An Exploratory Study in Managing World Wide Web History

Jason Marshall

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Lancaster University

Abstract

An exploratory experimental study was conducted investigating the use and development of World Wide Web History Mechanisms. The study employed two stages of investigation. A combination of screen evaluations and interviews were used with six participants to create a research agenda of key usability issues within the history domain. The participants revealed a strong preference for sorting (organising) information whilst browsing, personalising pages more, and text based hierarchical systems. It was decided that further examination of sorting strategies would yield the greatest potential for augmenting history mechanism design.

In consequence, the second stage required a more quantitative means to compare the sorting strategies. Ten participants performed a repeated web sorting and retrieval task with Microsoft Internet Explorer "Favourites" over two days. The results contradicted the user's preferences in the first study where sorting the web information after browsing induced significantly better retrieval times, accuracy, and subjective satisfaction. Surprisingly, sorting information after browsing took significantly longer to store and organise the web pages, and induced significantly more title annotations. No significant main effects were found for time, familiarity with the material, and sorting composition.

The paper provides a number of implications for interface design and browsing strategy. Further research is required to isolate the experimental parameters and implement the recommended interface changes to improve history mechanism design.

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1.0. Introduction

The suggestion that World Wide Web (WWW) navigation systems indicate where the user has been is not new (Bush 1945, Tognazzini 1998). Central to this theme is the "lost in space problem" (Nielsen 1990); because there are few restrictions on how users navigate through a vast body of information space, users become disorientated while navigating. Thus, where Hansel and Gretel placed bread crumbs through the woods, web users leave paths or trails that reduce the likelihood of getting lost.

It has been suggested that web browsing is a highly recurrent system where atleast 60% of web sites viewed are a repeat of a previous visit (Tauscher and Greenberg 1996, Catledge and Pitkow 1995, Cockburn and Mckenzie 2000). Therefore, a temporally ordered list of interactions, or "history mechanism" as defined by Greenberg (1993) should provide a variety of reuse benefits. Moreover, an effective history mechanism can assist the user in processing the vast amounts and poor structure of information by providing easy access to previously visited pages. If users follow paths solely as a route to a destination, shortcuts could supplant search engines and avoid intermediary pages. Similarly, history mechanisms can provide a sense of orientation thus reducing the user's cognitive and navigational overheads within the current context of the information space (Tauscher and Greenberg 1996). In quantitative terms, these advantages may be measured in terms of shorter information retrieval times of previously viewed sites (recall), increased accuracy, and increased user satisfaction.

However, contemporary WWW client applications (also termed browsers) and the abundance of graphical history visualisations have yet to fully realise the advantages mentioned above. Typically, stack-based mechanisms erase browsing history on backtracking, "favourites menus" provide little information scent, and 3D

visualisations offer occlusion and limited annotation capability. More importantly, these mechanisms tend towards ad-hoc approaches that do not appear to address the user's cognitive processes or preferences, the task at hand, or empirical findings regarding history support (Greenberg 1993). It is the author's opinion that some of the shortcomings mentioned above could be alleviated by conducting an exploratory study within the history domain to generate key issues and ideas for research.

When considering the use or development of history mechanisms one must recognise the complex multidisciplinary input afforded by memory, browsing and search behaviour, hypertext structures and visualisation. The following chapter identifies some of the key issues experienced in using history mechanisms and the tasks that influence history mechanisms. The next chapter observes existing interfaces for the purpose of history, browsing, and sorting exercises. Finally, the problems that this research seeks to address and thesis outline are stated.

1.1. Hypertext and the WWW.

In order to appreciate the goal of history mechanisms one must define the structure that makes up the WWW. In basic terms, the web is a Hypertext Information system that uses a non-linear text model. In contrast to a book, the reader can skip from one item of information to another, go back, and navigate the text based on what interests you have at the time. Although there is no generally accepted definition for hypertext, most hypertext systems can be characterized by five main features (Akscyn, McCracken, and Yoder, 1988):

1. Information is divided into small units, often called *nodes*. These units can contain text, graphics, audio and video. One node is usually displayed per window.

2. Nodes are interconnected by *links*.

3. Users *navigate* in a hypertext database by selecting links in order to travel from node to node.

4. Users build information structures by creating nodes and links.

5. Hypertext databases may be *shared* and also *distributed*. Multiple users can access information located on different computer systems.

Fundamentally, the web site is modelled as a directed graph (Busacker and Saaty 1965) where web pages constitute the nodes and the links or branching options between web pages constitute the branches. At the web site level, Fleming (1998), and Morris and Hinrichs (1996) perceive the web site as a hierarchy since there is always a distinct entry page which may be thought of as the "root" from which further navigations proceed. Whilst most web sites are more complex than true hierarchies, the taxonomy of web site structures produced by Gillenson, Sherrel, and Chen (2000) provides a clear and useful framework in which to visualise the web site form (as shown in Figure 1). The Introduction page (splash) is literally the first page that a user reaches upon entering a site. The site directory is a page or group of pages from which the primary to major subdivisions of the site can be accessed. At this level, the user should be able to determine the utility of the site and either initiate another search or proceed further into the site. Foundation pages provide the entrance or root page of major subdivisions that are directly accessed from the site directory. Intermediate pages typically hold the bulk of information within the web site and contain links pointing into it and links emanating from it. As Figure 1 suggests, terminal pages or "stubs" appear at the very end or bottom of the site. Therefore, these pages may not link to a lower-level page in its own sub-structure. It is important to recognise the

structure of Figure 1 in this case, since if there is a hierarchy in the data, it makes sense to exploit this for visualisation (Mann and Reiterer 1999).
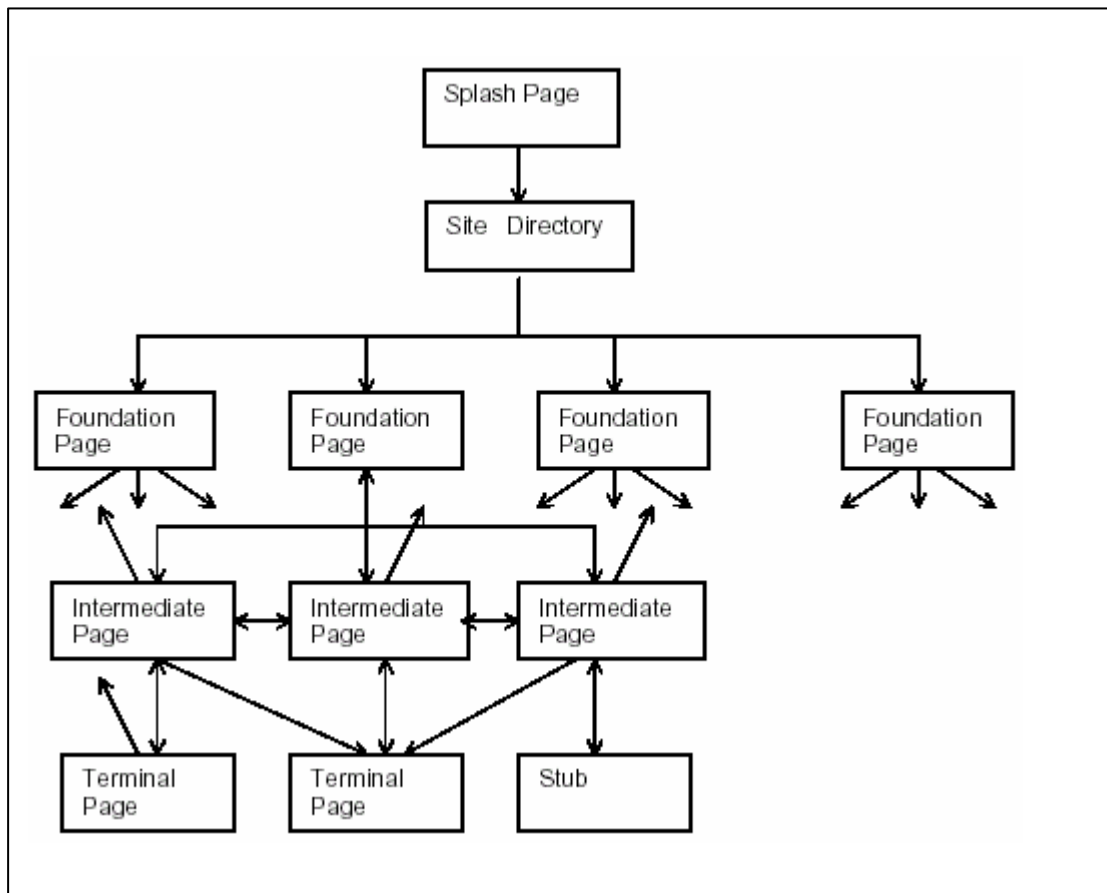
Figure 1. *The five Web-Site Page Types (Gillenson et al, 2000).*

The WWW supports two separate information discovery paradigms: hypertext links and indices. First, hypertext links allow users to access or *browse* WWW pages (nodes) without having to know how these pages are distributed (Berners-Lee, Cailliau, Groff, and Pollermann, 1992). Second, both hypertext links and the contents of web pages are amenable to indexing. Various search engines and databases now exist on the WWW that index web sites, and in response to a list of keywords, the search engine will return a Web page of hypertext links or indices. This search-and-browse paradigm that Berners-Lee et al. (1992) envisioned is a familiar method of navigating the WWW to all of its seasoned users.

Several features of the WWW make it a very powerful Internet exploration tool. First, information need only be stored once, since links can be made to its source and the page recalled without copying. Next, hypertext links allow the topology of the information to evolve, and support a structure that stretches from one's personal workstation to large databases on other continents. Third, indexes are interpreted as documents and can thus be found via searching. Finally, Web documents are not restricted to being static files; they can be "virtual", representing real-time views of changing data (Berners-Lee et al. 1992).

1.2. Machine based issues in WWW history navigation.

Having defined the main foundations of the WWW, the following sections examine those issues concerning the machine component of the Human-Computer Interaction. Navigation encompasses access ranging from information retrieval to browsing. This includes content and structure-based query; history based navigation, and sophisticated backtracking. Many of the problems associated with navigation are the product of internet data, inadequate browser interfaces (Cockburn & Jones 1996), poor WWW space design, and the constraints of the hypertext description language (Cockburn and Jones 1997).

1.2.1. The Characteristics of Internet data

The problems in identifying and re-accessing internet data are further compounded by the following five characteristics of Internet data:

1. The data is *diverse* in that it can exist in a variety of formats, be compressed with a variety of mechanisms that are platform dependent, and require special types of software to access.

2. Internet data is highly *decentralized* which can make locating information difficult. Centralized indexes provide a satisfactory solution to the problem but they do not scale well. WWW databases of page titles and contents are so large that the software "robots" or "spiders" that traverse the WWW to update these databases cannot be run on a frequent basis.

3. The data is largely *unstructured* and *fragmented* since standards do not exist for its form, identification, and classification.

4. Much of the data is provided and updated by many individuals in the Internet community, and its quality and currency varies.

5. Finally, whilst the growth of the internet may have begun to stabilise, an estimated 204 million internet hosts exist at the time of writing thus pushing the benefits of hyperlinks and search results to the limit (Netsizer.com 2002).

1.2.2. History Lists

Generally speaking, three types of history lists exist; Sequential, Stack-based, and Bookmarks (Hotlists). Sequential lists provide a time ordered list of all web page addresses (Uniform Resource Locators - URL) visited by the user, including revisits to the same URL. The problem with sequential lists is that repeated items have multiple entries (or duplicates) which occupy valuable space on a limited list. The main advantage and derivative of the sequential list; the Recency based history, displays the most recently (i.e. Greenberg 1993) viewed pages. Thus, the user will remember and can effectively predict which URLs appear on the list. However, most commercial browsers (i.e. Microsoft Internet Explorer and Netscape Navigator) are stack based rather than being linear lists of visited pages (Cockburn and Jones 1996, Brown and Schiller 1995). Therefore, web users may often find that previously viewed pages have "disappeared" upon using the "back button". Where the "back"

button should produce a stack of the most recently visited pages, a link selection while within a stack removes all pages above the current stack position with the affect that they cannot be re-accessed using either "back" or "forward". Forward and back then, allow the user to move up and down the stack of the history list but loading a page while within the stack risks losing the ability to recall pages. It should also be noted that there is a large degree of inconsistency in visual representation between browsers. For example, in Mosaic the stack grows from the top down with the most recent pages at the bottom, but in Netscape the stack grows upwards.

In contrast to the two history lists mentioned above, bookmarks or hotlists also provide an explicit means of managing history. Essentially the main distinction lies in the fact that web users make a conscious decision that they will need to return to a page and store the page manually. Stack and Sequence ordered lists store every page automatically through the web cache, and so the web user can return to pages that did not initially seem to be valuable.

1.2.3. WWW Subspace Design & Information Scent

Whilst the WWW lends itself to indexes, few browsing or history systems offer fundamental content and navigation information such as a pages relationship to others in a WWW subspace, its links to the previous or next page in a collection, or visual clues that may be used to forage the subspace structure. In depriving the user of this information, the *information scent* of the subspace is dramatically reduced. The concept of information scent is derived from the ecological approach of information foraging theory (Pirolli 1997, Pirolli and Card 1999, Olsten and Chi 2000). Essentially, Foragers (or web searchers) use proximal cues such as snippets, icons, or graphics to assess the distal value and cost of the goal page at the other end of the link. Just as animals may optimise their time and attention in the pursuit and consumption

of food energy from the organic environment, human *informavores* will seek to eliminate irrelevant or low value sites from their browsing and retrieval expenditure. However, where the user's goals change whilst browsing, the information scent maybe entirely subjective and imperfect pending on the perception of value (Chi, Pirolli and Pitkow 2000). Therefore, the provision of information scent visualisations should ideally be matched to the task and needs of the user in question, a task highly sort after via intelligent algorithms and automatic ranking visualisations (Chi, Pirolli, and Pitkow 2000, Chi, Pirolli, Chen and Pitkow 2001, Pirolli, Card, and Der Wege 2001).

1.3. User Centred Issues in WWW History

Having identified some of the factors originating the machine, it is important to recognise those limitations associated with the user.

1.3.1. Incorrect User Models

Perhaps the most common cause of navigation problems; users may have inaccurate models of the structure of the hypertext (Gillenson et al. 2000,1 Akscyn et al. 1988). Few users for example, may appreciate the nature of nodes and links, or the unstructured, fragmented mass of information that the WWW provides. In order to navigate between two or more points in a large space however, the navigator benefits from the ability to conceptualise the space as a whole (survey knowledge). As found in real world navigation, survey knowledge is hierarchical in nature (Stevens and Coupe 1978). Therefore, rather than encoding the absolute positions and directions of every web page encountered, fewer large, general, logically selected pages are encoded with sub-networks of smaller, more specific pages. One might anticipate a correlation between low hierarchical ability and navigation skills therefore.

Once the user has conceptualised the space as a whole, they must also know the sequence of actions required to follow a particular route (procedural knowledge). The problem occurs when the user may assume that the "back" button provides a purely sequential passage through previously viewed sites as opposed to the stack mechanisms that prevail (Cockburn and Jones 1996). The immediate argument perhaps is whether the user should have to render their model of the WWW for purposes of navigation although this precipitates another project altogether.

In having an incorrect model of the system state, the user's ability to utilise information scent is dramatically reduced. Moreover, the optimality of the "information" diet or pursuit sequence taken by the user will depend on their ability to rapidly categorise the www web types, assess their prevalences on the web locality, assess their profitabilities, and decide which categories to pursue and which to ignore (Pirolli, Pitkow, and Rao 1996). The optimisation can be further improved to the extent that the category members can be ranked, so that examples of a good category could be pursued first.

1.3.2. Information Processing

Having stated the utility of high information scent strategies above (i.e. categorising and ranking), it is important to recognise the cognitive structures and processes that will aid this optimisation. The standard information processing model accommodates much of the human limitations in information processing. Figure 2, highlights the three primary memory structure; sensory memory, working (or short term memory), and long term memory. Sensory memory is of short duration, a maximum of a couple of seconds, and is "raw", that is, uninterpreted. It should be noted that with regards to attention, the mind is unlikely to register anything that is not attended by any of the

sensory channels. Hence, history mechanisms may act as an intermediatary for

unattended web sites thus reducing cognitive load.
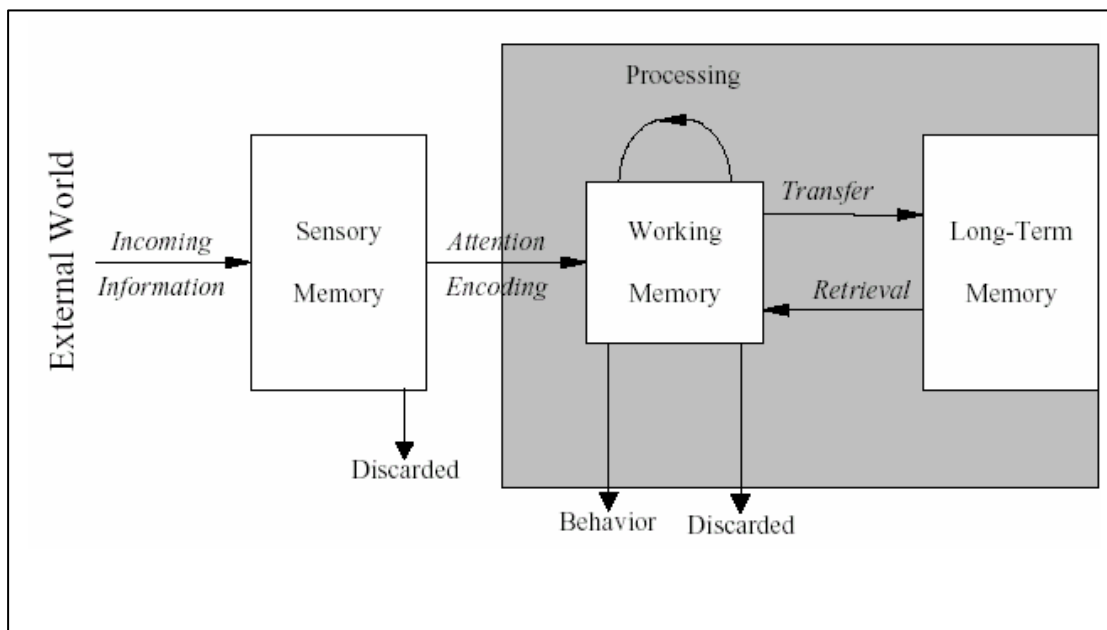
Figure 2. *General Information processing model (*From Doolittle 2001).

The first stage in memory involves encoding, or learning where the process of putting

things into memory occurs. Within Short-term memory, the user makes a conscious

effort to organise, connect, and rehearse information that they want to store. In terms

of structure, the short term capacity is limited to approximately 7 +/-2 items (Miller

1956) and so the vast quantity of information in any one browsing session may lead to

one of two types of *information overload*, a situation where the user can no longer

comprehend the information because of its volume (Keyes, Sykes, and Lewis, 1989).

Firstly, *information pollution* arises due to the amount of data that is redundant,

erroneous, and of generally poor quality. This information obscures the information of

high value that the user is interested in. Secondly, *information saturation* occurs

when the user cannot compare the value of available information sources on a

particular topic because the information space has grown too large. Thus, users may

forget what pages they have observed, how they got there, or even why their browsing

session directed them in a particular fashion. With regards to rehearsal, the Brown-Peterson paradigm (Brown and Peterson 1959) has shown that the lesser the opportunity the user has to rehearse the data, and the greater the retention interval, the poorer the recall accuracy. As the amount of material to be remembered (MTBR) increases, faster decay occurs due to the longer delay in rehearsing each item of the MTBR. In fact, the speed of rehearsal, has a direct influence on the working capacity where the faster the speed, the larger the capacity (Baddeley, 1986, 1990). In terms of processes, we can expect expert web user's to organise information more efficiently than novices due to superior pattern recognition abilities. Hence, the greater the user's ability to create accurate chunks or mental frameworks of the data's content, the easier the task of retrieval within history mechanisms becomes.

Should sufficient organisation, personal elaboration, and rehearsal occur within a satisfactory time frame, information should be deposited into the long-term memory. At this stage, concepts and information should be organised hierarchically (inclusive at top, specific at bottom) thus providing the cognitive structure to subsume (incorporate) other information. The final stage in the process involves retrieval. It should be noted that the ability to retrieve information could also be negatively influenced by interference and inhibition. Proactive interference occurs when activity engaged in prior to encoding the MTBR disrupts its retrieval (Keppel and Underwood 1962). Retroactive interference occurs when material *during* the retention interval disrupts retrieval of the MTBR, for example, forgetting the URL of a page before typing it because someone asked a question during the retention interval. Proactive inhibition occurs where previously learned material has a depressing effect on the learning/encoding of new material. Conversely, retroactive inhibition occurs when

new learning has a depressing effect on the retention of previously learned material (i.e. remembering previously viewed web sites).

In terms of human input, cognitive overheads may arise due to the additional effort and concentration necessary to maintain several tasks and trails through the network especially in large unfamiliar hypertexts (Conklin 1987). These issues are also related to the lack of information scent (i.e. representation of content) derived from information foraging theory (Olston and Chi 2000, Pirolli and Card 1999).

2.0. The Task

Having examined some of the basic origins of navigation problems within history mechanisms, we must also address those factors specific to the tasks that may be performed whilst browsing. The following paragraphs give a very brief account of the most salient issues.

2.1. Browsing & Searching the WWW

The act of browsing and searching (information retrieval) are addressed as one entity here since, a user's search strategy typically evolves through browsing (Bates 1989). If we consider a directed search where the search is known, the search pattern is perhaps more likely to take the depth first form. At the other end of the continuum, random browsing induces a more open goal oriented form of browsing which may be thought of as a breadth first (or hub and spoke) type of browsing. The form of browsing (or traversal pattern) is important in visualising history, since this will inevitably determine whether a linear or hierarchical display is required. Similarly, it has long been known that browsing is a recurrent task where between 61% to 81% of websites are revisits (Catledge and Pitkow 1995, Tauscher and Greenberg 1997A,

Cockburn and Mckenzie 2000). In consequence, it is not surprising that between 30% (Tausher and Greenberg 1997B) and 41% (Catledge and Pitkow 1995) of all logged navigations typically involve the use of the back button. Whether the command is activated through a button click, menu item selection, or shortcut key however, it is important to remember that the back function does not control the temporal ordering of previously visited pages.

2.2. Personalisation, Organising & Annotating Information

The creation of personal subspaces is a very broad area of research with many applications including search, tutoring systems, filtering emails, and customising access to information sources. Within the creation of "personal spaces", many overlapping terms appear within the literature. For example, the term "Annotation" may include bookmarks, landmarks, manual linking and commenting. The terms "Sorting" and "Topic Management" both refer to the organisation of information. Information filtering is concerned with "repeated uses of a system with long term goals with filtering unstructured or semi-structured data" (Belkin and Croft 1992). Perhaps the only common consensus however, is that bookmarks or hotlists are time consuming to create, organize, and maintain over time. The most common solution is to allow the user to explicitly collect Uniform Resource Locators (URLs) into multiple hotlists or bookmark folders that can be nested in a hierarchical fashion. In commercial use, Netscape Navigator and Micro Internet Explorer (IEP) had an estimated 10% and 84% share of the web browser use in January 2001 (W3 schools.com 2001). Within book marking behaviour, Abrams Baeker, and Chignell (1998) found that the use of folders begins at around 35 bookmarks, while the use of multi-level hierarchies becomes prevalent in archives of over 100 bookmarks. Therefore it would seem that the usability of book marking systems are also the

product of of the amount of information placed within them. When considering why user's bookmark, it should be noted that the relevance of a piece of information is not an intrinsic property of the document itself, but it can "only be assessed in relation to the embedding task environment" (Pirolli and Card 1995).

3.0. History within Graphical hypertext systems

A detailed account of the numerous storage, browsing, and history visualisations in use today is neither possible nor necessary for the purposes of this paper. The following paragraphs highlight some of the graphical cues used in prominent systems and the issues that need to be addressed within the visualisation and functionality of history systems.

3.1. Inter-Sessional Views and Linear History Lists

Contemporary browsers are all been keen to add inter-sessional histories as an appendage. Certainly, the linear history list is a popular feature of graphical WWW browsers and often appears as either a menu or dialogue box containing the page titles that are recallable. Microsoft IEP provides a choice of the last ten pages viewed (recency list), and a more extensive history function. Figure 3 shows how the History function provides a split screen with the means to display sites viewed by date, site, most visited, or order visited on the day. A key-word search function and small icons representing the type of document viewed are also provided.
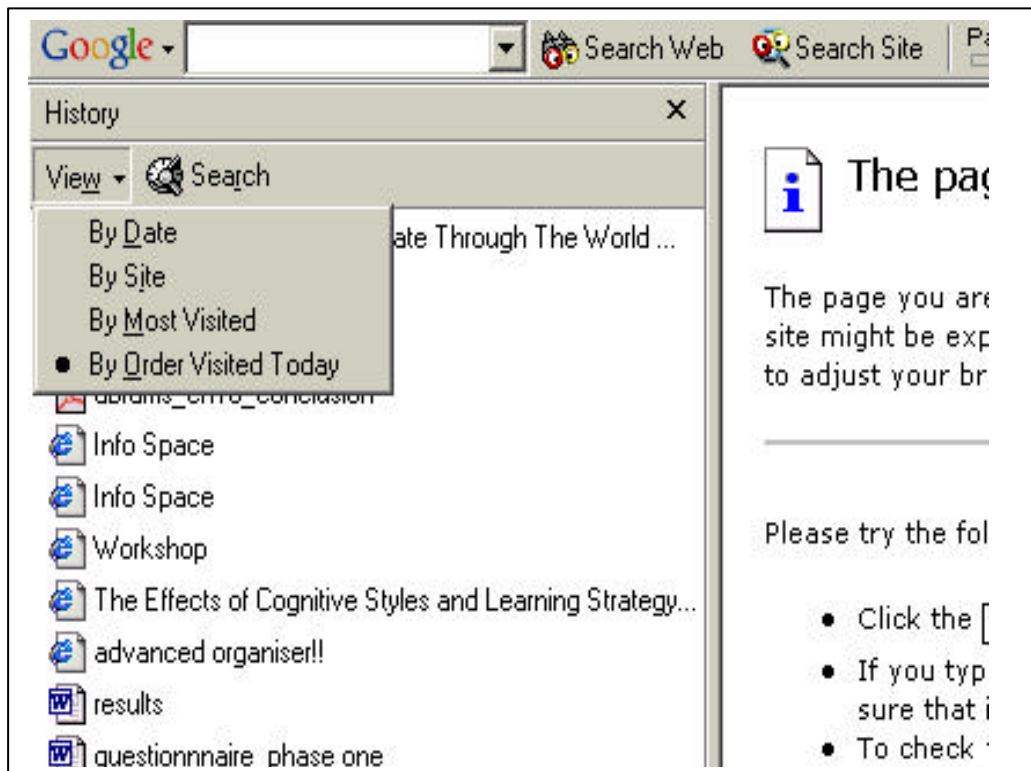
Figure 3. *The IEP History mechanism.*

In either case, the user simply clicks on any one of the web page titles to return to the page although the user has no means to save navigation histories on IEP. In contrast, Cockburn and Jone's WebNet (1996) is capable of saving browsing subspaces and inter-sessional views that may be used for individual and collaborative purposes.

3.2. Already visited cues

WWW inter-sessional history is limited to telling the user that a hyperlink has been visited previously by changing the colour or style of the link on any page it is encountered. This is perhaps the main "already-visited" cue in graphical browsers, and is based upon the users preferences (history expiry date) and global history list maintained by the browser. Whilst colour may be deployed for a variety of uses, one might question whether this simple cue could be augmented or developed to encompass more information.

3.3. Visual Characteristics

The use of visualisation techniques prompts the question of what exactly is visualised? Essentially, the history interface designer must consider three critical issues, the scope of the WWW space that can be visualised, the dimension, and the representation style.

3.3.1. Scope of the Subspace Visualisation

The two key issues in visualising the subspace scope include the temporal extent and range (or number of sites being viewed). Since we are primarily concerned with re-viewing sites viewed in the past, the issue of future temporal navigation (i.e. where can we go) shall not be discussed here except to say that history mechanisms should integrate this requirement. With regards to the range of the subspace, we can expect an inverse relationship between the number of data items and individual information scent. For example, hotlists and bookmarks do not scale well; beyond 50 to 100 items, the lists become unmanageable and awkward to use (Berghel, 1996). At times, the user may need to observe the complete subspace (meta level), and yet individual data items may require observation at the same time (document level). Ultimately, focus and context, and fisheye distortions as supported by Furnas (1986), Bederson (2000), Munzer and Burchard (1995), and Lamping, Rao and Pirolli (1995) must provide both meta and document level viewing functionality.

3.3.2. Dimension

Perhaps a solution to the problems experienced with scope, the graphical representation of web pages and links can be presented in both two and three dimensions. The question as to which method is superior is still undecided within the literature. Cockburn and Mckenzie (2001) found 2D interfaces favourable (but not significantly more efficient) for storing, organising, and retrieving "thumbnail

images" over Robertson, Czerwinski, Larson, Robbins, Thiel, and Dantzich's (1998)

3D Data Mountain (Figure 4).

Figure 4. *Robertson et al's Data Mountain (1998).*

In contrast, Cockburn and Mckenzie (2000) found the location of files in Cone-Trees

(a 3D method for visualising hierarchical structures) significantly less efficient with

regards to retrieval times. To note a medium perspective, Robertson et al (1998) also

found Data Mountain's 3D perspective cues to be significantly more efficient in

reaction times and accuracy in retrieval tasks over the purely 2D IEP Favourites

Mechanism. It should be noted that Robertson et al's Data Mountain employed more

use of spatial organisation than the strictly hierarchical ability offered via IEP

Favourites. Few, if any studies have been able to create a purely systematic

comparison between the dimensions. Each method brings its own characteristics; 3D

visualisations commonly bring difficult navigation interfaces (in accommodating roll,

pitch and yaw) or new forms of movement i.e. flying / orbiting (Tan, Robertson, and

Czerwinski 2001). 3D visualisations offer the largest potential information workspace, and are often subjectively preferred over 2D interfaces (Cockburn & Mckenzie 2001). However, 2D interfaces are still provide the mode of visual interfaces despite the fact that they provide a very limited information workspace that suffer from occlusion as datasets grow. 2D visualisations may owe much of their popularity to user-friendly navigation and file manipulation.

4.3.3. Structure and Page Representation

In augmenting a history visualisation the designer must choose how to represent both the structure of the data and the individual page. Since the structure of the WWW is a network, several systems provide a hierarchy or tree like visualisation. For example, Mosaic G (Ayers and stasko 1995) in Figure 5 below offers a very simple, yet effective hierarchical display.
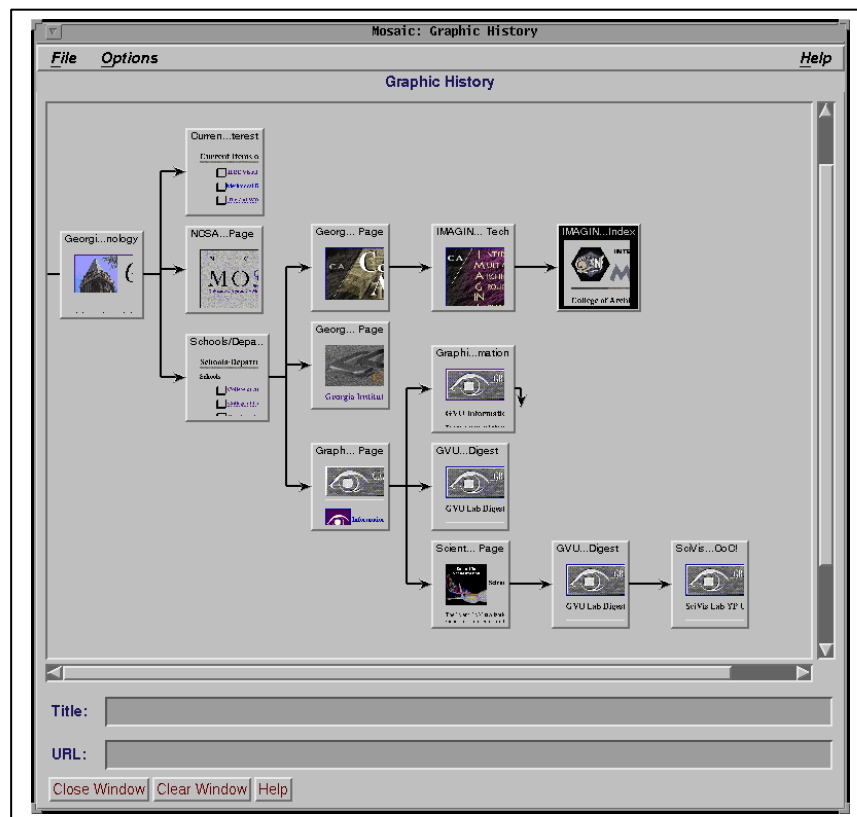
Figure 5. *Mosaic G. (Ayers and Stasko 1995)*

Other systems provide network views such as Cockburn and Jones's 2D WebNet (1996), and Munzer and Burchard's (1995) 3D hyperbolic visualisation. It should be noted that most of these systems make little or no provision for altering or adapting the visual representation of the pages and links.

Once the structure of the subspace visualisation is optimised, the individual page must also be represented. The most logical representation is perhaps a miniature or thumbnail or the web page itself as advocated by Elvins, Nadeau, and Kirsch (1997) and shown in Figures 4 and 5. Alternatively, textual labels such as the URL, title or heading text in the page's HTML source can be used. In a rare systematic comparison between 2D, 3D, and text interfaces, Sebrechts, Cugini, Vasilakas, Miller, and Laskowski (1999) found that textual visualisations could induce superior retrieval performance to 2D and 3D interfaces. The problem with textual representation occurs where both URL's and page titles become long and cryptic, truncated / abbreviated, or simply have nothing to do with the page content (Cockburn and Greenberg 1999). Also, some web sites may use the same page title through different levels of the site hierarchy (see Figure 1), thus reducing the extent that users can differentiate between pages. Where the size of the dataset prohibits the use of textual and thumbnails, various coloured icons or shapes can be used to represent each page. FrEcon and Smith's WebPath (1998) shown in Figure 6 employs a 3D collection of coloured cubes with up to eight metrics (loading time, number of images, server name) mapped onto the horizontal axes.
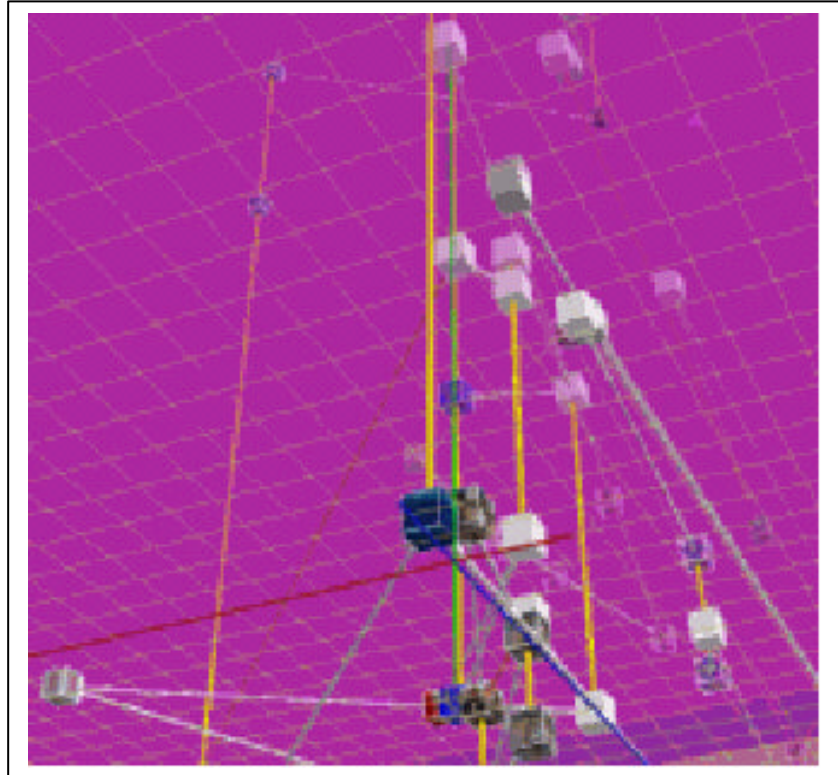
Figure 6. *FrEcon and Smiths WebPath (1998).*

As Figure 6 suggests, WebPath's implicit web page representations could be confusing for novice users.

With regards to explicitly created history lists, or bookmarks, IEP offers a text based hierarchical system with (redundant) icons to represent the type of document. (Figure 7). IEP Favourites can be exported and saved as hyperlink pages although very little annotation capability is provided. Folders can be arranged alphabetically, in the sequence they were added, or according to the user's preferences.
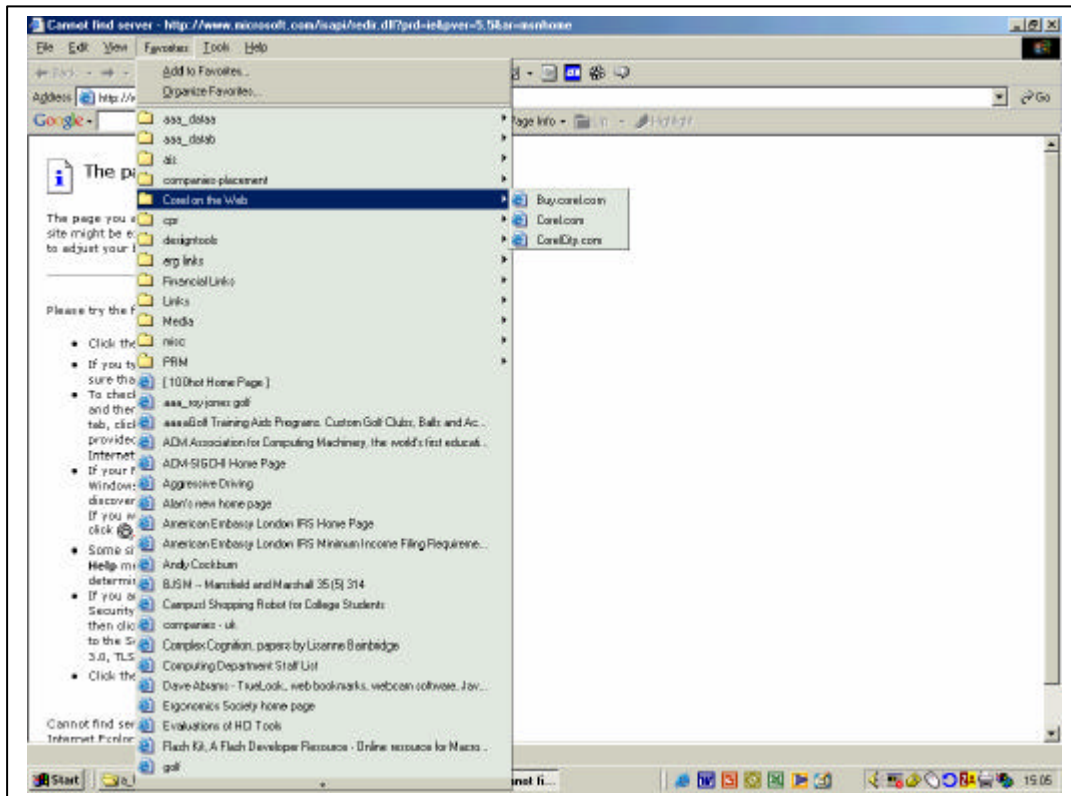
Figure 7. *IEP Favourites Version 6.0.*

3.4. Navigation Support Functions

Passive visualisations, with no associated functionality, are most useful for supporting

the user's short term model of the subspace. However, increased functionality in

terms of data manipulation aids can greatly enhance usability. In terms of the

problems mentioned above regarding scope and the users short term memory,

saveable navigation histories should be provided with all history mechanisms.

Equally, the user should have the means to dispose of unnecessary files as "temporary

files" often have to be discarded. The following paragraphs mention some of the key

navigation functions that should be incorporated into history systems.

As mentioned in the task chapter, visualisation filters allow the user to control

the amount, type, and representation style of information within the display. These

facilities help in reducing redundant information such as duplicate pages, and also to

highlight important information. The four types of filtering include; content-based in which nodes with specific attributes are shown or hidden; link-based in which certain types of links are shown or hidden; structure-based in which the topology of the visualisations are used as filtering criteria; and interaction-based whereby certain types of navigation actions could be omitted/highlighted on the history list. These functions should be included within preferences options of all history systems although few (if any) do so.

Users are likely have to a particular browser preference (which may also vary as new versions are released). It is for this reason that history mechanisms should possess cross platform/operating system capability. This is not to say that history mechanisms should be purely independent systems, but rather systems that can be deployed on different computers. For example, users using different computers throughout the day should be able to import or transfer their previous history to the current system.

4.0. Summary

Having provided a systematic introduction to the WWW history domain, it is possible to highlight the main issues for concern (Figure 8). When considering the sum of issues between the user, interface, and task, it is not surprising that few history mechanisms manage to successfully satisfy all components. Not only is the interface designer limited by WWW limitations but they must also accommodate individual variance. Also, it is not clear which area requires the most attention; are history mechanisms mainly flawed through lack of user understanding or are interface designers simply limited in what they can provide. What is not clear within the literature, is a focused agenda or general consensus for the development of history

mechanisms. Therefore, rather than randomly choosing one of the factors mentioned in Figure 8 (a valid choice in its own right), a combination of expert and user evaluation would force the most salient issues forward.
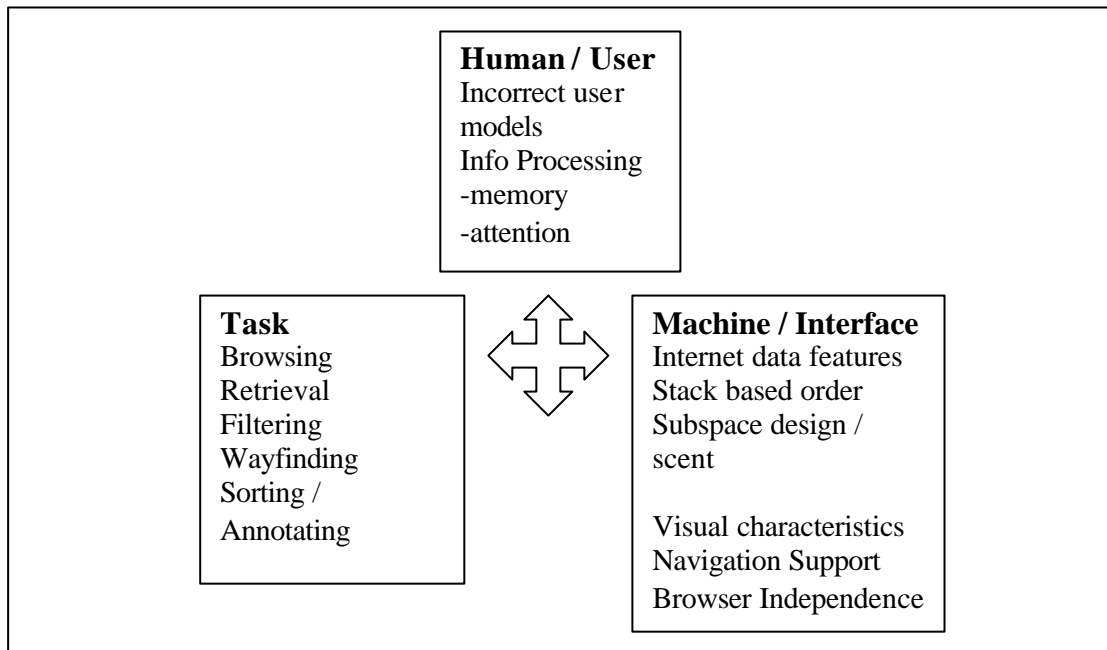
Figure 8. *Summary of Influencial Factors in History Mechanisms.*

5.0. Aims

Given the issues raised above, this paper has two aims:

1. To conduct an exploratory study in WWW history whereby web users provide a central loci for requirements engineering and creative thinking. It is expected that web users elicit a variety of key usability issues to be prioritised for further research.

2. Based on the agenda raised above, it is expected that one or more important issues will be selected and tested in controlled conditions. It should be emphasised that the time frame and suitability for obtaining an

experimental outcome will be the overriding metrics in choosing the theme above.

Note, the aims of this project place equal importance on discovering and testing those issues within the history mechanism domain that require most attention. Thus, the two phases maximise real world fidelity; the final outputs are the product of real user's agendas and requirements.

6.0. Method 1 – Identifying the Problems

The following paragraphs give a brief outline of the methods used to elicit the history domain agenda.

6.1. Design

A cross sectional, informal but guided interview was used to investigate the history mechanism problems experienced by WWW users. It was felt that the informal interview could adapt to the participant's responses and provide a more relaxed environment from which to assess existing systems and discuss ideas. Observational techniques were used to record search and retrieval tasks. The retrieval tasks were also recorded with the use of the IEP History mechanism. Sketching techniques similar to those suggested by Verplank and Kim (1986) were used to provide a visual mode of communication, and allow an additional medium for discussion.

6.2. The Sample

The sample consisted of six students from Lancaster University. Two of the participants were from the computer sciences whilst the remainder included politics, engineering, philosophy, and management. It was felt that whilst computer science

students might be more articulate in software evaluation, the everyday user would also have experienced retrieval problems and would subsequently be able to elicit requirements. The demographic details of the sample may be observed in Table 1. As the table shows, two of the participants were female though no gender comparisons were made. Whilst the participant's average age was approximately 23, all of the participants had used the WWW for four or more years. The participant's age was not expected to influence requirements gathering, since we were predominantly concerned with retrieval tasks. Please note, the participants were acquired from internal email advertisements and paid the sum of £5 for their time.

Table 1. *Demographic Details of the Sample.*

Factor	Men N=4	Women N=2	All N=6
Age			
Range	19-23	22-31	19-31
Mean (yrs)	21	26.5	22.8
Internet Usage			
How Often	Every day	Every day	Every day
How long using the WWW (Years)	4.25	5	4.5
Most commonly used browser	IEP	IEP	IEP

As the data suggests, the multidisciplinary participants averaged 23 years of age, used IEP as their most common browser, and were experienced web users.

6.3. Apparatus and Stimuli

The study was run on a high end Pentium 3 machine with a 17inch monitor and 256MB of memory. Microsoft Windows 2000 Professional was used in conjunction with IEP version 5.0. to provide browsing dialogues. The IEP History mechanism (including recency function) and 11 slides of prominent history systems were

generated for purposes of evaluation. Table 2 lists the systems and justification used

to prompt both visual and functional thinking (screen shots available in Appendix

Phase 1).

Table 2. Systems used for evaluation.

System	Features / Notes
IEP History / Recency (Microsoft)	• Sequential Textual display with no thumbnails or saveable history. Does provide search and indexing options however. Popular browser…
Data Mountain (Robertson et al. 1998)	• Spatial Organisation system for thumbnails incorporating 2D perspective landscape.
MosaicG (Ayers and Stasko 1995)	• 2D, Tree visualisation, no view filtering, uses thumbnails for pages and allows "collapsing" of sections of the visualisation.
WebView (Cockburn et al. 1999)	• Provides both hub n spoke and temporal displays, implicit and explicit bookmarking through dogears and thumbnails
Apple Mac Hotlist	• Pure text based book marking tool, offers individual page annotation and note facilities.
WebBook & WebForager (Card et al. 1996)	• 3D environment, uses books to represent web sites. "Bookcase" provided for further aggregation.
WebPath (FrEcon and Smith 1998)	• 3D History integrated with existing browser. Pages represented as cubes, loading time, number of images, server name mapped onto horizontal axes.

6.4. Procedure

The interview was designed and executed in three stages; the observation of search,

storage and retrieval techniques, asking generic questions, and the evaluation of

existing history mechanisms (see Appendix Phase 1 for record sheet). This sequence

was adopted for reasons of participant knowledge assumptions i.e. that participants

would not be familiar with developing history mechanisms and so prompts or specific questions would be avoided until the participant's innate knowledge had been recorded. Also, it was expected that the generic question asking section would be most demanding so it was conducted in the earlier stages of the interview.

A pre-interview orientation session was conducted by providing instructions and consent forms to participants (see Appendix Phase 1). Upon beginning the interview, general demographic data was recorded. Questions regarding browser preference, WWW experience and usage were used to establish browsing and retrieval familiarity.

The browsing, storage, and retrieval task required participants to search for and identify 11 web pages. Identification was taken to mean loading the correct page from either typing the URL name directly or searching for and loading the page via search engines of choice. Participants were asked to rate their familiarity with the sites as to justify their identification method. This period was also used as a warm up for the generic questions and evaluation phases.

The generic question phase was used to force participant to consider those issues raised in Figure 8. A variety of ad hoc scenarios were used to prompt responses to the core issues although the onus was on creative thinking for the participant, not a strictly directed discussion. The System evaluation phase required participants to observe screen shots of a variety of history, sorting and annotation systems. A brief description of each systems main functions and characteristics (as shown in Table 2) were provided for each participant. In essence, the participants were asked what they liked about each system and what they thought could be done to improve each system.

7.0. Results 1

Due to the two aims of this paper only the main points are considered in these results. Note, it should be remembered that some questions in the interview were asked several times, and the order of questions differed between participants. Thus, more emphasis was placed on the nature of the responses as opposed to the frequency (being that there were also only six participants). Also, nearly all of the participants failed to answer one or more questions and subsequently required more "prompts" in order to provide any feedback.

7.1. Searching, Storing and Revisiting Data

Generally speaking, most of the participants employed some form of hub and spoke browsing pattern by opening "new windows" from the search window. In effect, the two search engines used; Google and Jeeves, were employed as a history visualisation, so, the participants could see where they had been if their initial page was incorrect. Also, Due to the familiarity of the web pages and expert browsing behaviour exemplified by the participants, the web pages were most commonly accessed by directly typing the URL of the required page.

7.2. Memory Aids

When asked what information was most useful for remembering previous navigations, four of the participants stated that the URL or some derivative of the URL was most useful in remembering a site. Surprisingly, none of the participants explicitly stated the value of the page content or appearance. Similarly, only one participant mentioned "I try to remember the keyword" thus suggesting that perhaps the interaction history was not entirely necessary or useful in revisiting sites. In fact, only half of the participants felt that the interaction history i.e. how they got to a site, was

useful. Typical comments included "I am not really bothered about that, the URL is more important" or "if after a few weeks, it would not be important".

7.3. Visual and Functional Support

Upon prompting participants to illustrate and state their desired history mechanism in terms of visual characteristics and functionality, a rich variety of preferences were observed. The following points highlight desired features:

- Small thumbnails to represent pages. Rollovers (i.e. added information that appears as the cursor highlights a given area) could also augment page representation.
- Category filters and search engines within history mechanisms to isolate pages more.
- Recency based systems displaying the last "20 sites" or "days worth" of sites viewed.
- "An ability to give pages a ranking or relevance mark that cold be stored and viewed".
- "I would like to use different colours regarding how useful the site was".
- "An ability to list sites by the time accessed, the date, URL, description, and number of times accessed".
- "problem using info/history between computers i.e. history disappears between computers"

Figure 9 shows one example of a participants sketch. As the sketch shows, the user's preference is not dissimilar from IEP's document viewer with the added functionality of a search engine and filter mechanism.

Handwriting Reads-
* underlined function means can order list according to URL, or No. times accessed etc to see your most favourite sites.

1) Category filter eg. Mail Providers, search engines, etc
2) Search a key word to find a site you visited but one which you couldn't remember URL.
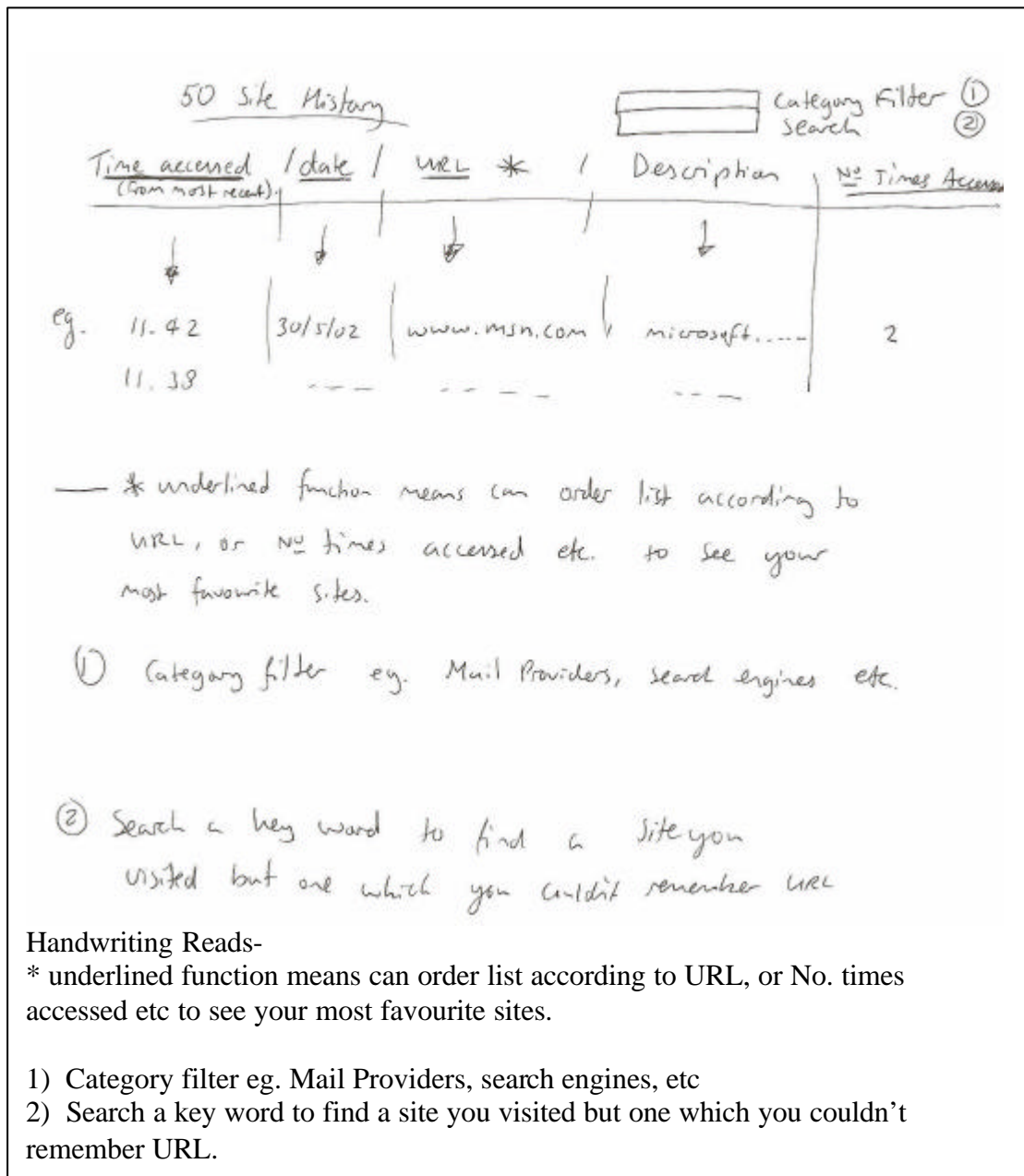
Figure 9. Example of a participant's sketch.

7.4. Annotation & Personalisation

Personalisation and annotation is essentially a form of navigational support or functionality although it is considered separately here for prominence. It should be noted that most participants felt that the ability to add some degree of personalisation or categorisation was equally (or more) important than the visual characteristics of the history mechanism. The fact that the Apple Mac hotlist (book marking system) and

WebView (Cockburn et al. 1999) systems were the most popular systems evaluated may owe much to their annotation capability. In terms of functionality, the Apple Mac hotlist is a purely textual based system although the user can change the page titles and add personal notes to each page. Other comments regarding annotation or personalisation included "annotation of pages is not necessary, I would rather cut and paste information into a text editor", and personal annotations should not "complicate the screen too much". Some participants broadened the use of annotation to the actual web pages being observed i.e. drawing or underlining text as one would in a book. In these cases "Simple highlighting and underlining" were suggested.

7.5. Concurrent Processing

Of particular interest in within these preliminary results was the participant's overriding preference to perform most actions whilst browsing. Typically, comments included "it would be nice to add to favourites or to categories whilst browsing", "Perhaps right clicking on a page and add to a category so no need to organise afterwards", and "the history mechanism should be actively integrated within the browser, to provide an active role during browsing". Similarly, where participants stated comments to the effect that they would rather cut and paste text into word processors rather than using bookmarks, the participants were implicitly stating that any information processing should be conducted concurrently.

7.6. Other Issues

The following bullet points highlight other issues not addressed above:

- All of the participants felt that history mechanisms were useful but only two were actually aware of the history function in IEP.

- One participant suggested that audio effects could be added to rollover images i.e. a voice read a description of the page when the cursor was over the page.

- One participant was concerned about security "People don't always like others to know where they have been browsing, the user would want to know where information would be kept and how they could get rid of it. Therefore preferences are required for where it could be stored".

- Generally speaking, text based representation was preferred to thumbnails/3D images.

- The organisation facility on Data Mountain (Robertson et al. 1998) was mostly perceived as being time consuming, whilst other participants thought WebPath's (Frecon and smith 1998) page representation was "confusing".

8.0. Discussion 1

Perhaps the most interesting finding within the results mentioned above, was the prominent desire to process information whilst browsing. This finding supports Amento et al's (1999) study where all of the participants wanted to record comments about sites as they visited and collected them. In practical terms, this preference may seem reasonable, since a web pages value is perhaps most obvious at the proximal level. However, it would also seem logical for web browsers to have a greater comprehension, or "sense of worth" for each data item after the whole dataset had been observed. Ausubel's "Advance Organiser" concept (Ausubel 1963) may be used to support this notion. If we use the analogy of building a house with regards to building an understanding of a body of web sites, it is only after the main frame (or scaffolding) is constructed that the smaller components i.e. windows, heating, and doors can be added. In knowing in advance what the conceptual framework is for any

data set (or having an overview of the data), the web user can place the smaller or more detailed items more accurately within their understanding. Optimal learning generally occurs when there is a potential fit between the web user's schemas and the material to be learned. Of course, web users cannot comprehend sites that have not been visited, but history mechanisms can provide an overview or global appreciation of the web sites to aid understanding.

Certainly, the lack of awareness of the history function within the participants favoured browser is concerning. If a history mechanism is particularly useful (or necessary), one might expect users to actively search for this function. Or, is it the case that users appreciated the value of the history mechanism, but were simply unaware of IEP's capabilities? It is the author's opinion that this is an example of poor interface design, since key tasks or requirements should be explicitly integrated into the interface.

With regards to visual characteristics, it was interesting to find that the Apple Mac hotlist system was one of the two most favoured systems. As a text based system, one would expect the system to struggle as the dataset increased. The subjective criteria for this preference was purely based on the title and description facility. Changing a page's title into a more "personal" one is most likely to enhance retrieval.

Having identified some of the main features found within the results, the limitations of the study should also be noted. The main threat to internal validity within any interview of this type is that participants may re-iterate what the interviewer has already said. It was for this reason that the finer details of history mechanisms and specific questions were avoided until the participant's existing knowledge had been exhausted. It is important to remember that the sample was cross

sectional, so many of the participants would not have been familiar with interface "jargon" or history terminology. It is not unreasonable then, to expect participants to use the interviewer's phrases if this aided their interpretation.

Also, whilst the frequency of responses was repeatedly stated in analysing the results, the rich qualitative data produced did not lend itself to coding. Therefore, the author was a possible source of bias in the semantic interpretation of comments made.

With regards to the system evaluation stage, the participants were only able to experiment with the IEP history interface. In real terms, one must question the validity of evaluations made purely from a still shot and limited descriptions. Ideally, fully working systems should have been tested over a longer period of time.

Despite the limitations mentioned above, the exploratory study has provided a very real question for everyday browsing. At the time of writing, no empirical study exists comparing the benefits of processing web information during and after browsing. A combination of ecologically valid and objective data in this domain could have implications for browsing strategy and interface design. Moreover, experimental data could perhaps suggest when web browsers efforts were best applied? Are inter-sessional views really necessary? Are web browsers suggestions actually valid with regards to performance?

9.0. Hypotheses

It is expected that *Sorting* the web information, that is, adding pages to a store and then organising them *After* browsing will be generally superior to performing these tasks whilst browsing. Sorting the information whilst browsing, or *During* browsing may be defined simply as annotating and organising pages at the time they are observed. Therefore, we should expect the *After* method to induce:

- Faster retrieval of individual pages from organised spaces.

- Faster Sorting times; that is, the sum of time required to add a page to a store and organise it as required for retrieval.

- Superior Accuracy; fewer failed attempts or loading of incorrect pages should be observed.

- Subjective preference; comments and opinions regarding sorting strategies should support the After method.

Within the conditions required to test these hypotheses, we may also record a main effect in the number of groups (folders), annotations (personalised titles), and time effects between the sorting methods. Note, an additional comparison between the use of web page "titles" and "descriptions" for retrieval tasks will be used for more flexible (and more powerful) statistical measures.

10.0. Method 2 – Comparing Sorting Strategies

10.1. Design

A cross sectional repeated measures design was used to investigate the merits of different sorting strategies in WWW internet usage.

10.2. The Sample

Ten experienced Microsoft IEP users from Lancaster University were paid to participate in this study. All students had to be familiar with the Microsoft Favourites mechanism. Participant ages ranged from 18 to 36 years, and all had normal or

corrected-to-normal vision. The number of females was balanced. The demographic

details of the sample may be observed in Table 3.

Table 3. *Demographic details of the sample*

Factor	Men N=5	Women N=5	All N=10
Age			
Range	19-36	18-22	18-36
Mean (yrs)	24.8	19.4	22.1
Internet Usage			
How often	Every day	Every day	Every day
How long using the net (years)	4.3	5.9	5.1
Familiar with Micro favourites	Yes	Yes	Yes
Most Commonly used browser	IEP	IEP	IEP

As Table 3 shows, the students came from a variety of disciplines. Six of the

participants were from either Psychology or Computing (or a combination of the two),

two came from Biology related subjects whilst the remaining two participants were

from Engineering, and Mathematics disciplines. English was the native language

for all but two participants although both of these participants were

completing Masters degrees and were highly proficient in the English

standard. Four of the participants were of European descent, four of African

American, and two from Asia.

10.3. Apparatus

The study was run on a high-end Pentium III machine with 256 MB of memory

(RAM). A 17-inch monitor with a screen area of 1024x768 pixels was used to present

the stimuli. Microsoft Windows 2000 Professional was used in conjunction with IEP version 5.0 to provide browsing and sorting dialogues.

An 8 inch output monitor and VHS recorder were used to record the screen interaction. In consequence, the Windows font sizes were changed to size 33 and 20 for the title bar of both the active and inactive windows to aid output screen resolution and post experimental analysis. A combination of on screen timers and stopwatches were used to record performance times.

10.4. Stimuli

Two datasets of 50 web pages were selected from 100hot.com's (100hot.com 2002) list of top web sites. Both datasets were designed to be equally homogenous and have similar implicit structures within the topic categories. To accomplish this, eight groups of 5 pages were randomly selected from 100hot's sub categories. This process was repeated for the other dataset only another eight subcategories were chosen from the same parent directory. A larger group of ten pages was purposely added to each dataset as to provide some degree of "overlap" within each topic area. The order of pages for each dataset was randomised as to conceal the implicit structure provided. Table 4 shows the categories from which the pages were acquired.

Table 4. *Categories acquired from 100hot listings.*

No.pages	Group A	Group B
5	Entertainment – books	Entertainment – movies
5	Business- finance	Business – jobs
5	Home and garden-cooking	Home & garden – gardening
5	News - magazines	News – newspapers
5	Shopping – cars	shopping – athletic gear
5	Technology – computing	Technology – wireless
5	Lifestyles – travel	Lifestyles – dating

| 5 | Lifestyles – spirits | Education - college |
| 10 | Sports & recreation - health | Lifestyles – beauty |

As the table shows, both datasets share the same parent folders for all but one category. Dataset A has a large sports and recreation group whilst Dataset B contains another lifestyle sub category; beauty (see Appendix Phase 2 and data disc for further dataset information). Each cropped or still page was burned onto CDR as to avoid any network lag or download confounds. The titles and descriptions provided by 100hot.com were retained for retrieval tasks (See Dataset information, Appendix Phase 2). The cue distribution was distributed evenly on both datasets as to avoid primacy/recency effects.

10.5. Procedure

Each participant was randomly assigned to one of eight conditions. Table 5 shows the counterbalanced conditions designed to accommodate the learning, sort method, question order, re-testing, and dataset confounds.

Table 5. *Counterbalanced conditions and Participant assignment.*

		Week 1				Week 2
		Test 1		Test 2		
Participant	Sort mthd	Dataset	Cue order	Sort mthd	Dataset	Retrieve
1	During	A	Linear	After	B	Dur / Aft
2	During	B	Reverse	After	A	Dur / Aft
3	During	A	Reverse	After	B	
4	During	B	Linear	After	A	
5	After	A	Linear	During	B	Aft / Dur
6	After	B	Reverse	During	A	Aft /

						Dur
7	After	A	Reverse	During	B	
8	After	B	Linear	During	A	
9	During	A	Linear	After	B	
10	After	A	Linear	During	B	

As Table 5 shows, six participants performed tests one and two over two days whereas participants 1, 2, 5, and 6 repeated the retrieval task again one week later. Also, participants 9 & 10 repeated conditions 1 & 5 respectively thus balancing the sorting the sorting methods. Whilst a fully counterbalanced experiment would require 16 participants, the order and number of sorting methods (During and After) are balanced.

On entering the room each participant would undergo a brief orientation period. During this time, the participant would read the "Instructions to Participants", sign a consent form, familiarise themselves with Microsoft Favourites, and then be given a set of parameters concerning the sorting method in question (See Sorting Paramaters in Appendix Phase 2). The participants were told that they would have to observe and sort 50 web pages into folders. The *during* browsing method required participants to add or sort each page immediately so each page was only sorted once. Note, at no time did the during method permit the use of the organise favourites facility so no meta or global view of sites was possible. In having to place each page into a folder immediately, the during required participants to create a new folder for each web page in some cases. In contrast, the after sorting method restricted participants to adding each page to favourites although no sorting or creation of folders was permitted until all web pages had been added to favourites. Both methods allowed personalisation of web page titles, subfolder creation, and were restricted to sorting or changing web titles once. Note that there are differing interaction restraints

in Microsoft favourites depending on the sorting method being used. In the during sorting method, the favourites window only displays the existing folders when each page is created; the pages within folders or "loose" pages not placed in subfolders are concealed. For the after method, the user is presented with a list of all pages that have been added, since no folders exist until all 50 pages have been added. In consequence, a meta-view of sites are available within the "organise" favourites dialogue for the purposes of sorting. The participants were informed that they would need to perform a retrieval task once all the web pages were sorted, and were encouraged to organise the data as they would at home or work (within sorting parameters).

The experiment would begin within the link window as shown by Figure 10.
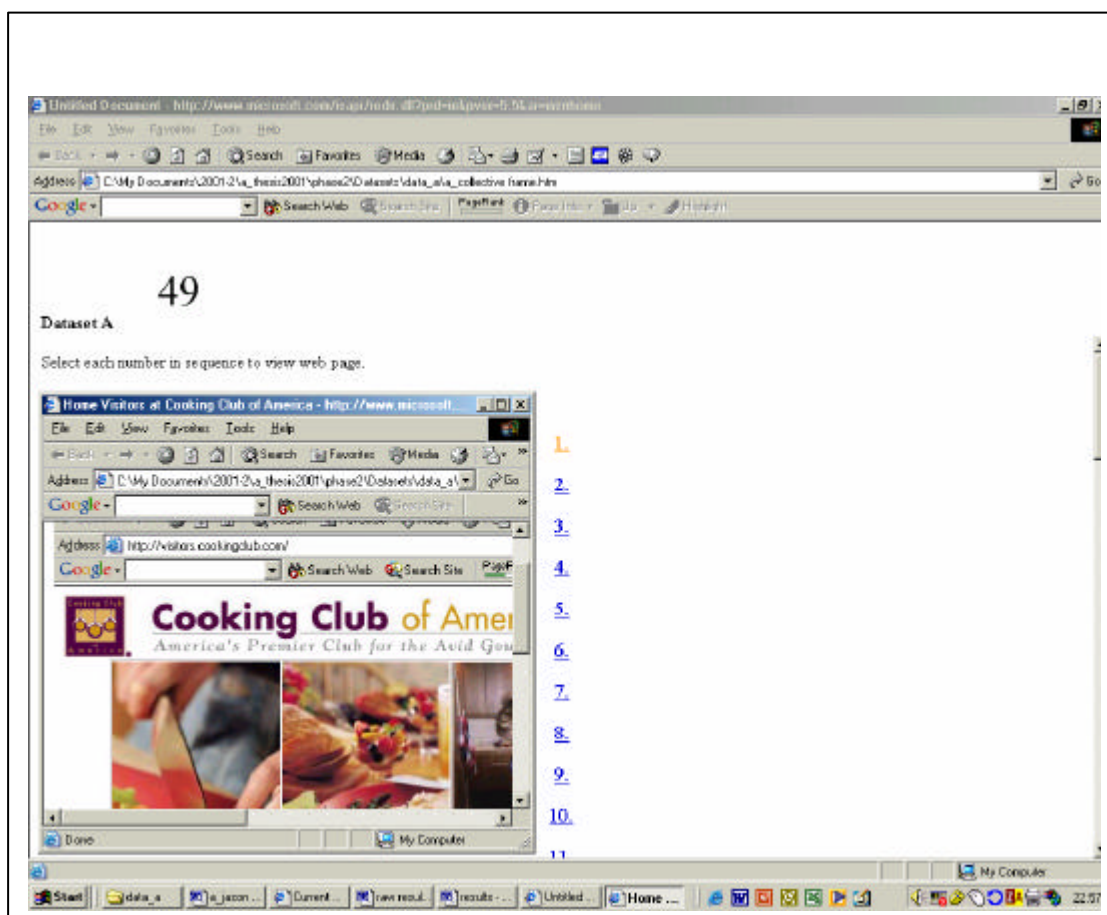
Figure 10. The *Link Window used to observe web pages.*

Upon entering the link window, a timer would record elapsed seconds as to indicate the collective observation and sorting time for the during method, and the individual observation and sorting times for the after browsing method. In clicking each of the fifty links in sequence, a web page would load in another window.

Upon completing the sorting task and having a short break, the participants were required to use their favourites categorisations to perform retrieval tasks. Figure 11 shows the Retrieval Window in which the cues were displayed. As Figure 11 shows, on-screen timers recorded the individual and total cue retrieval times.
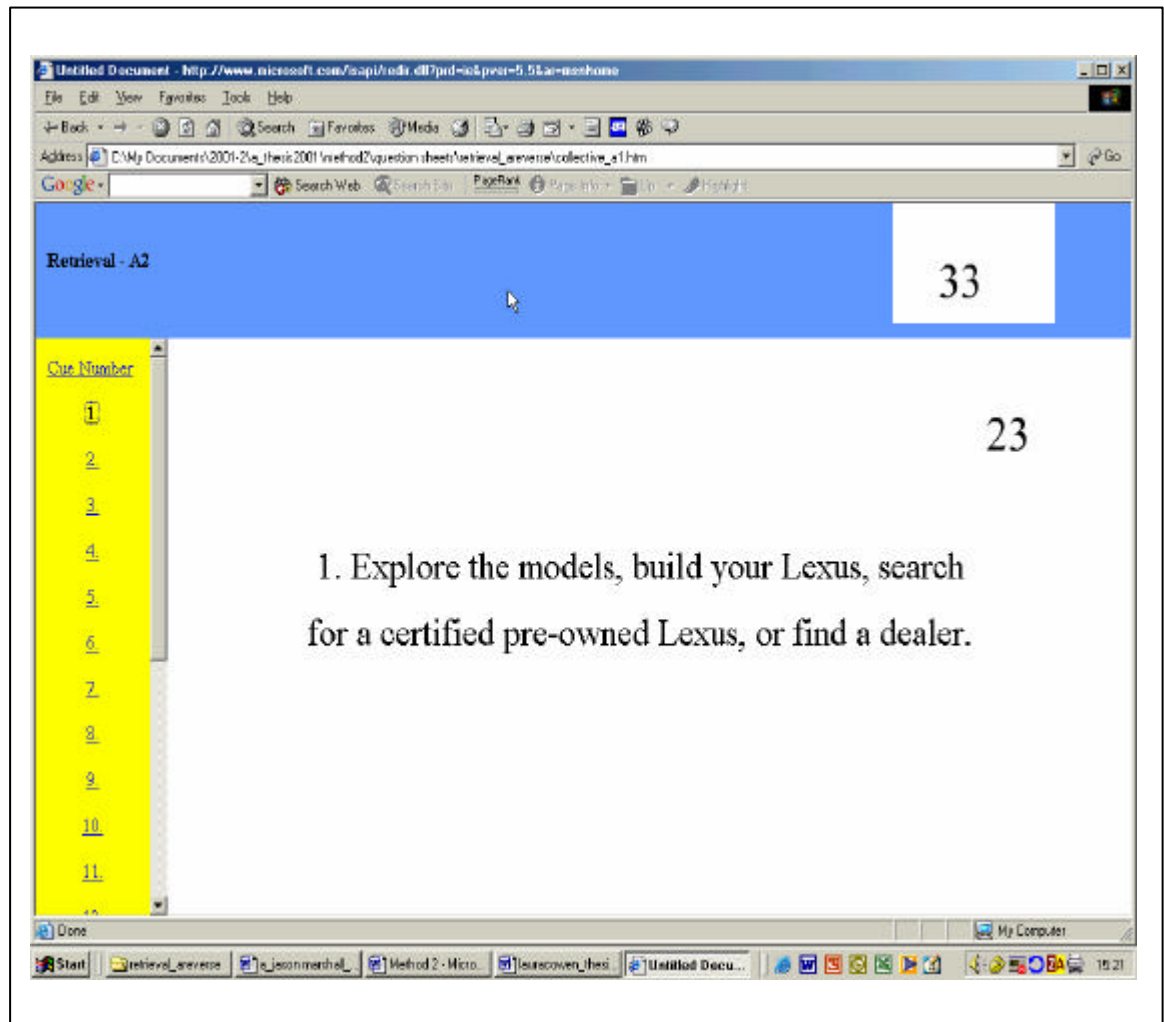
APPENDIX A FOR distribution of retrieval cues) and reversed for order effects.

Figure 11. *Retrieval Window used to observe Cues.*

Two varieties of cue description were used, the page title, and the page descriptions. Table 6 shows an example of each type of retrieval cue.

Table 6. An *Example of the two cuing conditions used in the study*

Title	Description
Cooking Club of America	Finally there's a home loan that works on your terms. Get a refinance or debt consolidation loan from Ameriquest.

A "time out" or "move on" prompt was called if a participant could not find the target page within two minutes or five attempts. Failure to recognise the page after five attempts was penalised with a 2 minute penalty (minus the time required to make five attempts). Participants were also permitted to move onto the next cue if they felt they were unable to locate the page. Page retrieval was defined as selecting an item from favourites to be displayed in another window. Participants were not explicitly discouraged from making incorrect retrievals. Six main dependent variables were used in this study:

    (1) Retrieval time

    (2) Sort time

    (3) The number of incorrect attempts before correctly identifying the web page

    (4) Personal annotation / changes to titles

    (5) Perceived familiarity with the material

    (6) The participant's subjective ratings for the sorting methods.

These dependent metrics were assumed to powerful indices of the participant's abilities to store and categorise information.

11.0. Results 2

It should be noted that in some data sets either a web page was not stored, or a retrieval cue time was missed. In both cases, missing values were accommodated by inserting mean values for relevant dataset. Alterations and missing values can be locate within the raw data on the data disk (See Appendix).

11.1. Retrieval Performance

The main finding in the retrieval time data was that the After method produced faster retrieval times on average than the During method. Also, Title cues were found to produce quicker retrieval times than Descriptions on average.   Table 7 shows the mean retrieval times and standard deviations between the two factors. It would appear that the during browsing condition and description cues were subject to more variance in terms of retrieval times.

Table 7. *Mean retrieval times for sorting method and retrieval cue (in seconds)*

	Mean	Std. Deviation
During browsing	584.2	232.73
After browsing	421.8	106.77
Title	415.2	154.26
Description	591.8	180.59

A 2x2 (Sort Method x Cue condition) analysis of variance (ANOVA) with repeated measures was performed on the retrieval time data (see data disk). A highly significant main effect was found on Sorting method, $F(1,9) = 6.33$, $p < .04$, and cue condition, $F(1,9) = 12.73$, $p < .01$. However, no significant interaction was found

between Sorting method and Cue condition, $F(1,9) = 4.35$, $p = .067$. Figure 12 shows the interaction between sorting method and retrieval cue.
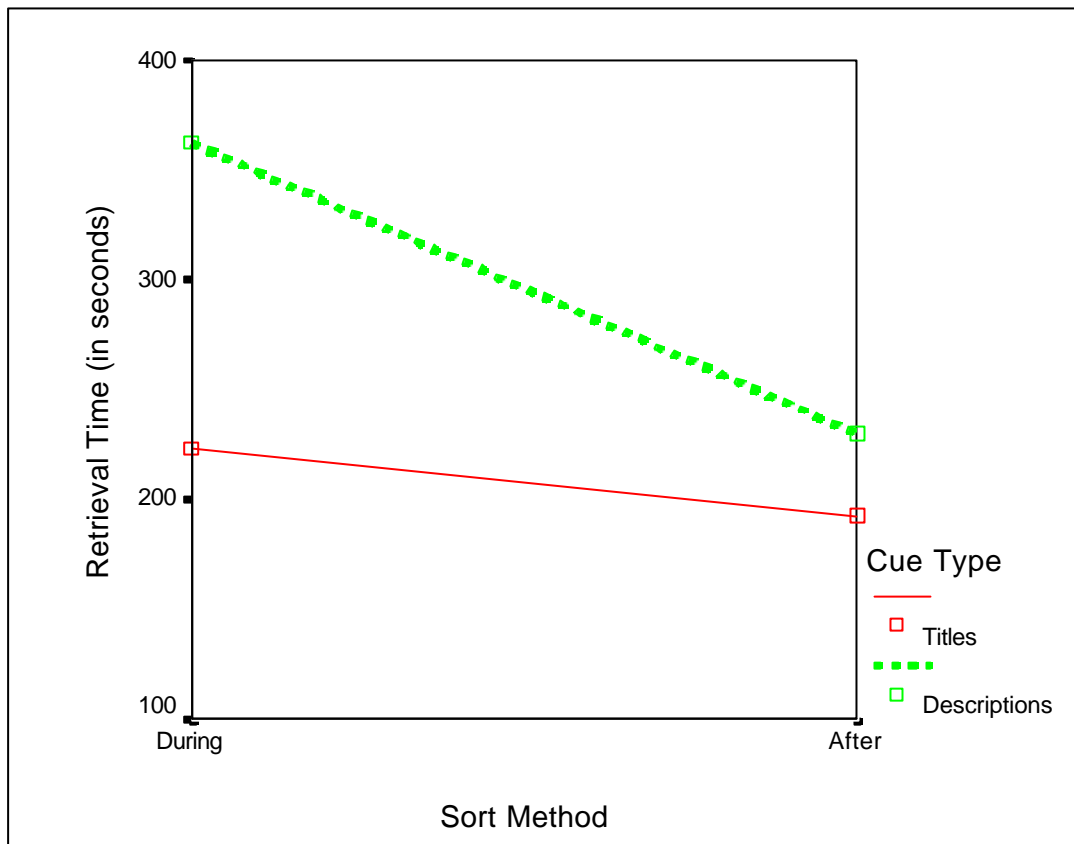
Figure 12. *Sorting Method & Retrieval Cue Retrieval Times*

As Figure 12 shows, Title descriptions were markedly more effective than descriptions in the during method although only marginally so in the after method.

In examining the individual cue retrieval times, the results showed that the worst five pages retrieved either excluded the URL, title, and or brand name from their title and or the description. In contrast, the fastest five pages retrieved used very concise titles or descriptions that included the brand name or company. Tables 8 and 9 shows the retrieval times and descriptions/titles provided by the 5 fastest and worst pages retrieved.

Table 8. The *5 Slowest web pages retrieved with descriptions/titles provided*

Company/brand name	Description / Title
1. www.epic4health.com	Top-rated Web site. Free info. Fast service. Low prices. Plus the most bioavailable health supplements available. One-year money-back guarantee, we're that confident!
2. www.extremetech.com	Wireless News and Reviews at ExtremeTech
3. www.buyingadvice.com	Discover the wholesale price of any new auto! As well as special deductions from factory invoice. Find incentives, "holdback", and potential hidden dealership fees with - buying advice.
4. www.careerjournal.com	Visit the premier career site for executives, managers, and professionals for job searches, career advice, salary and hiring info - The Executive Career Site from The Wall Street Journal.
5. www.seasilver-health.com	Seasilver - Free Shipping, Booklet &Tape

Table 9. The *5 Fastest retrieved web pages with descriptions/titles provided*

Company/brand name	Description / Title
1. www.airforce.com	U.S. Air Force - Cross into the Blue
2. www.chefsresource.com	Cooking at Chef's Resource
3. www.touchstonepictures.com	New Movie Info at Touchstone Pictures
4. www.lexus.com	Explore the models, build your Lexus, search for a certified pre-owned Lexus, or find a dealer.
5. www.aubrey-organics.com	Aubrey Organics - Beauty Care

To magnify the effect of sorting method proficiency, four participants repeated the retrieval tasks again with their previous favourites groups. Whilst one might expect the retrieval times to be marginally longer than the first week for both sorting methods, only one participant took longer to retrieve their during data, and only two participants took longer to retrieve their after data on both methods one week later. All of the other three participants performed either the During or After method faster than they done one week previously. Also, where the After method had produced faster retrieval times for all participants in the first week, two participants retrieved

their during categorisations faster than their after arrangements. Table 10 shows the differences in sorting method retrieval methods over two weeks, whilst figure 13 shows the collective relationship between the two methods.

Table 10. *Participants Retrieval times for Sorting methods over two weeks.*

Participant	During 1	During 2	After 1	After 2
1	445	383	323	274
2	670	448	516	698
3	672	435	570	440
4	841	871	565	570
Mean	659.50	534.25	493.50	495.5
SD	158.14	226.25	116.25	181
Total	2628	2137	1974	1982
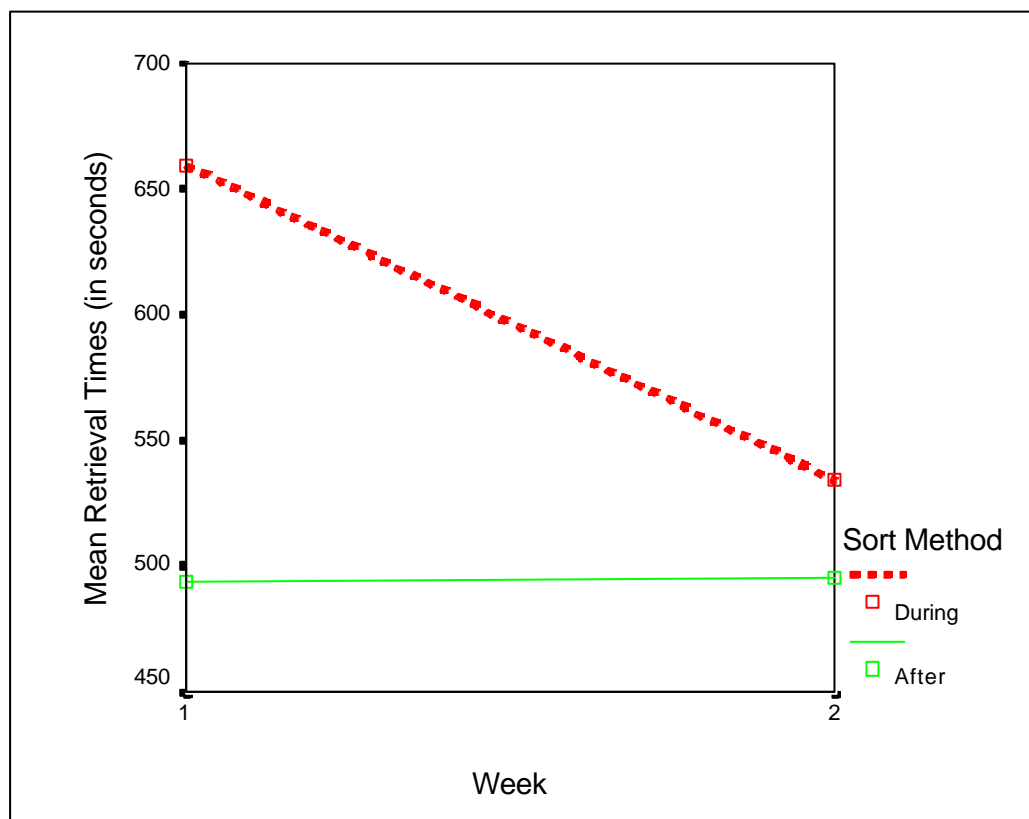
Figure 13. *Sorting method and retrieval times over 2 weeks*

As Figure 13 shows, the retrieval times for the During method dramatically improved although the after categorised data appears to become marginally more difficult to

retrieve. Despite the changes in retrieval performances after one week, the after

method still induces faster retrieval times. A two factor repeated measures ANOVA

(sorting method x Time) was conducted on the retrieval times for both sorting

methods over two weeks. No main effect was found on Sorting method, $F_{(1,3)} = 2$, p

= .253, Time, $F_{(1,3)} = 2.08$, p = .245, or interaction, $F_{(1,3)} = 1.75$, p = .278.

11.2. Sorting Time

In contrast to our initial prediction, the After browsing method took longer to perform

the sorting task than the during method. Table 11 shows the descriptive statistics

between the two sorting times.

Table 11 – *Descriptive statistics for sorting method sorting times (in seconds)*

	Minimum	Maximum	Mean	Std. Deviation
Sort during	832.00	2215.00	1413.60	464.25
Sort after	960.00	2431.00	1714.20	530.93

A Repeated measures T-test revealed a statistically reliable effect on sorting method

($p < .05$). Therefore, it would appear that sorting the information afterwards in

favourites takes significantly longer than sorting during browsing.

Given the relationship shown above and the significant effect on sorting

method and retrieval times, a further test was conducted to observe the relationship

between sorting time on retrieval performance with the assumption that longer sorting

times should produce better retrieval times. A one-tailed bivariate Pearson product-

moment correlation revealed no significant effect ($r = -.246$, p = .148) although Figure

14 does support the time/accuracy relationship.
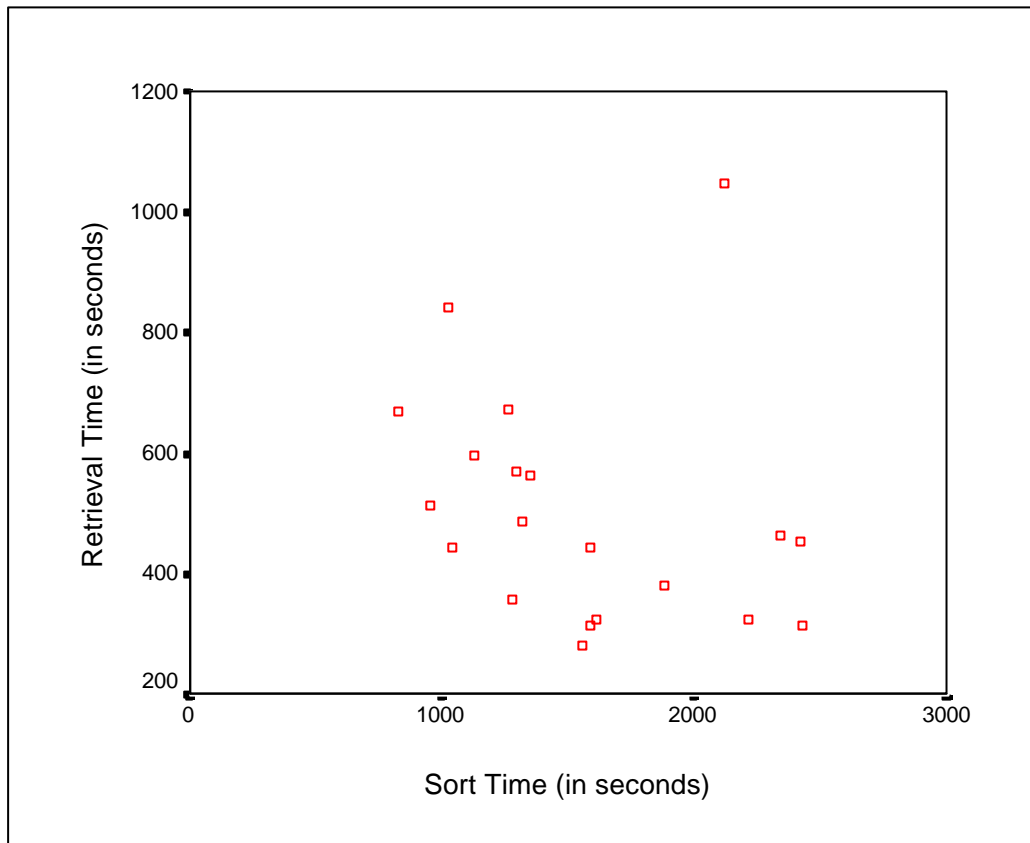
Figure 14. *Correlation between sorting time & retrieval time*

It would appear that the outlier in the top right corner could grossly distort the previous significance level. A further test between sorting time and retrieval performance was repeated as above without this one plot, subsequently producing a significant main effect ($r = -.571$, $p < .02$). Therefore, it would appear that sorting time also has a main effect on retrieval times where the longer the time spent organising data, the faster the retrieval time.

Given the poor results for the after sorting time, another sorting test was conducted with the same four participants repeating the retrieval task one week later. The assumption was that the poor after sorting times were largely affected by poor "organise favourites" interface. More specifically, the organise favourites dialog was action intensive in terms of having to select and move each web page, and drag and drop, and multiple selection actions were hampered by small "over" folder images.

Therefore, the four participants organised both datasets again within the windows document explorer window to acquire an average value for comparing the original favourites value. Table 12 shows that the windows document viewer permitted faster *sorting* times for all participants than the favourites organise dialog.

Table 12. Sorting *times between favourites and Document viewer (seconds)*

Participant	Favourites dialogue	Document viewer
1	684	495
2	555	451
3	699	530.5
4	590	362.5
Mean	632	459.75
SD	70.44	72.53

A repeated measures T- Test was conducted upon the sorting dialog data. A significant main effect was found in support of the windows document viewer inducing faster sorting times, t (1,3) = 6.669, p < .01. All four participants also expressed a subjective preference for sorting data in the document viewer.

11.3. Accuracy

The after sorting arrangements produced fewer incorrect attempts than the during method. A 2x2 (sort method x retrieval cue) ANOVA with repeated measures produced a significant effect for the number of failed attempts, F (1,9) = 117.19, p < .01, as well as a significant effect for cue type, F (1,9) = 12.22, p < .01. There was also a reliable interaction between sorting method and cueing condition, F (1,9) = 13.23, p < .01.
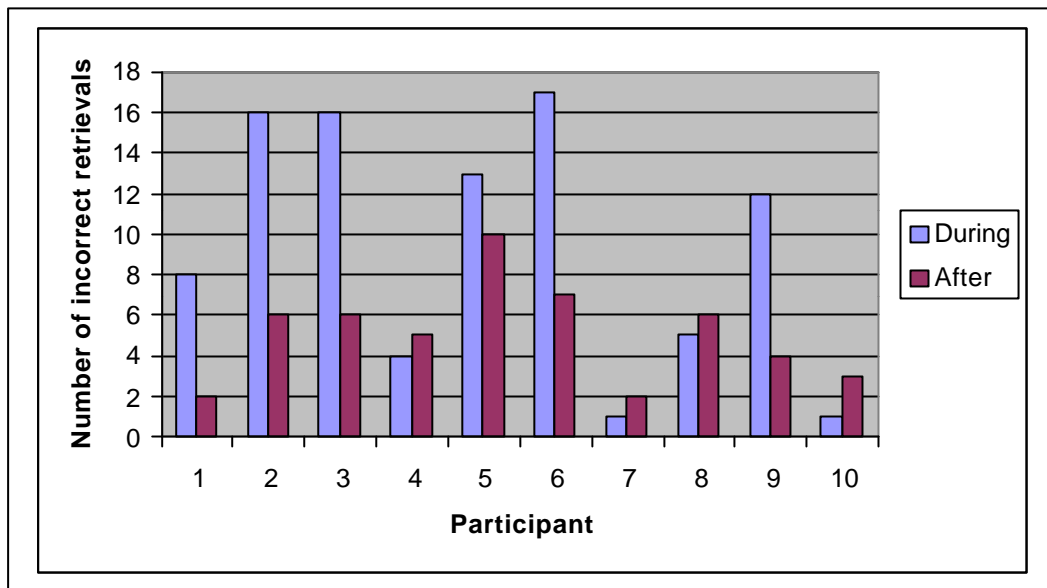
Figure 15. *Incorrect Retrievals for Sorting Methods – Week 1*

Closer examination of Figure 15 also reveals that only four participants performed worse in After condition, who also make few if any mistakes. The six participants that performed better in the after condition appear to make more mistakes.

Four participants repeated the same retrieval tasks again one week later for each of the sorting methods. Interestingly, where the after method produced fewer incorrect retrievals in week 1, the during method produced marginally fewer incorrect retrievals in week 2. A repeated measures two factor ANOVA (Sort method x Time) revealed a significant effect for sorting method, $F(1,3) = 19.12$, $p = < .03$ although no effect was found for Time, $F(1,3) = .001$, $p = .976$ or interaction, $F(1,3) = 6.261$, $p = .088$. Figure 16 and 13 table shows the change in accuracy observed over two weeks.
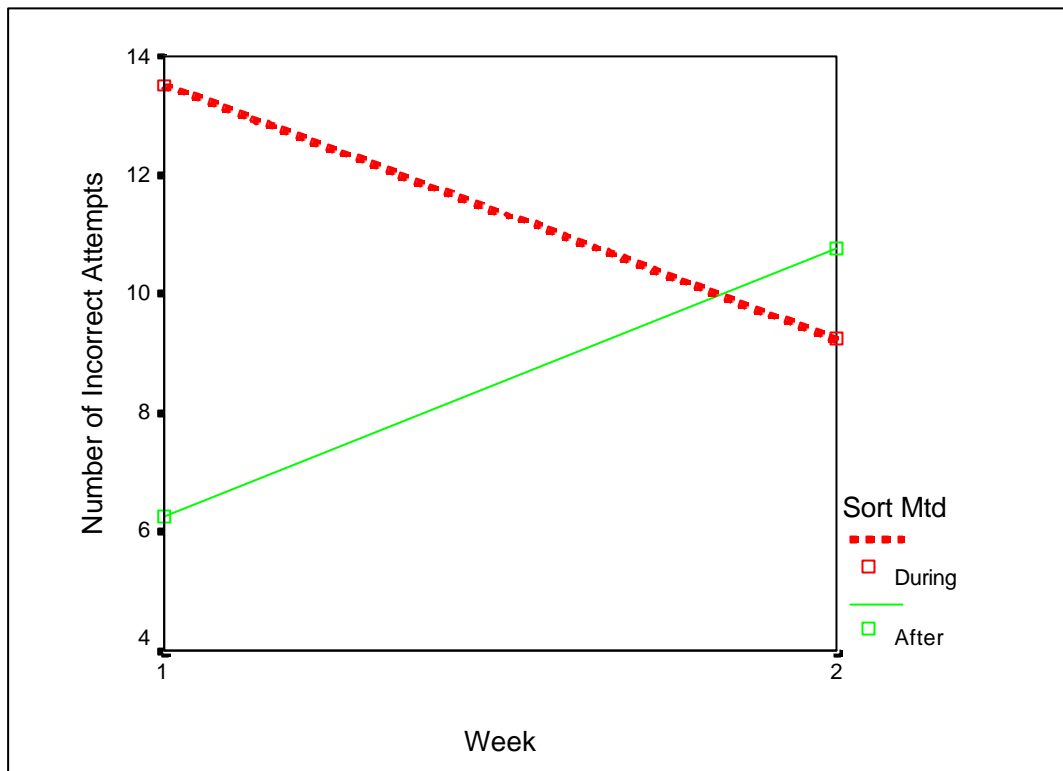
Figure 16. *Incorrect Retrievals between sorting methods over two weeks*

Table 13. *Number of Incorrect retrievals between sorting methods*

Participant	During 1	During 2	After 1	After 2
1	8	5	2	3
2	16	17	6	24
3	13	3	10	2
4	17	12	7	14
Total	54	37	25	43
Mean	13.5	9.25	6.25	10.75
SD	4.04	6.45	3.30	10.37

11.4. Group Composition.

Given the retrieval results mentioned above, the number of parent and sub-group folders was analysed to see if retrieval performance was due to group composition. For example, one might expect faster retrieval with fewer parent groups and subfolders where chunking methods had been used. Analysis of the number of groups produced within favourites showed little if any effect between sorting methods. A

Repeated Measures T-test was performed on the sum of parent and sub folders created between the sorting methods. No significant effect was found for the number groups produced between sorting methods, t (1,9) = -.318, p = .758.

11.5. Annotations / Titles

Post sorting analysis revealed that participants changed more titles in the after method than the during. Table 14 shows the descriptive statistics for titles changed between sorting methods. A two tailed repeated measures t-test revealed a significant relationship for sort method title changes, t (1,9) = -2.49, p = < .04. Also, the greater the number of titles changed or edited, the faster the retrieval task was performed. A one-tailed bivariate Pearson product-moment correlation revealed a significant relationship between number of titles changed and retrieval time, r = -.532, p < .01. Figure 17 illustrates this main effect. Two participants made no changes to titles in either sorting method. Many participants felt that title changes were most useful for the retrieval task although the personal changes also aided the sorting task. Most title changes occurred at the end of titles.

Table 14. *Number of titles changed between sorting methods*

	During	After
Total	40	161
Mean	4	16.1
SD	6.41	12.76
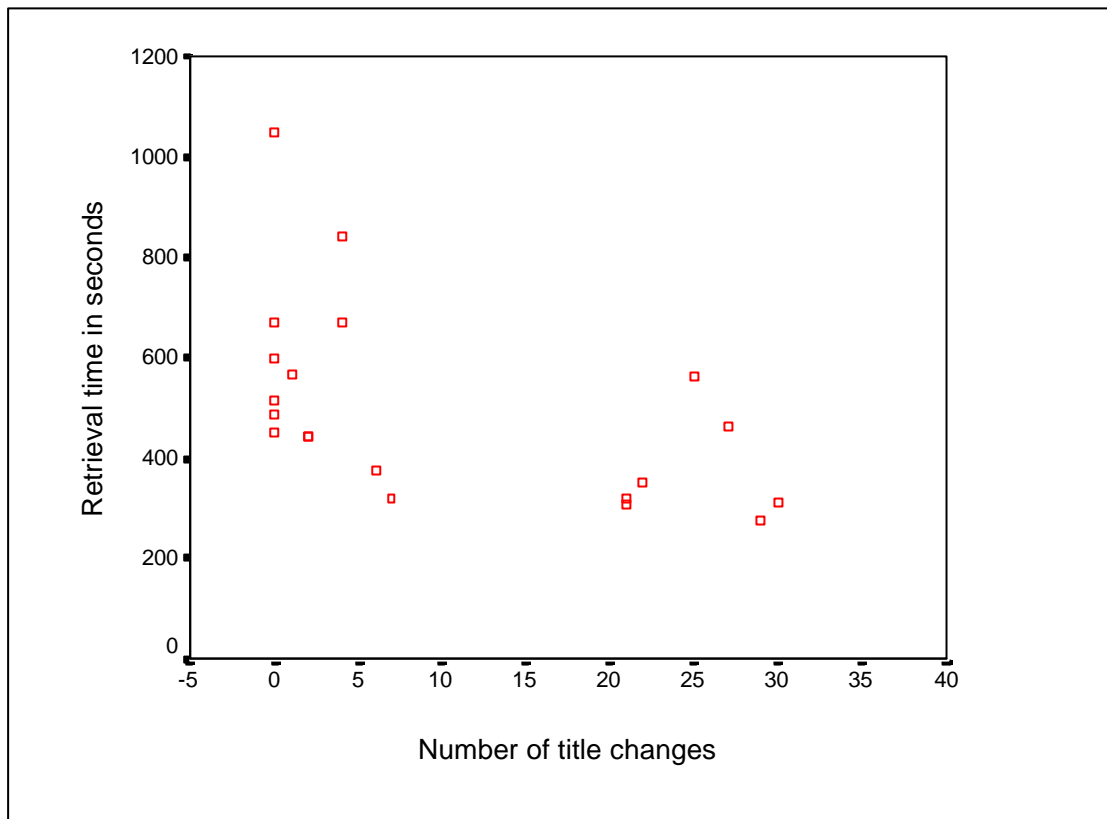
Figure 17. *Correlation between the number of title changes and retrieval times*

11.6. Familiarity

Participants were asked to report their familiarity with the categories used in each dataset. Any biased familiarity with either dataset or category would skew the sorting and retrieval times thus distorting the sorting effect. However, a one-tailed bivariate Pearson product-moment correlation revealed no relationship between reported familiarity and retrieval times, $r = .258$, $p > .05$. Figure 18 illustrates the lack of significance further. This finding can suggest that neither dataset was favourable in terms of familiarity, and reported familiarity had no association with retrieval performance.
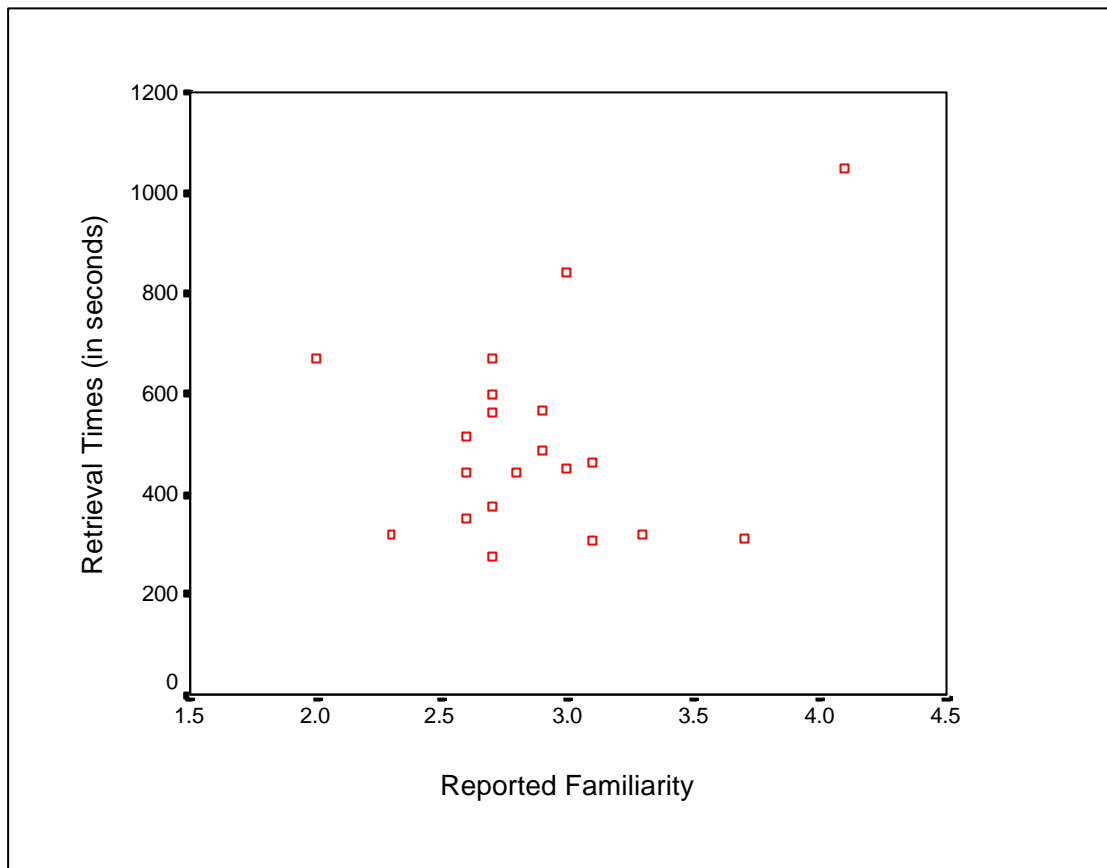
Figure 18. *Correlation between reported familiarity & retrieval times*

11.7. Subjective Remarks

Each participant was asked to record the degree at which they found sorting and retrieval easy, and their satisfaction with their sorting arrangement for each sorting method. Participants were also asked which sorting method they preferred. Table 15 indicates that participants found the After method easier to sort and retrieve information than the during method. The Participants showed a strong preference for the after method in all three measures of satisfaction. A one way repeated measures ANOVA (3 satisfaction metrics) found a highly significant effect on subjective satisfaction, $F(1,9) = 5.169$, $p = < .01$.

Table 15. *Participant averages on a 5 point scale where 1=disagree, 5=agree*

Statement / Question	During	After
The data was easy to sort	2.8 (.79)	4 (1.05)
The data was easy to retrieve	3.25 (.92)	4 (.67)
I was satisfied with my categorisations	2.7 (1.18)	4 (.82)
Which Method do you prefer?	20%	80%

With the combination of the results from the first study and the data above, we can now suggest implications for design.

12.0. Implications for Design

Using results from both the qualitative and quantitative studies, we can offer suggestions for browsing strategy, interface design, and general web page design. Of course, in terms of processing web info, the findings are more widely applicable than the web alone, since our findings could be used as generic maxims in other electronic / learning disciplines. Rather than developing new systems for each of these concepts, it would seem more logical to integrate this paper's findings within existing systems. Since IEP is the most popular browser in use (w3 schools 2002), and has been the focus interface throughout this project, we will apply our findings to improving the IEP interface where possible.

12.1. Browsing Strategy

The extent to which the after browsing method should be employed are addressed within the discussion. However, the after method appears to hold numerous benefits in terms of retrieval and accuracy. In general terms, the results may infer that where retrieval accuracy and speed is most important, the after method should be employed.

In contrast, if we ignore the results of Test 3, the during method should perhaps be used where browsing and sorting time is particularly limited. If future studies do support the findings in this paper, intelligent browsers could perhaps prompt sorting strategies more actively.

12.2. Interface Design

Sorting strategies aside, the subjective remarks made in both studies of this paper indicate several changes that could be made to improve the IEP browser. Certainly, if users wish to use concurrent browsing and sorting methods, the inter-sessional history dialogue shown in Figure 19 should implement a number of changes.
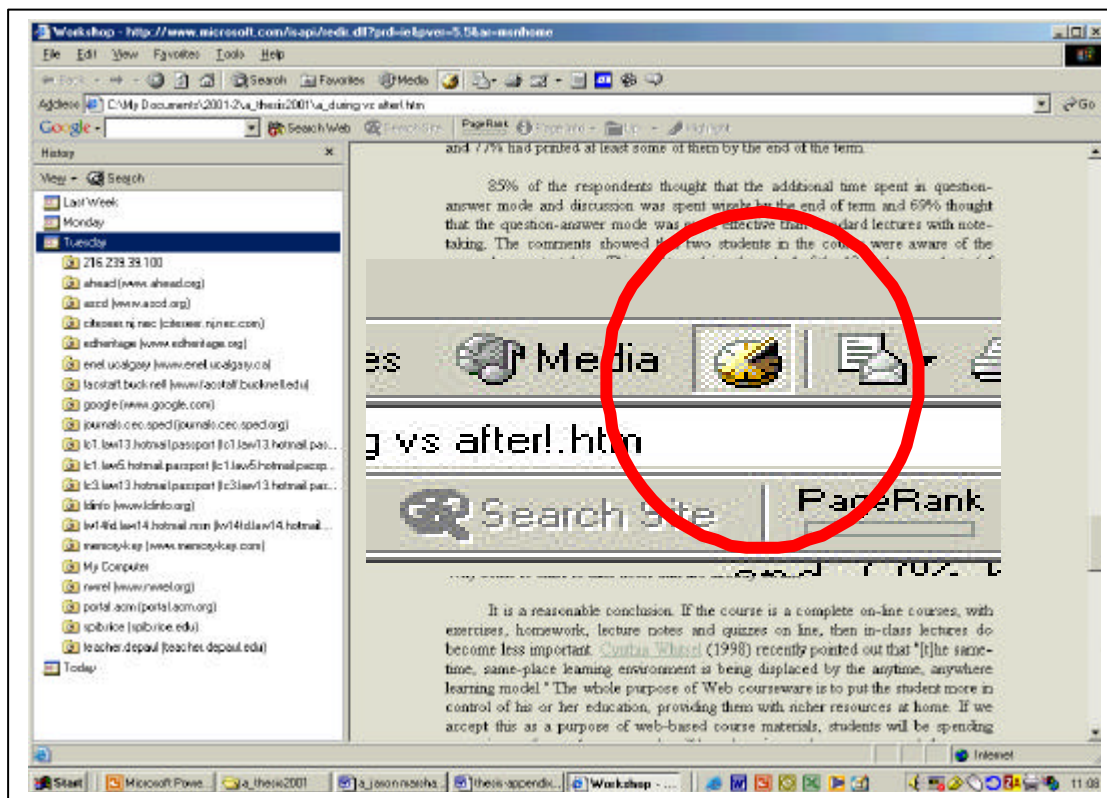
Figure 19. IEP's Inter-sessional viewer.

Moreover, the following changes should be made:

- **History icon.** Given that all participants used IEP as their preferred browser in both studies but only one was aware of it in the first study, it would seem

that the history icon (indicated in the circle, Figure 19) should be more prominent. Certainly, the use or function of what appears to be a "sundial" may appear confusing to novice users. The simple use of the words "history" (or a more explicit icon) could alleviate this problem thus promoting greater use of the history function.

- **Representing structure**. IEP should provide alternate representations of structure as provided by WebView (Cockburn et al. 1999), and MosaicG (Ayers and stasko 1995). Both Hierarchical and sequential views should be offered.

- **Representing Pages**. Thumbnails should replace the use of "folder" and "web page" icons. These icons are more apt within document viewer applications and should be used accordingly.

- **Organising Pages**. The inter-sessional page and Favourites dialogue should offer the same page manipulation options (i.e. drag and drop, multiple selection) as the document viewer window (see Test 3). On this note, the "over areas" within Favourites should be bigger, folders should not be moved whilst the user is sorting (as occurs with alphabetical ordering), and pages should also be able to be listed in the order of sequence viewed (to accommodate primacy/recency)

- **Saveable History**. Web users should be able to save their history from within the inter-sessional view as opposed to accessing the web cache. In real terms, all actions (on and off web should ideally be recorded and compressed thus providing a constant history).

- **Annotating Pages.** Annotations should incorporate rollovers/ Right click options i.e. add notes/descriptions to page….

12.3. Web Page Design & URLs

- Web names should be at front of title, not at the end.

- Ideally the character length should perhaps accommodate the most common book marking systems.

13.0. Discussion

The results provide strong support for most of our hypotheses; sorting information after browsing generally appears to be a superior sorting strategy to sorting whilst browsing. Due to the chosen methodology and paucity of research within history mechanisms, there are a limited number of comparisons that may be made from these findings. As far as the author is aware, this is the first paper to compare WWW sorting strategies in this fashion.

Judging by the retrieval results (section 11.1), it would appear that sorting web information after browsing provides faster retrieval speeds. It is suggested that this effect is caused by the benefits associated with meta information / global overviews. For example, greater comprehension of the MTBR is achieved with an initial framework in which to organise smaller data items as suggested by Ausubel's Advance Organiser concept (1963). On a broader note, research in educational psychology indicates that taking no notes in class probably results in lower memory retention and lower test performance (Beard, 1997). However, having the notes available before, during and after class does seem to improve student understanding of the MTBR and subsequent test performance. Corkill, Glover, Bruning, and Krug (1988), and Glover, Bullock & Dietzer (1990) discovered that while presenting students with organized notes after a lecture did not reinforce recall as much as self-generated notes, having the notes available prior to reading a passage or during the

lecture did. With regards to WWW recall, the during browsing condition is incapable of building this framework or rather employing it, since each page is organised immediately. As a result, so smaller items can not be re-organised as the content of the MTBR becomes more apparent. Similarly, the sorting parameters in the During condition are more likely to interfere with the encoding process than the after, since the user is forced to encode the data at the time of observation, not when it is most preferred. In terms of cognitive requirements, one might argue that the during sorting method places more load on the working memory since the user is aware that they may not observe any of the pages again unless they need to retrieve them. Therefore, the working memory becomes saturated, and the potential for individual web page rehearsal is reduced by increased capacity. The cognitive load on the after sorting method was commonly reported to be easier by participants. Other than ensuring that the title of each page provided sufficient information for purposes of sorting, little cognitive effort was required for the after condition.

Interestingly however, the after data retrieval times remained generally constant compared to the large improvement in the during organisations one week later. In terms of memory decay, one would expect inferior retrieval performance for both sorting strategies (Brown & Peterson 1959). Evidently, it would seem that a learning effect may occurred in terms of the retrieval format. The time interval between encoding and retrieval could also be attributed to the improvement in the during data retrieval times. If we consider that the time between encoding and retrieval is greater in the during condition (i.e. between observing and having to retrieve the first page), and perhaps less rehearsal is possible (since the participant must move onto the next page after saving it), these negative influences on retrieval may become redundant after one week. Despite the improvement in the during

retrieval times mentioned above, the after method still provided the fastest retrieval times. Hence, we can still be confident in the first week's retrieval times. It is important to note that whilst the after method prompted faster retrieval times in this study, we must also consider that the utility of both methods could change with more web sites, and possible greater time lengths. Of course, the faster retrieval times in the after method may also have been the result of significantly longer sorting times (mostly bad interface), and significantly more personalised title annotations. These points are discussed in the sorting and annotation sections accordingly.

As expected, Title cues were associated with significantly faster retrieval times. This data compares favourably with Robertson et al's (1998) study comparing thumbnails, titles, summaries, and a combination of all the cues just mentioned. Although no significant main effect was found between the title and "all cues" condition in Robertson et al's study, titles were found to be significantly faster to retrieve than descriptions or summaries. Both the quantitative and subjective remarks in this paper support this finding. However, some degree of overlap between titles and descriptions was present in the study. Whilst most page descriptions were longer than titles, some descriptions did not include the name of the page provider. Similarly, some titles did not give accurate description of the page.

Contrary to expectation, it took significantly longer to sort the information after browsing than the during method. Therefore, the significant main effect of sorting method on retrieval time may have been caused by the time spent sorting the data. Certainly, the significant correlation found between sorting time and retrieval performance seems logical (section 11.2); the greater the opportunity for encoding and rehearsal, the greater the user's association with the MTBR. It could be argued that that the longer sorting times in the after browsing method were largely the product of

the IEP's poor interface design as opposed to the sorting strategy. More specifically, the participants reported a large degree of dissatisfaction with the "organise favourites dialogue" in terms of moving pages into folders. The participants did not experience this problem in the during method because since all existing folders were presented in a large window upon selecting "add to favourites". Also, the user was only required to select the target folder and select "ok" to move the file in the during condition. Such was the inadequate drag and drop facility within IEP that the after condition required the user to select the file, choose "move to folder", select the folder, and then select "ok" before the next web page could be organised. Therefore, sorting the web pages in the after method required substantially more user actions than the during condition. A goals, operations, methods, and selection rules model; GOMS (Card et al, 1983) between the two sorting strategies on IEP would reveal the true extent of this inefficiency. Test 3 (section 11.2) supported this effect where sorting times were found to be significantly faster in the document viewer than the IEP dialogue. Despite the lack of validity of this test i.e. not accommodating for learning effects and familiarity with the data (sorting the same dataset for the second time), it is clearly apparent that the IEP dialogue added more task actions to the after condition. Further more, IEP Favourites prohibited the use of file organisation techniques i.e. multiple selections and drag and drop, thus distorting the true effect between the sorting method times.

With regards to accuracy, sorting the information whilst browsing provided significantly worse results than sorting it afterwards. This result compliments our initial hypothesis and further supports the benefits of meta-information views. More interestingly however, was the reversal in accuracy observed on the second week (11.3). While the after method induced significantly fewer incorrect retrievals in

week one, the During method produced significantly fewer errors in the second week. No main effect was found for time, so the change in accuracy in week two may have been due to the number of title changes produced in the after method.

In essence, users made significantly more alterations to web page titles in the after condition. This finding may account for the after method's superior retrieval performance, since the more familiar or stronger the memory anchors are within the MTBR, the greater the familiarity one can expect. The significant correlation found between the number of titles changed and retrieval performance supports this notion. Any change or modification to a web page can be interpreted as a type of implicit sorting for purposes of both sorting and retrieval, i.e. adding the word "cosmetics" to a web title only including the brand name. In fact, users reported sorting the web data in the form of title alterations and mental notes regarding previously viewed pages. Therefore, the true utility of the sorting methods may have been somewhat masked despite the sorting parameters; web browsers will process information sub-consciously regardless of organisation mediums. With regards to the tests conducted one week later, the benefits of the title changes in week one could possibly have demised by week two and actually become a greater form of nuisance or interference within the retrieval tasks.

The validity of the results discussed above were further appreciated by the participant's subjective remarks. Generally speaking, participants expressed a significant preference for the after method. More specifically, the participants preferred the after method for purposes of sorting information, retrieval, and overall use. Several participants felt that the during method would be more useful where time was an issue, i.e. they did not have infinite time to organise their browsing history. This is not to say that web users would operate with the same sorting parameters in

real life, but would prefer to use sort the information afterwards rather than whilst browsing. In terms of real world navigation, most users stated that a medium between the two methods would be used.

Given the main effects between sorting times and accuracy shown above, it was surprising to find no relationship between sorting composition or reported familiarity of the MTBR. The main reason for this is most likely to be the size of the MTBR. Abrams et al (1998) found that the use of folders begins at around 35 bookmarks, while use of multi-level hierarchies becomes prevalent in archives of over 100 bookmarks. Therefore, a much greater number of websites were needed to observe a difference in sorting composition (if a main effect in sorting strategy and composition exists). Also, it may be argued that the web content in both datasets were too clearly defined to induce different web organisations. Whilst the homogeneity in dataset material was a prerequisite to accommodate learning and order effects, fewer topics may have forced the participants to consider the material more precisely.

13.1. Limitations of the study

Having attempted to compare this paper's findings within the literature, the limitations of the study should also be noted.

13.1.1 Implicit Sorting & Annotations

It should be noted that most participants reported implicitly sorting the information whilst browsing in both sorting conditions. Post sorting discussions revealed comments such as "I knew I had already seen several car web sites so I knew I would have to create a car folder", so in effect, the sorting parameters could not restrict participants from making mental models or rehearsing the data whilst browsing. This may explain why the after condition had significantly more title annotations than the

during. The participants were using implicit "group" annotations to aid sorting and retrieval performance since they could not organise the data whilst browsing. It would seem that the after condition had more potential rehearsal ability therefore, where the information could be implicitly sorted whilst browsing and then more explicitly after browsing. This problem could be reduced by preventing any annotation when pages are added to favourites although little can be done to restrict mental processing. The benefits of personal annotations within the retrieval task was largely reduced by the increase in font size required in the active window to provide some degree of screen resolution on the output monitor (see method 2, 10.3). In consequence, most of the personal annotations at the end of the web age title were not viewable due to the character limit length in IEP favourites.

13.1.2. Sorting Parameters & The Task

In terms of external validity, it is highly unlikely that the sorting parameters or task conditions used in this study would be naturally replicated in the real world. Web browsers normally have a goal, and should expect to observe a logical sequence of web pages to satisfy this goal (even when browsing may seem random). In contrast, this study provided what would be random pages to the user, since they had no means of determining the content of the next page. Since the storing and observation of each page was mandatory, the participants may also have lost some of their natural "interaction" anchors from the data i.e. why they went to that page, thus the retrieval performance in this paper may have been slower than normal browsing behaviour. With regards to the retrieval task, the participants were only required to locate one distinct page within their organisations. More relational or complex tasks requiring the observation of several pages often have a large influence on retrieval performance (Pirollli , Card, Van Der Wege 2000). The exploration of such influences was

avoided for purposes of time restrictions in this paper although a variety of retrieval tasks may have revealed alternative results with regard to sorting strategy. Also, the retrieval tasks were essentially hierarchical, so slower retrieval times may have reflected poorer hierarchical processing ability in contrast to the sorting method. Amento et al. (2000), and Nardi and Barreau (1995) showed a distinctive preference for spatial organisation rather than creating explicit folders. In consequence, the construct validity in this paper is questionable (but necessary).

13.1.3. Sorting Time

Similarly, just as there were limits upon implicit sorting, the large variance in sorting time (between participants) could have distorted the effect of sorting method. In order to accommodate for the significant correlation between sorting time and retrieval performance, a maximum sorting time could have applied within the sorting parameters. However, without the precise ability to predict individual sorting times (or the slowest participant time), the number of pages observed and sorted would differ between conditions. Thus we could not necessarily provide equally distributed questions in terms of the primacy/recency effects. In addition, the author was unable to prompt those participants browsing or sorting "too long" for reasons of the inability to differentiate between time spent comprehending the MTBR and time spent encoding.

13.1.4. The Interface

Perhaps the largest threat to internal validity was the IEP favourites interface. It is not clear whether user's activities were more determined by browser limitations or rather by their desires. Several task execution strategies are provided within IEP favourites thus inducing fitts law variance. This variance is difficuly to control without either

restricting the task execution method or creating a more limited interface for testing conditions. Test 3 for example (see results, 11.2), highlighted that the IEP favourites mechanism was perhaps more inclined to adding pages than organising them, thus benefiting the during condition more in terms of sorting data. Also, a large degree of variance in terms of scrolling, page selection, and organisation methods were present. For example:

- Scrolling: some participants used the scroll bar, whilst others used the scroll device on the mouse (wheel).
- Maximising pages: some participants did maximise the windows, whilst others did not. Some maximised the window via the maximise icon, whilst others double clicked on the window pane.

Despite the problems mentioned above the IEP favourites dialogue provides a high level of external validity since it enjoys the most common usage and was also the participant's favoured interface.

Other problems in providing precise timings between sorting measures were largely the product of participant error. For example, whilst observing and saving pages, some participants forgot which page (or link) they had just visited. Therefore, some pages were viewed several times, in an incorrect sequence, or in some cases not at all. Whilst sorting, some folders were often created by accident or were not "accepted" due to the character "type" limits for folder names. Similar problems occurred within the retrieval task; some participants would forget which cue they were undertaking whilst searching within their favourites, close the wrong window (i.e. the cue window), or simply miss a retrieval cue out altogether. In each case, several hours

of video footage had to be re-analysed. Missing data items were compensated with average data values, so in effect, the timings were influenced by observer error and timing limitations. These points highlight some inadequacies within the observation (link) and retrieval interface design used in the experiment.

13.1.5. Timing & Motivation

In trying to maintain some degree of consistent retrieval performance, the time penalties awarded and attempt limits provide some threat to internal validity. For example, not all of the participants used either the full two minutes or five attempts permitted to locate the required page. In contrast, the participants that did take these opportunities were more likely to locate proceeding cues since they were more familiar with their organisations. The fact that some participants did not use all five attempts may also infer that not all the participants were equally motivated to find the web page in question. The question of motivation is a subjective one, all of the participants were aware that they were being timed and were requested to work as fast as possible. The "Hawthorne" effect would most probably motivate the participants to work close to their best ability although the large degree of between participant variance may suggest otherwise.

13.1.6. The Sample

In contrast to other studies i.e. Robertson et al. (1998), and Cockburn et al. (2001), a cross sectional study was used employing novices and experts alike. Therefore, many of the findings in this paper have some degree of external validity. Certainly, the large degree of between participant variance in sorting and retrieval performance owes much to expert / novice behaviour. It should be noted that the potential learning effect

between weeks one and two in terms of retrieval performance may have been adverted by only using expert users.

13.1.7. Familiarity & Stimuli

Whilst no relationship between reported familiarity and retrieval performance was found, it may be argued that the content of the websites influenced the results. Unlike Robertson et al.'s (1998) study, the web material was not rated for quality. Moreover, a large degree of variance was present in terms of page length, the number of animations per page, text content, and so on. Further analysis of the fastest retrieved pages might reveal additional compounds in terms of the animations used and screen density.

14.0 Conclusions & Future Work.

This paper has prompted several implications for managing WWW history. No attempt is made to suggest that one interface or browsing method is ideal for all circumstances, but rather to highlight the gulf between the user's preferences and the current limitations in history mechanisms. Clearly, the focus must shift from providing separate browsing and organisation dialogues to an integrated system that permits more personalisation and ease of use. The term "interactive" must become more apparent within WWW subspace design in order that the user's "scent" is more readily added and traced by users. Future studies could isolate the experimental factors more in this study (i.e. the number of web pages, sorting parameters) to reduce the potential noise mentioned in this paper (although all attempts should be made to ensure ecological validity). In addition, the interface "implications for design" could be implemented and tested to validate these findings. It is anticipated that the future

directions mentioned above should provide a more consistent integration between the user, task, and interface design.

15.0 Acknowledgements

16.0 References

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17.0 Appendix

17.1 Phase 1

Instructions
Consent Form
Record sheet
Screen shots of history mechanisms

Instructions to Participants

This is phase one of a two part study on problems with World Wide Web History mechanisms. This stage involves recording your understanding of where you have been on the web and your thoughts on how this information should be displayed. The study will be run in four parts:

1. Some brief questions regarding yourself, how often you use the internet etc.

2. An observation period of how you search, store, and retrieve information on the internet.

3. Some generic questions on how you think history mechanisms should be designed.

4. Examples of existing history mechanisms and how you feel they could be improved.

Your browsing history behaviour will be recorded with Microsoft Explorer. Our discussion will be recorded on questionnaire style paper and an audio recording.

Please note, the primary focus of this study is to generate user opinions on history mechanisms and so a structured forum is provided to record your thoughts. It is not an intelligence test as such; there are no wrong or right opinions within this domain.

After the interview, we can discuss your results/my thoughts on the subject if desired. You will also be paid the sum of £5 for completing the study.

If at any time you wish to terminate your participation within the study, you may do so without any reason. You will be paid at the hourly rate as specified within the psychology department.

Please read and sign the consent form now….

<div align="center">

<u>Consent Form</u>

University of Lancaster
Department of Psychology & Computer Science

Masters Research

</div>

Title of Research: An Exploratory Study in World Wide Web Navigation History

Investigator: Jason Marshall

Description of Research: This research examines user understanding, behaviour and thoughts regarding the improvement of WWW History Mechanisms.

This is to certify that I, …………………………………….., hereby agree to allow my World Wide Web Navigation History data to be observed by other researchers.

I understand that my identity will remain confidential for all purposes and that I may terminate my participation within the study at any time without justification.

I also understand that I will receive the sum of £5 upon completion of the study.

Participant's Signature …………………………………………. Date ………………….

Investigator's Signature …………………………………...

Record sheet – Method 1

1. Personal data

Participant …………………………….   Age ………………………
Genda: male   female
Occupation / department ……………………………

How often do you use the internet?
Every day   Every other day
Once a week   less than once a week

How long have you been using the Web?
Less than a year   several years

What is your most commonly used browser?
Microsoft Explorer   Netscape
Other

Why do you use the web?
Email   work related search
Leisure   all of above

2. Browsing/storing/retrieval

Please locate the following sites on the web and indicate you familiarity with the site:

Site	Familiar	Unfamiliar	Found	How?
Lancaster University's home page				
Lancaster's Wing Email provider				

Find and make a note of the following page, you will be required to return to it.

Yahoo's home page				

Continue locating the following sites:

AOL's home page				
Microsoft's Homepage				
Railtrack's Timetable page				
Liverpool football clubs official site				
Coca-cola's home page				
MSN's home page				
Ford's Uk homepage				

Upon completion return to:

Railtrack's Timetable page	███████			

Why did you use the retrieval technique above?
………………………………………………………………………………………………………
………………………………………………………………………………………………………

3. The Participant's ideas

You have been "searching/browsing" the web for several hours. You want to remember where you have been and what you have seen.

1. **What information would be most useful for remembering where you have been. Think about how you got there, URLS, intro page, content, appearance?**
    ……………………………………………………………………………………
    ……………………………………………………………………………………
    ……………………………………………………………………………………

2. **How would you like this information to be displayed?**
    Think about the functions you would like and how they would appear.
    Use diagrams where necessary.

3. Would the user like to control the information?

…………………………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………

4. How would the user like to annotate the information?

…………………………………………………………………………………………
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…………………………………………………………………………………………

5. Is knowing how you got there important?

…………………………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………

You find several pages (can either be within a site or the introduction page) of interest and want to mark them for later retrieval.

6. How would you like to do this? Give a brief account of why you chose the functions above.

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7. Does the goal or reason for using the web influence history preferences? Give an account of your preferences.

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8. What does the user think the main problems will be in presenting history lists?

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…………………………………………………………………………………………

10. Do you think history mechanisms are useful?

…………………………………………………………………………………………
…………………………………………………………………………………………
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…………………………………………………………………………………………

12. When would you anticipate viewing the history?

…………………………………………………………………………………………………… 87
……………………………………………………………………………………………………
……………………………………………………………………………………………………
……………………………………………………………………………………………………

3. Evaluating existing systems
Please note the things you find useful or think could be improved with each of these samples.

Microsoft Explorer

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Data mountain

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Mosaic G

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Webview

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Apple

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WebForager/Visualiser

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WebPath

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Are there any other issues you feel are important within the design of history mechanisms?

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Example of screen shots used for evaluation

Figure 1: Data Mountain with 100 web pages.

Data Mountain (Robertson et al. 1998)

MosaicG (Ayers and Stasko 1995)

a) hub and spoke   b) temporal ordering
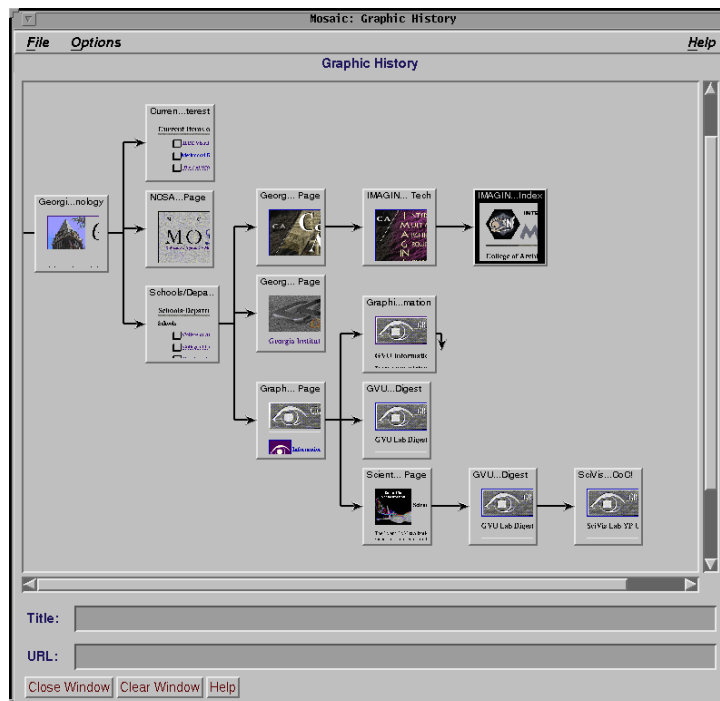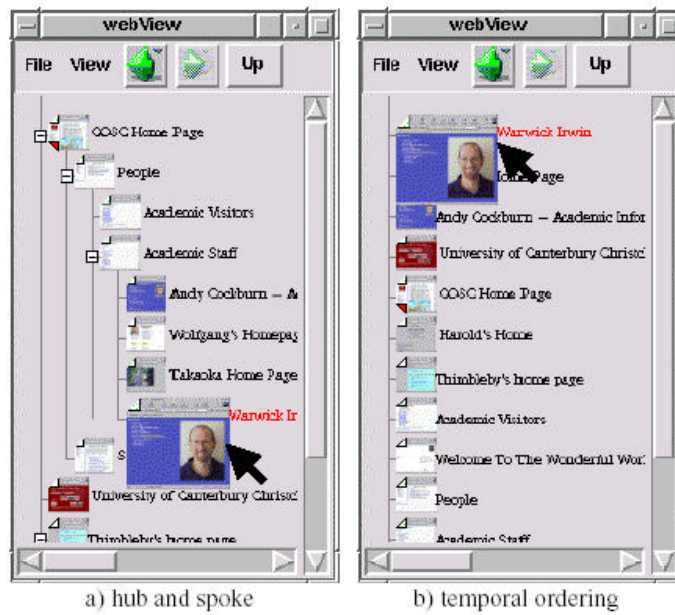
Figure 2: WebView's two display organisation schemes.

WebView (Cockburn et al. 1999)
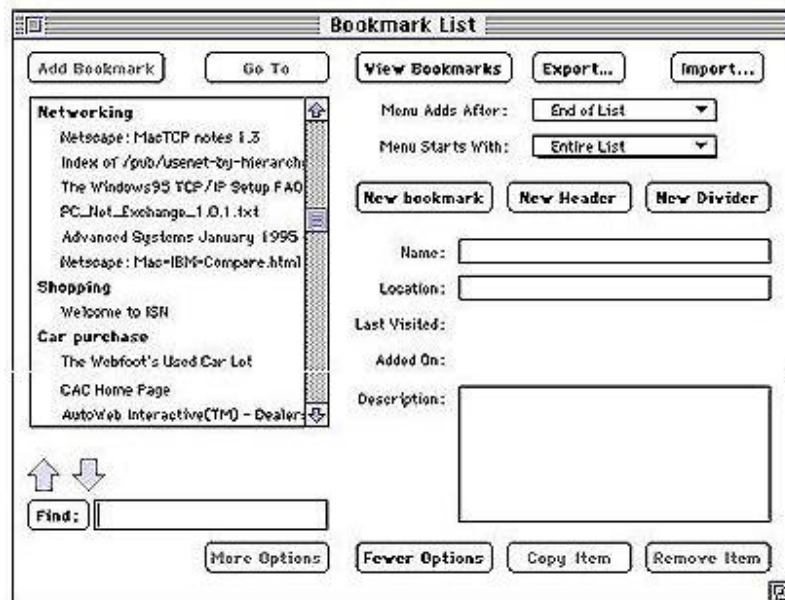
Apple Mac Hotlist

WebBook & WebForager (Card et al. 1996)
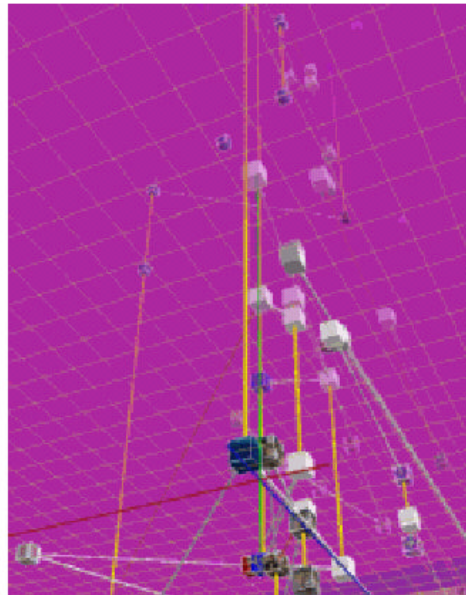
Figure 7: Browsing history as depicted by WebPath.

WebPath (FrEcon and Smith 1998)

17.2 Phase 2

Instructions
Consent Form
Record sheet
Sorting Parameters
Dataset A & Question Distribution
Dataset B & Question Distribution

Instructions to Participants – Phase 2

This study requires two sessions of participation. The experiment aims to record the way people sort and categorise information with different sorting strategies. The study will be run in three parts:

5. Some brief questions regarding yourself, how often you use the internet etc.

6. An observation period of how you store and retrieve information on the internet.

7. Some informal questions regarding your sorting technique and any other ideas.

Your sorting behaviour will be recorded with VHS cassette. Our discussion will be recorded by questionnaire and an audio recording.

Please note, the primary focus of this study is to observe sorting behaviour and so a structured forum is provided to record your thoughts. It is not an intelligence test as such; there are no wrong or right methods within this domain.

• You will be paid upon completion of the final test.

If at any time you wish to terminate your participation within the study, you may do so without any reason. You will be paid at the hourly rate as specified within the psychology department.

Please read and sign the consent form now….

<u>Consent Form – Phase 2</u>

University of Lancaster
Department of Psychology & Computer Science

Masters Research

Title of Research: An Exploratory Study in World Wide Web Sorting Techniques

Investigator: Jason Marshall

Description of Research: This research examines user understanding, behaviour and thoughts regarding the sorting and categorisation of WWW material.

This is to certify that I, …………………………………….., hereby agree to allow my data to be observed by other researchers as aggregates.

I understand that my identity will remain confidential for all purposes and that I may terminate my participation within the study at any time without justification.

I also understand that I will be paid upon completion of the second test.

Participant's Signature …………………………………………. Date ………………….

Investigator's Signature ……………………………………...

Record sheet – Method 2

1. Personal data

Participant …………………………….   Age ………………………
Genda: male / female
Occupation / Department …………………………

How often do you use the internet?
Every day   Every other day
Once a week   less than once a week

How long have you been using the Web?
Less than a year   several years

What is your most commonly used browser?
Microsoft Explorer   Netscape
Other……………..

Have you used Microsoft favourites before?

-orientation / restrictions
-record

2. Sorting

Time to observe if possible (post only)	
Time to sort (post only)	
Total time (during/post)	
No. of groups	
No. of Changes to title	
Comments –	

3. Retrieval

Wrong
Unable to answer/elapsed time…
Total time
Individual time

Retrieval number	Time elapsed	Number pages to identify	Correct	Comments i.e.	Time outs >30 secs.
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					

4. Interview
familiarity with material…

Data A		Data B	
Books		Movies	
Finance		Jobs	
Cooking		Gardening	
Magazines		Newspapers	
Cars		Dating	
Computing		Athletic gear	
Travel		Wireless	
Spirits		College	
health		Beauty	

Factor / opinion	Rating 1-5	Comment.
Ease of use		
The during method is easy to sort info		
The after method is easy to sort info		
Retrieval		
The during method is easy to retrieve info		
The after method is easy to retrieve info		
Satisfaction		
I was satisfied with my during categorisations		
I was satisfied with my after categorisations		
Preference (when both sets finished).		
I prefer the during method		
I prefer the after method		

Other remarks…

Sorting Parameters

<u>During</u>
In the during browsing method, you must perform within the following constraints:

- **Each and every page must be sorted immediately** within favourites after observation i.e. you must either create a new folder and then add the page to it or add the page to an existing folder.
- **You cannot return to a page** and re-name or change the position of any page. Therefore, pages are only sorted / categorised once.
- **Sub folders may be created within a folder** although the sub folder must be related in nature. For example, adding a football folder within a sports folder is acceptable, introducing a vehicles folder to a cookery folder is not.

<u>Post</u>
In the post browsing method, you must perform within the following constraints

- **You must add each page to the favourites** list and then return to the link window.
- **You cannot sort**, arrange the order, categorise, or position oany page until all pages have been observed.
- **You cannot return to a page** and re-name or change the position of any page. Therefore, pages are only sorted / categorised once.

<u>Both</u>
Both methods may employ the following methods:
- Any name may be used for a folder title.
- Any name / title may be used to save the page in favourites.

Data A Random Order & Question Distribution

No	Decription	question
1	**Cooking Club of America** Love to cook? Click here for a special free trial membership in the Cooking Club of America, includes a free issue of Cooking Pleasures Magazine. Start your free trial membership today. visitors.cookingclub.com	1
2	**Optimum Health Supplement: Two for One** Bovine colostrum for immune support and anti-aging effects, plus enhanced stamina and vitality. Proven in credible studies. Trial offer - buy one, get one free; money-back guarantee. www.metafoods.com	
3	**Home Equity Loans without Perfect Credit** Finally there's a home loan that works on your terms. Get a refinance or debt consolidation loan from Ameriquest. With over 185 branches nationwide, apply online, by phone or in person. www.ameriquestmortgage.com	2
4	**Mortgages for All Types of Credit** Mortgage Express, Inc. offers custom solutions for every residential mortgage financing situation. We look forward to earning your trust and business. www.webmei.com	
5	**myEyeNet - Vision Related Content** We are dedicated to setting the standard for Link Directory technology and how individuals find vision-related information. myeyenet.com	
6	**Become a Published Author** Dorrance Publishing Company has an eighty-year history of selling quality books by new and established authors. Come see our online catalog. We can help publish your book or e-book. www.dorrancepublishing.com	3
7	**New Car - Get Lowest Dealer Price Fast** Ready to buy? Get multiple price quotes on a new car from local and online dealers fast. Submit simple, no-obligation forms powered by the leading automobile sites. Compare for best deal. www.pricequotes.com	
8	**Your Health is Important to Us** We want to help you live a longer healthier life. We offer articles, information and help regarding health, nutrition, supplements, fatigue, anti-aging and more. www.sunchlorellausa.com	

9	**Factory Invoice Prices and Dealer Cost** Discover the wholesale price of any new auto! As well as special deductions from factory invoice. Find incentives, "holdback", and potential hidden dealership fees with – buying advice. www.buyingadvice.com	4
10	**Compare 30 Online Stores with One Click** Shop AllBookstores.com for low book prices on the Web. Compare prices at over 30 online bookstores with one click. Save time and money. Free book locating service, too. www.allbookstores.com	
11	**National Health and Wellness Club** Passionate about your health? Click here for a free trial membership in the national Health and Wellness Club, includes a free issue of Today's Health and Wellness Magazine and much more. visitors.healthandwellnessclub.com	5
12	**Save up to 80% at Magazines.com** A quick and easy way to buy or renew your magazine subscriptions. Over 1,400 titles. 100% satisfaction guaranteed. www.magazines.com	
13	**We Create Company Publications** CCI is the leading publisher of print and online company magazines and newsletters. We work with database-driven companies and associations in a broad range of markets. www.customcommunications.com	6
14	**Health problems-No Script Needed!** Do you have health problems? Buy the Drugs Express List to find pharmacies that deliver with or without a prescription legally. Viagra, Xanax, Soma, Valium, Ultram, Prozac. www.drugsexpress.net	
15	**Find Computing Tips, Reviews, Downloads** In-depth technology testing, commentary and reviews on computers, computer hardware and software. Find latest product releases, check prices - read it here. www.pcmag.com	
16	**500Mb Web Hosting - Domain Registration** 500MB Web hosting, unlimited data transfer, 1,000 e-mail accounts and only $22.95 per month. For a limited time we register your domain name for free! www.canaca.com	7
17	**Get a Free Preview of Discover Magazine** Enter a world of exploration, discovery, science and technology. Read articles about ancient life. Enjoy a free preview issue of Discover and get 11 more issues (12 in all) for just $15.97. www.discover.com	8
18	**Buy Books Now at Amazon.com!**	

	Amazon.com is the place to find anything you want online. We have Earth's biggest selection, including millions of books, CDs, videos, DVDs, toys, electronics and more at great savings. www.amazon.com	
19	Brewhaus Spirit Making Supplies Brewhaus imports and distributes supplies for home spirits distillation including activated carbon, turbo yeast, essences, and equipment. Buy direct and save. www.brewhaus.com	
20	HappyHours.com Magazine Online! Wine, food, beer, & spirits news every day! www.happyhours.com	9
21	AllCheapFares.com - Travel for Less Never pay retail for travel. Save 40% to 50% off retail. Discount airline tickets, hotels, tours and more. www.allcheapfares.com	
22	Magazines - Save up to 92% Over 1,200 magazines available at low authorized rates at Magazines of America. 30 years experience, free gift cards, worldwide delivery. Click for subscriptions. www.magazinesofamerica.com	
23	Voice Activated Computing Software Only Voice activate your computer using Dragon NaturallySpeaking software. Since voice recognition software is all we do, we do it well. Call toll-free or order online. www.voicerecognition.com	10
24	Learn How Celebrities Handle their Money Being a celebrity isn't all glitz and glamour. They also think about nest eggs, stock portfolios and liquid assets. Subscribe to access the New York Times "Talking Money With" archives. www.nytimes.com	
25	Find Low, Low Book Prices in One Click Don't get ripped off. Compare book prices before you buy. Free coupons. Find any title, new and used book. www.campusi.com	
26	S. Leikind - Liquor Industry Expert A beverage alcohol industry expert consultant in marketing, sales and brand development for liquor, beer and wine. www.bev-alcohol-expert.com	11
27	Best Lenders Home Finance Resources Financing information is provided to select best mortgage, refinancing, home equity, auto and credit card loan. Use the links for online application that results in multiple loan offers. 1000bestlenders.com	
28	Orbitz - Travel Trying to find the best travel deals? Find an incredible selection of flight options and Web fares in one place. Easy to	

	navigate. Easy to use. Visit Planet Earth via Orbitz today. www.orbitz.com	
29	Low Discount Prices at MagazineCity.Net No searching. You're one click from savings of up to 92% on over 1,500 magazines at MagazineCity.net. Low pricing, free gift cards, worldwide delivery and the truth about free trials. www.magazinecity.net	12
30	Taste Great with Flavorsolutions.com Minor's bases create rich, natural flavors every time. We use fine ingredients from good cuts of beef and fresh seafood, to ripe vegetables and natural seasonings. Buy them online. www.flavorsolutions.com	
31	Interfaith Holiday Gifts Books and gifts for interfaith couples, grandparents, and children, including titles related to Hanukkah and Christmas holidays. www.dovetailinstitute.org	
32	Homebrew Heaven Wine Making Supplies Wine making, liquors and spirit making supplies and equipment from Homebrew Heaven. Extensive Website and Secure online ordering. www.homebrewheaven.com	
33	Cooking Items Improve your kitchen today with our handy cooking items. www.kitchenandmuchmore.com	13
34	Best Source for Health Supplements Top-rated Web site. Free info. Fast service. Low prices. Plus the most bioavailable health supplements available. One-year money-back guarantee, we're that confident! www.epic4health.com	14
35	Health, Life, and Disability Insurance Our site features reviews of health insurance products for businesses and individuals. Short-term and travel also available. Choice of online quote and agent assistance in most states. www.healthinsure.com	
36	Seasilver - Free Shipping, Booklet &Tape Seasilver is an organic, plant-based, liquid nutritional health supplement full of antioxidants, phyto-nutrients, vitamins, minerals and enzymes. Free shipping/booklet/tape (USA only). www.seasilver-health.com	15
37	Shop Here for All Your Cooking Needs Shop the nation's largest kitchen store: www.cookscorner.com for all your cooking needs. www.cookscorner.com	
38	EyeOnCredit - Finance - Credit Cards	

	Browse comprehensive listings of credit cards that offer you rewards, including low APR cards, frequent flyer miles, cash back, free gas, secured cards, and more. Eyeoncredit.com. Links. www.eyeoncredit.com	
39	American Express Travel Services Choose from a variety of offers, including airfare packages, cruises and last-minute 48 weekend getaways from American Express Travel Online. travel.americanexpress.com	16
40	Buy a New Car Save hundreds or even thousands with the InvoiceDealers new car buying service. Select your car, enter your contact info and a local dealer will contact you with a great no-haggle price. www.invoicedealers.com	
41	Deals on Computing Products - Tech Depot Tech Depot by Office Depot lets you choose from over 60,000 low-priced computer and technology products, all with competitive shipping rates. Buy your computing products online now. www.techdepot.com	17
42	Buy and Sell Wine and Spirits Find out why thousands of satisfied members, along with CNN, Forbes and the WineSpectator, are recognizing WineCommune as a leader in the new world of buying and selling fine wine. www.winecommune.com	
43	Autoweb: Research and Buy, It's Free Get the facts on the vehicle you want. Enter your zip code to get prices, specs, photos and more on a car in your area. Autoweb - the haggle and hassle-free buying service. www.autoweb.com	18
44	Suburban Water Testing Labs: Health HealthGuard water testing kits. Free brochure. Fact sheets on health effects of drinking water contaminants. h2otest.com	
45	Clayton College of Natural Health CCNH offers degree programs in natural health and holistic nutrition. All courses through distance education. www.ccnh.edu	
46	Cooking at Chef's Resource Serious tools for serious chefs! Visit Chef's Resource for a great selection of gourmet cooking products. The best brands, plus select items from the food service industry! www.chefsresource.com?source=overture	19
47	Up to 40% Off Airfare at Cheap Tickets Over one million unpublished airfares. Discounted rates on hotels, rental cars and cruises. Click to discover one of the best kept secrets in travel. Register now. www.cheaptickets.com	

48	Luxury Link - The Luxury Travel Source Enter the world of the discerning luxury traveler. Auctions and exclusive buys thoughtfully chosen from our own inventory by experienced travel professionals. www.luxurylink.com	
49	Lexus.com - Official Site Explore the models, build your Lexus, search for a certified pre-owned Lexus, or find a dealer. www.lexus.com	20
50	Computing Made Easy! LearnOnYourOwn.com has an excellent selection of low-price computer training products for beginners to pros. Learn the basics or get certified- at your own pace, in your own home! www.learnonyourown.com	

Data B Random Order & Question Distribution

No	Description	q. no.	
1	**Wireless News and Reviews at ExtremeTech** In-depth news and reviews about new products and technologies: PC hardware, software and operating systems, 3D technologies, networking and security. Click here for ExtremeTech. www.extremetech.com	1	
2	**Fine Cosmetics from Canvas** Canvas Cosmetics is a progressive concept professional line of cosmetics and skin care products that are designed for men and women of all races and colors. All Items are 100% cruelty free. canvascosmetics.com		
3	**Wireless Concierge for Your Cell Phone** Get live, personal assistance by talking on your phone for just $19.95 a month. Get the Internet without a computer. Say&Send e-mail without a keyboard. Pronto. Change everything you know. www.askpronto.com	2	
4	**Believe in Beauty at Lancome.com** Need personalized beauty advice? Let the experts at Lancome.com find the right colors for you. Convenient, private and personalized. Believe in beauty at Lancome.com. www.lancome.com		
5	**DVDPlanet - All DVDs 25% Off and More** DVDPlanet is your online source for movies. You can pre-order new releases and find your favorite videos and DVDs - all at bargain prices. www.dvdplanet.com		
6	**New Movie Info at Touchstone Pictures** Visit Touchstone Pictures' Web site to learn more about great upcoming summer releases. View trailers, news, release dates and enter our sweepstakes. Find a show time in your area. www.touchstonepictures.com	3	
7	**Aromaland Aromatherapy Store** Looking for something that has beauty in shape and scent, then visit our site to buy quality and natural Aromatherapy and environmental fragrancing products. www.buyaromatherapy.com		
8	**Makeup Artist's Choice** Specializing in unique professional products including home chemical peel kits, pro makeup, mineral cosmetics, anti-shine, pro camouflage, accessories. www.makeupartistschoice.com		

9	[Newspaper Archive Search](#) NewspaperArchive - your source for full image newspaper archives. We have one of the world's busiest historic newspaper archives. Search 600,000 plus pages from throughout North America. [www.newspaperarchive.com](#)	4
10	[DiversityInc.com Career Center](#) Leading Web zine on the business case for diversity - has an active career center for management level people. Great sponsors such as Ernst & Young, Mercedes Benz, PwC, J&J, Lucent, etc. www.diversityinc.com	
11	[Mel Gibson's "Signs" Official Movie Site](#) M. Night Shyamalan follows up "The Sixth Sense" with his new feature film, "Signs," a supernatural suspense thriller starring Mel Gibson and Joaquin Phoenix. View the trailer online. [www.signs.movies.com](#)	5
12	[Greenhouse Kits](#) Easy to assemble greenhouse kits featuring double -walled corrugated panels and steel reinforced frame at factory direct prices. Secure online ordering. www.greenhousekit.com	
13	[U.S. Cellular: Wireless Phone Services](#) U.S. Cellular offers phones, accessories and calling plans in AL, CA, FL, GA, IA, ID, IL, IN, ME, MO, MT, NC, NH, OH, OK, OR, PA, SC, TN, TX, VA, VT, WA, WI, WV. Enter your zip to order. www.uscellular.com	6
14	[Yard Games at WorldWideSports.com](#) Shop WorldWideSports.com for inline skates, ice or roller hockey equipment, bags, backpacks, bikes, sporting goods, yard games, team sports equipment and more. Shop securely and tax free. www.worldwidesports.com	
15	[623 New Looks at Wigs.TV](#) Wigs, hairpieces and hair extensions from Raquel Welch, Dolly Parton, Cheryl Tiegs, Eva Gabor, Louis Ferre, Adolfo, Rene of Paris, Henry Margu, Look of Love, and Revlon. www.wigs.tv	
16	[Start a Greenhouse Business. New Book](#) Grow your love of gardening into a high-profit business. See "Secrets to a Successful Greenhouse and Business," a greenhouse book. You will love it. www.greenhousebusiness.com	7
17	[Beauty Treatments from the Dead Sea](#) Discover the beauty secrets of Ahava's, mineral-enriched beauty products. Rediscover your beauty today at deadseadirect.com. www.deadseadirect.com	8
18	[Newspaper, Chat and Greeting Cards](#)	

	World newspapers organized by continents, countries, and states. Easy to find and fast response. Includes some chat and greeting card Web sites. www.tilpon.com	
19	Discount Bodybuilding, Fitness Wear Discount Prices on the top names in bodybuilding, gym, and fitness apparel - Otomix, Hotskins, Body Alive, Pitbull and T Micheal. Tax free, worldwide sales. www.bestforminc.com	
20	$39 AT&T Prepaid Wireless Package Deal $39.99 includes everything. New Nokia phone, $50 airtime cards (* first 90 days service), free activation, no contract and no deposit. Refill airtime cards at a discount. www.phoneshark.com	9
21	St. Raphael Catholic Singles Large Web site exclusively for Catholic singles. We are the place single Catholics go online. www.straphael.net	
22	Logo Sportswear - No Minimums or Set-ups Buy mass personalized imprinted or embroidered sportswear. Conveniently create online without minimum order or set-up restrictions. Superb quality and great prices. www.logosoftwear.com	
23	CareerJournal by The Wall Street Journal Visit the premier career site for executives, managers, and professionals for job searches, career advice, salary and hiring info - The Executive Career Site from The Wall Street Journal. www.careerjournal.com	10
24	Kinerase, Look Younger - Feel The Beauty Kinerase kindly erases wrinkles. Low price, large Kinerase cream or lotion for $72, small for $43. Call us toll-free or order online. We will match any low price. www.kinerasedr.com	
25	Quality Dating Starts at Match.com Doesn't your dating life deserve high-quality? Choose Match.com with more photos and quality profiles to view. Media Metrix ranks Match.com one of the largest on the Web. Register today. www.match.com	
26	New York Times Home Delivery Stay informed with convienent home delivery of the New York Times. Read acclaimed articles and features daily. Save 50% when you subscribe online. www.nytimes.com	11
27	Earn Your College Degree Online! U.S. residents: earn your MBA, BA (Bus, CIS, MIS, Acct, CJ, RN-to-BSN) or AA degree from nationally known, accredited Universities with no classroom attendance. Study anytime, anywhere!	

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28	**Alsto's Home, Garden and Bath** Practical products for your home, yard, garden, pets, pool and patio. Get organized, entertain guests, make improvements. You'll find all kinds of timeless gifts and unique seasonal items. www.alsto.com	
29	**New Balance Web Express** Shop online for New Balance shoes and apparel for the serious and casual athlete who demands technical apparel with great fabrics and features. Discount closeouts, with up to 70% off. nbwebexpress.com	12
30	**Resume Writing for $150 at e-resume.net** Invest $150 in your career. Chosen by the "LA Times", as the best of the bunch of the top three Internet resume writing companies. Start now. www.e-resume.net	
31	**Affordable Greenhouse Kits** Extend your gardening season with a Farm Wholesale Greenhouse. Plants love our unique insulated panels. Buy a kit or use our panels to cover your own frame. www.farmwholesale.com	
32	**Earn Your College Degree Online** The Kaplan Colleges, a leader in online education, offers programs in nursing, education, legal studies, criminal justice, law, business and management. Online classes. www.kaplancollege.com	
33	**U.S. Air Force - Cross into the Blue** With America's Air Force, you will enter a world that's a step ahead. A world where you can make a career out of defending freedom and honor, with the most advanced technology in existence. www.airforce.com	13
34	**NY Film Academy: Learn Filmmaking** Hands-on filmmaking at the most innovative, dynamic film school in the world. Workshops in directing (16mm, 35mm and Digital), acting, screenwriting and animation. International locations. www.nyfa.com	14
35	**The World's Community Newspaper** Featuring free want ads - the unclassifieds. Community news, business news and auctions. www.kazor.com	
36	**Beauty 30% Glycolic Acid $1,200 in Peels** Doctor strength! $1,200 in peels in one 8 oz. Bottle! 30% glycolic acid rapid exfoliator. Free beauty report! Royal jelly, glycolic, hyaluronic-based moisturizers, cleansers and fresheners. www.30glycolic.com	15
37	**Great Expectations Dating Service**	

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38	Gardener's Supply Company We are your partners in gardening success. Gardening tools and supplies including composters, seed starting equipment, greenhouses and fertilizers. Environmentally friendly solutions. www.gardeners.com	
39	Great Phone Deals from Verizon Wireless Great phones at a great price. Shop Verizon Wireless now and save online. Plus get 50% off a combo pack with your purchase. With 1 or 2 yr. agreement. Enter your zip code to get started. verizonwireless.com	16
40	The Chubb Institute - 11 Locations We're a technical career school providing intensive training to develop the skills students need for a career in information technology. Request information or click through to our Web site. www.chubbinstitute.com	17
41	SnagAJob.com: Part-Time Jobs Nationwide Find great part-time jobs and full-time hourly jobs anywhere in the U.S. Search our huge database and apply online. Start earning extra cash today. snagajob.com	
42	Westwood College of Technology Online programs and campuses in Southern California, Colorado, Illinois, and Texas offer fast-track career programs in high tech, graphic design, CAD, aviation maintenance and other fields. www.westwoodcollege.com	
43	Yahoo! Personals - Dating at Its Best Post your free ad today and search photo ads for free. Meet millions of great singles now and find the one for you. Plus, get great dating tips, success stories and more. personals.yahoo.com	18
44	Olympic Champion - Athletic Apparel We want to be your first source for quality athletic apparel for men and women including polo shirts, athletic shirts, sweat shirts, sweat pants and running pants. Click here to purchase. www.buyolympicchampion.com	
45	Beauty and Cosmetics at NReagan.com Wrinkles, acne, fine lines? Is your skin are doing the job? Plus safe cosmetics, aromatherapy and Cellex-C. Free consultations, beauty advice and great service. Low shipping & free over $75. www.nreagan.com	
46	Aubrey Organics - Beauty Care Aubrey Organics - 100% natural hair, skin and body care.	19

	www.aubrey-organics.com	
47	Date Smarter with Matchmaker.com Free trial offer. This is your opportunity to find a soul mate, great dates, or new adventures in a safe and secure community. Stop waiting. Start living. Go meet somebody. Fill out form. www.matchmaker.com	
48	British Newspapers Online British Expat free online lifestyle magazine for Brits around the world. Links page to British newspapers. www.britishexpat.com	
49	Stratford University Respected career college in the historic Virginia suburbs of Washington, DC. Specializing in computer programming, computer networking, culinary arts, business and hotel/event management. www.stratford.edu	20
50	Get Four Amazing DVDs for Only $.49 Each Get your favorite movies, like Gladiator and Traffic for only $.49 each. You pay only $1.99 shipping and handling each. Join Columbia House and start building your collection. See details. www.chdvd.com	

17.3 Data disk

Paper – PDF
Final Presentation
Phase 1 & 2 material
Datasets / Link pages
Results / Statistics

17.4. Research Diary