CYBERSURFER: A ONE WINDOW INTERNET BROWSER

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Dedicated to my parents

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ACKNOWLEDGEMENTS

ABSTRACT

Dipankar Roychowdhury

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The Web browser interaction model popularized by NCSA Mosaic in 1993 contributed to the exponential growth of the Internet and has remained largely unchanged since then. However, even with multiple windows and bookmarks, it has become ineffective as a tool for managing Web pages, because the number of Web sites visited by users has increased. This study analyzes Internet browsing patterns and, based on that analysis, proposes a new interaction model that facilitates efficient Web browsing in a single window using two novel tools: "clone" and "mark." The innovative interface that embodies this interaction model improves access to visited pages and enhances the management of links on a page. This study also compares Web browsing performance using the interface of the Cybersurfer Web browser to that of Internet Explore 6.0. The findings reveal the drawbacks of the currently used multiple window browsers and the potential efficiency, convenience, and pleasure of a new interface for single-window browsers.

CHAPTER ONE: INTRODUCTION & BACKGROUND

An Internet browser is a software application that enables a user to display and interact with text images and other information typically located on a Web page on the World Wide Web. Through several generations of Internet browsers, browser technology has seen improvements in terms of security and privacy. However, little has been done to make the browsing more efficient and easy. For instance, revisiting a particular page is difficult unless the user "Bookmarked" it or can recall its URL or navigate the series of links from a recalled page to the required page. Popular Web browsers like Microsoft Internet Explorer (MSIE) allow users to open pages in new windows to enable easy access to those pages that need revisiting.

On average, users visit forty two differant pages in a session (Byrne et al. 1999); also, browsing the Internet is often accompanied with the use of some other application. If more than six windows are open, the labels on the minimized windows become too short to be recognized and the clickable area on the label is greatly reduced, making it difficult to access the desired window. Mozilla Firefox provides the feature of opening different pages under different tabs within the same window. Again, if more than six tabs are opened then tab selection becomes confusing. Although the user can have twelve pages open using only two windows, the user may have to check the tabs under each window to find the required page.

"The fact that the Internet doubles every year implies that at any time half the number of users will have been on the net for less than a year." (Nielsen, J.,

1998, http://www.useit.com/alertbox/980405.html). Furthermore, the average user's vocabulary of Web pages (the number of pages frequently visited) has grown and the median user's viewings are expected to double every 30 months (Montgomery & Faloutsos, 2001). Hence, the Internet browser should provide easy to use functionality for novice and intermediate users with tools that facilitate recognition and efficient management of Web pages.

The list of bookmarks/favorites has grown rapidly, making it hard to recognize the page from the title and equally hard to manage the bookmarks. Growth in Web activity is primarily due to more frequent, not longer, browsing sessions (Montgomery & Faloutsos, 2001). Also, more users are navigating the Web and performing some other activity at the same time. Hence, each time they start a new session, information like some key pages from the previous session should be available to the users. Using bookmarks for such key pages from previous session will increase the load on bookmarks.

The focus of this research is to create a novel approach to interaction design through the development of a new Web browser that includes visualization tools, which improve the usability and efficiency of Web browsing. The new browser referred to as Cybersurfer, will also include a unique easy-to-use interface for executing all interaction functions.

How Do Users Browse Web Pages in a Multiple Window Browser?

The most popular and widely used function in all Web browsers is the "Back button," (Cockburn & McKenzie, 2001). It is a favorite with beginners, while intermediates and experts have often found ways of reducing their reliance on the Back button, such as using the multiple window or tab features. By opening links

in new windows, the user does not have to go back to the parent page each time to access a different link. The page in the new window can be kept open for revisiting later, so that when the page is required later in the session, the user will not have to go back many levels.

Through observation, I have learned that there are patterns in the way users employ the "open in a new window" function, while browsing the Web. When a Web page has more than one interesting link, those links are opened in new windows. Also, when a page has important information and an interesting link, the link is opened in a new window. The idea is to keep the important pages easily accessible.

Let the page from which links are selected be termed as the "root page" and the links opened in new windows be termed "leaf pages" (see Figure 1). On the root page, the user decides which link(s) should be opened in new window(s). The leaf page (link) may be left open to revisit later or closed. At this point, the user must make a decision to revisit it or reduce the number of open windows by closing the window or use the window to visit a different page. If the links on the leaf page are opened in new windows, then it becomes a root page too. Hence, as the number of open windows increases it becomes difficult to manage them, because if a window is closed the entire stack of pages on that window including the last visited page is lost.
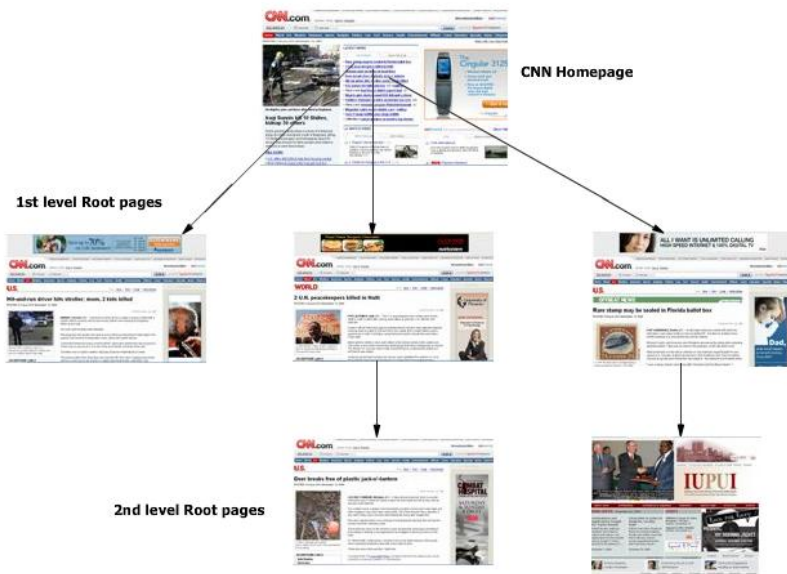
Figure 1: Browsing pattern on a multiple window browser

Advantages of the multiple window browsing approach:

- Efficient navigation

- Less reliance on the Back button

Disadvantages of the multiple window browsing approach:

- Too many window or tabs are difficult to manage.

- When a window is closed, the entire trail of pages on it is lost.

- When a link opens in a new window, it is confusing to beginners, as the Back button does not take them to the page on the previous window.

- The hyperlink structure that exists between pages is not clearly represented.

CHAPTER TWO: LITERATURE REVIEW

Internet Browsing Patterns

The median user's vocabulary of Web pages has grown, and the user's viewings are expected to double every 30 months (Montgomery & Faloutsos, 2001). Hence, the list of bookmarks/favorites has increased in size dramatically, making it hard to distinguish the page from the title and equally hard to manage the bookmarks. Growth in Web activity is primarily due to more frequent, not longer browsing sessions (Montgomery & Faloutsos, 2001). Also, many users are navigating the Web and performing some other activity at the same time. Hence, each time they start a new session, information like some key pages from the previous session should be available to the users.

Berkun (2004) presents a valuable overview of bookmarks and visualizations and how they are important UI components of a good Internet browser. In a more detailed study (Cockburn & McKenzie, 2001) provide an empirical characterization of user actions using the Web browser. Both studies confirm the report by Montogomery et al., that Web page revisitation is a prevalent phenomenon; users had previously visited almost 81% of the pages accessed. Their studies suggest that the bookmark feature should contain tools to assist users and that there should be some shortcut mechanisms to access a small set of frequently visited pages. The list of marked pages in the proposed interaction model aims to fulfill this need, and it can be customized to store the most frequently accessed pages. Further, the pages marked in a session can be made available to other sessions as well.

Byrne et al. present a taxonomy of the tasks undertaken on the Web and determine the tasks that are the most time consuming; their analysis is insightful and has helped in understanding the requirements for the design of the tool proposed in this research.

Novel Interaction Models

Brown & Schillner (1995) developed the "Deckscape Browser." It uses the metaphor of a deck of cards to facilitate managing Web pages. For example, a user can keep the homepages of all of his or her colleagues in a deck named "Colleagues." This model allows the user to drag a page from its home deck and temporarily display it in a separate window; such a page is called an "away" page. When a link on the away page is clicked, the page opens in the home deck rather than obscuring the away page. The concept of away pages has inspired the design of the clone tool in Cybersurfer (CS). The link on the clone opens in the main window, while the clone is easily accessible at the top corner.

Kandogan & Schniederman (1997) presented a hierarchical Web browser called "Elastic Browser." In this model, new pages are opened inside the original window, and the space is shared among the pages. The desired page can be zoomed in to for viewing, so that its context is maintained and the user can easily back up to a certain page. Overviews can be created for visited pages to give the user a sense of location and to provide fast access to a hierarchy of Web pages. Their research proposed a solution to a common problem for internet users, getting lost. Because the previously visited pages are viewable, they provide context to the current page. The need to provide context has inspired the design of the clone feature, which provides context to the main page. Also, the stack of

cloned pages and the list of marked pages gives the user an idea of the pages browsed in the session.

Tausher & Greenberg (1997) explored the possibilities presented by history lists. Their study found that the home page is primarily used as a bridge to other pages. Hence, if the user had a shortcut to reach the desired page, the browser's overall efficiency would be improved. This is the basic reasoning behind the mark feature, which goes a step further in allowing the user to control what goes into the list. Kaasten & Greenberg (2002) propose a model for integrating the Back, History and Bookmark features. They present a recency-based list that contains all the pages visited in a session in the order of recency, with the most recently viewed page at the top of the stack.

The pages in the list are represented by a thumbnail size image of the page and page title. The model is interesting in the way it employs tools like sliders and "Dogears" to efficiently scan through the list. However, this model neglects to address the fact that, if thumbnails are too small, they do not significantly enhance the user's ability to recognize the page any more than page titles alone would (Dziadosz & Chandrasekar, 2002). There are other problems with this model, such as an excess of visualization features and unwanted entries.

Jones, Marsden, Mohd-Nasir, Boone & Buchanon (1999), compared user performance on an internet browser on a large screen and a small screen display. In the process, they discovered that small screen users have a poorer understanding of the model of the Web site and require almost twice the number of within site searches to find the desired information. This finding suggests that a hierarchical browser or any browser that produces a nesting of Web pages under a single window, is not a

good design. The analysis presented in this study helped me to understand the constraints involved in the interaction design of a Web browser.

Challenges in Developing a One Window Browser

A good interaction design for a Web browser should provide the advantages of the multiple window browsers, while reducing the disadvantages as much as possible. Developing a Web browser with the above goal poses a number of challenges. As the first step, it was decided to develop a one window browser in which the user could perform his or her entire navigation in a single window. The second step was to design an interaction model for such a browser that would provide the abovementioned advantages.

The literature review covered studies on internet browsers elucidating the attributes that make a browser more usable and efficient. Based on that knowledge, specifically, the new model seeks to:

- Provide context to the leaf pages,

- Provide support to revisit important pages,

- Efficiently manage all the pages,

- Provide a brief history of the important pages visited in the previous session,

- Facilitate page recognition,

- Facilitate opening links from a page while keeping the parent page easily accessible, and

- Display all open pages so that they are clearly readable.

The basic interaction design of a browser is such that when a link is clicked

the corresponding page opens in the window. The one window, one-click interface is appealing in its simplicity, but poor in efficiency. For efficient navigation, the parent page should be easily accessible so that links on it can be visited.

Context is a problem with all popular browsers; they do not provide an overview or a sense of location in the current information structure being browsed. A hierarchical window browser tries to solve this problem by opening links within the same window (Kandogan & Schneiderman, 1997), providing a detailed overview of the lineage of links. Disorientation stems from a lack of knowledge not only of the current position in the whole information structure, but also the path(s) to the desired destination. Hence, browsers should provide functionality such that user can easily abandon a certain track and switch to another to reach the destination. History lists and auto completion URLs are good features, but these tools gives users little flexibility in filtering out unwanted information.

Research Questions

A good interaction design for a Web browser should provide the advantages of a multiple window browser, while reducing the usability problems as far as possible. Through one window operation and visualization tools, Cybersurfer provides a flexible organization in which users can easily arrange the Web pages and filter information on the screen as they browse the Internet.

I aim to address the following questions in evaluating the performance of Cybersurfer and Microsoft Internet Explorer (IE):

1. Compared to IE, does Cybersurfer (CS) offer a faster method of viewing multiple links using the clone tool?

2. Compared to IE, does Cybersurfer (CS) provide a faster way to switch between tasks using the mark tool?

3. Compared to IE, does Cybersurfer (CS) provide a quicker and reliable way to access previously viewed pages?

General user preference questions related to Cybersurfer include:

4. Is the Cybersurfer (CS) interface intuitive?

5. Does the Cybersurfer (CS) interface make it easy to arrange Web pages and filter information during surfing?

CHAPTER THREE: METHODOLOGY

Overview

The usability testing of the interface and interaction model was divided into three phases. *Phase 1* was a semi-structured interview to gather user opinion of the interface and the browser tools at an early stage in the design process. *Phase 2* was GOMS comparison study on the performance of Internet Explorer 6.0 and Cybersurfer. *Phase 3* was a questionnaire survey to determine user response to the innovative tools and the one-window browser interface.

Participants

Two average Internet users who were knowledgeable on topics of design and user experience were selected for phase 1. Because the test was conducted at an early stage in the design process and the main purpose was to see if the system was easy to learn, a large number of users was not required. Phase 2 did not require any participants because it was a GOMS study.

In phase 3, six participants were recruited, with the following demographics:

1. Participants were in the age group 21-30

2. Intermediate to expert internet users.

3. Four males and two females

Implementation of the Prototype

Development of the full ready-to-use browser is not within the scope of this research. However, a prototype of the browser has been implemented using Macromedia Flash. The prototype of Cybersurfer provided the test participants with a setting for the same behavior that an actual browser would have. It was also useful in determining the reaction of the end user to this novel application.

Also, the prototype did not load pages from the Internet; instead pages were downloaded onto the hard disk and presented in the browser as images. The links on the Web pages were implemented using transparent buttons. So when the user clicked on a link, the corresponding page was brought up using ActionScript. The tools like clone and mark were implemented using a combination of movie clips and ActionScript.

The toolbars were developed using buttons and movie clips. The window used the standard scroll pane component to display Web pages which were stored as movie clips. Depending upon the text in the address bar or the link selected, the appropriate movie clip (Web page) was played on the scroll component. The prototype implemented the design exactly as it had been conceived.

Specific Interaction Design of the Prototype

Interaction design is the definition and design of the behavior of the prototype, environments, and systems as well as the formal elements that communicate that behavior. Hence, the interaction design of a product describes its use, form, and behavior, in the context of its communication with the user. The following section describes the various tools or functions of Cybersurfer.

The Clone Tool

The basic idea behind the clone function is to create a copy of the page that the user would visit often in a session for example the homepage of a news portal. The copy of the homepage should be easily accessible, and it should be possible to open the links on it. This functionality is not useful in a multiple window browser because the links on the homepage can be opened in new windows to keep the homepage accessible, but in a one window browser the link will open on top of the parent page there by obstructing quick access to it. Hence cloning will improve the efficiency of browsing.

When a page is "cloned," a copy of the page is created. This copy is presented as a thumbnail at the top right corner of the window. You may continue surfing in the window, but the cloned page is always accessible at the top right corner (see Figure 3). When the mouse pointer moves over the thumbnail, it is maximized. The maximized thumbnail is an active page, and links on it can be clicked. The links open in the window on top of the previous page (see Figure 4).
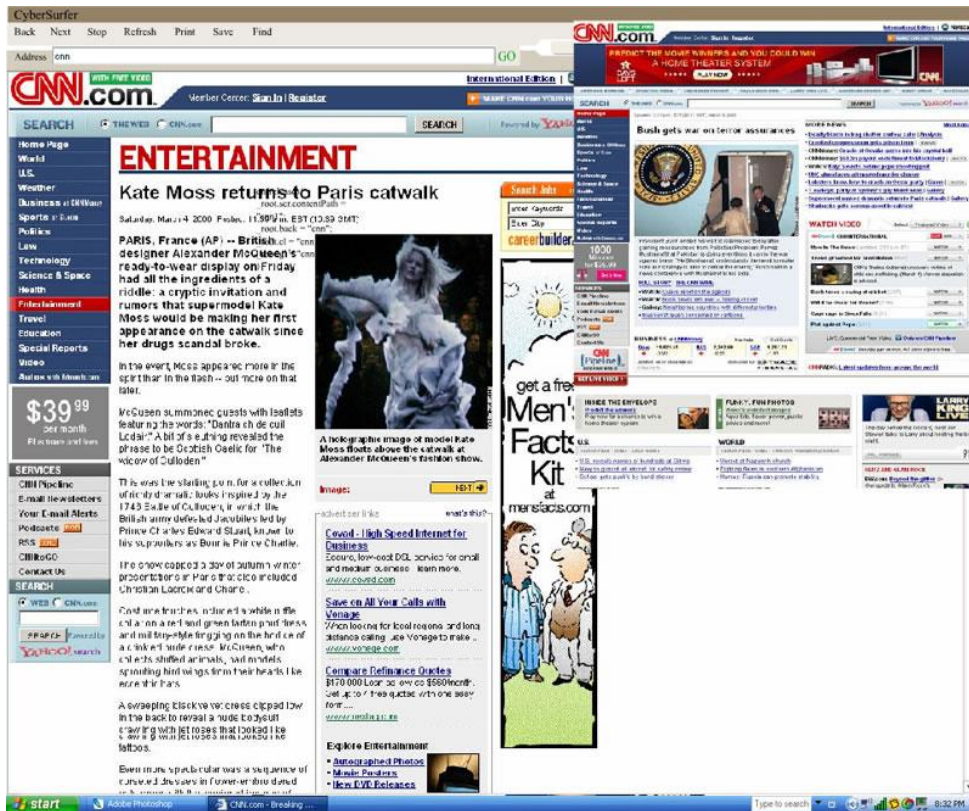
Figure 3: Clone page

Figure 4: Maximized clone

The user can still continue surfing in the window and have easy access to the clones. In the course of surfing, many more pages can be cloned. Each new clone image is placed on the top of the previous one. The stack of clone pages has its own Back, Next, and Clone buttons (see Figure 2). The stack of clone images can also be accessed as a list. An additional feature is the "Rewind" button, which turns active when a link from the clone is accessed. Its function is to rewind back to the page that was open before the clone was used, so that users can open a link from the clone and navigate through it, but to return to the previous task they do not have to hit the Back button several times.

In IE, some links are programmed to open in a new window. This function is generally a distraction, and most users try to hit the Back button to go back to the previous page. In CS, when the user clicks on such a link, the current page is cloned, and the link page is presented. The clone provides context to the link page, and the user has easy access to the parent page.

In Figure 1, the "root" page should be cloned so that it is easy to visit the links that may seem interesting. If a page has more than one interesting link or if the page is important and has an interesting link, that page should be cloned. As mentioned above, in such a situation the links will be opened in new windows in a multiple window browser. So the main purposes of the clone function are:

- To effectively manage links on a page,

- To provide context to the leaf page open in the window,

- To provide easy access to the parent page, and

- To manage cloned pages throughout the session.

An advantage of the clone tool is that the links that automatically open in a new

window in most browsers open in the same window in Cybersurfer, and the parent page is automatically cloned.

The Mark Tool

The "mark" functionality draws upon the history tool in Internet Explorer, but differs in that users get to choose which pages are entered into the list. The history tool is unused in popular browsers largely because of the way it is implemented, and because users have to scan through the list to find the required link (Kaasten & Greenberg, 2000). Content rich pages like news articles, product descriptions, or blog pages that would be required again in a session can be "marked" to facilitate future access. The pages marked become available as a list, which may also serve to keep track of the tasks performed in a session. Hence, the success of the mark tool largely depends on the way it is implemented.

Clicking the Mark button on the standard toolbar marks the page that is currently open, and a reference to that page is saved for future access. The reference is in the form of a thumbnail image of the page, its title, and URL and is available under a drop down list on the Mark toolbar. When a page is marked the Mark toolbar appears on the screen, just below the standard toolbar.
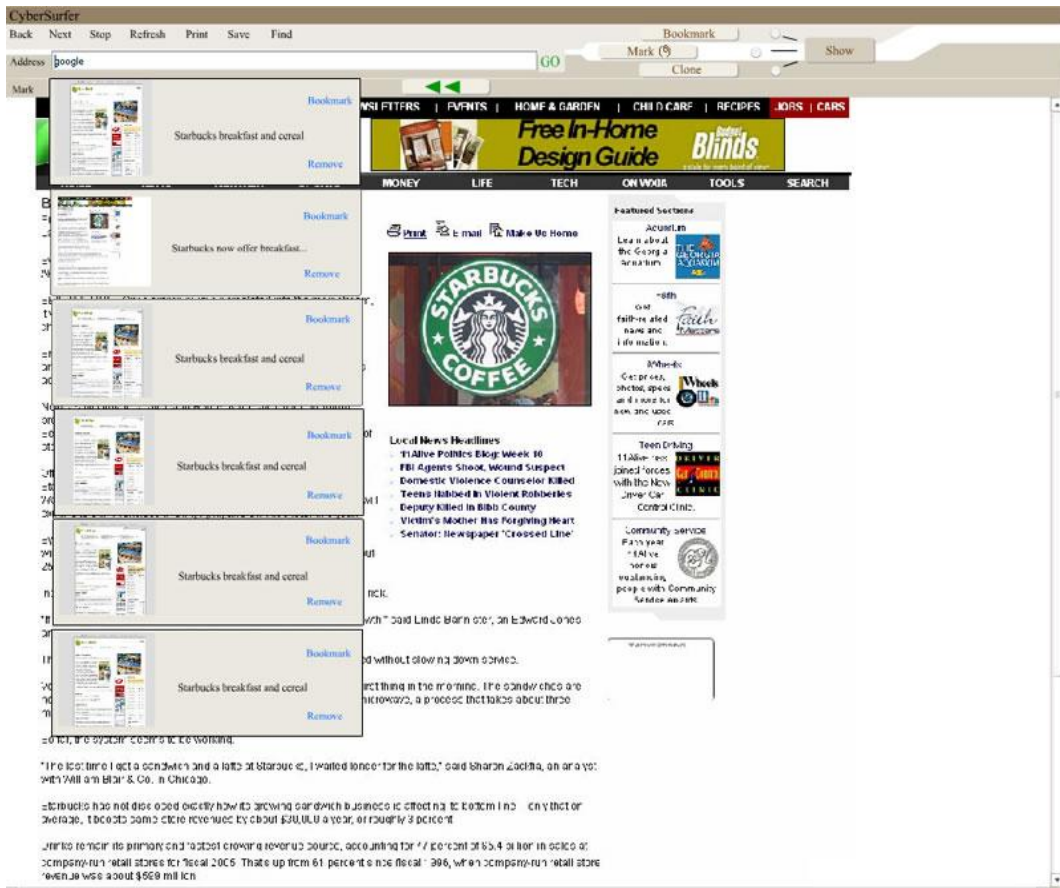
Figure 5: The list of marked pages

Moving the mouse pointer over the drop down list on the Mark toolbar expands it (see Figure 5); if the mouse is moved away the list collapses back. The list presents the thumbnail and title of the marked pages in the order in which they were marked. The user also has the option of bookmarking pages or removing them from the stack. Upon clicking the thumbnail or the title, the corresponding page opens in the window, while a mouse over it provides the URL. After marking a page, the user can continue browsing and revisit the page anytime using the drop down list. An additional feature is the "Rewind" button, which turns active when a marked page is accessed. Its function is to rewind back to the page that was open before the marked page was accessed, so that users can open a marked page and navigate through it, but to switch back to the previous task they

do not have to hit the Back button several times. The toolbar can have at most two lists, and between them the lists can manage up to fourteen pages (see Figure 6). By default, the marked pages are available only for that session, but the tool can be customized to make the pages available to other sessions as well. The list of marked pages can also be exported in CSV format for use on other machines.

Figure 6: The second list of marked pages.

In Figure 1, the "leaf" page should be marked, so that if the user would like to visit it again, he or she can easily access it.

So the main functions of the mark tool are:

- To allow the user to revisit important pages in a session,
- To facilitate recognition of pages using thumbnails and text, and

- To support managing multiple pages for tasks that require switching between the pages, like comparison of information across some pages.

<u>The Bookmark Tool</u>

The bookmark tool is not within the scope of this project. Currently, it has the same functionality as the bookmark feature in Internet explorer. Clicking the Bookmark button on the toolbar bookmarks the page currently open. When a page is bookmarked, its title and URL are saved for future access. The list of bookmarks can be retrieved by selecting the appropriate radio button and clicking "Show."

Interface Design

Interface design refers to the visualization of the interaction design, i.e., the screen layout, buttons, icons, color, and text. The interface design of Cybersurfer has been improved over many prototypes. Some important guidelines followed in the design are:

- Consistency ("Principle of least astonishment")

- Simplicity

- Human Memory Limitations

<u>The Toolbar</u>

The way some tools are implemented in CS is different from the traditional menu based model. The problem with menus is that the user is not aware of the functions available unless they check under the menu.

In Cybersurfer a more direct approach is used to replace menus. For instance, to mark a page the user has to click the Mark button and to view the list of marked pages they have to look under the drop down menu on the mark toolbar

(see Figure 8). Alternatively, to view the list of marked pages, the user can select the radio button for Mark and hit "Show" (see Figure 7).
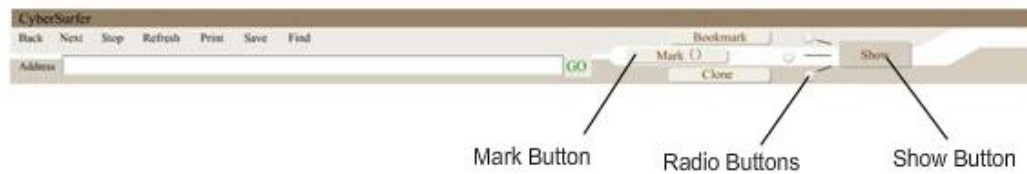
Figure 7: Cybersurfer Toolbar
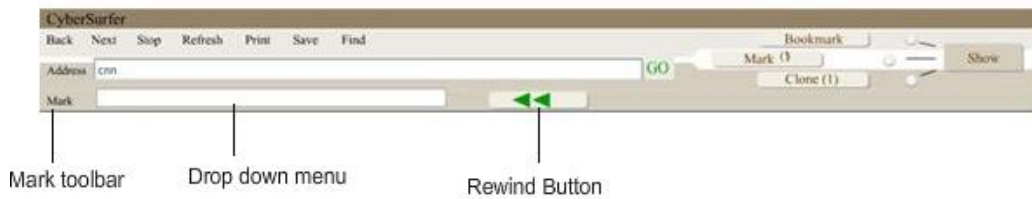
Figure 8: The Mark toolbar

For the most part, the toolbar looks like the toolbars on popular browsers; the user does not have to look for the basic features. Also, the buttons on the toolbar can be customized by the user.

<u>The Clone Tool</u>

The basic problem in designing the interface for the clone tool was how to present the cloned page effectively. In one of the prototypes depicted below (see Figure 9), the cloned page would be placed on the left, slightly zoomed out to fit in the frame. The user can click on the links on the clone, and the corresponding page opens in the frame on the right. The vertical bar separating the two frames can be moved to increase or reduce the size of the frames. The difficulty with this design is that the entire page may not be visible to the user, and the user may have to adjust the frame size often.
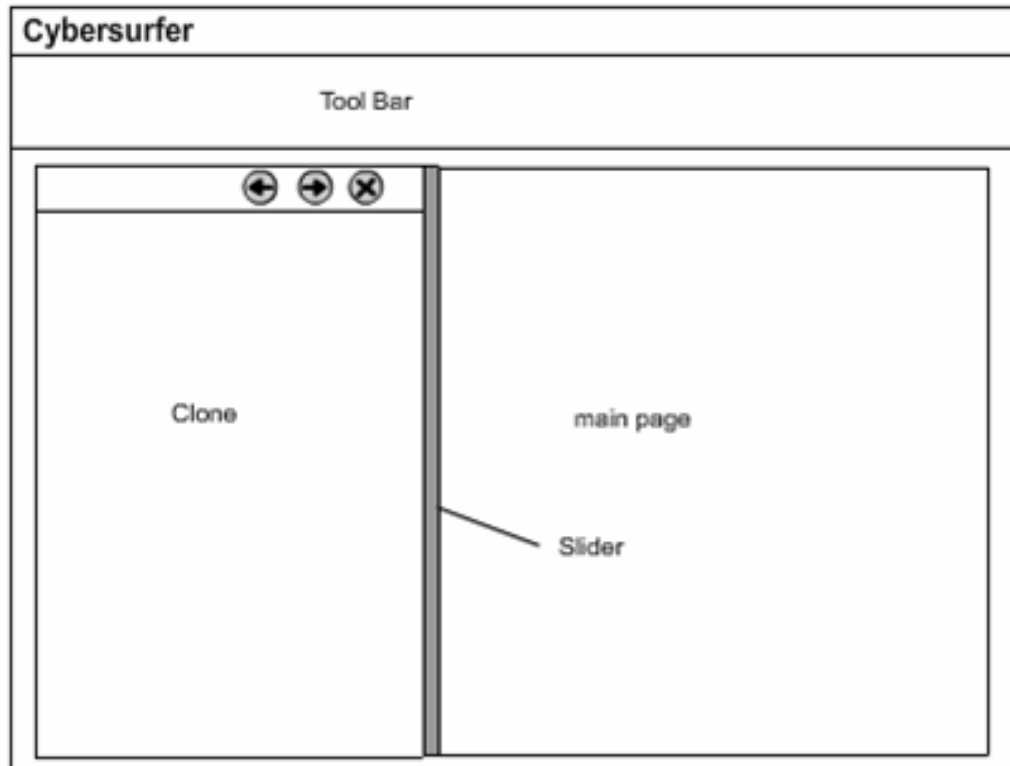
Figure 9: A prototype of the clone tool

The current design which presents the clone as a thumbnail solves the above problems in the following ways:

- The clone does not obstruct the view of the page that is open, as shown in the results of the questionnaire.

- The links on the clone page can be quickly accessed by a mouse over, and the clone goes back to its small size when the mouse pointer is moved out of its border.

- Users find it easy to open links on the clone page (see questionnaire results).

- The buttons for Mark and Clone are located in the same toolbar, because both these tools assist in managing Web pages.

<center>The Mark Tool</center>

In a previous prototype, the Mark toolbar was placed towards the lower edge of the window and had different features. The Mark toolbar showed the URL of the page currently open in the window. That URL was actually a link; when the link was clicked, a menu appeard, and the page could be marked by selecting the proper option from the menu (see Figure 10). To display the pages the user could click on the list box on the toolbar and the list would pop up.

<center>Figure 10: Prototype of the Mark Tool</center>

The former design of the mark tool was lacking in that the Clone and Mark buttons are on different toolbars. Hence, the user could become confused over which toolbar to access. It was decided that related controls should be grouped together. Also, the Mark button was represented as the URL of the page at the bottom of the window, which would not have been intuitive to the user. The

current design is better, because:

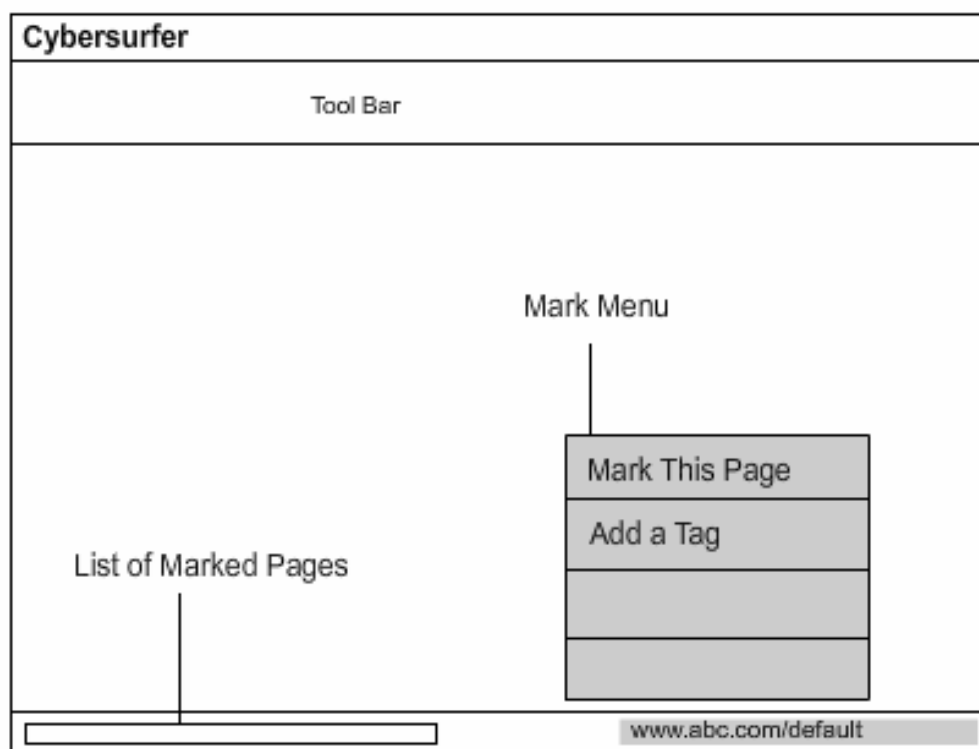- It provides a button titled "Mark." Hence, it is obvious to the user to click on it to mark a page.

- The marked pages are presented as a drop down list, and it is not necessary to scroll to see all the marked pages.

- Mark and Clone are placed in the same toolbar.

Evaluation

When the initial design for the interface of Cybersurfer was created, an important question was: "Is the interface intuitive?" The method chosen to determine the answer was a walkthrough of the prototype followed by a semi-structured interview. The advantage of this methodology is that very specific issues about the design can be unearthed, and in discussion with the participant possible alternatives can analyzed. In addition, the participant's expressions and mood reveal if they like or dislike something.

A reliable comparison between two interfaces can be made by means of a usability test. However, the problems with that approach were:

- It is hard to find users who have no experience in Internet Explorer.

- The prototype could not be tested in a normal Web surfing environment; the test conditions could be questionable.

Hence, the method chosen was GOMS. GOMS is a quantitative means of analysis, which assumes an expert user and calculates the time required to perform a task. So the time required to achieve a goal on Internet Explorer can be compared to that on Cybersurfer. For instance, the time required to open more than one link from a page on the two different browsers was compared using

GOMS.

However, comparing the time required to switch between two different tasks is not necessarily a simple, straightforward matter. Switching between tasks basically implies:

- Switching between browser windows in case of a multiple window browser or Web pages in case of CS

- Switching between an application (e.g., presentation) and a browser window

In IE, the task of switching can be achieved by having the two different pages open in two different windows, while with CS the pages would have to be marked and swapped using the Mark toolbar. GOMS was used to compare the time required in both scenarios. In the latter case, it was deemed unnecessary for the result to be tested, because in IE switching between two applications will involve one or more browser windows. In CS, it will always involve only one browser window (CS is a one window browser), so the time required in CS will be equal to or better than that on IE.

While browsing, most users try to leave certain pages that they would like to revisit within reach. In IE, that can be achieved by keeping that page open in a window, while in CS that can be done by marking the page. The selected page can be retrieved by clicking on the appropriate label on the task bar in IE or on the right option on the drop down list in the case of CS. GOMS was used to compare the time required to retrieve a previously visited page and to discover if it is related to the number of pages open.

GOMS can be used to measure the efficiency of the interface but does not

evaluate usability. Hence, to determine the usability and pleasantness of the new tools, a walkthrough of the prototype followed by a questionnaire survey was conducted. The walkthrough introduced the participant to the browser and its features, and the questionnaire was used to assign a value to the user's experience of the browser interface and the new tools, Mark and Clone.

Procedures

Phase 1: Interview

1. Cognitive Walkthrough: The participants were introduced to the concept behind a single window browser and the features of Cybersurfer that aim to achieve the related advantages. Then, they performed a set of tasks using the Cybersurfer prototype with assistance from the experimenter.

2. Interview: Following the walkthrough, interview were conducted with the participants to seek their views on various aspects of the browser. The interview was audio recorded. The questions are listed in Appendix C. Some follow-up questions were asked to further understand the responses of the participants. The participants had access to the prototype and were allowed to use it during the interview.

Phase 2: GOMS

The test was performed using a software tool called CogTool. CogTool is based on keystroke level model of GOMS (Kieras et al., 1996). The screenshots used in the experiment were images of 800 x 600 resolution.

The times required to perform the following four tasks using Internet explorer 6.0 were compared to the times required on Cybersurfer:

1. Opening two links from the same parent page

2. Opening six links from the same parent page

3. Revisiting a previously opened page from the current page in both the browsers, when 6 windows are open

4. Revisiting a previously opened page from the current page in both the browsers, when 10 windows are open

Phase 3: Questionnaire

1. Cognitive Walkthrough: The participants were introduced to the concept behind a single window browser and the features of Cybersurfer that aim to achieve the related advantages. Then, they performed a set of tasks using the Cybersurfer prototype with assistance from the experimenter.

2. Questionnaire: Following the walkthrough, the participants were asked to fill out a questionnaire. They were free to use the browser to answer any of the questions. For the list of questions, see Appendix D.

CHAPTER FOUR: RESULTS

Phase 1: Interview

The participants had the following views about the design of Cybersurfer:

Pros:

- The clone feature is always accessible, yet it does not obscure the main page.

- The mark feature provides a thumbnail image of the page that is marked; hence, it is easy to recognize it.

- The concept of comfortable browsing on a single window, rather than working with several windows

- The feature that allows the user to export the list of marked pages as a document, so that the file can be used on other stations

Cons:

- Too much effort required to retrieve the list of marked pages. The user has to select the appropriate radio button, then select Show, then click the Down arrow on the mark toolbar.

- The clone pages are difficult to sort within the stack, using the Back and Next buttons.

- The three buttons, Mark, Clone, and Bookmark are a bit hard to differentiate on the toolbar.

Phase 2: GOMS

The following four tasks were performed on both Internet Explorer 6.0 and Cybersurfer, and the performance of both the browsers was analyzed

using CogTool (a KLM-GOMS based software tool):

1. Opening two links from the same parent page

2. Opening six links from the same parent page

3. Revisiting a previously opened page from the current page in both the browsers, when 6 windows are open

4. Revisiting a previously opened page from the current page in both the browsers, when 10 windows are open

Steps involved
Internet Explorer 6.0 1. Right click on the link. 2. Left click on "Open in a new window" on the sub menu. 3. Move to the task bar at the bottom of the screen and left click on the parent window. Repeat steps 1 and 2
Cybersurfer 1. Left click the Clone button. 2. Mouse over the clone in the corner of the window. 3. Left click on the link on the maximized clone. 4. Mouse over the main page to return the clone to its thumbnail size. Repeat steps 2 to 4.

Table1: Opening two links from the same parent page

Figure 13: Open two links off the CNN homepage in IE
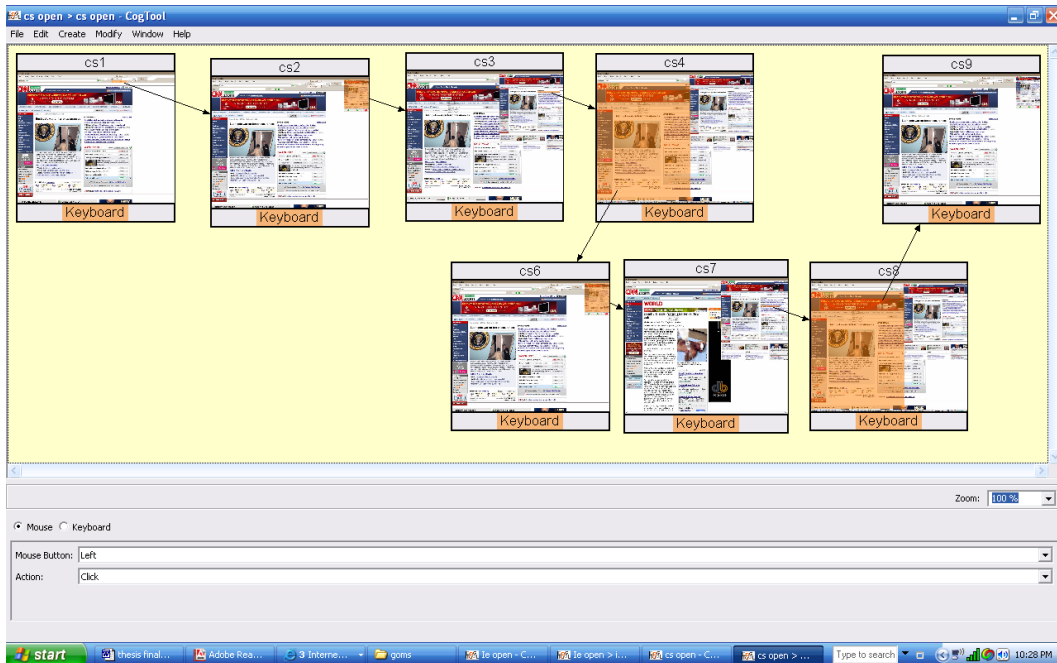
Figure 14: Open two links off the CNN homepage in CS

Steps involved
Internet Explorer 6.0   1. Right click on the link.   2. Left click on "Open in a new window" on the sub menu.   3. Move to the task bar at the bottom of the screen and left click on the parent window.   Repeat steps 1 to 3, four times
Cybersurfer   1. Left click the Clone button.   2. Mouse over the clone in the corner of the window.   3. Left click on the link on the maximized clone.   4. Mouse over the main page to return the clone to its thumbnail size.   Repeat steps 2 to 4, four times.

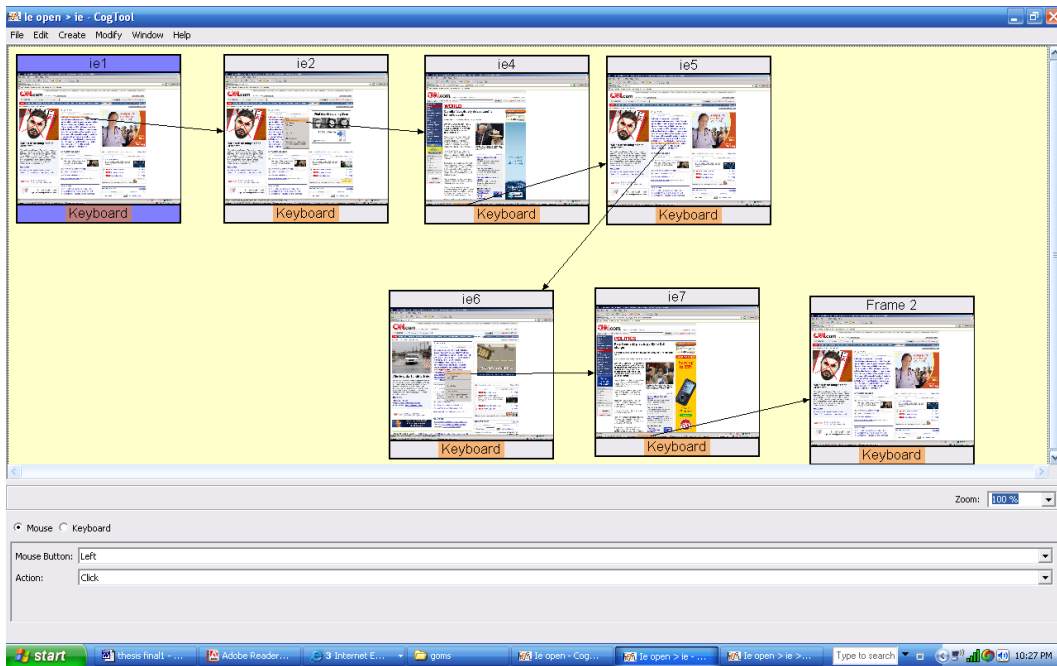Table 2: Opening five links from the same parent page
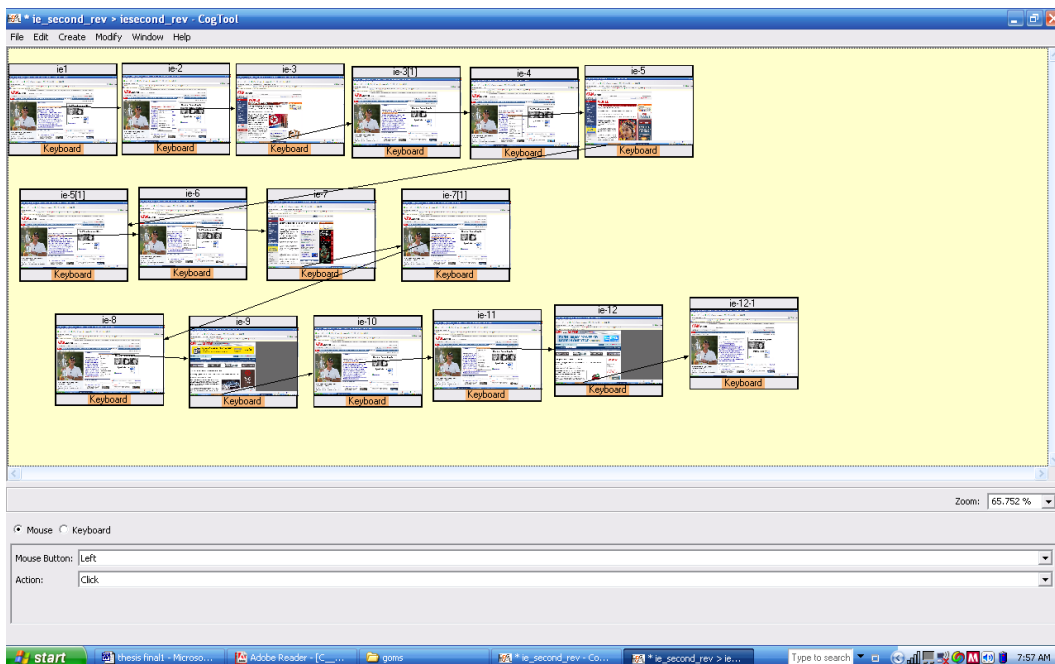
Figure 15: Open five links off the CNN homepage in IE
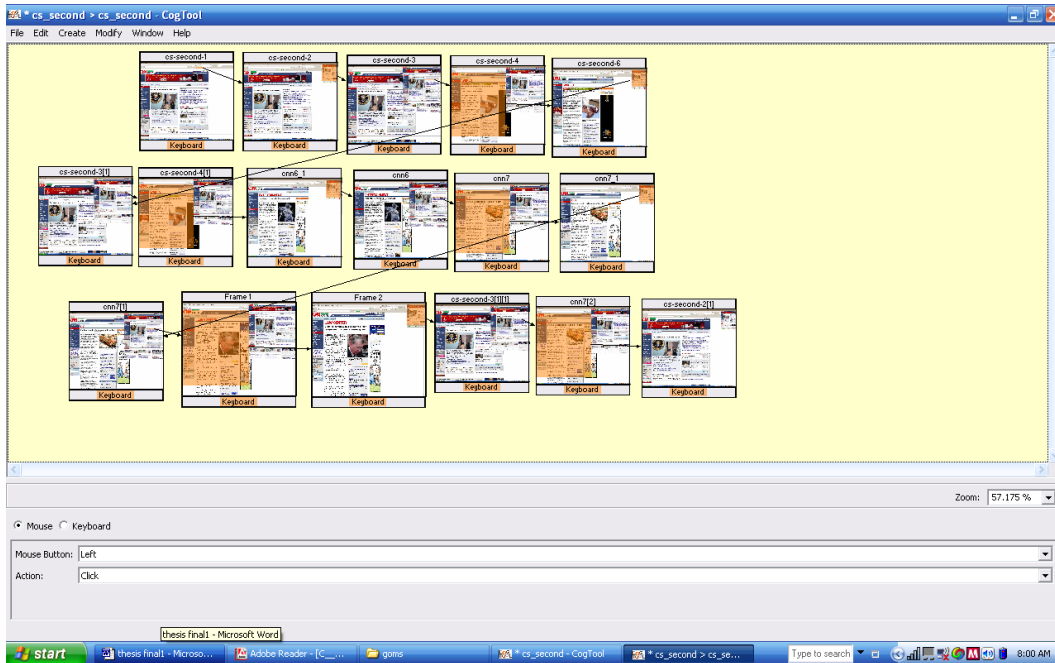
Figure 16: Open five links off the CNN homepage in CS

Steps involved
Internet Explorer 6.0 1. Mouse over the appropriate label on the task bar to confirm the page wanted. 2. Left click on the label.
Cybersurfer 1. Mouse over the drop down menu on the Mark toolbar. 2. Left click on the appropriate thumbnail or title. 3. Mouse over the main page.

Table 3: Revisiting a page from the current page when six pages are open
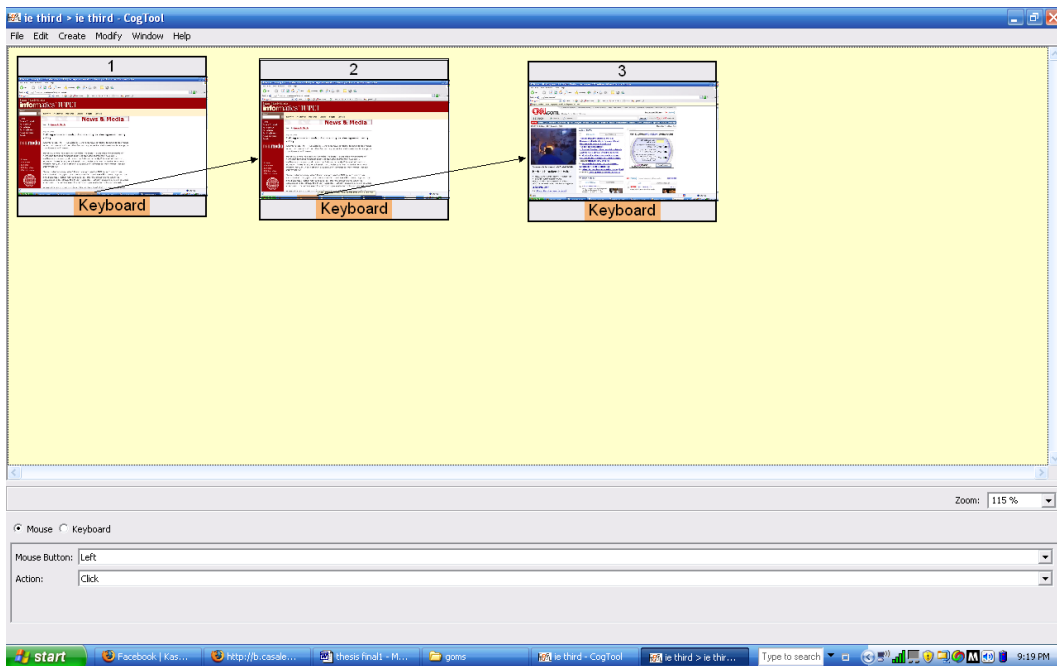
Figure 17: Revisit a page among six open pages in IE
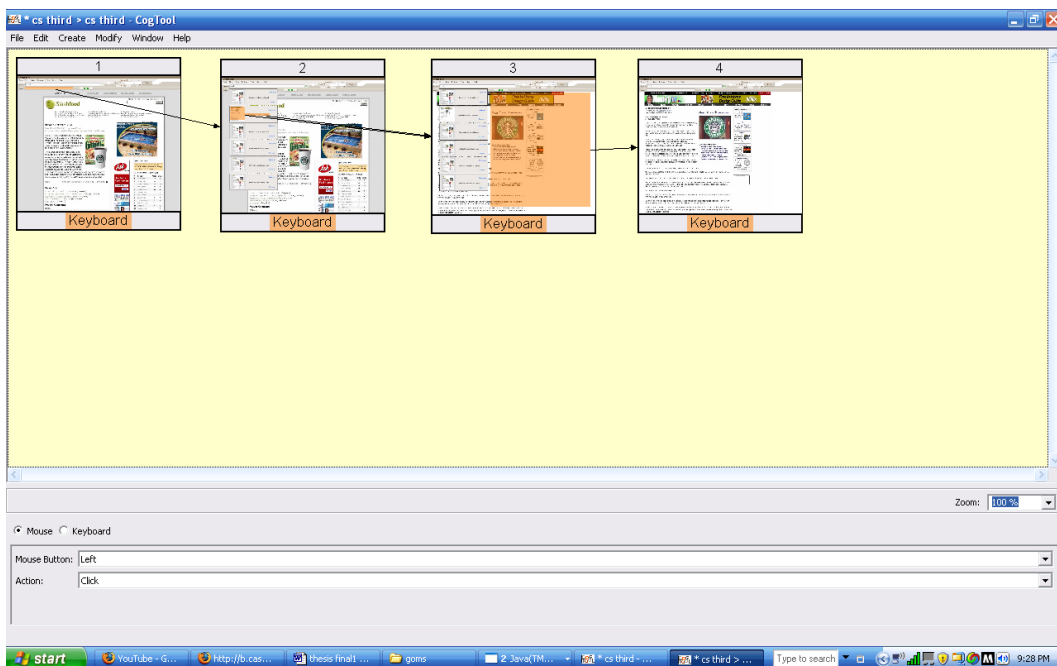
Figure 18: Revisit a page among six open pages in CS

Steps involved
Internet Explorer 6.0 1. Left click on the internet explorer label on the task bar at the bottom of the screen. 2. Mouse over the appropriate label on the list of pages to confirm the page wanted. 3. Left click on the label
Cybersurfer 1. Mouse over the drop down menu on the left of the Mark Toolbar 2. Mouse over the drop down menu on the right of the Mark toolbar (optional) 3. Left click on the appropriate thumbnail or title 4. Mouse over the main page

Table 4: Revisiting a page from the current page when six pages are open
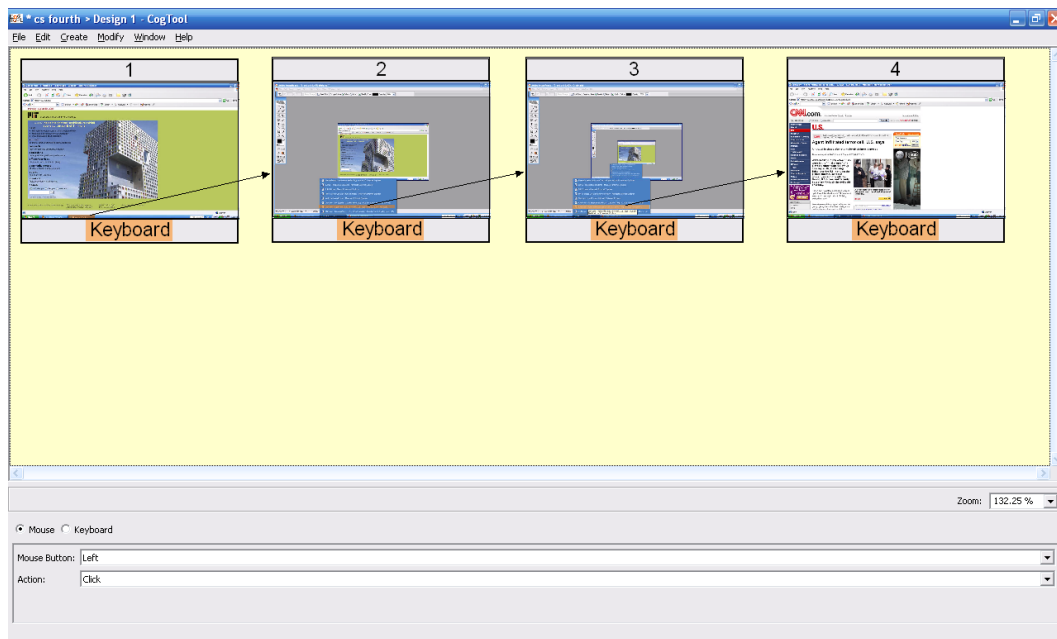
Figure 19: Revisit a page among ten open pages in IE
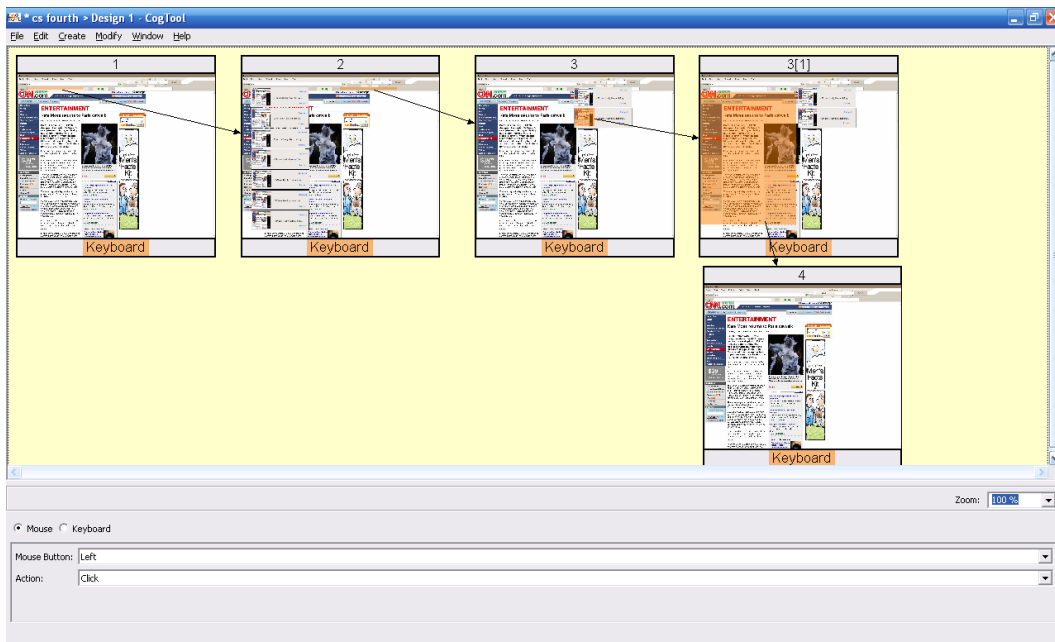
Figure 20: Revisit a page among ten open pages in CS

The table below shows the times calculated by CogTool on both the browsers.

Tasks	Internet Explorer	Cybersurfer
Open two links	12.448 seconds	9.005 seconds
Open five links	29.853 seconds	24.370 seconds
Revisit a page among 6 pages	3.310 seconds	4.059 seconds
Revisit a page among 10 pages	5.628 seconds	5.342 seconds

Table 5: Times recorded on IE and CS
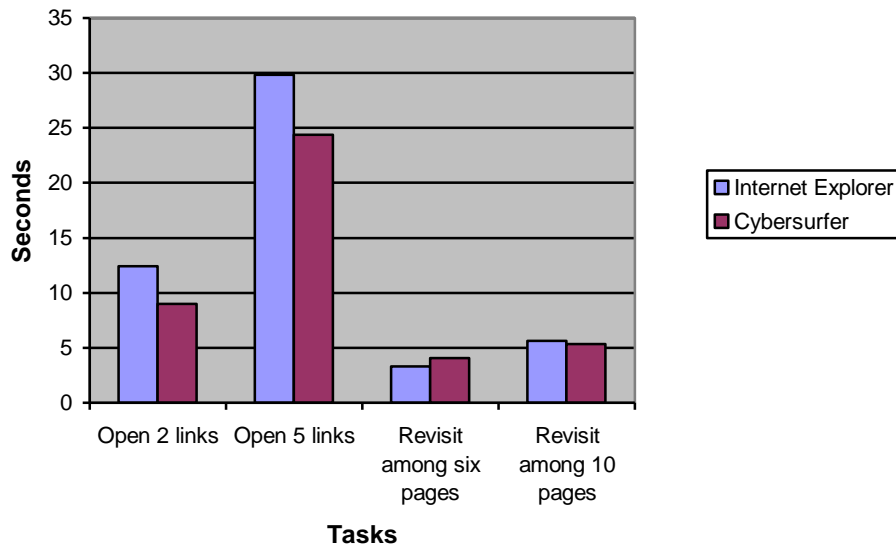
Figure 21: Graph depicting the results of the GOMS analysis

Phase 3: Questionnaire

The walkthrough of the prototype with the participant began with the explanation of the concept of a single window browser. No comparisons to any multiple window browser were made to avoid any bias. The clone feature was demonstrated by cloning the home page of CNN.com and selecting links off the clone to read. One participant said "This is even better than opening the link in another tab." Another participant mentioned, "I like the way it zooms in and out; it is easy and does not cover the screen."

Participants were asked to mark specific pages during the walkthrough. Then they were asked to access the pages marked to compare information on Starbucks breakfast menu on two different pages. Participants liked the idea of a thumbnail image of the page and were instantly able to recognize the CNN article about Starbucks from the list. One participant said, "There are some pages that I switch back to many times; I could mark them."

The questionnaire results are as follows

SA   - Strongly Agree
MA   - Moderately Agree
SLA   - Slightly Agree
N   - Neutral
SLD   - Slightly Disagree
MD   - Moderately Disagree
SD   - Strongly Disagree

	Q2	Q3	Q4	Q5	Q7	Q8	Q9	Q10	Q11	Q13	Q14	Q16
P1	ma	sa	sa	sa	sa	ma	n	sa	sa	ma	sa	sa
P2	ma	ma	sa	n	ma	sa	sld	sa	sla	sa	sa	sla
P3	sa	sa	ma	ma	sa	sld	md	n	ma	sa	sa	n
P4	sa	sa	sa	sa	ma	sa	sld	sa	sa	ma	sa	sa
P5	sa	sa	sa	sa	sa	sa	md	ma	ma	ma	sa	ma
P6	ma	sa	sa	sa	ma	ma	md	sa	ma	ma	sa	sla

Table 6: Results of the questionnaire

If we rate the response as follows:

Abbreviation	Response	Rating
SA	Strongly Agree	3
MA	Moderately Agree	2
SLA	Slightly Agree	1
N	Neutral	0
SLD	Slightly Disagree	-1
MD	Moderately Disagree	-2
SD	Strongly Disagree	-3

Table 7: Rating scale of the questionnaire

Following is the listing of the questions on Cybersurfer and the average response received.

Q. No	Question	Avg Reponse
2	It is easy to mark and clone pages.	2.0
3	It is easy to access marked pages.	2.83
4	It is easy to open a link on the cloned page	2.83
5	It is easy to open multiple links on a page by cloning the page	2.33
7	It is easy to scan through the list of marked pages to find the required page.	2.5
8	By marking pages from two different sites, I can easily switch between those sites when desired	2.0
9	The presence of the clone makes the main page less readable	-1.33
10	The cloned parent page provides context to the link page opened in the window	2.33
11	The list of marked pages help me recognize the pages quickly	2.16
13	The web browsing features of Cybersurfer are intuitive	2.33
14	Managing pages using clone and mark is comfortable	3
16	The list of marked pages provides a record of the important pages visited in a session	1.66

Table 8: Analysis of the questionnaire response

CHAPTER FIVE: DISCUSSION

Analysis of the Results

<u>Phase 1</u>

Based on the results from the interviews, some changes were made to the design of Cybersurfer. In the prototype, the list of marked pages could only be accessed by selecting the corresponding radio button and then clicking the Show button. Subsequently, a drop down list was presented, which would roll back up upon clicking the down arrow button. Participants in the interview felt that Cybersurfer required too many clicks to access the marked pages. In discussion with one of the participants, an alternative using the mouse roll over feature was developed. The current implementation of the Mark tool is based on that alternative.

Figure 11: Earlier prototype of the Mark tool

Figure 12: Current prototype of the Mark tool

The background color of the three buttons was changed to enhance the difference between them. Like the list of marked pages, a list of cloned pages was developed, so that if the stack of clones is big the user would have the option to view it as a list. Also, the list can be accessed using the radio button and Show.

<u>Phase 2</u>

As the results of the study for tasks 1 and 2 suggest, the time required to open multiple links off a page is greater on Internet Explorer than Cybersurfer. In other words, if only one link on a page is selected at a time, the required time is the same for both IE and CS, but when more than one link on a page is accessed, CS performs better. Switching between Web pages like e-mail and news Web sites would be more efficient in Internet Explorer with a few windows, but as the number of windows increases Cybersurfer becomes the better choice. In the case of switching between two different applications, for example, a Powerpoint presentation and a Web page, as the number of browser windows increases, switching will become less efficient in the IE browser.

Cybersurfer, on the other hand, is a single window browser. Hence, the switching time does not depend upon the number of pages visited. If a page were bookmarked, the time required to access the bookmarked page would be the same as in IE, because CS has a similar bookmark tool. While in IE a page would be left open in a window, it is marked in CS. Additionally; in CS the cloned pages can be used to visit a previously opened page. From a usability perspective, the mark feature can manage fourteen pages, while managing fourteen windows in IE is difficult.

<u>Phase 3</u>

Overall the questionnaire results indicated that the tools were useful and easy to use. One participant termed it as a creative approach to handling problems with multiple windows. Questions 2, 4, 5, 9, 14 concerned the clone tool, and the responses to these questions indicate that users understood the purpose of the tool and had no problems using it. Questions 3, 7, 8, 11, 14, 16 were meant to understand user views on the mark tool. The responses to those questions indicate that the users liked the mark tool, because they saw its value in switching between tasks, while finding it easy to scan through. However, some users had doubts about the new interface's management of large numbers of pages.

CHAPTER SIX: CONCLUSION

Overview of Significant Findings

The interviews conducted at an early stage helped identify some usability problems with the interface, such as issues with the number of clicks and the location of widgets. Any issues with the purpose of the tools were not discovered. The GOMS study compared the performance of Internet Explorer to Cybersurfer. The main purpose behind this study was to determine if CS is as efficient at managing Web pages as a multiple window browser. This is also the purpose of the first three research questions. The results indicate that that, in terms of efficiency, CS and IE are quite close. This is a significant point and suggests that it may be possible to avoid managing multiple windows and still be able to browse the Web conveniently. It may be argued that in a multiple window browser one could click a link in one window and browse through a page in another window while the link loads, but in CS that would not be possible. However, using the clone tool, one can access the home page easily even from the deepest of links. Such points of contention cannot necessarily be resolved, because both browsers provide very different tools.

The questionnaire survey was conducted to elicit user opinion on the design. The results clearly indicate that users liked the new tools (Clone and Mark). The results provide user views not only on the interface, but also on the usage of the tools. Users applauded the way the clone tool solved their problem of opening a link in a new window and, at the same time, provided context to the main page. Users could appreciate the way Mark helped them in switching

between pages. Also, users felt that the presence of the thumbnail along with the page title facilitated page recognition. It was concluded that page management with clone and mark is comfortable for users; also, the GOMS study suggests that Cybersurfer is almost as efficient as a multiple window browser. Therefore, CS can be considered a good alternative to multiple window browsers.

Limitations of the Study and Recommendations for Further Research

The browser design was focused on creating an efficient single window browser. In the process, other features of a standard browser, like tools, view options, and privacy features, were not developed. The way these features should be added to the browser is a question for future work. Another very important feature that could not be developed, due to limited time, was the bookmark. Many researchers have studied users' bookmarking patterns and proposed ways to improve current bookmark designs. Ways to integrate the bookmark feature into the model of Cybersurfer need to be investigated.

A usability test of CS could not be conducted, because the browser is not completely functional. Hence, a future project should attempt to implement Cybersurfer as an actual browser or create an improved flash prototype that has internet connectivity and can present actual pages from the Web. It would be interesting to have users perform tasks on the working browser and compare performance on IE and CS. In comparing the performance of CS and IE, the metrics used were opening multiple links off a page and revisiting a page. There are other metrics that can be used to compare efficiency, and they need to be researched.

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APPENDICES

Appendix A: Questions for the Interview

Please write your age and preferred browser on the form.

1. What is your favorite news Web site or entertainment site?

2. Can you please open it and surf through, the way you would usually? I assure you that the Web site or the pages you choose to read are not being recorded.

3. Can you explain why you did/did not open the links in new windows?

4. Do you recall having problems in managing multiple windows?

5. Can you think of any particular situation? ** Cognitive walkthrough and explanation of the rationale behind the design.**

6. What do you think about the overall design?

7. Does the presence of the thumbnail image of the parent page help you in surfing? how?

8. Of these five Web pages which ones would you clone? Why?

9. Do you have any concerns about the design of the Clone feature?

10. Of these five Web pages, which ones would you mark? Why?

11. Do you have any concerns about the design of the Mark feature?

12. How far would you agree that the integration of Clone and Mark serves the purpose of opening new windows?
   □ Disagree
   □ Agree

13. How far would you agree that using clone and mark tool simplifies managing web pages while browsing?
   □ Disagree
   □ Agree

14. How will you see the pages that are marked?

15. Do you have any concerns about the interface?

16. Would you rate the interface design as intuitive?
   □ Disagree
   □ Agree

Appendix B: Questionnaire survey on Cybersurfer

Post-Task Questionnaire

Participant Number: _____   Date: _____

Evaluator(s) _____

1. Please specify your gender
__ Male   __ Female

2. Please enter your age.
__ 18 to 20   __ 21 to 30   __ 31 to 40   __ 41 to 50   __ 51 to 60   __ 61 or older

3. Your Favorite Internet browser?
___ Microsoft Internet Explorer
___ Mozilla Firefox
___ Netscape Navigator
___ Google Opera
___ Apple Safari
___ Don't know

Circle your response to the following questions based on your experience of using the Cybersurfer web browser:

1.   I am an expert Internet user.
__ Strongly disagree
__ Moderately disagree
__ Slightly disagree
__ Neutral
__ Slightly agree
__ Moderately agree
__ Strongly agree

2.   It is easy to mark and clone pages.

__ Strongly disagree
__ Moderately disagree
__ Slightly disagree
__ Neutral
__ Slightly agree
__ Moderately agree
__ Strongly agree

3.   It is easy to access marked pages.

__ Strongly disagree

    __ Moderately disagree
    __ Slightly disagree
    __ Neutral
    __ Slightly agree
    __ Moderately agree
    __ Strongly agree

4. It is easy to open a link on the cloned page.

    __ Strongly disagree
    __ Moderately disagree
    __ Slightly disagree
    __ Neutral
    __ Slightly agree
    __ Moderately agree
    __ Strongly agree

5. It is easy to open multiple links on a page by cloning the page.

    __ Strongly disagree
    __ Moderately disagree
    __ Slightly disagree
    __ Neutral
    __ Slightly agree
    __ Moderately agree
    __ Strongly agree

6. It is easy to open multiple links in new windows.

    __ Strongly disagree
    __ Moderately disagree
    __ Slightly disagree
    __ Neutral
    __ Slightly agree
    __ Moderately agree
    __ Strongly agree

7. It is easy to scan through the list of marked pages to find the required page.

    __ Strongly disagree
    __ Moderately disagree
    __ Slightly disagree
    __ Neutral
    __ Slightly agree
    __ Moderately agree
    __ Strongly agree

8. By marking pages from two different sites, I can easily switch between those sites when desired.

    __ Strongly disagree
    __ Moderately disagree
    __ Slightly disagree
    __ Neutral
    __ Slightly agree

__ Moderately agree
__ Strongly agree

9. **The presence of the clone makes the main page less readable.**

__ Strongly disagree
__ Moderately disagree
__ Slightly disagree
__ Neutral
__ Slightly agree
__ Moderately agree
__ Strongly agree

10. **The cloned parent page provides context to the link page opened in the window.**

__ Strongly disagree
__ Moderately disagree
__ Slightly disagree
__ Neutral
__ Slightly agree
__ Moderately agree
__ Strongly agree

11. **The list of marked pages help me recognize the pages quickly.**
__ Strongly disagree
__ Moderately disagree
__ Slightly disagree
__ Neutral
__ Slightly agree
__ Moderately agree
__ Strongly agree

12. **The page titles on minimized windows help me recognize the pages quickly.**
__ Strongly disagree
__ Moderately disagree
__ Slightly disagree
__ Neutral
__ Slightly agree
__ Moderately agree
__ Strongly agree

13. **The web browsing features of Cybersurfer are intuitive.**
__ Strongly disagree
__ Moderately disagree
__ Slightly disagree
__ Neutral
__ Slightly agree
__ Moderately agree
__ Strongly agree

14. **Managing pages using clone and mark is comfortable.**
__ Strongly disagree
__ Moderately disagree
__ Slightly disagree

__ Neutral
__ Slightly agree
__ Moderately agree
__ Strongly agree

15. Managing pages with multiple windows is comfortable.
__ Strongly disagree
__ Moderately disagree
__ Slightly disagree
__ Neutral
__ Slightly agree
__ Moderately agree
__ Strongly agree

16. The list of marked pages provides a record of the important pages visited in a session.
__ Strongly disagree
__ Moderately disagree
__ Slightly disagree
__ Neutral
__ Slightly agree
__ Moderately agree
__ Strongly agree

17. What do you like about Cybersurfer?

18. What do you dislike about Cybersurfer?