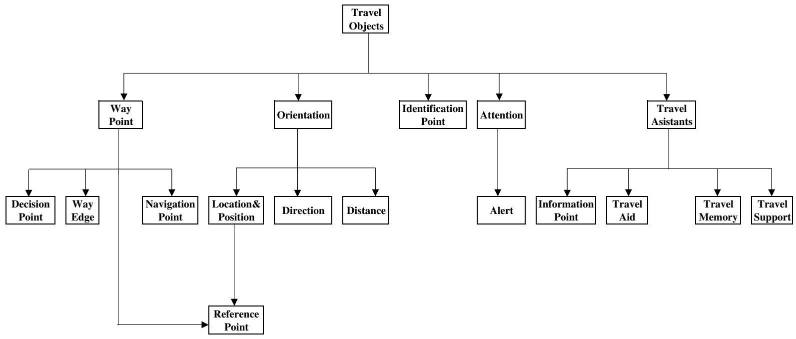


Figure 5.1: Travel object classifications.

define them as the most salient cues in any environment.

Long *et al.* [48] indicate that using landmarks is one of the strategies used by visually impaired people to travel efficiently in their homes and communities. They define landmarks as the perceptible features of the environment that permit travellers to know their precise location in a known environment. Some important characteristics of landmarks are specified as: easily distinguishable, unique, always recognizable or identifiable when they are encountered, and always provide relatively precise information for orientation [48].

Passini *et al.* [58] identify two sources of information that visually impaired people use as:

1. *reference points* to identify the person's position and destination;
2. information used to maintain a wayfinding direction while proceeding toward a destination.

Reference points have to communicate some specific identifiable features [57]. Reference points or landmarks may be primarily physical objects, but they can be sounds, odours, temperature or tactual stimuli [16, 48, 57]. For example, a restaurant may be used as a landmark or reference point because of its distinguishing visual, auditory, or tactile features (e.g. pink shutter, distinctive music, carpeted entry) and its contents (e.g. odour of French fries or the smell of coffee beans roasting).

Reference point components are directly related to information points defined by Long *et al.* [48]. They are defined as two or more stimuli that, when linked, allow a traveller to determine his or her exact location. A single reference point component might not be enough to identify the exact position of the traveller itself. Whereas, when two or more reference point components are linked, a traveller can determine his or her exact position. They are common features which do not provide precise position. However, they might help in determining one's general position.

5.2.2 Orientation

Orientation is defined as the knowledge of one's direction and distance relative to things observed or remembered in the surroundings and keeping track of these spatial relationships as they change during locomotion [14]. Similarly, Brambring [16] defines spatial orientation as "the ability of a person to estimate his own position with regard to immediate surrounding, such as orientation of distances as well as direction of his own body with respect to directly perceivable environment". Long *et al* [48] indicate that the concepts[1] of position or location, directionality and laterality are important cognitive

[1] Concepts are defined as mental representations, images or ideas [48]

components for orientation during mobility. Moreover, as one moves towards a desired goal, establishing orientation and maintaining orientation are critical components of successful travel [48].

The definitions provided above suggest that a person's orientation requires information at least but not last about the location or position, distance and direction. Landmarks are also important for one's orientation. Landmarks are identifiable objects that can be used to give sense of location [37]. Long *et al.* [48] state that "the Landmarks are the spatial anchors because they provide precise information about one's location". That is to say, using landmarks or reference points are critical to visually impaired travellers because using landmarks is one of the most important ways for them to confirm their position in the environment [14]. We have already discussed landmarks in Section 6.2, therefore, in the following paragraphs, we will only discuss objects that provide explicit location or position information, distance and direction.

Direction Directional information is essential to the navigator's ability to remain oriented with the environment [28]. Lynch [49] notes the importance of frequent directional cues to orientation maintenance. Passini [59] also addresses the importance of direction information for orientation as "a sense of orientation is usually equated with a sense of direction, that is an ability to maintain direction while moving". Directional information can be provided through the directional signs. Passini [59] describes them as the signs that designate direction towards a place, an object or an event in form of a name, symbol or pictograph and an arrow. They may also show which direction the traveller is moving along.

Distance The ability to make accurate distance estimations facilitates establishment and maintenance of orientation [48]. Objects that provide distance information could indicate distance from the traveller's starting position or indicate distance from the traveller's destination. They may show where one is with respect to nearby objects and the target location.

Location or Position Landmarks are important environmental features which provide information about the location or position. Landmarks provide implicit location or position information because the different travellers may have varying amount and type of information about landmarks. On the other hand, there may be some objects in the environment which provide location or position information explicitly. Location or position objects are directly related to reassurance signs identified by Passini [59]. He defines reassurance signs as checkpoints which are used by travellers to reassure that they are on the right track [59].

5.2.3 Identification Points

Identification points are directly related to identification signs stated by Passini [59]. He describes them as the most elementary state description of a location and usually perceived when the destination is reached [59]. These points identify an object, a place or a person in the space [59].

Identity is what makes one part of an environment distinguishable from another, that is to say, it is a characteristic that allows the traveller to differentiate one part of the environment from another [10]. The travellers can use identification points to validate their arrival to the destination ("this is it").

5.2.4 Alert and Attention Objects

Attention These are the objects that attract traveller's attention. They may change the traveller's focus. They are "eye-catching" and attention grabbing. These objects may be used for observing (see Chapter 3). Marchionini [50] states that observations may lead to interesting discoveries but yield most initiation control to the environment.

Alert Alerts the traveller to a change in the environment or control of the journey [30]. They differ from attention objects. Like the attention objects, they also attract the traveller's attention, but they usually notify approaching action or danger.

5.2.5 Travel Assistants

All travellers may experience problem in orienting themselves from time to time in an unfamiliar or familiar environment. They use different strategies for solving this problem including consulting a map; exploring the space systematically, either alone or with a guide; or following verbal or written directions [48]. Each of these strategies might be used by both sighted and visually impaired travellers [48]. In the following paragraphs, we will explain four different ways of obtaining assistance during a journey:

Information points They can be considered as a medium that a traveller can directly request information. The traveller controls the type and amount of information request and supply, so they can be considered as active information supply.

As Long *et al.* [48] indicate travellers can update their spatial information by interacting with the public while travelling. This is one of the strategies used by travellers for reorienting themselves in case of disorientation. Passini and Proulx [60] also suggest that a supportive environment be thought of in terms of information points at short and regular intervals. They indicate that information points may be particularly important for visually impaired travellers since they compensate for not having access to distant cues that are so useful to the sighted traveller [60].

Travel aids They provide an overview of the environment. They usually place the entire environment within the traveller's view. We refer to them as passive information supply because, unlike information points, the traveller does not control the type and amount of information request and supply. They can also be considered as secondary sources which can be used for spatial knowledge acquisition [27]. As Darken *et al.* [27] indicate, they may help travellers to determine their position in the environment, their direction of travel, and the relative position of other objects or places in the environment.

Travel memory holds information about where the traveller has been and provides means to get back there. It can be considered as an external memory aid to supplement internal memory [30].

Travel support A traveller may make a journey without controlling all the details of the journey, that is to say, the traveller may not actively control the undertaken journey. Travellers may have a journey by actually being guided throughout the journey. This could be a strategy for travellers to learn the spatial relationships in an unfamiliar environment, particularly for visually impaired travellers [48].

5.3 Stage One: Creating Travel Object Inventory (TOI)

This section explains the first stage of the travel analysis framework. The first stage of this travel analysis is to create an inventory of travel objects by inspecting a web page or pages. A travel object is an environmental element that is used during a journey, particularly in the Web, they are supplied by the page design and the browser. There is no formula to extract such objects from a page –these are determined by the analyst and will be somewhat subjective and dependent upon experience. We can, however, offer a set of guidelines and best practice (see Section 5.4).

The outcome of this stage will be a collection of regions of the page. These can be the result, in the rendering, of HTML elements, collections of HTML elements or parts of elements. These portions of a page are the travel objects; they can be placed in a structure, that describes the travel about a page

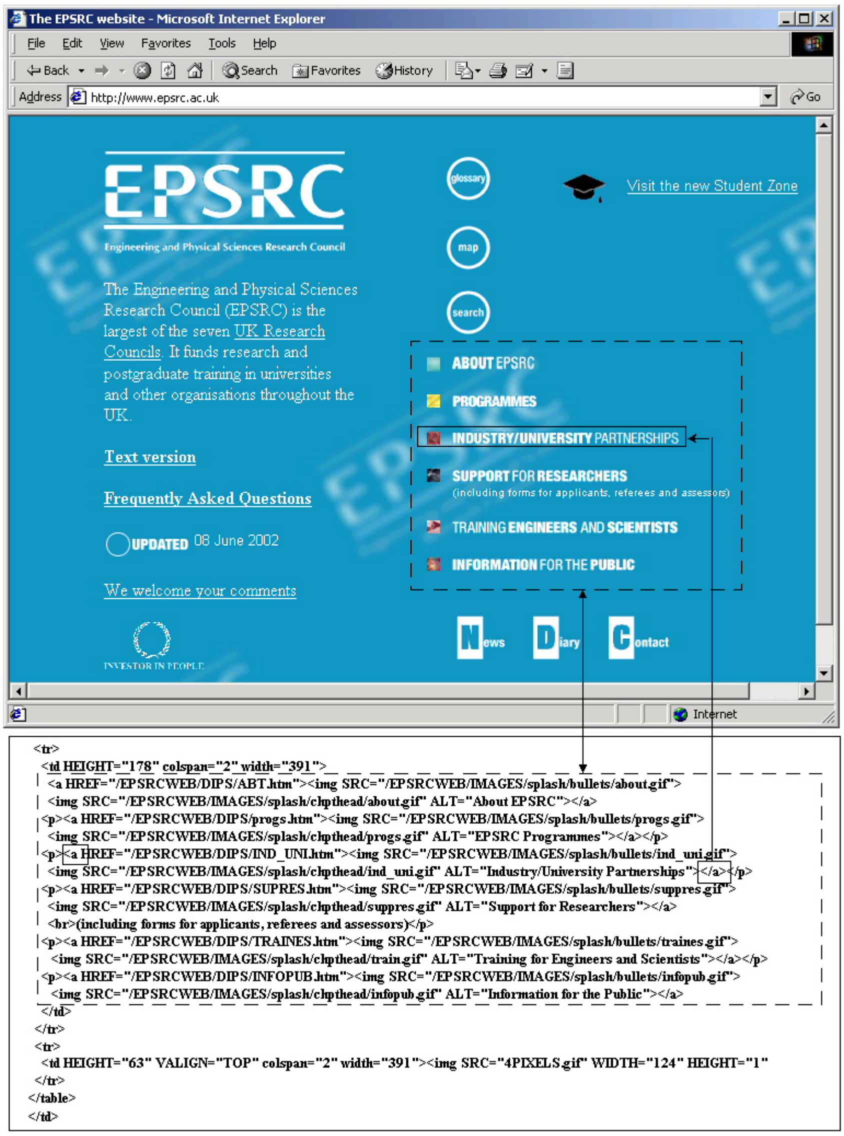
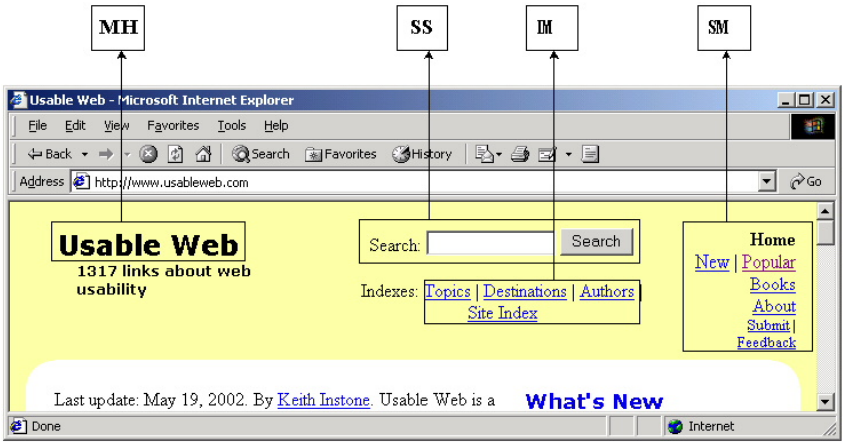


Figure 5.2: An example that demonstrates how to use source code alongside the visual rendering.

(see Figure 5.2). This initial stage is the identification of these portions of a page that make such travel objects.

It is useful to note that the analyst needs to inspect both the rendering of a page and the code that supports the page itself. The analyst needs to view these side-by-side during this part of the task. The analyst needs to make a journey, to travel, through the page, noting which parts of the page (rendering or underlying code) are useful in promoting the onward journey. These become the travel objects.

The second stage of the travel analysis task, described in Section 5.5, is to classify these travel objects. The following section explains a collection of guidelines that should help to identify travel objects. The analyst needs to remember that this is probably an iterative process; the analyst will not find all objects in one pass through a page. First, the larger, more important objects will be found. Subsequently, the finer, more detailed objects will be discovered.



MH	Main heading
SS	Site Search
IM	Index Menu
SM	Sub-Menu

Figure 5.3: The *Usable Web* home page (22-May-2002).

5.4 Travel Object Inventory Guidelines

This section explains the guidelines that can be used during the first stage of the framework, which is extracting travel objects from a web page and creating an inventory. The guidelines are grouped into four and will be presented in the following four sections.

5.4.1 How to Start Extracting Travel Objects from a Page

The following guidelines explain the fundamental strategies for extracting travel objects from a page, as well as the important aspects about the environment and travel objects.

1. **A bird's-eye view** of a page may help to spot the visual groupings and draw a sketch of the page. Then the sketch can be extended by zooming in and out from the groupings and considering their relationships.

2. **The main travelling environment** is composed of the underlying web page and the browser. Thus, parts of the browser can also be considered as travel objects. For example, scrollbar, status bar and title bar.

3. **Environment Details:** During the process of travel object inventory, the analyst does not need to consider every single thing in the environment, the important and main parts of the environment should be considered.

4. **Granularity:** A travel object may be composed of other travel objects. In the questionnaire, the travel objects can be considered individually as well as compositely (see Figure 5.4).

5. **Travel object Id:** An Id can be assigned to each item in the inventory so that referring to them, particularly during the next analysis stage, would be easy (see Figure 5.3).

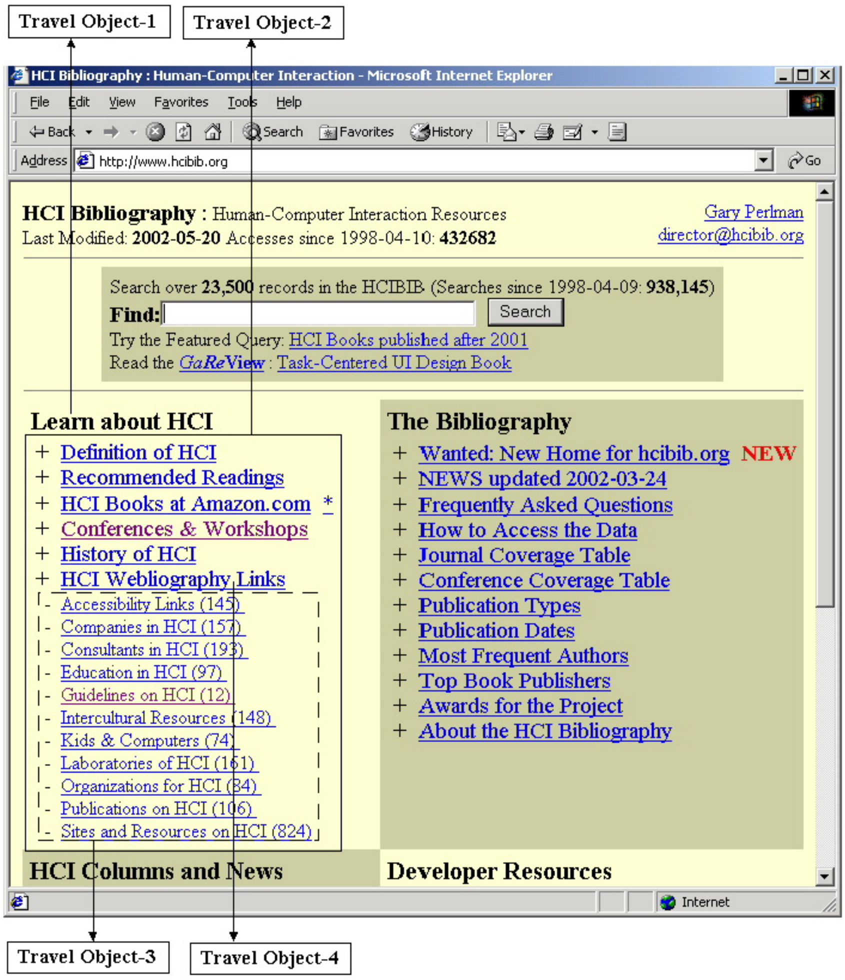


Figure 5.4: An example for composite travel object (www.hcibib.org).

5.4.2 How to Use HTML Source Code Alongside the Rendering

It is important to inspect the HTML source code alongside the rendering because some details are hidden in the source code and some are in the rendering.

1. **An image map** is a graphic that can be divided into multiple areas, and each area of the map can point to a different URL.When the rendering of a page is analysed, it may be difficult to realize the image maps, whereby analysing HTML source code may help to figure out the details of the image maps.

2. **Differentiate images:** In some pages from the rendering, it may not be easy to differentiate images, particularly "text images" from the text. So it may be useful to analyze the HTML source code alongside the rendering. Similarly, it may not be easy to recognize if there is a link on an object or not, particularly if the object is not text or not appropriately formatted text (underlined and coloured blue).

3. **Layout tables:** The details of invisible layout tables, can be obtained from the HTML source code. Sometimes groups of objects are located in a cell of the layout table, so it may help to check whether or not they can be considered as a single travel object or not.

5.4.3 Using Elements of the Standard and HTML Document

The general knowledge about the structure of a standard document can be used in finding out the travel objects (the role of a part of a document can be considered). For example, sections, paragraphs, titles, headings, bullet or numbered lists are all different travel objects. Similarly, the HTML elements can also be considered, for instance, links. The following guidelines explain how some special elements may help in revealing the travel objects.

1. **Sections and Heading:** Sections are important parts of the travel object inventory and are usually identified by a heading with an optional number. The heading and the content part should be considered separately because it is likely that they have different roles during a journey. The headings can be obtained by checking whether the source code contains H1 through H6 tag set. But this may not be enough because not all the headings are explicitly specified by using this tag set. Different typefaces may be used to indicate the headings, thus it is important to inspect both the rendering and the underlying source code.

2. **Menu:** If there is a list or series of hyperlinks with similar presentation style then they can be considered as a single travel object.

3. **Repetition:** If the objects with different content and same style (image, text, color, shape, size, font) are repeated then they can be considered as a single travel object(menu).

4. **Color boundaries**, which are used to partition the layout, may help the analyst to spot the different parts of a page, and it is highly probable that the different parts contain different objects.

5. **Colour boundaries themselves** may also be considered as travel objects. A distinctive formatting in a part of a page, may also help to reveal the travel objects.

6. **Line boundaries** are used to visually divide information or sections. Some examples of creating them are using HR tag, using more than one small image consecutively and colouring a column or a row in a table. Besides helping the analyst in recognizing the context division in a page, they may also be considered as travel objects.

7. **Space boundaries:** It may help to consider that some sections or parts of a page, or some objects are separated just by leaving space in between them.

8. **Graphic** A reasonable size graphic object on a page is usually considered as a travel object.

9. **Image:** If an image next to a text link, points to the same page, then they can be considered as a single travel object (see Figure 5.2).

10. **Animation & Advertisement:** If there is an animation or an advertisement in the page, then it should be considered as a single travel object, because it usually has a different context from the main context of the page.

11. **Logo:** If there is a logo in the page, it can be considered as a travel object.

12. **Links:** All the links on a page are candidates for being a travel object despite the fact that they could be grouped together with other objects depending on the context.

13. **Elements that have capability to manipulate** (or change) the environment should be considered as travel objects. For instance, if there is an arrow which points to the next image in the sequence of images, then it should be considered as a separate travel object, because it has the functionality to change the environment.

5.4.4 Using Functionality, Interaction and Context

Objects that are grouped together to provide a common function can be considered as a single travel object. Similarly the following points may be used to spot the travel objects according to the interaction and contextual changes.

1. **Functional dependency:** If the functionality of an object depends on an other object then they can be considered as a single travel object. For instance, the search capability in a page is usually provided by a search box, a 'go' button and a label. These three objects can be considered as a single travel object because the functionality of the 'go' button depends on the search box and cannot be used on it's own.

2. **Uniformity:** If the analyst recognizes a uniformly organised part in a page, then it is highly probable that there is a composite travel object in that part.

3. **Content or Context Change:** When an analyst analyses a page linearly (from top to bottom) and notices either context or content change, then it may be considered as a clue that he(she) is moving from one object to another.

4. **Interaction:** If the traveller needs to interact differently with consecutive objects then they may be considered as different objects.

5.5 Stage Two: Classification of Travel Objects in the Inventory

The second stage of the travel analysis is to classify the travel objects in the inventory arising from the first stage. The main goal of this classification is deciding what is the role (roles) of each travel object in the created inventory. Every travel object has at least one role during a journey and depending on the journey, it may have more than one role or it may have different roles in different journeys. Since we cannot consider all the different possible journeys, we will only try to consider, what are the possible roles of travel objects in a general context.

For this stage, we have provided the following materials:

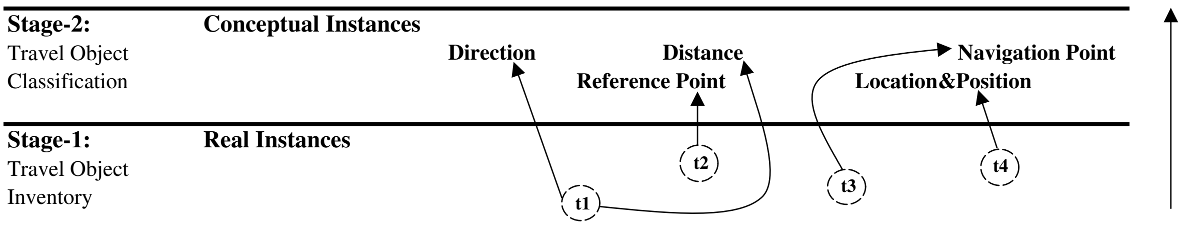


Figure 5.5: Stages of the framework.

- a questionnaire that the analyst has to answer for every object extracted from a page (for every item in the inventory which has been created in the first stage) (see Table A.1)
- definitions of all the the travel object classes, and examples from the real world and the Web (see Section 5.2 and Table 5.1)
- a diagram which illustrates what we are trying to achieve by this framework (see Figure 5.5)

Although the main classes of roles have been provided to the analyst (see Section 5.2 and Table 5.1), he(she) does not need to use the definitions during the classification. However, it may help to use the examples provided (see Section 5.3). For every item in the inventory, the analyst needs to answer all the questions related to every class (see Table A.1). Then from the given answers, the possible roles of the travel objects will be deduced. The expected answers are *yes* or *no*. However if the analyst cannot give an answer as *yes* or *no*, he(she) could state a reason in order to help us improve the framework. The aim of asking every question to every object is trying to decrease the subjectivity. We would like to have consistency at least when the same analyst tries to analyze different pages. As it is highly probable that different analysts create different travel inventory from the same page.

The analyst can start to answer the questions by using the first object in the inventory. If he(she) cannot answer the questions then it is better, if he(she) turns back to the first stage and checks the travel objects in the inventory. As it is indicated before there is no formula for obtaining travel objects from the page and the inventory may not be complete after the first trial. Consequently, throughout the analysis, the analyst needs to consider that it is a cyclic process.

Finally, the following techniques may be useful while answering the questionnaire;

Multiple Role: An object may have more than one role. For instance, a heading with a link can be considered as an identification and a navigation point.

Dynamic Changes: While answering the questionnaire the dynamic changes such as showing the current page, should also be considered.

Repetition & Questionnaire: If a travel object is repeated in a page, then there is no need to consider every instance in the questionnaire. The derived information can be transferred to the repeated objects.

5.6 Evaluation of the Travel Analysis Framework

In this section, we will explain the evaluation of the framework that has been done. The aim was to test whether this framework enables users to analyse the travel support offered within a page. The evaluation concentrated on testing the applicability of two stages of the framework -extracting travel objects and classifying them.

The evaluation consists of two sub-evaluations: first analysing the *Google Directory* page and second analysing the home page of *Royal National Institute of the Blind (RNIB)* by using the framework.

In the following sections, first we will discuss the hypothesis of the evaluation. Second, we will explain the procedure followed, the Web pages and the participants used in both evaluations. Last, we will present the results and discussions of both evaluations.

5.6.1 Evaluation Hypothesis

The main goal of both evaluations was to test the applicability of this framework. The key hypothesis of this evaluation could be stated as follows:

> If the users of the framework would be able to create a travel object inventory, classify travel objects and the results would be consistent between users, then we would be able to design a tool to support this framework.

In order to support this key hypothesis, we would test the following sub-hypotheses:

1. The framework would enable the users to create a travel object inventory.
2. The framework would enable the users classify travel objects.
3. The framework would be consistent between different users.
4. The provided guidelines and the examples would be used and help the users to extract travel objects from a web page.
5. The framework would help the users to understand the notion of travel on the Web.
6. If the user gained experience in applying the framework, then it would take less time to apply it. In other words, the users would spend significantly less time analysing the second page than analysing the first.
7. In the second stage of the framework, it would not be difficult to answer questionnaire as *yes* or *no*.
8. The users would find applying the overall framework easy.
9. The users would be confident during the application of the framework.

5.6.2 Evaluation Procedure

Same evaluation procedure was followed in both evaluations. The first evaluation was devised to have three parts: introduction, main part and conclusion.

In the introduction part, we explained the problem domain, the goal of the framework and discussed some accessibility issues with each participants. We also explained the notion of the travel on the Web and mobility because the participants were not familiar with them. During the main part of the evaluation, the participants were not accompanied. Therefore, in the introduction part, the expectations from participants were stated. The expectations were:

- Recording the time to complete the framework
- Indicating the extracted travel objects on the printed visual rendering
- Providing the details and id's of the extracted travel objects

- Answering the questionnaire for each object in the created inventory

The main part of the evaluation was the application of the framework. Since the participants were not accompanied during this part, we provided a document and asked participants to read the document before they started to the apply the framework. The document explained mainly the following issues in detail:

1. the problem domain,
2. the notion of travel and mobility,
3. how to apply the framework,
4. the two stages of the framework,
5. guidelines for extracting travel objects from a page,
6. examples of analysed pages.

This document provided enough material to a participant to be able to analyse a page by using the framework. In the conclusion part of the evaluation, we collected the analyses results from each participants and asked him(her) a set of questions concerning the overall framework and some of the stated hypotheses (see Table A.2). The collected analysis results included created travel objects inventory and answers for the questionnaire which was for the classification of the travel objects.

In the second evaluation, the same procedure was followed. However, this time the introduction part was not needed because all the participants in the second evaluation had taken part in the first evaluation.

5.6.3 Participants

Twelve participants were used in the first evaluation (referred as P1-P12). All the participants were experienced web and HTML user. They had created at least one web site before and were familiar with the Web page design concepts. The participants were also a mixed group of graduate students and experienced web designers.

In the second evaluation, six of the twelve participants used in the previous evaluation were reused. The familiarity with the framework of these participants allowed experience to be taken into account.

5.6.4 Materials Used in the Evaluation

Two different web pages were used in the first and second evaluation. These web pages are the *Google Directory* page (see Figure 5.6) and the home page of the *RNIB* (see Figure 5.7). In the first evaluation, the *Google Directory* was used. Twelve participants analysed the *Google directory* page. This page has a hierarchical structure. The page design is simple, navigation based and provides many travel objects. Although, it has a simple design, it is obvious that it was not designed with accessibility in mind. This page was used in the first evaluation because it is a well-known page and includes many travel objects. We did not want to use a complex page and confuse the participants, because they were not familiar with the notion of travel and did not have experience in identifying the travel objects. Moreover, if they could not succeed in analysing a simple page, they would not succeed in analysing a more complex page. In the second evaluation, the home page of the *RNIB* was used. Six of the twelve participants used in the previous evaluation analysed the *RNIB* home page. This page has a linear structure. It is more text-driven than the Google Directory page. While the design of this page is not as simple as *Google directory*, the main design focus of this page was providing accessibility. In the first evaluation, participants would gain experience in applying the framework, so for the second evaluation we had chosen *RNIB* page which is more challenging for applying the framework.

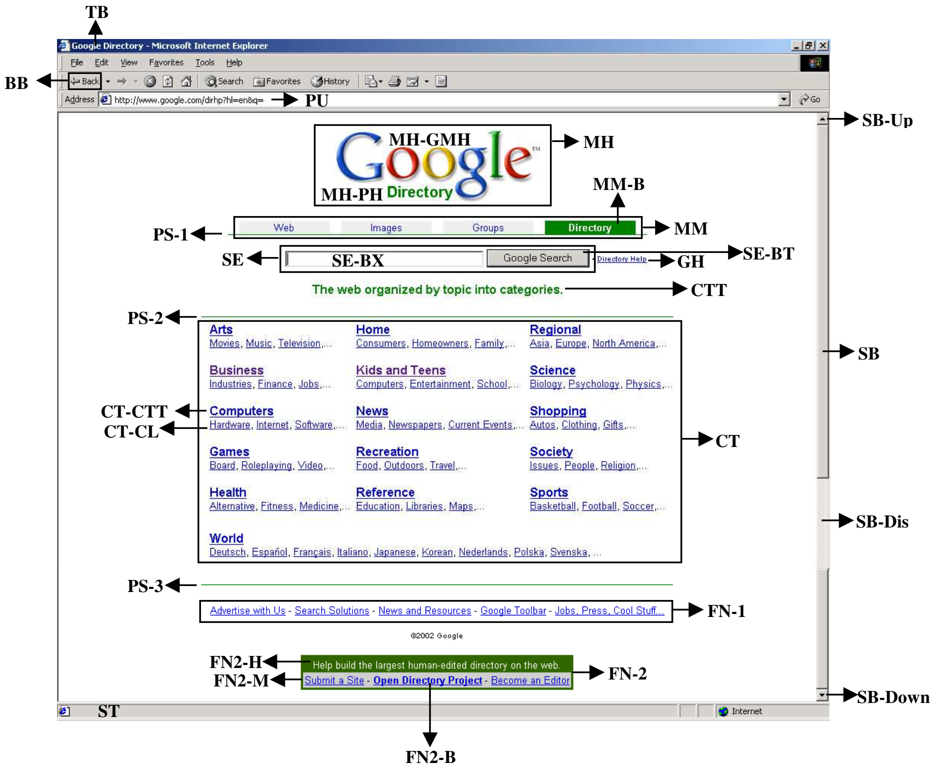


Figure 5.6: The *Google Directory* page (12-Mar-2002).

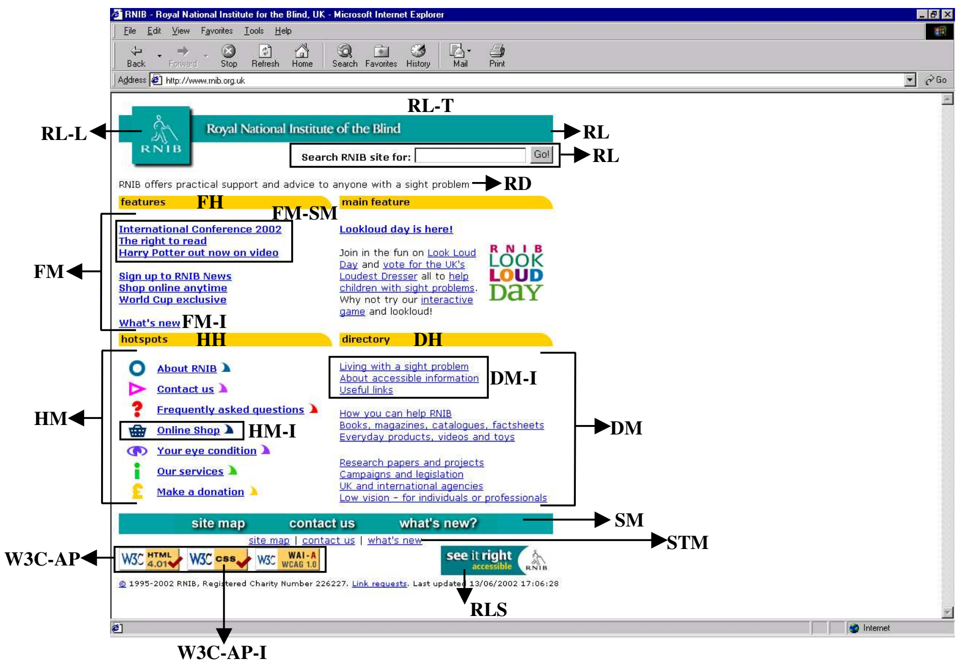


Figure 5.7: The home page of *Royal National Institute of the Blind (RNIB)* (12-Jun-2002).

Id.	**Description**	**Detail**
Page- Travel Objects		
MH	Main Heading	The Google logo and text ”Directory”
MM	Main Menu	Menu: web, images, groups, directory
SE	Search Engine	Search box and search button
GH	Google Help	Link with the text ”Google Help”
PS1	Page Separation-1	Separation line after the main menu
PS2	Page Separation-2	Separation line before the categories
PS3	Page Separation-3	Separation line after the categories
CTT	Categories Table Title	Title of the categories table
CT	Categories Table	Table that all categories are placed
CT-CTT	Category Title	Refers to any of the category titles
CT-CL	Category List	Refers to a list under any category title
FN1	Footnote-1	List of links; ”Advertise with us...”
FN2	Footnote-2	Small table at the bottom of the page
Browser- Travel Objects		
TB	Title Bar	Title provided by the title tag
BB	Back Button	Refers to the back and forward button
PU	Page URL	URL of the page
ST	Status Bar	Status bar of the browser
SB	Scroll Bar	Scroll bar of the browser

Table 5.2: Travel object inventory for Figure 5.6 (*Google Directory* page).

5.6.5 Results and Discussion

Both evaluations were successful in demonstrating the applicability of the framework. The participants were able to create inventories of the travel objects on both web pages and classify travel objects in the created inventory. The conducted evaluations could also demonstrate the consistency of the framework as well as the flaws in the framework. We have grouped the results into creating a travel object inventory, classifying extracted travel objects and the overall framework.

Discussion of creating a travel object inventory

All the participants were able to create an inventory of travel objects on both analysed pages. The inventories of participants were highly consistent. However, there were some objects that, different participants considered in different granularity. These objects confirmed that the subjectivity cannot be eliminated completely. In the following paragraphs, we will first discuss the results from the analysis of the *Google Directory* page and then we will discuss the results from the *RNIB* home page.

Table A.3 shows all the extracted travel objects from the *Google Directory* page by all the participants and Figure 5.6 shows these travel objects on the visual rendering. We will not discuss all the extracted travel objects, but we will discuss some of them that were able to demonstrate the consistency and flaws of the framework, as follows:

- All participants included MM (Main Menu), PS2 (Page Separation-2), CT (Categories Table) and FN1 (Footnote-1) objects in their inventories.

- Eleven participants included SE (Search Engine) and PS3 (Page Separation-3) objects in their inventories. One participant considered the search box (SE-BX) and search button (SE-BT) as two individual travel objects, rather than considering SE as a single object. One participant did not consider PS3 as a travel object.

- Ten participants included MH (Main heading) and GH (Google Help) objects in their inventories. Two participants considered the ”Google” (MH-GMH) and ”Directory” (MH-PH) headings as

Id.	Role	Reason
MH	Reference Point	Distinctive feature of the page and because of it's distinctive design, it is easy to memorise. Although the Google logo is used in every page of the site, MH is unique to this page because the text ”Directory” and green colour is only used in this page.
	Identification Point	Identifies this page; is unique label of the directory page.
MM	Decision Point	It provides a set of options (web, images...) that the traveller has the opportunity to select among.
	Navigation Point	Each item provides a possible route that a traveller exercises some control by choosing to follow or not to follow it.
	Location & Position	The Directory item is highlighted with green colour which shows the active page in the menu.
SE	Information Point	The traveller controls the type and amount of information request and provides a medium for direct request of information.
	Navigation Point	Provides ability to move within the environment.
GH	Navigation Point	Can be used to move to the Help page.
PS1	WayEdge	Is used as a dividing line between the first part; Google logo and menu, and the second part; search engine.
PS2	WayEdge	Is used as a dividing line between the second part; search engine, and the third part; categories.
PS3	WayEdge	Is used as a dividing line between the third part; categories, and the fourth part; private information about the Google.
CTT	Identification Point	It is used to identify the web categories.
CT	Decision Point	Provides multiple categories that the traveller can choose from.
	Navigation Point	Ability to move within the hierarchy of the categories.
CT-CTT	Navigation Point	Ability to move to the main page corresponding to that category.
	Identification Point	It is used as a heading for the sub categories.
	Travel Memory	When it is followed and return, it's colour changes which convey the information that this place has been visited before.
CT-CL	Decision Point	List of links that the traveller can choose from.
	Navigation Point	Ability to move to the main page corresponding to that sub category.
	Travel Memory	Each of them changes colour when it is followed.
FN-1	Decision Point	Provides multiple links concerning the Google itself.
	Navigation Point	The traveller exercises some control by choosing to follow or not to follow each item in the list.
	Travel Memory	Each item changes colour when it is followed.
FN-2	Decision Point	There is a list of hyperlinks in the second row.
	WayEdge	The borders of the table are explicitly coloured and used to separate it from the other parts of the page.
	Navigation Point	Provide ability to move to the corresponding page.
	Travel Memory	Each item changes colour when they are followed.
TB	Reference Point Component	When it is linked with other travel objects, it might help the traveller determine his(her) exact position, otherwise, it might not be enough to identify exact position.
	Identification Point	It is used as a label for this page.
BB	Direction object	It shows the direction the traveller can move along.
PU	Reference Point Component	It might not be enough to identify exact position (because abbreviations are usually used in the URL) but when it is linked with other travel objects, it might help the traveller determine his(her) exact position.
	Identification Point	It is the unique label of the page.
ST	Alert Object	It alerts the traveller to a change in the environment; it shows the status of the document while downloading.
SB	Direction	The traveller can either move up or down by using it.
	Distance	It shows how far the traveller from the top and bottom of the page is.

Table 5.3: Role of the travel objects for Figure 5.6 (*Google Directory* page).

two individual travel objects rather than considering them as a single travel object.

- CTT (Category Topic Title) was considered as a travel object by eight participants and FN2 (Footnote-2) was considered by nine participants. Although, FN2 object was identified as a single object by nine participants, it was the only object that confused participants. The heading in the FN2 object (FN-H) was considered as individual travel object by three participants and the menu in the FN2 object (FN-M) was considered by six participants.

- We were expecting most of the participants to identify the CT-CTT (Category Title) and CT-CL (Content List) objects as individual travel objects, rather than only considering the CT (Content Table) as a single object. However, as indicated before, all the participants considered CT (Content table) as a single object, and only four participants identified CT-CTT and three participants identified CT-CL as individual travel objects.

- In the provided guidelines, we indicated that the environment composed of the underlying browser and the page itself. However, most of the participants did not identify the travel objects provided by the browser. For example, six participants considered title bar (TB), four participants considered URL of the page (PU) and, one participant considered status bar as travel objects. This could be because participants usually use the same browser and after a while they use the browser instinctively, without considering the facilities provided by the browser. When they access the Web, the only changing thing in their environment is the retrieved page. Additionally, participant P11 stated as ”I did not consider the browser because it is the third party and difficult to change, modify or improve, but we could try to change or improve the design of the Web pages”.

The participants were also able to create an inventory of the travel objects on the home page of *RNIB*. Although the *RNIB* page is a static page (the content is not retrieved from a database), a part of the page is updated regularly since it includes information about the current events. Unfortunately, during the evaluation period, it had updated as well. Therefore, we will not discuss the identified travel objects from that part of the page. Table A.4 shows all the extracted travel objects from the *RNIB* home page by all the participants and Figure 5.7 shows these travel objects on the visual rendering. Some of the extracted travel objects from the *RNIB* page will be discussed as follows:

- All the participants included the SS (Site Search), FM (Features Menu), FH (Features Heading), HH (Hotspots heading), DH (Directory heading), DM (Directory Menu), HM (Hotspots menu) and the RLS (RNIB small logo) objects in their inventories.

- The RL (RNIB logo) and W3C-AP (W3C approvals) objects were identified by five participants. One participant considered RL (RNIB logo) object as two individual travel objects: (RL-L (RNIB logo) and RL-T (RNIB title)) rather than a single object. He(she) stated the reason as ”although they look single object, they are two different images”. Similarly, one participant considered only W3C-AP-I (W3C approval item)(is an item in the W3C-AP object) in his(her) inventory but not the W3C-AP.

- Although all participants considered FM (Features Menu), HM (Hotspots menu) and DM (Directory Menu) as single objects, some participants also included parts of those objects in their inventories. For example, two participants considered individual items of the HM menu (HM-I) as well as the HM object. One participant considered DM-SM (Directory sub-menu) and DM-I (Directory item) as well as the DM object.

- The menu (SM (Site menu)) at the bottom of the RNIB page looks as if it is repeated and thus confuses the participants. Half of the participants considered them individually (SM and STM) and the other half considered them as a single travel object in their inventory. In addition, RD (RNIB description) object is only considered by two participants.

Id.	Description & Role	Detail
RL	(RNIB Logo)	The RNIB logo and title banner
	Way Edge	
	Reference point	
	Identification point	
SS	(Site Search)	Search box and search button
	Navigation point	
	Information point	
RD	(RNIB Description)	A sentence that describes RNIB
	Identification point	
FH	(Features Heading)	Heading as ”Features”
	Way Edge	
	Identification point	
FM	(Features Menu)	List of links under features heading
DM	(Directory Menu)	A list of links under the directory heading
	Decision point	
	Navigation point	
	Travel memory	
FM-SM	(Features Sub-Menu)	FM includes three list of links
DM-SM	(Directory Sub-Menu)	A sub list in the DM
	Decision point	
	Navigation Point	
	Travel memory	
HH	(Hotspots Heading)	Heading as ”Hotspots”
	Way Edge	
	Identification point	
HM	(Hotspots Menu)	List of links under the hotspots heading
	Decision point	
	Navigation point	
	Attention	
HM-I	(Hotspots Menu Item)	An item in the HM
	Navigation point	
	Reference point component	
	Attention	
	Travel memory	
DH	(Directory Heading)	Heading as ”Directory”
	Way Edge	
	Identification point	
SM	(Site Menu)	A menu at the bottom of the page
	Way Edge	
	Decision point	
	Navigation point	
STM	(Site Menu (text))	Text version of SM
	Decision point	
	Navigation point	
	Travel memory	
W3C-AP	(W3C Approval Menu)	List of W3C approval icons
	Decision point	
	Navigation point	
	Attention	
W3C-AP-I	(W3C Approval Menu Item)	Only one of the W3C approval icons
	Decsion point	
	Navigation point	
	Attention	
RLS	(RNIB Logo (small))	A small RNIB logo
	Navigation point	
	Reference point component	

Table 5.4: Travel object inventory and role of the travel objects for Figure 5.7 (the *RNIB* home page).

As a conclusion, the hypotheses, the framework would enable the users to create a travel object inventory and the framework would be consistent between different users, were supported. Additionally, both evaluations confirmed that we would not be able to eliminate the subjectivity completely in extracting the travel objects from a web page.

Discussion of classifying the travel objects

All the participants successfully answered the questionnaire for each travel object in their inventory. Before testing the framework with participants, we have created our own inventory of the travel objects on the *Google Directory* (see Table 5.2) and the *RNIB* home page (see Table 5.4), and we have classified each of the extracted travel objects (see Table 5.3 and 5.4). We will use our own classifications to discuss the classifications of the participants. Table A.3 shows all the classifications of all the participants for the *Google directory* page. However, we will not discuss all the details of the yielded results, we will discuss the classifications of some objects which demonstrate that participants were able to classify travel objects and illustrate the flaws of this stage of the framework. First, we will discuss classifications of some objects from the *Google Directory* page as follows:

- The CT (Categories table) object was identified by all the participants. This object was expected to be classified as a decision point and a navigation point, and it was classified so by eleven participants.

- The SE (Search engine) object was identified by eleven participants. This object was expected to be classified as an information point and a navigation point. Ten participants classified it as an information point and eight participants classified it as a navigation point.

- The FN-1 (Footnote-1) object was identified by all the participants. This object expected to be a decision point, navigation point and travel memory. Eleven participants classified it as a navigation point, ten participants classified it as a decision point and three participants classified it as a travel memory. Generally, the classifications suggest that participants failed to classify objects as a travel memory. This could be because the participants had to visit the links and then answer the questionnaire, but they usually answered the questionnaire without following the links.

- All the participants included the PS2 (Page separator-2) object in their inventory. This object was expected to be classified as a way edge and all the participants classified it so. Similarly, eleven participants included PS3 in their inventory and classified it as a way edge.

- The MH (Main heading) object is identified by ten participants. This object was expected to be classified as a reference point and an identification point. Ten participants classified it as a reference point, however only five participants considered it as an identification point. It was also classified as an attention object by one participant and a travel aid by another. This object is important because it illustrates that we could not eliminate subjectivity completely in classifying travel objects. Another example which illustrates the subjectivity problem is the MM (Main menu) object. All the participants classified it as a decision point, ten participants classified it as a navigation point and three participants classified it as a location&position object, which were the expected classifications. Additionally, it was classified as an identification, attention and travel aid by three participants.

- Some of the classifications that had been done suggest that some questions in the questionnaire need to be improved. For example, although some objects were not travel aid object, they were classified so, e.g CTT (Category topic title), FN1 (Footnote-1) objects.

In the second evaluation, the classifications were more consistent. This could be because participants became familiar with the questionnaire and the classifications. Table A.4 shows all the classifications of all the participants for the *RNIB* home page but we will not discuss all the details of this evaluation as well. We will discuss classifications of some objects that highlight the consistency and the flaws of the framework.

- The FM (Features menu) object was identified by all the participants. The expected classifications for this object was a decision point, navigation point and travel memory. Five participants classified it as a decision point, all participants classified it as a navigation point and three participants classified it as a travel memory. As in the first evaluation, participants generally failed to classify objects as a travel memory again in this evaluation.

- The FH (Features heading) object was identified by all participants. The expected classifications were way edge and identification. All participants classified it as an identification point and four participant classified it as a way edge.

- The SM (Site menu) and STM (Site text menu) objects were important for the evaluation. Although the STM object looks as a repetition of the SM object, actually it is not, they have different roles in the page and the framework can draw the distinction between them. SM object is a way edge but the STM is not. Similarly, STM object is a travel memory but the SM is not. One Participant commented that ”these two objects show what is missing in a text browser and is a good example why this framework is important”.

- This evaluation also suggested that some questions in the questionnaire need to be improved. For example, several objects were classified as a direction object even though they were not.

As a conclusion, the sub-hypotheses, the framework would enable the users to classify travel objects and the framework would be consistent between different users, were confirmed. Both evaluations also demonstrated the flaws of this stage of the framework. Particularly, the results confirmed that some questions in the questionnaire need to be improved. Some participants also provided suggestions and feedbacks for this stage of the framework, which are as follows:

- Participant P1 mentioned the ambiguity of the word *environment* in the questions and indicated that this made answering questions difficult. He(she) said that the word *environment* may refer to the page, site or the Web which effects the answer of the question.

- Participant P11 mentioned that the location and position should not be considered in the same class. She indicated that these two words indicate different granularity. For example; location (I am in Manchester), position (I am at the phone box, outside the Precinct centre in Oxford road in Manchester). He(she) indicated that, in this context, some objects were providing the location information but not the position, so it was difficult to answer some of the questions.

- In the definition of direction, we only considered the movement direction in the page (up, down, left, right), but some participants stated that it should include the journey direction as well.

- Similar to direction, in the definition of distance, we only considered the distance in a page, for instance, how far is the traveller from the bottom of the page. Some participants indicated that the journey distance should also be considered, e.g the number of links that a traveller should follow to reach his (her) destination.

Discussion of results concerning the evaluation of the overall framework

In this section, we will discuss the yielded results concerning the overall framework as follows:

- **Guidelines and examples:** The fourth sub-hypothesis, the provided guidelines and the examples would be used and help the users to extract travel objects from a web page, was confirmed by both evaluations. After completing both analysis, the participants were asked to rate the usefulness of the guidelines and examples (see Table A.2). In the first analysis, all the participants followed the guidelines and examples for extracting the travel objects from the page. The guidelines on average were rated as very useful and the examples were rated as quite useful (see Table A.5). On the other hand, in the second analysis, only one participant followed the guidelines and four participants used the examples (see Table A.6).

- **Understanding the notion of travel on the Web:** We asked the participants to rate their understanding of travel on the Web before and after the evaluations (see Table A.2). After the first analysis, ten participants stated that the framework improved their understanding of travel on the Web (see Table A.5). Participants P9 and P11 stated that the framework did not change their understanding of travel on the Web, however P11 commented as "although framework did not change my understanding of travel, it has changed my point of view to the travel on the Web". After the second analysis, only one participant indicated that his(her) understanding of travel was improved (see Table A.6).

- **Time:** The sixth sub-hypothesis, if the user gained experience in applying the framework, then it would take less time to apply it, was also demonstrated. Although the exact time to apply the framework was not recorded, each participants was asked to provide the approximate time that he(she) spent to complete the framework. Table 5.5 shows the approximate times provided by each participant to complete the first and the second anlaysis. As it can be seen from Table 5.5, the participants spent significantly less time anlaysing the *RNIB* home page than analysing the *Google Directory* page. The time difference between two analysis suggests that, after a user analyses three or more pages, it will take him(her) quite short time to apply the framework. Additionally, some participants, for instance participant P2, indicated that the first analysis required a lot more concentration than the second analysis because of being unfamiliar with the framework and also with the concept of travel object. Moreover, in the second analysis, five participants stated that they did not follow the guidelines and two participants did not use the examples. On the other hand, in the first analysis all the participants followed the guidelines and used the examples. The familiarity with framework, not following the guidelines and not using the examples could be considered as the reasons for spending significantly less time analysing the second page.

- **Answering questions as *yes* or *no*:** In the second stage of the framework, the participants answered a questionnaire for every object in the created inventory. The expected answers were *yes* or *no*. After both analysis, we asked the participants about the difficulty of answering that questionnaire as *yes* or *no* (see Table A.2). For both analysis, they rated on average as easy. However, some participants, particularly after the first analysis, commented that it was difficult to understand some questions. Participant P11 indicated that "some of the questions were explicit but some of them were implicit and difficult to answer". Generally, in both analysis, all the participants were able to answer the questions as *yes* or *no* and only one participant rated as difficult.

- **Difficulty:** We asked participants questions concerning the difficulty of the overall framework and the two stages of the framework individually (see Table A.2). After the first analysis, on average, the overall framework and the first stage, were rated as easy, and the second stage was rated as moderate (see Table A.5). After the second analysis, on average, only the rating for the

Participant	Time (Google)	Time (RNIB)
P1	2:30	1:00
P2	2:15	1:15
P3	2:10	1:05
P4	2:00	1:15
P5	1:30	
P6	1:10	
P7	2:15	1:00
P8	1:40	
P9	3:00	
P10	2:30	2:00
P11	2:45	
P12	3:00	
Average	2:13	1:15

Table 5.5: Time taken for doing the first analysis (*Google Directory* page) and the second analysis (the home page of *RNIB*).

second stage was changed from moderate to easy (see Table A.6). This could be because of the familiarity with questionnaire in the second stage. Generally, participants found the first stage easier and more enjoyable than the second stage. They usually commented that answering the questionnaire in the second stage was a bit long and difficult process.

- **Confidence:** We asked participants how confident they were during the analysis (see Table A.2). After the first analysis, they rated on average as moderately confident and after the second analysis, they rated as quite confident (see Table A.5 and A.6). Therefore, the sub-hypothesis, the users would be confident during the application of the framework, was supported.

As a conclusion, all the points discussed above confirmed the efficiency and the applicability of the framework.

5.7 Conclusion

This chapter first explained the extended and modified classifications of travel objects, then the new travel analysis framework and finally the conducted evaluation to test the applicability and consistency of the framework. In the previous chapter, we have discussed the problems of the Harper's framework [32] and the new framework can be differentiated in the following aspects:

- The new framework focused on extracting travel objects and discovering their roles, however Harper's framework focused on providing a mobility rating.

- Harper's framework provide a mobility rating based on the number of obstacles and cues on a web page. However, in our framework, we do not consider obstacles and cues; we focused on discovering the roles of travel objects and precisely specifying the travel objects.

- *Transferable*: The conducted evaluation demonstrated the applicability and usability of the new framework, however there is no substantial evaluation which shows the applicability of the Harper's framework.

- We provided a set of guidelines to creating a travel object inventory, which was omitted in the Harper's framework.

- The conducted evaluation demonstrated that the new framework is systematic and consistent. Despite the subjectivity of the travel analysis process, participants were able to apply the new framework consistently and systematically.

- In the new framework, we first extended and modified classifications of proposed travel objects [30] and considered all of them. However, Harper's framework considered only landmarks and memory objects from the proposed real world travel [30].

As a conclusion, the conducted evaluation demonstrated the applicability of the new framework; all the participants were able to create a travel object inventory and classify the extracted travel objects. Despite the subjectivity of the travel analysis process, participants were consistent. Thus, it could be concluded that we will be able to design a tool to support this framework. The aim is to develop a semi-automated tool to support the new framework. The reason for not aiming to devise a fully automated tool is that, although we were able to decrease the subjectivity in the travel analysis process, we could not eliminate it completely. Subjectivity exists in the nature of travel analysis process. In the next chapter, we will explain the approach to devising the semi-automated tool to support the new framework.

Chapter 6

Conclusions and Future Work

In this continuation report, we have described the work carried out in the first year of this PhD project. This final chapter summarises the work described in the report and outlines the tasks and work plan for the remaining two years of this PhD project.

6.1 Summary and Discussion

As it can be seen from Chapter 2, visually impaired people have a number of difficulties accessing the Web with the currently available web access technologies:

1. They are focused on supporting a 'sensory translation' of a page rather than enhancing movement on the page.
2. They support micro-navigation, but they do not support navigation in the large view.
3. Only a small part of the page is usually viewable, an overall picture of the page is usually not provided or maintained.
4. They produce superficial information about the page; all layout which is often a key for understanding the content of a page, style, font, or the nature of the information content is lost.
5. All the visual navigational cues are missing so navigation is almost impossible.

The difficulties that visually impaired people have in accessing the Web is not only because of the technological advances, it is also because of the inappropriately designed web pages. Several organisations, particularly, the W3C Web accessibility initiative, recognise these difficulties and provide guidelines to promote the accessibility on the Web. Although the provided guidelines are sensible and important, designers rarely follow these guidelines. Moreover, the main focus of these guidelines is also supporting the sensory translation rather than providing mobility on the Web.

Some tools are also introduced to validate or repair web pages against these published accessibility guidelines. Although these tools provide quick reference to web site's accessibility, they cannot provide either complete automatic evaluation or repair of, for example, the layout of the page. In addition, the navigation structure cannot be evaluated or repaired. As a summary, there is very little research in understanding how the overall process of accessing the Web is accomplished by users.

Harper [32] proposes using the notion of travel and mobility on the Web to improve the accessibility for visually impaired and other travellers. The notion of travel is also the foundation of this PhD project. The model of travel was then extended to a mobility analysis framework [32]. In Chapter 3, we have discussed browsing which is a related activity to travel. This was used to extend the notion of travel on the Web. Browsing is usually described in a task orientated fashion – movement in an information

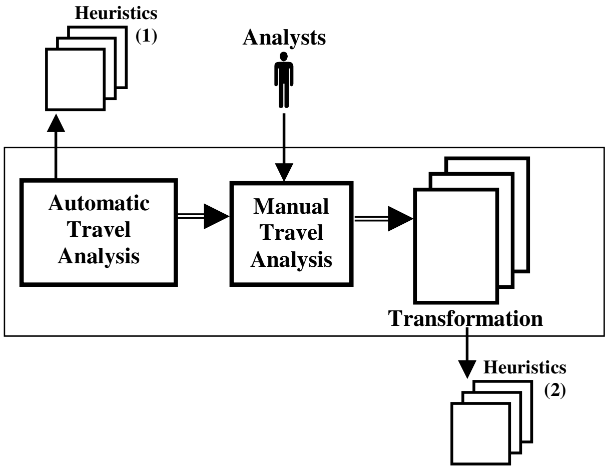


Figure 6.1: The main components of the Travel Workbench.

space, in a particular style, in order to accomplish a task. These notions can be used to contextualise travel so that we know what sort of travel to support upon a web pages.

Our main goal is to provide tool support for travel on the Web. This will be achieved by extracting travel objects from a page, discovering their roles and transforming a page into another form so that travel objects can fulfill their intended roles. Although, the framework proposed by Harper [32] addresses creating a travel object inventory and analysing extracted objects for mobility support, the main focus is providing a mobility metric for the underlying page. Furthermore, it is subjective and craft based and a tool cannot be built on a craft. Chapter 4 discussed the Harper's framework and stated all the problems. Therefore, we created a new framework for extracting travel objects and discovering their roles (see Chapter 4). The new framework is the foundation of the work that will be carried out in the remaining two years of this PhD project.

We have also extended and modified the model of real world travel, and explained in Chapter 5. The new framework is for extracting travel objects and discovering their roles. We have also conducted evaluations and demonstrated the applicability of the framework (see Chapter 5). The users were able to create an inventory of the travel objects on analysed pages and they were able to classify the extracted travel objects. However, the evaluation of the framework confirmed that we could not eliminate the subjectivity completely, therefore, we would not be able to create a fully automated tool to extract travel objects and classify them. Consequently, the next step in this project, which will be explained in Section 6.2, will be devising a semi-automated tool to support travel on the Web.

6.2 Work Plan

The current section presents the work plan for the remaining two years of this PhD project. Our main goal is to provide tool support for the travel on the Web. The main goal of this tool is to enhance the mobility of the visually impaired people on the Web. The new framework is the foundation of this tool. This tool will be semi-automated for extracting travel objects, classifying them according to the role they play in the travel process and transforming the page into another form in which the travel objects can play their intended roles.

We are planning to create the tool as a workbench and we named it as Travel Workbench. The Travel Workbench will be comprised of the following three components and the Figure 6.1 depicts the relationship of these components:

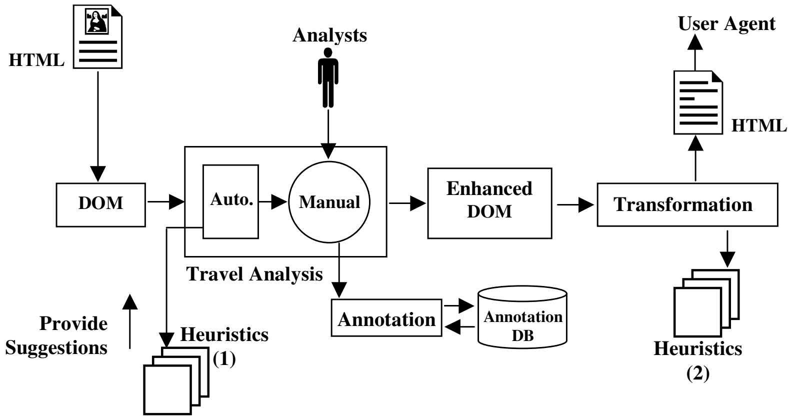


Figure 6.2: The method that will be followed by the Travel Workbench.

1. Automatic travel analysis
2. Third party travel analysis and annotation
3. Transformation

Figure 6.2 illustrates the overall method that links three components of the Travel Workbench. The overall method can be divided into four steps:

Step 1 We are planning to use the Document Object Model (DOM) representation of a web page and the methods it provides to access the content of the page.

Step 2 There will be two parts in this step: An automatic travel analysis part and the manual part (analyst support). The travel analysis will be done through the DOM representation of the page. The automatic analysis part will extract and classify candidate travel objects based on the heuristics. In this part, two sets of heuristics will be used: one set of heuristics for extracting travel objects and one set for classifying extracted travel objects. The heuristics for extracting travel objects will be developed from the guidelines used in Chapter 5 and evolved throughout the application. Similarly, the heuristics for classifying travel objects will be developed from the proposed classifications of travel objects and from the questionnaire used in the second stage of the new framework (see Chapter 5).

The automatically extracted travel objects and classifications will be proposed as suggestions to an analyst. In the manual part, the analyst will be able to accept or reject the proposed suggestions. He(she) will also analyse the travel support provided by the page: he(she) will be able to create an inventory of the travel objects on the page, classify them and provide further descriptions about the objects (or annotate them).

Step 3 An enhanced Document object model will be created at this step. This enhanced DOM will reflect the extracted travel objects, classifications and annotations that have been done in the previous step.

Step 4 A page may be analysed and annotated by more than one analyst (annotator). This is depicted in Figure 6.3. If more than one analyst analyse a page, we will be able to create different views of the same page. Different analysts may create different travel object inventories (TOI) and provide different annotations, where multiple views can be supported by using these TOIs and annotations.

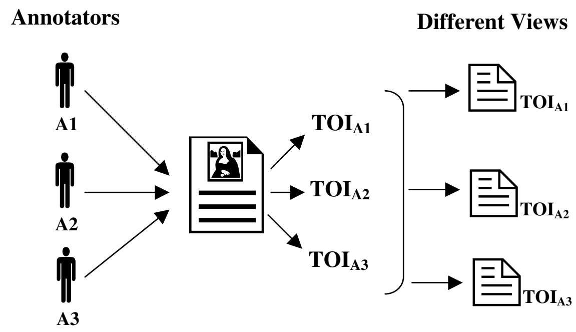


Figure 6.3: More than one analyst can analyse a page, which may be help to create different views of the same page.

When only one analyst analyses a page, the enhanced document model from stage three will be used to transform the page. The transformation will also be based on a set of heuristics. These heuristics will be developed from the travel object classifications (see Chapter 5) and the user preferences. Finally, the transformed page will be rendered by a user agent.

The steps above will also be followed in order to create the complete Travel Workbench. However, before starting to implement the Travel Workbench, the steps suggest the following issues that need to be investigated and clearly specified:

1. Deciding on inputs (HTML, XHTML, XML)

2. The heuristics for automatic identification of travel objects and classifications need to be explicitly specified.

3. The representation strategies of heuristics need to be investigated.

4. The technologies that will be used to enable analysts to extract travel objects, classify and annotate. The Xpath, Xpointer and the RDF annotation schema might be used or the Annotea RDF infrastructure and it's implementation in Amaya [42] might be used. All these technological resources will be explained in the next section.

5. The storage mechanism that will be used to store travel object inventories, classifications and annotations.

6. The heuristics for transformation of a page need to be specified.

After investigating the issues specified above, we will focus on the design and implementation of the Travel Workbench. In the next three sections, first, we will discuss the technological resources that might be used in the implementation of the Travel Workbench. Second, we will present the outline of the thesis structure that will be delivered at the end of this project. Finally, we will present the work schedule in the remaining two years of this PhD project.

6.3 Technological Resources

In this section, we will provide a summary of some technological resources that might be In this section we will discuss the resources that might be used in the manual travel analysis part of the Travel Workbench:

- **Annotea** Travel analysis will be done either automatically or manually by a analyst. In the manual part, the analyst will be able to identify travel objects, classify and annotate them. For the manual part, we could use up and coming technologies about annotation such as Annotea and Amaya. Annotea provides a simple infrastructure for associating annotations with web documents, without having to modify these documents [42]. This is an important feature because we want to analyse a web page for travel support without modifying it.

  Annotea is a shared web annotation system based on a general-purpose open RDF infrastructure, where annotations are modelled as a class of metadata. Some of the features of the Annotea can be summarised as follows [42]:

  – Annotea is an open infrastructure, it uses an RDF schema for describing the properties of annotations, Xpointer for associating annotations to documents and HTTP for the client-server interactions. XPointer can be used for defining the positions within XML documents [7].
  – Annotations are seen as metadata about a whole document or part of the document which can be HTML or XML.
  – Annotations are stored in generic RDF databases.
  – Annotations can be stored either locally in the user's host computer or in an annotation server.

  An instance of Annotea has also been implemented using Amaya editor/ browser and a generic RDF database.

- **Amaya** is a full featured web browser and editor developed by W3C for experimenting and validating web specifications at an early stage of their development. It includes implementation of the Annotea which is based on RDF [4], Xlink [6] and XPointer [7].

- **RDF** provides a very flexible framework for describing properties of any web resources [4]. RDF provides *resource*, *property*, *value* triples. A single triple is a statement that indicates that a *resource* has a given *property* with a given *value*.

  – The *resource* can be any web resource identified by a URI.
  – The *properties* are attributes that describe resources.
  – The *value* may be a literal string or may be the URI of another web resources. RDF permits separate communities to develop independent metadata vocabularies. Consequently, we could create our own travel object vocabulary.

As a conclusion, in this section, we have provided an overview of the technological resources that could be used in the implementation of the Travel Workbench, but further investigations need to be done to find the appropriate technological resources to implement the Travel Workbench.

6.4 Thesis Structure

We can propose a thesis structure based on the work done in the first year and explained plan for the remaining two years of this PhD project. The structure of the thesis that will be delivered at the end of the third year can be outlined as follows:

1 Introduction

2 State of the Art

3 The Travel Analysis Framework

4 The Travel Work Bench

4.1 Automatic Travel Analysis

4.2 Manual Travel Analysis

4.3 Evaluation of the Travel Analysis Part

4.4 Transformation of a page

4.5 Evaluation of the Transformation part

5 Confirming the Improved Accessibility of the Transformed page (Evaluation of the Travel Workbench)

6 Conclusions, Contributions and Future Work

6.5 Project Management

Figure 6.4 depicts the preliminary task decomposition (as described in Section 6.2) and milestones of this PhD project as a Gantt chart. Table 6.1 depicts the further task decomposition. The papers to be written are also planned. We expect to be able to write papers concerning the following tasks:

- Travel analysis framework and conducted evaluation
- Contextualising travel by using browsing (Browsing and tables)
- Travel analysis part of the Travel Workbench and the evaluation that will be conducted
- Transformation part of the Travel Workbench
- Travel Workbench and overall evaluation

Tasks	Months
preliminary study	
literature survey- web accessibility	09.01-08.02
literature survey- browsing	
studying TOWEL project	
characterise travel objects	
creating travel analysis framework	
evaluating travel analysis framework	
****Continuation report write-up**	
decide on inputs (XML, HTML)	9.02
survey of technological resources	9.02
(Travel analysis- automatic part)	
heuristic specifications	10.02-11.02
functional design of the automatic analysis part	12.02-02.03
implementation of the automatic analysis part	03.03-04.03
(Travel analysis- manual part)	
functional design of the manual analysis part	05.03-06.03
implementation of the manual analysis part	07.03-08.03
evaluation of the overall travel analysis part	09.03-10.03
***Second year report**	
(Transformation part)	
heuristic specifications	10.03
functional design of the transformation part	11.03
implementation of the transformation part	12.03-01.04
overall evaluation of the tool	02.04-03.04
****Thesis write-up**	03.04-08.04

Figure 6.4: WorkPlan

Task	**Months**	
decide on inputs (XML, HTML)	Sep-02	
-HTML, XHTML, XML		
-DOM		
survey of technological resources	Sep-02	
-Annotea, Amaya and other annotation tools		
(Travel analysis- automatic part)		
heuristic specifications	Oct-02	Nov-02
1.heuristics for extracting travel objects		
2.heuristics for classifying travel objects		
-how to represent heuritics		
-how to store heuristics		
functional design of the automatic analysis part	Dec-02	Feb-03
-how to refer to travel objects (XPointer)		
-how to store travel objects		
-how to store classifications		
-how to present travel objects (XLink)		
implementation of the automatic anlaysis part	Mar-03	Apr-03
(Travel analysis- manual)		
functional design of the manual analysis part	May-03	Jun-03
-how to modify and extend automatic TOI and classifications		
-how to annotate travel objects		
-how to store annotations		
-how to create enhanced DOM		
implementation of the manual anlaysis part	Jul-03	Aug-03
evaluation of the overall travel analysis part	Sep-03	Oct-03
***Second year report**		
(Transformation Part)		
heuristic specifications	Nov-03	
-heuristics for transformation		
-how to represent		
-how to store them		
functional design of the transformation part	Dec-03	
-how to present TOI		
-how to present classifications		
-how to present annotations		
-how to create different views		
implementation of the transformation part	Dec-03	Jan-04
overall evaluation of the tool	Feb-04	Mar-04
****Thesis write-up**	Mar-04	Aug-04

Table 6.1: WorkPlan

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Appendix A

Evaluation of The Framework

A.1 Materials Used in the Evaluation

Role	Questions		
Decision Points [Def]	Does it provide a set of options (more than one) for making a decision about a journey?		
	[1] [4] [5] [6] [7] [8] [9] [10] [12] [13] [15] [17] [18] [19]		
WayEdge [Def]	Does it provide a kind of border to another object?		
	Is it used to break continuity?		
	Is it used to separate two regions of the page?		
	Is it a linear or continuous element?		
	Is it a linear element that serves as dividing line between parts of the environment?		
	[1] [3] [5] [6] [7] [8] [9] [10] [11] [12] [14] [16] [17] [18] [19]		
Navigation Points [Def]	Can it be used to move from one place to another in the environment?		
	Can it be used to move either within a page or between pages?(Where can I go?)		
	Does it provide a possible route that a traveller exercises some control by choosing to follow or not to follow it?		
	[3] [4] [5] [6] [7] [9] [10] [11] [12] [14]		
Reference Points (Landmarks) [Def]	Does it help the travellers place themselves within the environment? (Does it help the travellers know where they are in the environment?)		
	Can it be considered as a distinctive, recognizable or unique feature of the environment?		
	Would it be easily identified in the environment for any of the following reasons?(Size, color, architectural design, shape, physical properties, frequently used, function or meaning) (i.e Can it be easily differentiated in the environment from any of the previously stated reasons?)		
	Is it a salient object (strong or prominent)?		
	Can it be considered as memorable or easy to memorize object? (After the traveller leaves the environment, is it likely that he/she will remember this object and it's location in the environment. Thus when he/she will revisit, will this object help him/her remember the place?)		
	[1] [2] [5] [6] [7] [8] [9] [10] [11] [12] [13] [14] [15] [17] [19]		
	Reference Point Component [Def]: Can it be combined with other travel objects which allow a traveller to determine his (her) exact (precise) position in the environment?		
	Reference Point Component [Def]: Does it provide sufficient information to identify the exact position of the traveller itself?		
	Reference Point Component [Def]: Is it adequate for determining one's position in the environment?		
Direction [Def]	Does this object show which direction the traveller is moving along? (Does it show the current direction?)		
	Does this object show which direction the traveller can move along? (Does it show the possible directions that the traveller can move along?)		
	[8] [13] [14] [16] [18] [19] [20]		
Distance [Def]	Does it show how far is the traveller from the starting point?		
	Does it show how far is the traveller from a destination?		
	[2] [16]		
Location&Position [Def]	Does it **explicitly** show where the traveller is within the environment? (For example: It could be an object that shows where the traveller is in the active site, for instance, *Home>Education*)		
	Does it **explicitly** help the traveller keep track of the position in the environment?		
	[1] [2] [4] [6] [8] [11] [13] [14] [16] [20]		
Identification Point [Def]	Does it identify a part of the environment or another travel object?		
	Is it used to describe something?		
	Can it be used to identify the destination on arrival?		
	Is it a distinguishable property of a part of the environment or another travel object?		
	[1] [2] [3] [4] [5] [6] [7] [8] [9] [10] [11] [12] [13] [14] [15] [16] [17] [18] [19] [20]		
Alert [Def]	Does it show a change in the environment?		
	Does it notify the user of approaching action or danger?		
	Does it issue a warning to the traveller?		
	[19]		
Attention [Def]	Does it attract the traveller's attention?		
	Does it have a different context from the general context of the environment?		
	Does it change the focus of a traveller?		
	[5] [7] [8] [9] [10] [11] [14] [15] [19]		
Information Point [Def]	Can the traveller ask for detail information about the environment?		
	Does it provide a medium for direct request of information (two-way communication)? (Information about environment)		
	Does the traveller control the type and amount of information request from this object?(Information about environment)		
	Does the user need to initiate the request for information?		
	[3] [4] [6] [8] [11] [12] [14]		
Travel Aid [Def]	Can it be considered as a passive information supply? (The traveller is not involved in the information supply process) & (Information about environment)		
	Does it provide an overview of the environment?		
	Is the traveller able to control what information is revealed?		
	[10] [11] [12] [14] [15] [16] [19]		
Travel Memory [Def]	Does it show where the traveller has been?		
	Does it show previously visited places?		
	Does it show how the traveller can get back to where he (she) was?		
	Does the object record information about the travel undertaken so far?		
	[4] [10] [12] [17A] [17B]		
Travel Support [Def]	Does it provide an automated journey?		

Note: The supplied examples are obtained by using IE (Internet Explorer).

Table A.1: The questionnaire used for travel object classifications.

1	How was your understanding of travel on the web before the analysis?	☐ Not good at all ☐ Not very good ☐ Moderately good ☐ Quite good ☐ Very good
2	How is your understanding of travel on the web after the analysis?	☐ Not good at all ☐ Not very good ☐ Moderately good ☐ Quite good ☐ Very good
3	How easy did you find the overall framework?	☐ Very difficult ☐ difficult ☐ Moderate ☐ Easy ☐ Very easy
4	How easy did you find first part which is creating the travel object inventory?	☐ Very difficult ☐ Difficult ☐ Moderate ☐ Easy ☐ Very easy
5	How easy did you find the classification of travel objects (Answering the questionnaire)	☐ Very difficult ☐ Difficult ☐ Moderate ☐ Easy ☐ Very easy
6	How difficult did you find answering the questions as 'yes' or 'no'?	☐ Very difficult ☐ Difficult ☐ Moderate ☐ Easy ☐ Very easy
7	How confident were you during the analysis?	☐ Not confident at all ☐ Not very confident ☐ Moderately confident ☐ Quite confident ☐ Very confident
8	How subjective did you find the questionnaire (Classifications of the travel objects)?	☐Not subjective at all ☐ Not very subjective ☐ Moderately subjective ☐ Quite subjective ☐ Very subjective
9	How useful did you find the guidelines?	☐ Not useful at all ☐ Not very useful ☐ Moderately useful ☐ Quite useful ☐ Very Useful
10	How useful did you find the examples?	☐ Not useful at all ☐ Not very useful ☐ Moderately useful ☐ Quite useful ☐ Very useful
11	Did you use the definitions of the classifications of the travel objects?	☐ Not useful at all ☐ Not very useful ☐ Moderately useful ☐ Quite useful ☐ Very useful

Table A.2: Questions asked for the overall evaluation of the framework.

A.2 Evaluation Results

Id.	Description & Role	Expected	P-1	P-2	P-3	P-4	P-5	P-6	P-7	P-8	P-9	P-10	P-11	P-12	Total
MH	(Main Heading)	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓		10
	Reference Point	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓		10
	Reference Point Component				✓								✓		2
	Location & Position		✓			✓			✓						3
	Identification Point	✓	✓	✓		✓	✓			✓					5
	Attention						✓								1
	Travel Aid					✓									1
MH-GMH	(Main Heading- *Google*)										✓			✓	2
	Way Edge										✓				1
	Reference Point										✓				1
	Reference Point Component										✓			✓	2
	Attention													✓	1
MH-PH	(Page Heading- *Directory*)										✓			✓	2
	Reference Point Component										✓			✓	2
	Identification Point										✓			✓	2
MM	(Main Menu)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	12
	Decision Point	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	12
	Navigation Point	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓		✓	10
	Reference Point Component		✓		✓					✓	✓			✓	5
	Direction		✓					✓	✓		✓			✓	5
	Location & Position	✓	✓		✓						✓				3
	Identification Point				✓	✓					✓				3
	Attention					✓					✓			✓	3
	Travel Aid				✓						✓			✓	3
MM-B	(Menu Menu Bolded item- *Directory*)		✓	✓		✓	✓				✓	✓	✓		7
	Navigation Point		✓			✓					✓				3
	Reference Point Component		✓				✓						✓		3
	Location & Position		✓	✓		✓							✓		4
	Identification Point					✓					✓		✓		3
	Travel Aid					✓					✓		✓		3
SE	(Search Engine)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		11
	Navigation Point	✓	✓			✓	✓		✓	✓	✓	✓	✓		8
	Reference Point							✓	✓	✓					3
	Attention		✓					✓	✓				✓		4
	Information Point	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓		10
SE-BX	(Search Engine- Search Box)										✓			✓	2
	Navigation Point										✓			✓	2
	Information Point										✓			✓	2
SE-BT	(Search Engine- Button)													✓	1
	Navigation Point													✓	1
	Reference Point													✓	1
GH	(Google Help)	✓	✓	✓	✓	✓	✓	✓		✓		✓	✓	✓	10
	Way Edge					✓									1
	Navigation Point	✓	✓	✓	✓	✓	✓	✓		✓			✓	✓	9
	Identification Point					✓							✓		2
	Travel Aid			✓						✓			✓	✓	4
	Travel Memory		✓												1
PS1	(Page Separation-1)	✓	✓								✓	✓	✓	✓	5
	Way Edge	✓	✓								✓	✓	✓	✓	5
PS2	(Page Separation-2)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	12
	Way Edge	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	12
PS3	(Page Separation-3)	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	11
	Way Edge	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	11
CTT	(Categories Table Title)	✓		✓	✓		✓	✓			✓	✓	✓	✓	8
	Reference Point Component				✓			✓						✓	3
	Location & Position				✓										1
	Identification Point	✓		✓	✓							✓		✓	4
	Travel Aid				✓		✓				✓		✓	✓	5
CT	(Categories Table)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	12
	Decision Point	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	11
	Navigation Point	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	11
	Reference Point							✓		✓			✓	✓	4
	Reference Point Component					✓									1
	Direction		✓							✓			✓		3
	Identification Point								✓				✓		2
	Information Point					✓									1
	Travel Aid				✓								✓	✓	3
	Travel Memory		✓						✓				✓		3

Table A.3: Travel object inventories and classifications by all participants for Figure 5.6 (*Google Directory* page).

	Id.	Description & Role	Expected	P-1	P-2	P-3	P-4	P-5	P-6	P-7	P-8	P-9	P-10	P-11	P-12	Total
	CT-CTT	(Category Title)	✓	✓		✓		✓						✓		4
		Decision Point				✓										1
		Navigation Point	✓	✓		✓		✓						✓		4
		Identification Point	✓	✓										✓		2
		Travel Aid				✓								✓		2
		Travel Memory	✓	✓										✓		2
	CT-CL	(Category List)	✓	✓								✓		✓		3
		Decision Point	✓									✓		✓		2
		Navigation Point	✓	✓								✓		✓		3
		Direction		✓										✓		2
		Travel Memory	✓	✓										✓		2
	FN1	(Footnote-1)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	12
		Decision Point	✓	✓	✓	✓	✓		✓		✓	✓	✓	✓	✓	10
		Navigation Point	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	11
		Direction		✓												1
		Identification Point					✓			✓				✓		3
		Attention					✓									1
		Travel Aid									✓			✓		2
		Travel Memory	✓	✓						✓				✓		3
	FN2	(Footnote-2)	✓	✓		✓	✓	✓	✓		✓		✓	✓	✓	9
		Decision Point	✓				✓				✓			✓		3
		Navigation Point	✓						✓		✓			✓		3
		Way Edge	✓	✓			✓	✓					✓	✓	✓	6
		Identification Point		✓			✓									2
		Attention		✓		✓	✓		✓		✓			✓		6
		Travel Memory	✓													0
	FN-B	(Footnote-2 Bolded item)		✓				✓								2
		Navigation Point		✓				✓								2
		Attention		✓				✓								2
		Travel Memory		✓												1
	FN-H	(Footnote-2 Heading)			✓								✓		✓	3
		Identification Point			✓								✓			2
		Way Edge											✓			1
	FN-M	(Footnote-2 Menu)		✓	✓	✓		✓					✓		✓	6
		Decision Point		✓	✓	✓							✓		✓	5
		Way Edge											✓			1
		Navigation Point		✓		✓		✓					✓		✓	5
		Attention		✓												1
		Travel Memory		✓												1
Browser- Travel objects	TB	(Title Bar)	✓	✓				✓				✓	✓	✓	✓	6
		Reference Point						✓				✓		✓	✓	4
		Reference Point Component	✓	✓			✓					✓				3
		Location & Position		✓												1
		Identification Point	✓	✓											✓	2
	BB	(Back Button)	✓										✓			1
		Direction	✓										✓			1
	PU	(Page URL)	✓				✓	✓				✓	✓			4
		Navigation Point					✓									1
		Reference Point Component	✓				✓	✓				✓				3
		Location & Position					✓					✓				2
		Identification Point	✓				✓									1
	ST	(Status Bar)	✓					✓								1
		Direction		✓												1
		Distance		✓												1
		AL	✓	✓				✓								2
	SB	(Scroll Bar)	✓	✓			✓	✓					✓			4
		Navigation Point		✓			✓									2
		Direction	✓	✓			✓						✓			3
		Distance	✓	✓				✓					✓			3
	SB-Up	(Scroll Bar Up)					✓	✓						✓		3
		Direction					✓	✓						✓		3
	SB-Down	(Scroll Bar Down)					✓	✓						✓		3
		Direction					✓	✓						✓		3
	SB-Dis	(Scroll Bar Distance)					✓							✓		2
		Distance					✓							✓		2

Table A.3: (continued).

Id.	**Description & Role**	**Expected**	**P-1**	**P-2**	**P-3**	**P-4**	**P-7**	**P-11**	**Total**
RL	(RNIB Logo- (logo+banner))	✓		✓	✓	✓	✓	✓	5
	Way Edge	✓							0
	Reference Point	✓		✓	✓	✓	✓	✓	5
	Reference Point Component					✓		✓	2
	Identification Point	✓		✓					1
	Location & Position						✓		1
RL-L	(RNIB Logo- only logo)		✓						1
	Reference Point		✓						1
RL-T	(RNIB Logo- only banner)		✓						1
	Identification Point		✓						1
	Reference Point		✓						1
SS	(Site Search)	✓	✓	✓	✓	✓	✓	✓	6
	Navigation Point	✓	✓				✓	✓	3
	Identification Point						✓	✓	2
	Information Point	✓	✓	✓	✓	✓		✓	5
	Reference Point					✓	✓		2
RD	(RNIB Description)	✓		✓				✓	2
	Identification Point	✓		✓					1
	Way Edge							✓	1
	Travel Aid							✓	1
FH	(Features Heading)	✓	✓	✓	✓	✓	✓	✓	6
	Way Edge	✓		✓	✓	✓		✓	4
	Identification Point	✓	✓	✓	✓	✓	✓	✓	6
	Reference Point Component					✓			1
	Direction					✓			1
	Distance							✓	1
FM	(Features Menu)	✓	✓	✓	✓	✓	✓	✓	6
	Decision Point	✓	✓	✓	✓	✓		✓	5
	Navigation Point	✓	✓	✓	✓	✓	✓	✓	6
	Travel Memory	✓	✓	✓				✓	3
	Travel Aid		✓		✓				2
	Way Edge					✓		✓	2
	Direction					✓			1
FM-SM	(Features Sub-Menu)	✓						✓	1
	Decision Point	✓						✓	1
	Navigation Point	✓						✓	1
	Travel Memory	✓						✓	1
	Way Edge							✓	1
FM-I	(Features Menu Item)		✓					✓	2
	Navigation Point		✓					✓	2
	Travel Memory		✓					✓	2
HH	(Hotspots Heading)	✓	✓	✓	✓	✓	✓	✓	6
	Way Edge	✓		✓	✓	✓		✓	4
	Identification Point	✓	✓	✓	✓	✓	✓	✓	6
	Reference Point Component					✓			1
	Direction					✓			1
	Distance							✓	1
HM	(Hotspots Menu)	✓	✓	✓	✓	✓	✓	✓	6
	Decision Point	✓	✓	✓	✓	✓	✓	✓	6
	Navigation Point	✓	✓	✓	✓	✓	✓	✓	6
	AT	✓							0
	Travel Aid		✓		✓			✓	3
	Travel Memory		✓	✓				✓	3
	Way Edge					✓		✓	2
	Direction					✓			1
HM-I	(Hotspots Menu Item)	✓	✓					✓	2
	Navigation Point	✓	✓					✓	2
	Reference Point Component	✓							0
	AT	✓							0
	Travel Memory	✓	✓					✓	2

Table A.4: Travel object inventories and classifications by all participants for Figure 5.7 (the home page of *RNIB*).

Id.	**Description & Role**	**Expected**	**P-1**	**P-2**	**P-3**	**P-4**	**P-7**	**P-11**	**Total**
DH	(Directory Heading)	✓	✓	✓	✓	✓	✓	✓	6
	Way Edge	✓		✓	✓	✓		✓	4
	Identification Point	✓	✓	✓	✓	✓	✓	✓	6
	Reference Point Component					✓			1
	Direction					✓			1
	Distance							✓	1
DM	(Directory Menu)	✓	✓	✓	✓	✓	✓	✓	6
	Decision Point	✓	✓	✓	✓	✓		✓	5
	Navigation Point	✓	✓	✓	✓	✓	✓	✓	6
	Travel Memory	✓	✓	✓			✓	✓	4
	Travel Aid		✓		✓				2
	Way Edge							✓	1
	Direction					✓			1
DM-SM	(Directory Sub-Menu)	✓						✓	1
	Decision Point	✓						✓	1
	Navigation Point	✓						✓	1
	Travel Memory	✓						✓	1
	Way Edge							✓	1
SM	(Site Menu)	✓			✓	✓		✓	3
	Way Edge	✓			✓	✓		✓	3
	Decision Point	✓			✓	✓		✓	3
	Navigation Point	✓			✓	✓		✓	3
	Identification Point				✓			✓	2
	Travel Aid				✓			✓	2
	Direction					✓			1
STM	(Site Menu (text))	✓			✓	✓		✓	3
	Decision Point	✓			✓	✓		✓	3
	Navigation Point	✓			✓	✓		✓	3
	Travel Aid				✓				1
	Travel Memory	✓						✓	1
	Direction					✓			1
SM-T	(SM+STM)		✓	✓			✓		3
	Way Edge						✓		1
	Decision Point		✓	✓			✓		3
	Navigation Point		✓	✓			✓		3
	Travel Aid		✓						1
	Travel Memory		✓	✓					2
W3C-AP	(W3C Approvals Menu)	✓	✓	✓	✓	✓		✓	5
	Decision Point	✓	✓	✓		✓			3
	Navigation Point	✓	✓	✓	✓	✓		✓	5
	AT	✓	✓		✓	✓		✓	4
	Travel Aid		✓						1
W3C-AP-I	(W3C Approvals Menu Item)				✓		✓	✓	3
	Decision Point	✓	✓	✓					2
	Navigation Point	✓	✓	✓	✓		✓	✓	5
	AT	✓	✓		✓			✓	3
	Travel Aid		✓						1
	Identification Point						✓		1
RLS	(RNIB logo (small))	✓	✓	✓	✓	✓	✓	✓	6
	Navigation Point	✓	✓	✓	✓	✓	✓	✓	6
	AT				✓			✓	2
	Reference Point Component	✓							0
	Identification Point					✓	✓		2
LR	(Link Requests)		✓		✓	✓		✓	4
	Navigation Point		✓		✓	✓		✓	4
	Direction					✓			1
	Travel Memory		✓					✓	2

Table A.4: (continued).

	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	Average
Q1	2	3	3	3	4	4	1	3	5	2	5	2	3
Q1	4	4	4	4	4	4	4	4	5	5	5	4	4
Q3	4	4	3	3	3	4	5	3	3	4	4	2	4
Q4	2	2	4	4	4	5	4	4	4	4	4	3	4
Q5	4	3	4	2	3	3	4	2	2	3	3	3	3
Q6	3	3	4	3	3	5	4	4	4	5	2	4	4
Q7	2	3	4	4	4	4	3	3	4	3	4	3	3
Q8	3	4	2	3	3	3	4	2	5	2	2	3	3
Q9	5	5	4	5	5	3	5	4	5	5	5	4	5
Q10	3	5	4	5	2	4	5	5	3	5	5	4	4
Q11	2	4	4	5	4	3	5	5	5	5	3	4	4

Rate	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11
1	1										
2	3		1	2	3	1	1	4		1	1
3	4		5	1	6	4	5	5	1	2	2
4	2	9	5	8	3	5	6	2	3	3	4
5	2	3	1	1		2		1	8	6	5
Average:	3	4	4	4	3	4	3	3	5	4	4

Table A.5: Answers given to questions in Table A.2 after analysing *Google Directory* page.

	P1	P2	P3	P4	P7	P11	Average
Q1	4	2	4	3	4	4	4
Q1	4	4	4	4	5	4	4
Q3	5	3	4	4	4	4	4
Q4	5	4	4	5	4	4	4
Q5	5	4	4	2	4	4	4
Q6	5	5	3	3	5	3	4
Q7	5	4	4	5	4	4	4
Q8	2	3	3	3	4	3	3
Q9	6	6	6	6	5	6	6
Q10	4	4	4	6	5	6	5
Q11	3	4	3	5	4	3	4

Rate	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11
1											
2	1				1			1			
3	1		1			3		4			3
4	4	5	4	4	4		4	1		3	2
5		1	1	2	1	3	2		1	1	1
Average:	4	4	4	4	4	4	4	3	5	4	4

Table A.6: Answers given to questions in Table A.2 after analysing the *RNIB* home page.