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Animated and Hypertext User Interfaces: A Comparative Study

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ABSTRACT

The Web has evolved from mere HTML static pages to dynamic pages and providing information to users in interactive and engaging ways. One of the most revolutionary tools that has changed the online experience of Internet users is the Macromedia Flash. Nowadays, Web designers are providing both the HTML and Flash interfaces to users. However, the users are still not sure about which interface style, i.e., hypertext-based HTML interface or animated-based Flash interface, is better to use in terms of usability and effectiveness. This paper compares the strengths and weaknesses of both animated and hypertext Web interfaces in terms of their usability and also users' attitudes and perceptions about these interfaces. To conduct the comparative study, an animated user interface was developed using Flash for the Division of Information Studies website of Nanyang Technological University, Singapore. This interface was compared with the existing hypertext user interface of the same website. It was found that animated user interface was preferred for its text readability, appropriate use of colours and buttons, visual consistency and sequencing of screens, attractiveness of design, pleasantness and user-friendliness of interface, ease of use, content coverage, organisation of information, navigation, and usability. The hypertext user interface was preferred for its speed of downloading and its navigational capability that complemented the Web browser navigation.

Keywords: User interfaces, HTML interface, animated interface, flash interface

1. INTRODUCTION

The Web has come a long way from mere static HTML pages to highly interactive and engaging ones. It is now home to many multimedia applications featuring text, sound, images, and videos that allows interactive data access, data input and links to other sites[1]. One of the most revolutionary multimedia technologies to take the Web design community by storm in recent years has been Macromedia's Flash. When it first premiered in 1996, Flash was an unknown program and plug-in called FutureSplash that enabled designers to add simple animated graphics to websites. Today, renamed and improved, Flash has evolved into a powerful Web authoring tool and application, which is not only redefining the art of interface design, but also dynamically changing the online experience worldwide. Flash-enabled websites require user browsers to have the Flash player or plug-in installed on their computers before the Flash movies can be viewed. This plug-in can be freely downloaded from Macromedia's website. Macromedia claims that Flash player is the most widely viewable rich client technology in the world, providing a consistent deployment experience across desktops and device platforms, and has a reach of over 436 million people[2].

Flash, unlike other multimedia authoring tools is a vector-based authoring program. It works with vector data instead of bitmaps or raster graphics like GIF and JPEG. Vector-based contents and applications download faster over all types of connections, and programs like Flash provide engaging and interactive contents with a multi-sensory experience that includes interactive streaming video, animation, audio, and vector and bitmap graphics[3]. From its earliest version FutureSplash to the latest version, Flash has come a long way from being a tool purely used for adding gimmicks and excitement to a website to being one that can be used to create an entire website without the knowledge of

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HTML code[4]. Website's whether designed in HTML or Flash, are searched for certain information. The ease of getting this information from a website is the one that is going to determine whether the user will come back or recommend the website to others. Designers often give a lot of importance in making their websites impressive and overwhelming using attractive animations, graphics, sounds and videos[5]. But the only thing that really matters is whether the message the site is carrying reaches to the user, and how quickly and effectively this message reaches the user is what that often determines the success of a site.

However, animation used judiciously often helps to enhance the look and feel of an interface in explaining and communicating a concept clearer than just text alone[6]. Several researchers have studied the comparison of HTML and animated user interfaces for webpages design in various contexts and noticed their strengths and weaknesses[7-11]. On the Web we often come across websites designed in HTML and Flash interfaces existing concurrently. The user is given the option to surf the HTML or the Flash interface. With its growing prevalence on the Web and the possibility of Flash being an alternative to HTML for website design, the question arises which interface style, i.e., hypertext-based HTML interface or animation-based Flash interface, is better in terms of usability and effectiveness.

In this study an animated interface was developed to compare against the existing hypertext interface of the website of the Division of Information Studies, Nanyang Technological University, Singapore. The aim of this study was to develop and evaluate concurrent HTML and Flash interfaces of similar content and compare them in terms of usability and effectiveness.

2. OBJECTIVES

The objectives of this study are:

- To examine how animation has been used in Web user interfaces.
- To examine the reasons for dual interfaces on the Web (HTML and Flash).
- To identify strengths and weaknesses of both animated and hypertext Web user interfaces.
- To compare the usability of an animated interface against a hypertext interface in terms of interface design, navigation, system capabilities, and usability.
- To find out users' attitudes and perception of an animated user interface against an equivalent hypertext user interface.

3. REVIEW OF SELECTED FLASH/HTML WEBSITES

For the purpose of the research, several sites using both Flash and HTML were reviewed. In the review, sites presenting content in both Flash and HTML were chosen. Some sites were using Flash only for 'intro movies' and for adding interactivity to certain elements in the webpage. These sites were left out as Flash was used as one of the many effects included in the webpage. The selection of these sites was based on the categories as mentioned by Calongne[12], which includes, sites selling product or services, educational/information sites, entertainment sites, and ego-based sites. Ego-based sites mainly deal about art, information or ego including e-commerce, catalogues, and online shopping. These categories were used as a guideline to review how and why different websites have their sites both in HTML and Flash versions. The websites reviewed were:

3.1 Within Reach Concepts

Within Reach Concepts (http://www.wreach.com/flash.htm?welcome) is a website of a company specialised in designing Flash-based applications. The website have both Macromedia Flash 6 and an HTML version. Both the versions have their own look and feel. The Flash version begans with an 'intro movie'. The 'skip intro' link takes the user to the full Flash version of the website. Flash as well as HTML version of the website used simultaneously. A link to the Flash plug-in download has also been provided to get the latest Flash player.

Besides usability problems, user may also encounter problems with different versions. However, user has the freedom to switch to the other design at any point of time. Unlike the Flash site where the contents were compactly packed within a screen, the HTML interface has information spread over on the screen, which requires to scroll up and down.

3.2 Go 2 Graphics

Go 2 Graphics (http://www.2ginc.com/) is another premium website development company. The company's website has both Flash 6 and HTML versions. The user has been informed that the HTML option is meant for low bandwidth users and the Flash option is for high bandwidth users. The user has also been provided with a link to download the latest Flash player. The Flash version begins with an 'intro movie'. The 'skip intro' link takes the user to the full Flash version of the website. The look and feel of both versions are very similar, but the navigation style used is different. In the HTML version, the navigation links are presented at the bottom of the screen. In the Flash version, the user has to take

some time to figure out where the navigation links are. The HTML version also has a useful slide out menu on the left. This menu provides main menu links as well as sub-menu links. The links in the HTML version loads almost immediately, while the Flash version takes some time to load. In either version the user is given the choice to switch from one to another at any point of time. In the HTML version there is a link to go to the Flash version without the 'intro movie'.

3.3 Embry-Riddle Aeronautical University

Embry-Riddle Aeronautical University (http://www.erau.edu/Universe/indexflash.HTML) is an aviation and aerospace education centre. Its website is available both in Flash and HTML versions. Though the look and feel of both versions is similar, their navigation styles differs. While the HTML version has conventional navigation links on the left hand side of the screen, in the Flash version links have been presented in the form of a spider web. It needs sometime to understand this structure before clicking on the links. The website's Flash version is available for the first two layers (i.e. navigation layers) as subsequent layers lead to HTML pages. This was probably due to the fact that being an academic website the information pages were heavy in content and were more relevant to the users as simple text pages done in HTML.

In both versions, the choice has been given to switch from one to the other interface. The Flash homepage version looks very compact as all information is presented within the screen unlike the HTML homepage where the user needs to scroll up and down. At this site, all information pages have been enabled as HTML pages even in the Flash version. This helped in the Flash version of the website searchable though the results were displayed in a HTML pages with the search results as links to the specific HTML page.

3.4 Algonquin Collage

Algonquin College is in Ottawa, Canada. The Flash version of its website (http://www.algonquinc.on.ca/highband/swf/index.htm) took sometime to download unlike the HTML version, which came on instantly. Both the versions were very similar in terms of navigation style, layout, and design. In the Flash version users can also access HTML version and vice versa in the HTML version. While in the Flash site, the contents were compactly packed within a screen, in the HTML version, these can be scrolled up and down. However, in the Flash version screen size is small and therefore divided into many portions with directional arrows that help in navigating easily. A lot of links in the Flash interface opened up in new windows that displayed information on a hypertext interface. This was also there in the HTML version. Sound effects were present in the Flash interface for mouse clicks on navigational links. The search feature is available in the HTML version and presents the results in a HTML page.

3.5 Kreativ InfoTech

Kreativ InfoTech (http://www.kreativindia.com/) is an e-business solutions development company. The look and feel and layout of its websites is similar on both the HTML and the Flash versions. The navigation structure is similar too, thus no problems in using either of these sites. Both the HTML version and Flash version are presented within a screen and therefore do not require the use of scrollbar. However, when pages are clicked, both versions displayed information in fixed size windows. These windows come with their own vertical scrollbars. The size of these windows is relatively small compared to the area used in presenting graphics on both versions. The font size of text used in the information area of the fixed size window within the Flash version is rather small for an average user to make out. The browser 'Back' button in the Flash version does not bring the user back to the previous state unlike the HTML version. The user is given options, to switch in both versions at any point of time.

3.6 Perceptron

Perceptron (http://www.perceptron.com) produces information-based process improvement solutions for industries. The look and feel, layout and the navigation style of its websites are similar in both Flash and HTML versions. Users of both sites would have no problems in using either site because the designs are very similar in both the sites. Users do not have to re-learn anything when they switch from one version to the other. Links are provided in both the versions to switch in between Flash and HTML versions. This makes it easy for the user to toggle between the two versions. As seen in other Flash sites, the browser 'Back' button in the Flash version does not bring the user back to the previous state unlike in the HTML version. However, the navigation elements used in the Flash version are very clear making the movement between previous and next states easier.

3.7 We've Got Your Logo

We've Got Your Logo (http://www.wevegotyourlogo.com/HTML/index.HTML; http://www.wevegotyourlogo.com/flash/evegotyourlogo.com/flash/) is an information website provided by IP in Australia. The design is almost similar in both the versions. Users do not have to re-learn much when they switch from one version to the other. There are also options given in both versions to switch to the other version at any point of time. The Flash version

presents information within a screen and user do not require to scroll up and down. However, information is presented in small parts and users have to click on the next arrow link to view the next screen. In the HTML version most of the information is presented in one page. This feature enables the user to print the page with all the information in it. As with most Flash enabled sites, including this site, the browser 'Back' button was not able to bring the user to the previous state of navigation unlike the HTML version, which was able to do so. In the Flash version, user had to rely on the arrow buttons to move in between previous and next screens.

3.8 Escaflowne

Escaflowne (http://www. escamovie.com) is a movie website in both HTML and Flash versions. The designer of this site has strived for similarity in the look and feel of both versions. In both versions, user is able to switch in between the two versions at any point of time. Though the Flash version took some time to load, the effective use of a status indicator tells how much percentage of the page has been loaded. Navigation buttons in both versions were very similar therefore user need not re-learn the navigation style in the other version. Being a movie website there was extensive use of graphics in both the HTML and the Flash versions.

3.9 Brave

Brave (http://www. bravemusic.com/) is a music band group. The look and feel and the navigation links of its website are very similar in both HTML and Flash versions. From the main site, users can access either of the HTML or Flash versions. Both versions open up in separate smaller windows, which are not maximisable. In the HTML site, the user has to scroll up and down, if information presented is not within the screen. The Flash version presents information within the screen. However, there are custom built scrollbars, which enable the user to view portions of information at a time. The font size used in Flash version is too small. On the whole, both versions have an aesthetically pleasing look and give the feel of being at a music site. However, once the user is inside in one version there is no option to switch to the other version unless the user goes back to the main page and access the other version.

3.10 Sarolta's Webpage

Sarolta's (http://www3.sympatico.ca/sgyoker/) is a personal website enabled in both HTML and Flash versions. The Flash version took some time to load unlike the HTML version, which downloaded quite fast. The look and feel, layout design, and navigation style used in both versions were very different, but pretty easy to use and learn. However, in the Flash version, the links were enabled when the mouse went over them only. This was a bit frustrating as the user had to make sure that his mouse is positioned over the right link all the time. The Flash version began with a very long 'intro' with no option to skip this 'intro' movie. The font size used in both the versions was rather small. However, in the HTML version, this could be overcome by changing browser font settings.

In the 10 sites reviewed, the information content and coverage were similar in the HTML and Flash versions. However, the way the information was presented differed. The HTML version was usually faster to download unlike the Flash version, was better in terms of look and feel, design, and the navigation elements that were often more compelling and attractive to the users. A number of business sites involved in e-business solutions had their sites in both HTML and Flash to show their capability in being able to deliver information in both interfaces.

The 'Escaflowne' movie website has both the HTML and the Flash versions. But the Flash version with its introductory animation clip and music gives the user the experience of a movie, which the HTML version lacked. The HTML site was done for users who want quick information about the movie whereas Flash version was done to give the users a feeling of the movie through the animation and sound. Information presented with animation interface was also interesting and appealing as could be clearly seen in the 'We've Got Your Logo' website. The way the pages have been displayed was very similar to how a user flips through the pages of a book. Though the Flash version took more time to download than the HTML version, it certainly was more appealing than the later. By providing sites in both Flash and HTML the content providers were able to cater and please a wider range of audience.

After reviewing the 10 websites that have both HTML and Flash interfaces, a checklist was prepared to rate the sites against the following features: (i) interface design, (ii) content coverage and organisation, (iii) navigation, system capabilities, and usability measures. Each parameter, as shown in Table 1 was given a rating from 1-10 with 1 being very unsatisfied and 10 being very satisfied. The set of 11 parameters were then added and the average percentage values were calculated for each category of all sites. The checklist is not a perfect analysis of the sites as it was a subjective rating from just one user's point of view. However, it helped to identify certain features that each interface lacked and also provided useful guides in analysing the findings of the evaluation that was conducted as part of this study.

Table 1. Checklist for reviewed websites

	WR		G2G		ER		AC		KI		P		IP		E		B		SW	
	H	F	H	F	H	F	H	F	H	F	H	F	H	F	H	F	H	F	H	F
Interface Design																				
Text readability	8	8	8	8	8	8	8	8	7	5	7	8	7	7	7	8	7	6	6	7
Appropriate use of colours	7	7	8	8	7	7	9	9	9	9	8	8	8	8	8	8	7	7	7	6
Appropriate use of buttons	7	7	7	8	7	6	8	9	8	8	8	8	7	8	7	7	6	7	7	7
Visual consistency & sequencing of screens	7	8	8	8	7	7	9	9	9	9	8	8	7	9	8	8	8	8	8	7
Attractiveness of design	7	9	7	8	6	7	9	9	9	9	7	7	7	8	8	8	8	8	7	6
Interface is pleasant to use	7	9	7	8	6	7	8	9	9	9	8	8	7	8	7	8	7	8	7	6
User friendliness of site	8	8	7	8	7	7	8	8	8	8	8	8	7	8	7	7	7	7	7	7
Ease of use	8	9	7	8	7	7	8	8	8	8	8	8	7	9	8	8	7	8	8	6
Ease of learning the system	8	7	8	8	8	7	8	8	8	8	8	8	8	7	8	7	7	8	8	7
Information provided is easy to understand	8	8	7	7	7	7	8	8	8	8	8	8	8	8	8	7	8	8	7	7
Content Coverage and Organisation																				
Information coverage	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	7
Organisation of information	8	9	8	9	7	7	8	8	8	8	7	8	7	9	8	8	7	8	6	7
All appropriate links under a category	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
Navigation																				
Easy navigation from one screen to another	8	9	8	9	8	7	8	9	9	9	9	9	7	9	8	7	6	8	8	6
Easy to return to page you left off	7	4	7	4	7	4	7	6	7	4	7	6	7	8	7	6	4	4	7	4
Navigation aids helpful and sufficient	8	9	7	8	8	7	8	8	8	8	8	8	8	8	8	7	6	7	7	4
System Capabilities																				
Speed of downloading	8	6	7	8	8	7	8	8	8	8	7	7	7	8	7	6	7	8	7	6
Nielsen's (1993) Usability Attributes																				
Learnability	8	7	7	8	8	7	8	8	8	8	9	9	9	8	8	7	8	8	8	7
Efficiency	8	8	8	8	8	7	8	8	8	8	7	8	7	9	7	7	6	7	6	6
Memorability	8	8	8	8	8	8	8	8	9	9	9	9	9	9	8	8	8	8	8	7
Errors	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	7
Subjective satisfaction	7	8	7	8	6	6	8	9	9	9	7	8	7	9	8	7	6	6	7	6

WR=Within Reach Concepts; G2G= Go 2 Graphics; ER= Embry-Riddle Aeronautical University; AC= Algonquin Collage; KI= Kreativ Info Tech; P= Perceptron; IP= Intellectual Property Australia; E=Escalflowne; B= Brave; SW= Sarolta's Webpage; H=HTML; F=Flash.

4. METHODOLOGY

The methodology adopted for this study was the Prototyping Model. A mock-up prototype of the site was built with Macromedia Flash, which was then tested among the users. The prototype was iteratively revised with the feedback given by the users. The evolutionary prototype method was adopted in this system evolving from a very limited initial version to its final version. For conducting a comparative study between HTML and Flash interfaces questionnaire-based survey method was used.

This method is less formal and is useful in eliciting details of the user's views about the system[13]. The advantage of this method is that it gets the user's viewpoints directly and may reveal issues, which have not been considered by the designer. Questionnaire was chosen as the tool as it is easy to implement as well as administer. Questionnaires can reach a wider group of audience and can be analysed rigorously. Also, the questionnaire included general, open-ended, scalar and multiple-choice type questions. However, higher priority was given to scalar and multiple-choice type questions as they reduce the burden on the respondent and so encourage a high response rate. They also have the advantage of being easier to analyse.

4.1 Questionnaire Design

The questionnaire designed for this study had the following eight sections:

Personal Profile: Questions related to the background of the user and his place within the subject population. The questions in this section were about sex, age, educational qualifications, occupation and computer experience.

Interface Design: Questions concentrated on the interface design issues that are critical in measuring the user friendliness of interfaces. The questions covered text readability (font size, colour, style), appropriate use of colours and buttons, visual consistency and sequencing of screens, attractiveness of design, pleasantness of interface, user friendliness of site, ease of use, ease of learning the system and whether the information provided is easy to understand.

Under each section, questions were asked on a scalar format where the user was asked to judge the specific statement corresponding to a given scale. An open-ended question was included at the end of each section to gather general subjective information to identify errors that may have been missed by the designer.

Content Coverage and Organisation: It contained questions on information coverage, organisation and use of appropriate links to identify a category.

Navigation: The questions covered included navigational issues, such as ease of use of navigation aids.

System Capabilities: This section covered the speed of downloading and the connection the users were using.

Usability Measures: It comprised a set of questions related to the five usability attributes (learnability, efficiency, memorability, errors, and satisfaction) that are associated with user interfaces as mentioned by Nielson[14]. They are discussed in greater detailed in Section 5.

Flash Interface: The questions concentrated purely on the animated user interface. Users were asked to outline any problems that they encountered while using the animated interface.

Overall: Questions covered the overall assessment of the site including the most liked and disliked features of each interface style as well as their comments and feedback.

4.2 Survey Sample

A varied sample group comprising undergraduate and postgraduate students, varied professionals such as IT professionals, training professionals, lawyers, and auditors were asked to evaluate the user interfaces. The target audience was also selected based on some degree of IT literacy. This was essential, as the animated site required the use of Macromedia Flash plug-in so that if a particular computer has no plug-in, the user must have prior knowledge of downloading such plug-ins from the Macromedia website. The survey was conducted online via the Web. Altogether 55 people responded to this survey.

5. DESIGN AND DEVELOPMENT OF THE PROTOTYPE WEBSITE

The site being developed was an academic site. Thus the design features that were used had to complement the contents the site will carry. Design was made to ensure that information could be delivered effectively as well as attractively. The animated interface was developed with a screen size of 750 pixels by 500 pixels. This size was chosen so that all screen elements can be seen on 800 x 600 pixels resolution as well as on a 1024 x 768 pixels resolution. The screen size was also fixed such that the user will not be able to maximise the screen. This was put in place to make sure that the bitmaps that were included do not lose their resolution when screen size adjustments occur at users' end.

The layout of the site was kept consistent throughout in all the frames in the movie. The top banner was used to hold the School's name and the Division' name with links to the respective websites. The left navigation panel was included consistently in all the screens and the right section was used for displaying the contents (Fig. 1). This template was then consistently applied to all the pages in the site to maintain visual consistency. By its look and feel, this site looked similar to HTML version (Fig. 2).

5.1 User Interface

The typefaces that were used in the site were Times New Roman and Arial. Times New Roman was used mainly for the headings and Arial for all the textual contents. Unlike in hypertext interface where the fonts used may differ from browser to browser depending on the users' browser settings, there was no worry about fonts displayed in Flash version. In Flash, it is possible to create websites using any font, as they will be displayed to the user accurately with the plug-in installed. To provide a consistent look and feel a common background colour was set for all the scenes and frames in the site. This background also included the building image of the School of Communication and Information which is not available in HTML version. When planning sites, it is helpful to use metaphors that build on free associations of object or ideas[4]. These metaphors can relate to sounds, images or movement. The moving equaliser image was such a metaphor that was included throughout the site to inform the user about the presence of background music in the site. This image also was added as a button to stop the background music.

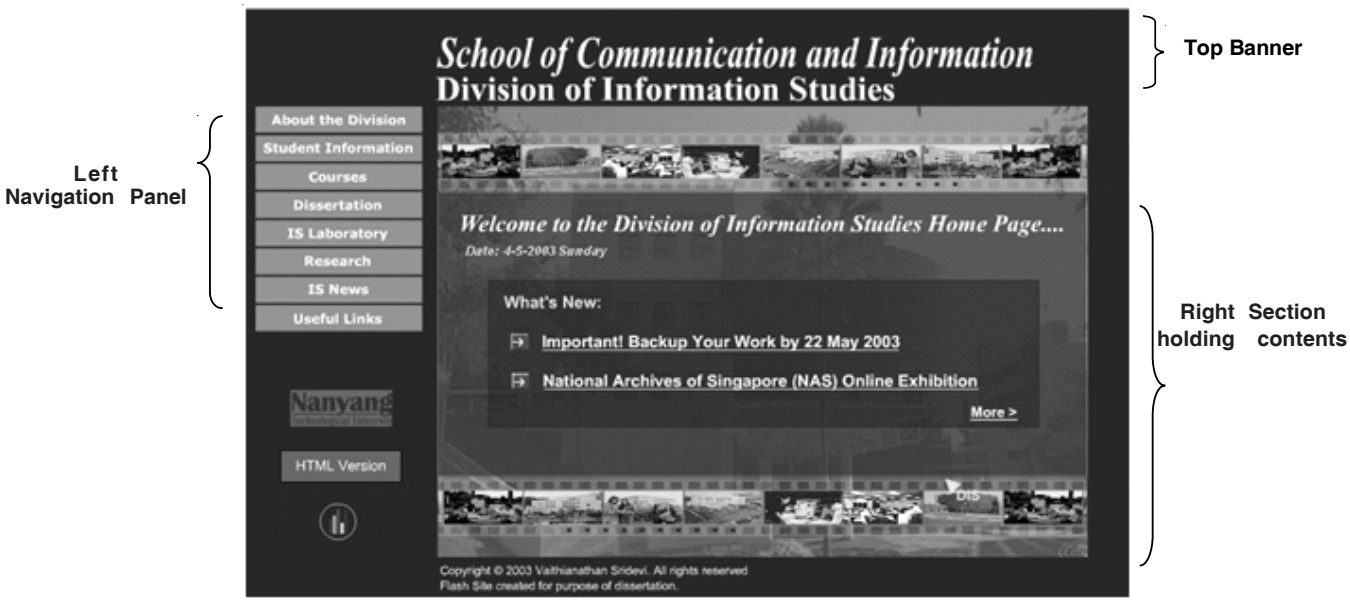

Figure 1. Flash version—common screen layout.

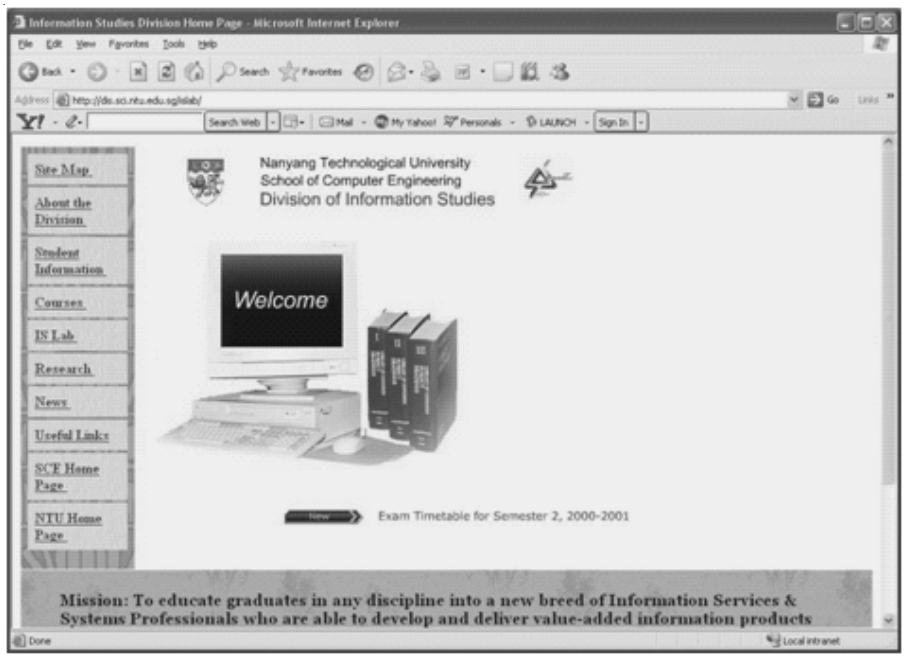

Figure 2. HTML version's homepage.

5.2 Content Organisation

The contents in the Flash site were recreated as they were in the HTML version. All external links that were available in the HTML version were included in the Flash version too. The coverage of information was limited to things pertinent to the Division which the website was aiming to provide leaving out individual course pages and lecturers' home pages. Some rearrangement of information from the hypertext interface was done to make sure that the contents were categorised under the appropriate headings for better organisation and easy understanding. Also, long chunks of information were arranged in scrollable text boxes (Fig. 3) instead of breaking them into several pages so as to minimise the number of mouse clicks by the user in getting to the information.

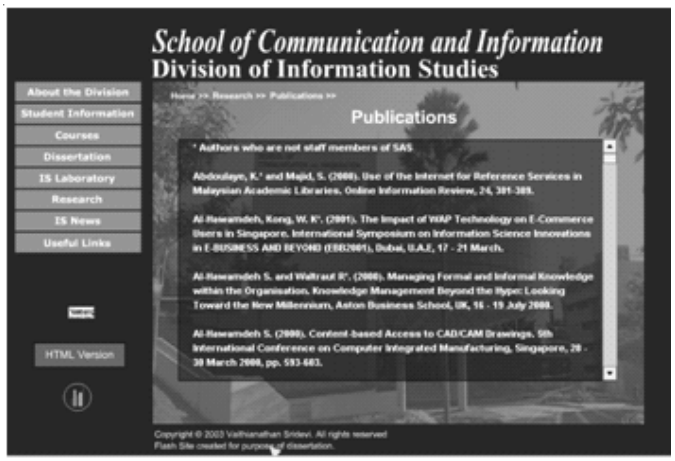

Figure 3. Scrollable textbox.

5.3 Navigation

While browsing a site users get frustrated when they cannot get what they wanted[15]. A comprehensive navigational structure is important and helpful and should be made available to user on every page. The main navigation bar on the left hand side was made available on all the pages of the site. Also, an additional navigational history path was made available on every page to let the user know from where he has come and where he is (Fig. 4). This was distinctively placed at the top for the user's convenience.

Two approaches for structuring content on the Web have emerged: the drill-down structure and the flat structure[15]. A drill-down structure means that the information in the site is layered in several levels beneath the homepage of the site and users must drill down through the layers to see it. The flat structure is a lessening of the drill down approach with one or two levels of drill down but with minimum number of layers so that users get faster to the information they want. The information for this site was a flat structure as shown in Fig. 5.

Figure 4. Navigation path.

The file size of the animated site developed using Flash needs careful consideration especially since users will be accessing the site on the Internet. The developed site was made to ensure that it downloads on the user's computer at an acceptable speed. At the clients end, the users may be using connection of different types such as 56 kbps, ADSL, cable modem, wireless modem, or LAN to access the site. The animated site was optimised in the following ways as per Web design guidelines[16].

- All graphics that were used more than once were converted into graphic symbols.
- All animations that were used more than once were converted into movie clip.
- Tweened animations were used instead of frame-by-frame animations due to their larger file size.
- Extensive use of bitmap images was avoided while creating animations.
- Before publishing the movie, all unused items imported into the document library in Flash were deleted so that Flash does not publish them with the movie.
- The number of fonts used also contribute to the file size. This was kept to four, viz., Arial, Verdana, Times New Roman, and Monotype Corsiva.
- Use of special strokes such as dotted lines or dashed lines were minimised as they add to file size.
- Use of gradients was minimised as they result in larger file size.
- Use of Alpha transparency was minimised so that playback of movie is not slowed down.

The 'Bandwidth Profiler' in Flash has a feature that allows simulation using different types of network speeds. It was used to test the download speed of the animated site on different types of networks. There are five usability attributes that are associated with user interfaces as mentioned by Nielson[14]. These attributes and were included and tested in the design of the animated site and are:

Learnability: Measures how easy it is to learn the interface so that the user can rapidly use and complete

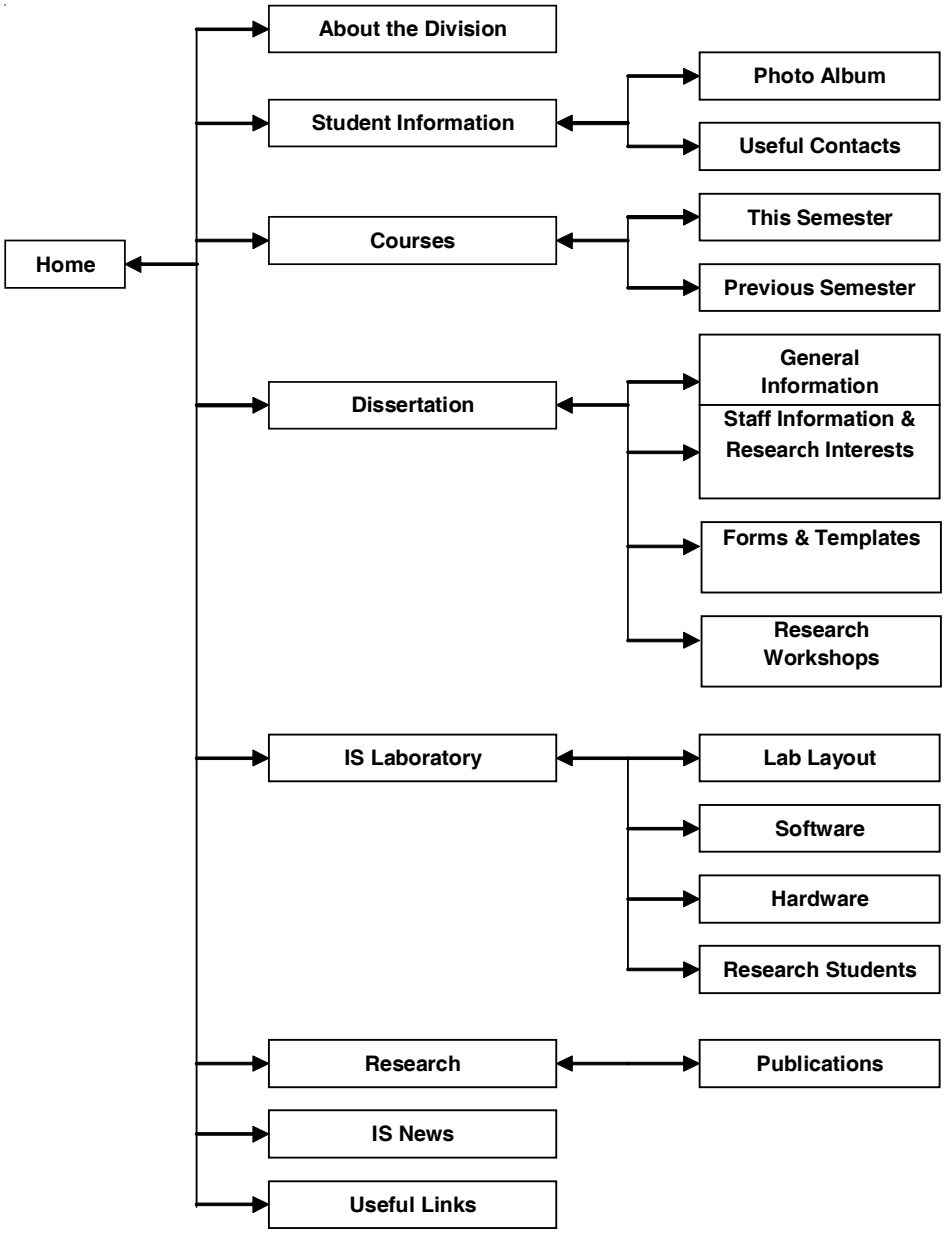

Figure 5. Navigational structure of the system.

the tasks. The animated site made use of familiar navigation styles. Also, metaphors that were used in the site, were made to ensure that they were easy to understand and learn. For example, the moving equaliser image was such a metaphor that was included throughout the site to inform the user about the presence of background music in the site.

Efficiency: Determines whether once users have learnt to use the interface, they are able to use it productively. The navigation style and structure of the interface was designed in such a way that the user could go to wherever and whenever they wanted to. A set of navigation buttons were presented to the user on the left hand side of the screen and maintained consistently on all the pages of the site. Also, the navigation history path provided on all the pages helped the users to know their position and use the system efficiently.

Memorability: Measures whether the interface is easy to remember so that the casual user is able to use the site again without having to re-learn everything. The interface design and navigation style was kept consistent throughout the site and this certainly made the site easy in terms of memorability.

Errors: The site was tested on different platforms and by different people to ensure that no errors existed in any of the pages.

Satisfaction: Determines whether the interface is pleasant to use, and users are subjectively satisfied when using it. The high degree of consistency, efficient

and effortless navigation style and the careful design considerations that went into the interface design were all targeted to ensure that users will feel satisfaction when using the site.

Other screen elements such as graphics, animation and audio that were included in the site were:

Graphics: Graphics give visual appeal to any interface. The images that were used in the interface were optimised in terms of size and resolution using Macromedia Fireworks and were imported into Flash. Though Flash is a vector-based software, images that were imported into it and converted to vector format resulted in loss of quality and colour. Thus all images that were imported into Flash and later converted lost their original quality. However, optimising the file size of the images helped to manage the size of the resulting Flash movie.

Animation Effects: Animation was included in all the pages of the site. Animation was extremely essential for the purpose of this study to complement the information that was being displayed. Some of the animation elements comprised: (i) flying effect of the top banner; (ii) navigation bar on the left loading in incrementally; (iii) mouse over effect on navigation buttons; (iv) animated link button to the NTU homepage; (v) animated equaliser button that shows the presence of music; (vi) moving bar of images on the main page; (vii) pages in the site loading in with animation and audio effect; and (viii) animated slideshow of images.

Audio: Sahlin[16] observed that adding sound to a Flash movie generates more compelling experience for the viewer. In Flash sound can be added as an ongoing background music loop or it can be tied to an event as well. In the animated interface sound was added as background music as well as to the following events: (i) navigation buttons on the left hand side navigation bar play a sound on the event of mouse over on that particular button, and (ii) a sound effect comes on when each page opens up on the screen.

The developed animated interface was tested well to ensure that all the links, and audio and animation effects were working for different resolutions as well as on different operating systems like Windows 98, Windows 2000, and Windows XP. The interface worked consistently on all these systems with a Flash plug-in in the user computer. The type of Web browser used did not affected the way the site worked. The site is currently being hosted at http://www.ntu.edu.sg/home/sridevi/diss/IS_Introv3.swf.

6. EVALUATION OF USER INTERFACES

Evaluation of the animated and the hypertext interfaces was carried out using a questionnaire-based survey method. The questionnaire was sent via e-mail to information studies students, working colleagues, friends, and acquaintances. The target group was identified by their computer literacy and experience with the Internet. There were altogether 55 people who responded to the questionnaire. Of the 55 respondents, 56 per cent were females and 44 per cent were males. Of the total, 54.5 per cent of the respondents were in their late twenties, 34.6 per cent were from 30-40 years age group, 7.3 per cent were from 40-50 years age group, and the remaining 3.6 per cent were less than 25 years of age. The majority of the respondents had a Masters degree (53 per cent), followed by Bachelor's (40 per cent), and one PhD. The rest (5 per cent) did not specified their educational qualifications.

The respondents came from various fields. One-third (31.7 per cent) were from the IT industry. This category was technically savvy and able to evaluate the systems objectively bearing in mind the various technical constraints that are involved in interface design. The second highest category of people was executives followed by librarians, students, consultants, engineers and people from the teaching profession. In terms of computer literacy, 47.3 per cent respondents had 6-10 years of computer experience. More than a quarter (27.3 per cent) had 1-20 years experience, less than a quarter (23.6 per cent) had 1-5 years experience, and rest of these (1.8 per cent) had more than 25 years experience.

6.1 Comparison of User Interfaces

Amongst the respondents, 57 per cent found the text size for the animated user interface to be readable and clear. On the other hand, 46 per cent felt that the text readability was fine in the hypertext user interface. The text size in the hypertext user interface was generally small and not adjustable at the browser end by increasing the font size. The animated user interface had a larger text size that was easy to read. Research has shown that fonts smaller than 10 point result in slower user performance[17].

Amongst those surveyed, 60 per cent of the respondents found the buttons used were appropriate for the animated user interface, whereas 45 per cent of the respondents felt that the buttons were appropriate in hypertext user interface (Table 2). The animated user interface had buttons, which changed colour, and synchronised audio effect when the mouse went over on

them to simulate the effect of clicking. The respondents felt that the buttons in the animated user interface were attractive and pleasant to use. The animated user interface rated well in terms of visual consistency and sequencing of screens (63 per cent) compared to the hypertext user interface (50 per cent). Consistent interfaces reduce the cognitive complexity that users encounter in software programs and other interfaces.

A study done to analyse consistency for interface design showed that inconsistent display layouts had a slightly detrimental effect on the speed of performance[18]. In terms of attractiveness of design, 67 per cent of respondents found that the animated user interface was attractive because of its animated features, lively and appealing interface, jazzy presentation, dynamism in displaying content during transition more impressive than HTML interface, innovative style of presentation of information, animation, and music. Only 28 per cent of the respondents found that the hypertext user interface was attractive. The majority of them (53 per cent) found that the hypertext user interface is average, however, some respondents felt that the hypertext user interface was simple and clear, neatly organised and straightforward to use.

The animated interface was rated by 58 per cent of the respondents as pleasant to use compared to 44 per cent for the hypertext user interface. The higher rating for the animated user interface was attributed to the compactness of the interface as it was presented within one screen without the user having to scroll up and down for more text which many found cumbersome in the hypertext user interface. A study showed that users spent about 13 per cent of their total time scrolling within pages. Although each scrolling takes little time, it was noticed that users spend a considerable amount of time in scrolling. So, it was recommended that each page size should not go beyond three screens[19]. Due to this factor, higher percentage (44 per cent) of respondents felt that the animated user interface was more pleasant and user-friendly than the hypertext user interface (39 per cent).

The animated interface was rated as easy to use by 64 per cent of the respondents compared to 59 per cent of the respondents to the hypertext user interface. Regarding ease of learning, about 70 per cent of the respondents (70 per cent) rated hypertext interface very high compared to 60 per cent who rated animated user interface as very high. Many of the respondents were students of DIS, and therefore familiar with the hypertext user interface for sometime; this might be attributed to the higher rating for the hypertext interface.

6.2 Content Coverage and Organisation

Both the animated user interface (61 per cent) and the hypertext user interface (62 per cent) rated well in terms of organisation of information. The flat structure that was adopted in both the interfaces seemed to appeal to the respondents. When creating a website, it

Table 2. Comparison of user interfaces

Design Issue	Animated User Interface					Hypertext User Interface				
	VG	G	A	P	VP	VG	G	A	P	VP
Text readability	24	33	27	15	2	15	31	36	15	4
Appropriate use of colours	17	52	15	17	0	8	42	38	9	4
Appropriate use of buttons	16	44	29	11	0	9	36	43	11	0
Visual consistency & sequencing of screens	19	44	24	13	0	2	48	33	15	2
Attractiveness of designs	26	41	20	9	4	2	26	53	17	2
Interface is pleasant to use	15	43	22	15	6	4	40	36	15	6
User friendliness of site	13	44	31	7	5	9	39	35	13	4
Ease of use	15	49	22	11	4	9	50	22	17	2
Ease of learning the system	15	45	24	13	4	13	57	11	17	2
Information provided is easy to understand	16	47	18	15	4	17	48	19	13	4
Total in %	**17**	**44**	**23**	**13**	**3**	**9**	**41**	**33**	**14**	**3**

VG=Very Good; G=Good; A=Average; P=Poor; VP=Very Poor

is beneficial to "flatten" the hierarchy and to provide information quickly. The more steps or clicks users take to find the desired information, the greater the likelihood they will make a wrong choice[20]. Amongst the respondents, 63 per cent felt that it was easy to navigate from one screen to another in the animated user interface compared to 58 per cent who found it easy in hypertext user interface. Some respondents who were using Netscape browser to view the hypertext user interface found that the navigation menu did not work properly.

Regarding ease to return to a page, both the interfaces were rated almost the same (animated 53 per cent vs hypertext 54 per cent). Many of the respondents felt that the animated user interface lacked a 'Back' button. One respondent commented that 'back space' key too did not work in the animated user interface, which works in browser environments bringing users to the previous state. Also the navigation menu in the animated interface was not designed to show a sub-menu when the mouse went over it, however, it was available in the hypertext user interface.

6.3 Navigation

Amongst the respondents surveyed, while 49 per cent felt that the navigational aids were helpful and sufficient in the animated user interface, 40 per cent felt similarly about the hypertext user interface. One of the most common comments regarding the hypertext user interface was that the pages were too long and users need to scroll all the way up after viewing a page so as to get to see the navigation bar again. The animated user interface on the other hand packed all content within one screen and the navigation menu was always available for the user on the left hand side. However, the navigation in the animated user interface lacked the 'Back' button feature and the pop-up sub-menu feature that many DIS students used in the hypertext user interface.

6.4 Speed of Downloading

About half of the respondents (48 per cent) found that the animated site downloaded at a good speed. However, 64 per cent felt that hypertext version downloaded much better. The 10 sites reviewed earlier indicated similar results whereby hypertext interfaces downloaded faster than their animated counterparts. It is important that websites need to load quickly. In a study, Web users rated download time up to 5 seconds as good, up to 6-10 seconds average and over 10 seconds as poor. Users will generally wait about 10 seconds for a page to download, sometimes 15 seconds, before they lose interest[21]. In another study, it was found that Web users' tolerable waiting time for downloading webpages in information retrieval is approximately 2 seconds[22]. Almost half of the respondents (47 per cent) had accessed the sites from local area networks (LAN) both from NTU or their respective workplaces, and about (23 per cent) of them were using 56 Kbps connection. It was noticed that network connection also plays an important role in downloading webpages and also responding to users' interaction with the system. Table 3 shows users' rating of the downloading speed of the animated interface for the various connection types. A Chi-square test was conducted to verify that there is a relationship between the speed of downloading the animated user interface against connection type. The relationships (P: 1.14 at 0.05 level) was found significant (Table 4). Further, a Chi-square test was carried out to find out whether there is a significant difference in downloading speeds of animated interface versus the hypertext interface. The relationship (P: 0.000215 at 0.05 level) between the type of interface and download was significant (Table 5).

6.5 Usability of the Interfaces

The five usability attributes (learnability, efficiency, memorability, errors and satisfaction) that are mentioned by Nielson were also tested in this study.

Table 3. Speed of downloading animated user interface versus connection type

	Very fast %	Fast %	Average %	Slow %	Very slow %
56 kbps	-	25	25	50	-
ADSL	25	50	-	25	-
Cable modem	-	50	33	17	-
Wireless modem	-	-	100	-	-
LAN	20	32	16	24	8
Not Sure	-	-	100	-	-
Others	-	-	-	-	-

Table 4. Speed of downloading versus connection type

	High speed	Average speed	Low speed
56 kbps	25 (42.3)	25 (24.6)	50 (33.0)
Cable modem	50 (42.3)	33 (24.6)	17 (33.0)
LAN	52 (42.3)	16 (24.6)	32 (33.0)

Table 5. Speed of downloading

	High speed	Average speed	Low speed
Hypertext interface	64 (55.5)	28 (25)	8 (19.5)
Animated interface	47 55.5)	22 (25)	31 (19.5)

Learnability: The majority (75 per cent) of the respondents found that the animated user interface was easy to learn and almost equal percentage (73 per cent) of the respondents rated hypertext user interface also well in terms of learnability. The chi-square test also showed a significant association between the respondents for the animated user interface and the hypertext user interface in terms of learnability.

Efficiency: Of the total, 82 per cent respondents, found both user interfaces efficient to use. The chi-square test showed a strong dependence between the animated user interface and the hypertext user interface as well in terms of effectiveness in use.

Memorability: In this case, 75 per cent of the respondents found that the animated user interface was good compared to 69 per cent who found hypertext user interface good. The chi-square test also revealed that the memorability of the animated user interface and the hypertext use interface were dependent on one another.

Errors: Both the animated and the hypertext interfaces were tested on different platforms by different people to ensure that no errors existed in any of the pages in the respective sites. The respondents were also asked to list the errors encountered while using these interfaces in the questionnaire. It was noted that most (98 per cent) of the respondents found no errors in the animated user interface and also in the hypertext user interface (94 per cent).

Satisfaction: Satisfaction is an important indicator of user attitude towards using and continued use of a website[23]. The majority (84 per cent) of the users were satisfied with the animated user interface and slightly higher percentage of users (87 per cent) were satisfied with the hypertext user interface. The remaining 16 per cent who were not satisfied with the animated user interface found that the window size of the animated user interface was too small and wanted to incorporate window resizing features in it. Three of those respondents also mentioned that the animated site was a bit boring with too much information. A few of them mentioned that the colour combination of blue and white is a bit dull and boring and did not like its longer downloading time. About 13 per cent who did not like the hypertext user interface found that the interface is cluttered with too much information that resulted in scroll up and down. The presentation was mentioned as 'a poor visual treat and laborious to read'. Overall the design was found to be 'monotonous' and 'boring' and that they got lost while surfing for information.

Most of the users (96 per cent) had no problems while using the animated user interface and the effect of animation on the users' perceptions of an interface was profound. Inappropriate use of animation will seems childish and drive users away, however, sensibly applying the same could make an interface more graceful and enjoyable to user[6]. The majority (65 per cent) of the respondents found good use of animation that was present in the animated user interface. Many liked the animation and commented that it was light and downloaded reasonably fast compared to other sites where heavy animations resulted in long downloading times. Respondents commented that animation did complement their actions and did not obstruct them in any way. One respondent commented that more animation would have made the site more interesting, however, another respondent felt that the mouse pointer animation was unpleasant and blocked the view when clicking on the links. The chi-square test that was done for the speed of downloading the animated user interface against the animation in the animated interface derived a value of 0.02, which showed that there was a significant relationship between the two.

The respondents found the audio that was present in the animated user interface satisfactory (42 per cent). Some of the respondents found the audio, especially the background music as distracting and irritating and felt it was not necessary for the purpose of this site. However, a few respondents felt that the music gave an extra impetus and wanted those features whereby options to select the type of music is also given. The Chi-square test that was done for the speed of downloading the animated user interface against the audio in the same interface showed no significant relationship between speed and how respondents felt about the audio.

For the images that were present in the animated user interface, 67 per cent of the respondents found them good. Some of the respondents commented that the moving images on the first page were nice and that more images throughout the pages would have enhanced the site look even better. Contrastingly some respondents had also commented that more images may result in slow downloading time.

On the whole, 61 per cent rated favourably towards the animated user interface in terms of interface design as compared to 50 per cent rating for the hypertext user interface. From the review of the 10 sites reported in the earlier section, eight of the sites rated higher because of their animated user interfaces. The total rating percentage for content coverage and organisation was better for the animated user interface than the hypertext interface. This was similar to the 10 sites reviewed earlier in this study where animated sites rated better for content coverage and organisation as compared to their hypertext counterparts. Overall, a total of 55 per cent of respondents felt easy while navigating in the animated user interface against 51 per cent in hypertext user interface. For the 10 sites reviewed earlier, eight of the hypertext sites rated high because of easy navigation. The animated site that was developed therefore paid special attention to navigation, especially for ease of returning to page from where they had left, which was a common problem in all the animated sites reviewed. Though in the developed site the browser 'Back' button was disabled completely, there was history path that helps user to return to previous page.

On the whole for usability the animated user interface rated well in terms of learnability, efficiency, memorability and errors. This was in line with the 10 sites reviewed earlier as part of this study. The 10 sites reviewed earlier also had rated well for subjective satisfaction, which was not the case for the developed animated user interface.

7. ONGOING STUDIES AND FUTURE EXTENSIONS

This study on animated user interface against hypertext user interface focussed on Flash against HTML. There are various other tools that can be used for designing animated user interfaces and this can be explored further. The animated user interface lacked a 'Back' button, which is a set back, and an issue brought up by several respondents of this study. The standard backtracking method in the Web browser takes the user out of the animated site itself. This was rectified in the developed animated site through other means.

Penner[24] had suggested a way of combining Flash with HTML to solve this problem of the 'Back' button in Flash. Additional research can be done to find out how this can be resolved with Flash itself without the use of HTML. In this study both the animated interface and the existing hypertext interface lacked a 'Search' feature. Though it is possible to incorporate a search feature in hypertext interfaces easily, Flash in general integrates poorly with search. In future research this feature can be explored too.

8. CONCLUSION

The 10 sites reviewed as part of this study existed as dual interfaces in HTML and Flash, presented the same information, however, the style of presentation was different in these interfaces. Most of the Flash versions were better in terms of design and the motion elements. However, the Flash versions were usually slower to download unlike the HTML versions.

From the evaluation of the animated and hypertext user interfaces, it was found that the animated user interface was preferred for its text readability, appropriate use of colours and buttons, visual consistency and sequencing of screens, attractiveness of design, pleasantness and user friendliness of interface, ease of use, content coverage, organisation of information, navigation and usability. Similarly, the majority of the respondents (89 per cent) found the developed animated user interface as good. This was in line with the ratings of reviewed 10 sites, which rated better because of their animated interfaces. On the other hand, the hypertext user interface was preferred for its speed of downloading and its navigational capability that complemented the Web browser navigation. Though history path was provided to replace Back button in animated interface, some of the users are not satisfied with it and preferred hypertext interface. In both cases, most of the respondents did not face any problems while using these interfaces. The main problem encountered by some of these users is downloading time which is dependent on connection type used. It is hoped that technology will soon solve this problem by introducing cheaper and fast communication lines.

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