

The Display of Electronic Commerce within Virtual Environments

S. S. Morar, N. Patel and R.D. Macredie

Department of Information Systems and Computing, Brunel University, London, UK

ABSTRACT

In today's competitive business environment, the majority of companies are expected to be represented on the Internet in the form of an electronic commerce site. In an effort to keep-up with current business trends, certain aspects of interface design such as those related to navigation and perception may be overlooked. For instance, the manner in which a visitor to the site might perceive the information displayed or the ease with which they navigate through the site may not be taken into consideration. This paper reports on the evaluation of the electronic commerce sites of three different companies focusing specifically on the human factors issues such as perception and navigation. Heuristic evaluation, the most popular method for investigating user interface design, is the technique employed to assess each of these sites. In light of the results from the analysis of the evaluation data, virtual environments are suggested as a way of improving the navigation and perception display constraints.

1. INTRODUCCION

The appropriate presentation of products and information is considered of the utmost importance for e-commerce websites. This is substantiated by organisations employing professional bodies such as window-dressers and media companies to ensure that the display of products and information is visually appealing in the real world. However, with regards to e-commerce sites, many companies appear to overlook this factor (Stolze et al. 1998) which is normally so important for shop windows and internal layout, company brochures, and advertising campaigns. Furthermore, it appears that little consideration has been given to how a visitor to an e-commerce site may perceive the information, which in turn, could effect the way the site is navigated (Stolze et al. 1998).

Current displays may be considered as predominantly two-dimensional whereby the display would be viewed from either a single viewpoint or by adjusting the vertical and horizontal scroll bars (Wann and Mon-Williams, 1996). Adding a third dimension by using Virtual Environments could be a useful way to allow users to further 'traverse' the e-commerce site by interactively changing the viewpoint. The objective of this paper is to identify whether the perception and navigation aspects of e-commerce sites can be enhanced with the use of Virtual Environments. This is achieved by conducting heuristic evaluation on three e-commerce sites with the aim of identifying navigation and perception issues. Heuristic evaluation has been selected because, in addition to being the most popular user interface evaluation technique (Nielson, 1999) certain heuristics are particularly applicable to the navigation and perception aspects of user interfaces. Following this is an investigation of how the use of Virtual Environments could enhance current two dimensional e-commerce displays.

2. EVALUATION CRITERIA FOR E-COMMERCE DISPLAYS

The quality of application displays has been an important issue within the area of human computer interaction. The manner by which information is presented can influence the extent to which the application is effectively used (Shneiderman, 1992). By creating displays, which are sensitive to users' abilities and requirements, more intuitive applications may be developed. This is increasingly important as applications become web based, providing services to a broader customer domain (Shneiderman, 1997). Electronic commerce refers to the process of conducting business transactions on the web. The transactions can be between businesses and their customers, either other businesses or members of the public. The presentation of these transactions can determine how effectively they are undertaken, which places an emphasis on interface design issues. Design principles and methods have been widely discussed and developed within the human factors field. They have been incorporated into displays that are either platform specific (Microsoft, 1992) or abstract, adapting to general purpose displays (Heckel, 1991). However, the design issues focussed on within this paper are the effective perception and navigation of e-commerce sites. Shneiderman (1997) acknowledges that textual displays are only an aspect of web display and visual information seeking will have to accommodate the increase of web display variations. These display variations are particularly evident in the display of e-commerce since customers now have the option of viewing and purchasing products on the web. It is the display of the products and the ability for customers to browse effectively which pursues the concern of this paper.

An e-commerce system can be considered only as good as the interface that presents it. Lohse and Spiller (1998) address user interface design issues specifically for electronic shopping. They have expressed the lack of importance developers often place on the user interface aspect of e-commerce applications. This neglect can be recognised from the limitations of menu systems resulting in poor navigation and perceptually weak displays (Conklin 1987, Baty and Lee 1995, Tilson et al. 1998). Baty and Lee (1995) have described the display limitations as creating

‘navigational confusion’ and this is further maintained by Chau et al. (1998) who agreed that poor design of shopping interfaces is a significant factor contributing to unsuccessful e-commerce. Shneiderman (1997) addresses this concern broadly by recognising the growth of web content and respective displays. He explains that the trend of designers is to use old forms to create new websites or identify the lowest-common-denominator design and this may not effectively accommodate the larger, enhanced displays. Henninger et al. (1995) also agree that current interface development guidelines provide weak support for diversity of information displayed. Shneiderman (1997) states that the current knowledge of interface design would have to be used until more practical cases are proposed. He considers the user’s tasks and suggests that this provides the designer with a display guide, perhaps it could even be considered a fundamental guideline.

2.1 Design Principles

Various interface design issues have been discussed in the human factors field highlighting the importance of display attributes to support interactive tasks (Gould and Lewis 1985, Norman 1988, Shneiderman 1992, Nielsen 1996, Shneiderman 1997). Shneiderman (1992) lists eight design principles for dialogue design. These cover the requirement for consistency, the use of shortcuts to reduce the number of interactions and increase the pace of interaction. Informative feedback is another principle stated which refers to clearly indicating the end of a process. Other principles include simple error handling, ability to reserve actions, ability for the user to feel in control and the reduction of short term memory load. Shneiderman (1997) progresses to consider categories of websites. The first categorisation reflects the originator’s identity, which may give an indication about the content and objectives of the site. The second categorisation concerns the number of pages within the site. The number of pages varies from small personal websites to medium and large organisational sites presenting company product or service information (see Shneiderman 1997, Table 1). Consideration of this principle could be to ensure

that a website contains a suitable number of pages. For instance, a company web site that does not have a limited number of pages. The third categorisation concerns the goals of the originator as presented by the designer. This may refer to the ability of an e-commerce website with the use of the display attributes to fulfil the business objective. Shneiderman (1997) states the fourth categorisation of web sites by the measure of success which can vary from individuals achieving their personal objective to corporate web sites achieving recognition from the number of visits or more directly from the number of sales of their products.

Nielsen (1999) reconsidered the design principles he proposed three years earlier. He refers to the design principles as “mistakes” which are various detrimental features incorporated into web pages. The mistakes vary from incorporating too much animation and scrolling text within the pages to lack of navigation support. This refers to whether features such as a site logo are missing from the page; if so it may be difficult for users to determine exactly where they are within the site. Outdated information has also become a very severe problem in websites. Nielsen (1999) stresses the importance of updating information especially in the growth of e-commerce as displaying outdated information could result to losing credibility. Nielsen and Molich (1990) established a method for evaluating interfaces according to particular issues framed as heuristics. Table 1 illustrates the heuristics used for the display evaluations.

The first of the nine heuristics considered whether the interface provided simple and natural dialogue, which meant that the display should present relevant information in a natural, logical order. The second heuristic considered whether the interface was comprehensible to the user and did not display information in system-orientated terms. The third heuristic concerned minimising the users memory load by ensuring that the user did not have to remember information and complicated instructions were simplified. The fourth heuristic referred to the consistency of the display so that the user was not confused about the meanings of display

attributes and whether they meant the same thing. The fifth heuristic concerned the provision of meaningful feedback to keep the user informed about tasks within a reasonable time period. The sixth concerned providing clearly marked exits so that the user is able to satisfactorily deal with a mistake by ending a dialogue without have to complete further instructions. The seventh concerned providing shortcuts so that the user can proceed through the display efficiently. The eighth heuristic concerned the provision of good error messages and the ninth concerned the features of the interface that help to prevent errors.

<u>HEURISTICS</u>	<u>INTERPRETATIONS</u>
Simple and Natural Dialogue	: <i>Relevant information presented in natural, logical order.</i>
Speak the Users Language	: <i>Dialogue expressed in words, phrases and concepts familiar to user.</i>
Minimise User Memory Load	: <i>Instructions for use should be simplified and easily retrievable.</i>
Be consistent	: <i>Avoid different words, situations or actions meaning the same thing.</i>
Provide Feedback	: <i>Keep the user informed about tasks within reasonable time period.</i>
Provide Clearly Marked Exits	: <i>Provide visible escapes for users correcting mistakes.</i>
Provide Shortcuts	: <i>Features to eliminate verbose dialogues.</i>
Good Error Messages	: <i>Precise information about the cause of a problem.</i>
Prevent Errors	: <i>Features to prevent problems occurring in the first place.</i>

Table 1: Nine Usability Heuristics (Nielsen and Molich 1990)

2.2 Heuristic Evaluation

The principles discussed by Shneiderman (1992) seemed similar to the nine heuristics devised by Nielsen and Molich (1990). The heuristic evaluation technique covered display design issues regarding information content and structure. Heuristics such as ‘simple and natural dialogue’ and ‘minimise user memory load’ reflected the amount of display attributes such as hypertext and graphics used as metaphors. This reflects the cognitive psychological issue raised by Miller (1956) who claimed that individuals could remember seven chunks of information consecutively, plus or minus two chunks. Heuristics such as ‘providing clearly marked exits’ and ‘providing shortcuts’ could reflect upon the navigational aspects of the displays.

Nielsen and Molich (1990) stated the advantages of heuristic evaluation as being cheap, intuitive and easy to use, does not require advance planning and can be used early in the development process. However, the nature of the evaluation technique means that it can be biased by the opinions of the evaluators and usability problems may be identified without providing solutions for them. The heuristic evaluation technique seems the most suitable for evaluating e-commerce displays because it appears to focus on the required design issues and yet retains its adaptability. The nine heuristics were considered in respect to the three websites by ten evaluators. Molich and Nielsen (1990) expressed that the heuristic evaluation technique was more effective with the results from a number of evaluators. Their study indicated that ten evaluators provided up to 97% of problem identification therefore, ten evaluators were selected to undertake the task.

3. E-COMMERCE WEBSITES

Examples of popular e-commerce web sites are Amazon (Amazon, 2000) which is the web based book shop, Lastminute.com (Lastminute.com, 2000) which is the online travel shop and Egg.com (Egg, 2000) which is the internet banking service. These particular web sites are widely accessed which could broadly prove the extent of their usability. For the purpose of this paper, three alternative web sites were selected. The first was an online clothing store called Nine Lives. The second was Tesco online supermarket and the third web site was Bradleys Estate Agency. The reason for these particular selections was that within the real world environments, individuals would be involved with 'browsing' through each of these business types in order to make their purchase decisions. Therefore the purpose of this paper is to evaluate how effectively customers can use the e-commerce versions since display attributes such as metaphors (Shneiderman 1997) and the structure of displayed information can be considered particularly important.

3.1 Nine Lives Clothing Store

McEachern and O'Keefe (1998) describe a case of a second hand clothes store creating a presence on the web. In 1994 Nine Lives clothes store was one of the first small businesses to be represented on the World Wide Web. It specialises in buying and selling second hand goods by well-known designers. Initially, the site consisted of an electronic catalogue containing information about all the items at Nine Lives. One of the partner's was not satisfied with this so, being an enthusiastic C programmer, he decided to combine the store database with the existing website. The purpose of this was to allow visitors to perform queries regarding the availability of specific items with immediate results. This facility was further enhanced with the implementation of an *agent* (although it was not known as this at the time). The visitor was able to save queries in their personal shopping profile and could access this via a password at any time. A comparison between user queries and stock contained in the shop was performed on a daily basis. If a match was found the user was automatically emailed. The advantage of this, for the user, is that it saved repeated visits to the site. They knew that when their item came in they would be informed. This resulted in a huge increase in customer sales for Nine Lives (1999).

3.2 Tesco Supermarket

Tesco, founded in 1924, is Britain's leading food retailer (Tesco, 1999). In 1996 Tesco introduced the concept of Home Shopping. This allowed people to do their shopping from home via the Internet and a CD-ROM (provided by Tesco). The CD-ROM contained a list of all the products, along with prices, available at Tesco's so that the consumer could make their order off-line and send it using the internet. Through research, Tesco determined that, in comparison to the past, people were working longer business hours. This meant they had less free time – visiting a supermarket would not be an ideal way of using limited leisure time. Later on that year, Tesco developed this service further to include on-line Internet-based home shopping.

3.3 Bradleys Estate Agents

Bradleys Estate Agents was founded in 1992 and opened its first branch in Exmouth (Bradleys On-line, 1999). Over a period of six years they have managed to acquire an additional 16 offices in the south-east region of England. Until 1997, Bradleys worked in the traditional manner of Estate Agents i.e. properties and related information displayed via storefronts. Potential buyers/renters could take away a list of information and perhaps a photograph of the property they were interested in. In order to gain knowledge about the internal structure of the property it was necessary to book an appointment and view it personally. In an effort to provide a better service to its customers, Bradleys began investigating the benefits of having a presence on the web.

4. OBSERVATIONS AND RECOMMENDATIONS

The nine heuristics (Nielsen and Molich, 1990) were applied to the three web sites by ten evaluators. The evaluators proceeded through each web site and rated the particular heuristic according to their opinion of how well the e-commerce display met the evaluation criteria. Tables 2 shows the ratings in percentages of the ten evaluators.

4.1 Results and Observations

With regards to the results for the first evaluation criterion the Tesco e-commerce site was considered the least logical because numerous hierarchies of lists needed to be navigated before reaching the desired product. Furthermore, it was necessary for the visitor to be aware of what categories the desired products were stored under in order to shop efficiently. Bradleys Estate Agents was evaluated slightly higher than the Tesco site. The general comments in relation to the second site was that although all the relevant information was presented it did not appear to be in any logical order. The results from the Nine Lives site were relatively high with regards to this criterion. Evaluators appreciated the fact that the site was structured in the manner of a physical shop, that is, Menswear in one section and Women's in another.

In response to the second criterion all ten evaluators were satisfied that each of the sites used no systems language and felt that the language that was used was appropriate and relevant to the context. For example, Nine Lives only uses dialogue that is found in physical clothes stores. The same applies to Tesco and Bradleys Estate Agents who use words and phrases used in a physical supermarket and estate agents respectively.

The results for the third criterion are average for all three e-commerce sites. It appears that with each case the procedure to find, select or buy something generated a process which the visitor was required to remember. The obvious and most common example was finding an item from the Tesco website. This required identifying what set of categories the item was stored under and then this sequence would have to be memorised the next time a visitor purchased an item.

For the fourth criterion, which is related to the consistency of the e-commerce site, the results are all above average. The most consistent site was Tesco who use the same template throughout the site. There was some level of consistency with regards to Nine Lives and Bradleys Estate Agents but the main layout of the pages seemed to change from page to page.

With respect to the fifth criterion, which is concerned with providing the visitor with appropriate feedback, the values again are above average. Two examples provided to illustrate this point are when a search for an item that does not exist was carried out. The Tesco site returned the same page for the user to complete again without any error message or indication of what the problem was. However, the Nine Lives site provided a detailed error message along with suggestions for what may have activated the error message.

The values for the sixth criterion, which is related to the site providing clearly marked exits, are high in all cases. The evaluators found that they were guided throughout by the options on the site and the exit route available on each page.

In relation to the seventh criterion, which relates to the provision of shortcuts, the findings are above average. It appears that the Nine Lives site received the lowest percentage in this particular category because it is mainly text based and only provides shortcuts via the 'point and click' shopping facility. The results from Bradlays Estate Agents are in-between Nine Lives and Tesco. Evaluators noticed that although the site uses many shortcut icons the associated text is placed beside or inside the icon. The Tesco site achieved the highest figure for this category because it uses a combination of text and icon based options.

The penultimate criterion concerns the quality of error messages, in particular, information regarding the cause of the problem. The Tesco site gained the lowest percentage because when errors were initiated no error messages were returned. For example, when the wrong clubcard number was entered the site returned the page but did not explain that an error had occurred. With regards to Bradleys Estate Agents evaluators found that it was difficult to initiate any errors and felt that this was a good feature therefore assigned a relatively high score. The Nine Lives site received the highest value for this category because in all cases the site returned a detailed error message and making suggestions regarding the cause of the problem. For instance, when the site was asked to search for an account number that did not exist an error message was returned explaining that the account could not be properly identified and this could be due to a number of reasons including: capitalisation or typography. Furthermore, it advises that the program is case sensitive and to try again. If the visitor still encounters problems the site provides a contact number for further assistance.

The final criterion relates to the prevention of errors. All three sites gained high scores for this category. The evaluators felt that each site guided them through the site and they did not encounter any problems.

Table 2: Overall Percentage Results

<u>HEURISTICS</u>	<u>Nine Lives</u>	<u>Tesco</u>	<u>Bradleys</u>
Simple and Natural Dialogue	70	55	57
Speak the Users Language	100	100	100
Minimise User Memory Load	50	50	60
Be consistent	60	70	60
Provide Feedback	65	60	62
Provide Clearly Marked Exits	90	85	90
Provide Shortcuts	65	75	70
Good Error Messages	90	55	60
Prevent Errors	90	90	90
Total Averages 96.2	75.5	71.1	

The results from this evaluation and in relation to the three websites show that the results for the first (Simple and Natural Dialogue) and third (Minimise User Memory Load) criteria are low in comparison to the other categories. The former heuristic relates to presenting relevant information in a natural, logical order (Molich and Neilson, 1990). Since the initial version of 'heuristic evaluation', Nielson (1994) has extended this heuristic to include issues such as comparing the system and the real world and identifying if the system follows real world conventions. This suggests that the closer an e-commerce site is to the real world the higher it is rated with regards to heuristic evaluation. A possible way of achieving this is to use Virtual Environments, which facilitate the replication of a three-dimensional environment. The latter heuristic relates to minimising a user's memory load. It is believed that by presenting the user with an environment with which they are already familiar in the real world may decrease the amount of information to be memorised whilst navigating an e-commerce site. Familiarity with the environment would save them from having to learn new ways of achieving the desired outcome. For instance, in a physical supermarket a buyers shopping technique involves browsing

by walking up and down the aisles. The e-commerce version of a supermarket involves navigating through hierarchies of categories. This means that the buyer is required to learn and memorise the sequence of categories for each item. A three-dimensional version of a supermarket where the layout and procedures are the same as a physical supermarket would be a possible way of minimising the user's memory load.

4.2 Recommendations: Virtual Environments

Currently the majority of e-commerce is displayed in a two dimensional manner by which various navigational tools, graphics and narrative facilitate business transactions. Human factors issues highlighted in section 4.1 convey the display inefficiencies, which influence progression through the websites. The results indicate that the major issues concern limiting the users memory load and providing simple, natural dialogue in a logical manner. It is proposed within this section that introducing another dimension to the displays may be considered as the supplement for these two-dimensional interface deficiencies thus improving perceptiveness and navigation. Wann and Mon-Williams (1996) suggest that as more variety of information becomes available, applications can benefit from enhancing the traditional two-dimensional display techniques.

Virtual environments provide the means of displaying the added third dimension in either an immersive or non-immersive (desktop) manner. Immersive Virtual Environments refers to the presentation of a three dimensional environment through the use of the head mounted display (HMD). The HMD provides the user with a stereoscopic view of the third dimension in which users are able to view and move through the immersive, synthetic environment (Barfield and Furness, 1995; Kalawsky, 1993). The alternative presentation of virtual environments is on a non-immersive, desktop display which is considered more applicable to the context of this paper since applications on the desktop are more widely accessible in comparison to HMDs.

Desktop virtual environments can describe the ability for information to be presented in an enhanced, three-dimensional manner on the desktop. In particular, this would relate to the idea expressed by Wann and Mon-Williams (1996), which acknowledges the current use of multiple windows to display information within and between applications and recognises that this representation is subject to two-dimensional constraints. According to the evaluation results presented in the previous section, the main two-dimensional display issues concerned the presentation of information in a natural, logical manner, which could accommodate the users short-term memory load. It may be the case in the current displays that the user becomes overwhelmed with the presented information and confused with the organisation of respective displays, especially if a process is involved. Therefore, with the introduction of a third dimension, the existing information could be structurally organised to improve navigation. For instance, a two-dimensional flowchart would be viewed from a single viewpoint or by adjusting the vertical and horizontal scroll bars. With a desktop virtual environment, the user has the ability to interactively change the viewpoint which would increase the number of views of the same flowchart (Wann and Mon-Williams, 1996).

Applying the desktop virtual environment concept to e-commerce may improve the perception of websites through the presentation of more viewpoints or ability to present the information in a more “realistic” manner. It is the idea that users approach shopping on the web with the experience and background of shopping in the real world, that drives the idea of ‘desktop virtual e-commerce’ (Baty and Lee, 1995; Lohse and Spiller, 1999). The following sections discuss how the use of Virtual Environments may be applied to each of the three business domains considered in the evaluation: supermarkets; estate agents; and a clothes store.

4.2.1 Online Supermarket

Manipulating the displays in this manner could accentuate the perception of information. Kalawsky (1993) argues that developing virtual environments would provide the most natural means of communicating with a computer. Humans have developed a three-dimensional spatial processing capability, which could be supported by the computer's representation of an environment (Kalawsky, 1993). With respect to e-commerce applications, this is particularly applicable to the concept of home shopping which enables a user to shop for supermarket items via the internet, from home (Lohse and Spiller, 1998).

Current home shopping applications seem to place emphasis on the textual descriptions of the products and their aisle locations (Tesco, 1999). As a result, users are unable to view the products they are selecting or possible alternatives that may be available in the supermarket, which is the case when proceeding through an actual aisle in the physical world (Titus and Everett, 1996). Therefore, the two-dimensional representation may be considered elementary if compared to the possibilities of a virtual environment home shopping application.

Within the three-dimensional representation of a supermarket, users would have the capacity to navigate through virtual aisles, which would consist of product images. This concept would mimic a real shopping experience, providing perceptive displays of a shopping environment and hence, a sense of familiarity. A consideration and possible human factors issue would relate to the sense of immersion of such e-commerce displays (Robertson et al., 1997) and at the same time minimising users short term memory load which was an evaluation concern. Ideally, the aim would be to captivate the user's attention by creating a display that enables the user to feel completely engrossed within the context of the e-commerce application (Robertson et al., 1997). This is usually related to the capabilities of Immersive Virtual Environments, requiring the use of HMDs to literally submerge the user in the synthetic environment (Kalawsky, 1993). It can, however, be suggested that proper three-dimensional cues and the ability to manipulate virtual

objects within the desktop virtual world can initiate mental and emotional immersion (Csikszentmihalyi and Kubey, 1981).

4.2.2 Online Clothing Store

With reflection on the Nine Lives clothes store example discussed within this paper (McEachern and O'Keefe, 1998), the current website displaying various clothing items can be considered limited with respect to user capabilities. For example, the user is able to select one category at a time, such as shirts, and would not be able to compare this item with any other, to see if they match. Enhancing the Nine Lives application with virtual environments could provide potential customers with the ability to browse through the shop by manipulating the viewpoints of the various shop displays (Wann and Mon-Williams, 1996).

4.2.3 Online Estate Agency

Navigational considerations can be regarded as particularly applicable to the cognitive aspects of the estate agent website discussed in the third e-commerce example (Bradleys On-line, 1999). The current application consists of menus for selecting property categories that are of interest and their respective photographs. For example, the type of house and the area in which it is situated. Enhancing this e-commerce website with virtual environments could enable prospective buyers to navigate through a virtual representation of a chosen house and possibly gain more of an insight to the overall structure of the property. Of course, it is accepted that a virtual representation would not be as accurate as visiting the actual property. However, a good virtual representation may provide an opportunity to satisfy the initial stages of curiosity.

First time visitors to a particular virtual property would be undertaking an exploration task according to Darken and Sibert's (1996) wayfinding categories whereby the prospective buyers are more interested in the layout of the property rather than finding a specific search target.

Therefore in the interest of navigational ease, imaginary virtual objects, such as paintings or flowerpots may not exist in the actual property but may be virtually represented as landmarks (Robertson et al., 1997). This relates to the human factors issue of influencing perception by altering the colours of the property's interior walls to reflect possible effects of sunlight and exterior environment such as the landscape of the garden in order to create a more appealing and informative representation. These possibilities would obviously be subject to the property owners feelings, legal and financial considerations.

5. DISCUSSION AND CONCLUSIONS

The paper considered the current displays of e-commerce web sites in acknowledgement of their growing popularity. Heuristics evaluation (Nielsen and Molich, 1990) was undertaken to assess the usability of the current web sites. The heuristics considered perceptual and navigational aspects of the e-commerce displays. Ten evaluators rated three e-commerce web sites in terms of how well the web sites conformed to the heuristics. For instance the consistency of the displays and how well they presented information in a natural, logical manner. The results of the heuristics evaluation showed that the major issues concern limiting the users memory load and providing simple, natural dialogue in a logical manner.

Desktop virtual environments were proposed as a method of supplementing the two dimensional display constraints. Wann and Mon-Williams (1996) maintain that as more variety of information becomes available, applications can benefit from enhancing the traditional two-dimensional display techniques. Shneiderman (1997) also agrees that some display guidelines would have to be modified to support the web context and others would have to be invented to support the dimensional enhancement. Therefore it would appear that consideration has been

given within the field to extending the current two-dimensional displays however, not much has focussed on how the e-commerce web sites would benefit from an additional dimension.

The paper explored the possibilities of transforming the sample e-commerce displays to involve desktop virtual environments. The e-commerce web sites were considered in terms of the issues identified from the heuristic evaluation. Therefore consideration was given to whether desktop virtual environments would sustain users short-term memory load as well as providing a natural and logical dialogue between the user and the display. These two issues could be regarded as trade-offs and would require more substantial research in the area of desktop virtual environments and e-commerce display requirements to determine effects and influences. The evaluation criteria and web sites used for this particular investigation were not exhaustive but were suited to the objective of this sample study which was to draw attention to the possibilities of enhancing the current two-dimensional e-commerce displays.

6. REFERENCES

- Amazon, (2000). <http://www.amazon.com>
- Barfield, W and Furness, T. A. (1995). Virtual Environments and Advanced Interface Design. Oxford University Press. New York. U.S.A.
- Baty, J.B and R.M.Lee. (1995). Intershop: Enhancing the vendor/customer dialect in electronic shopping, Journal of Management Information Systems. 11:4
- Bradleys On-Line. (1999). <http://www.bradleys-estate-agents.co.uk/>
- Chau, P.Y.K. Au, G. Tam, K. Y. (1998). Impact of Information Presentation Modes on Online Shopping: An Empirical Evaluation of a Broadband Interactive Shopping Service. Journal of Organisational Computing and Electronic Commerce.

- Conklin, J. (1987). Hypertext: An Introduction and Survey. *IEEE Computer*, 20 (9), pp 17-41
- Csikszentmihalyi, M., and Kubey, R. (1981). Television and the rest of life: A systematic comparison of subjective experience. *Public Opinion Quarterly*. 45:317-328
- Darken, R.P., and Sibert, J.L. (1996). Wayfinding Strategies and Behaviours in Large Virtual Worlds. *ACM CHI '96*. pp.142-149
- Egg (2000). <http://www.egg.com>
- Gould, J.D. and Lewis, C. (1985) Designing for Usability: Key Principles and What Designers Think. *Communications of the ACM*. 28, 3
- Henninger, S. Haynes, K. and Reith, M.W. (1995) A Framework For Developing Experience-Based Usability Guidelines. *Proceedings of the Symposium on Designing Interactive Systems*, Ann Arbor, MI, August, ACM Press, New York. pp.43-53
- Heckel, P. (1991) *The Elements of Friendly Software Design*, Sybex, San Francisco 1991
- Kalawsky, R.S. (1993). *The Science of Virtual Reality and Virtual Environments*. Addison-Wesley. Cambridge. U.K.
- Lastminute.com, (2000). <http://www.lastminute.com>
- Lohse, G. L. and P. S. Spiller, (1998). Electronic Shopping. *Communications of the ACM*. 41(7): 81-87
- Lohse, G.L. and P.S. Spiller, (1999). Internet Retail Store Design: How the User Interface influences Traffic and Sales. *Journal of Computer Mediated Communication*. 5(2)
- McEachern, T. and R.M. O'Keefe. (1998). *Rewiring Business*. John Wiley & Sons, U.S.A.
- Microsoft. (1992). Microsoft Corporation, *The Windows Interface: An Application Design Guide*. Microsoft Press, Redmond, WA, U.S.A
- Miller, G. A. (1956). The magical number seven plus or minus two: Some limits on our capacity for processing information. *Psychological Review*, 63, 81-97.

- Molich, R. and Nielsen, J. (1990) Improving a Human-Computer Dialogue. Communications of the ACM. 33, 3
- Nielsen, (1994). http://www.useit.com/papers/heuristic/heuristic_list.html
- Nielsen, (1996). <http://www.sun.com/960416/columns/alertbox/>
- Nielsen, (1999). <http://www.useit.com/alertbox/990502.html>
- Nielsen, J. and Molich, R. (1990) Heuristic Evaluation of User Interfaces. CHI'90 Proceedings. Communications of the ACM. pp241-256
- Nine Lives Clothing Store (1999).
http://www.los-gatos.ca.us/los_gatos/businesses/nine_lives/nine.html
- Norman, D (1988). The Psychology of Everyday things. Basic Books. U.S.A
- Robertson, G., M. Czerwinski and M. Van Dantzich. (1997). Immersion in Desktop Virtual Reality. ACM.
- Shneiderman, B. (1992) Designing the User Interface. Strategies for Effective Human-Computer Interaction. Addison-Wesley Publishing Company. U.S.A
- Shneiderman, B. (1997) Designing information abundant web sites: Issues and Recommendations. International Journal of Human-Computer Studies 47, 5-29.
- Stolze, M., Steiger, P. and Good, M. (1998). Beyond Internet Business-as-Usual. Proceedings of the CHI 98 summary conference on CHI 98 summary: human factors in computing systems, Page 210
- Tesco. (1999). <http://www.tesco.co.uk/>
- Tilson, R. Dong, J. Martin, S. Kieke, E. (1998). A Comparison of Two Current E-commerce Sites. ACM
- Titus, P.A. and P.B. Everett (1996). Consumer Wayfinding Tasks, Strategies, and Errors: An Exploratory Field Study. Psychology and Marketing. 13(3): 265-290

- Wann, J and M. Mon-Williams. (1996). What does virtual reality need?: human factors issues in the design of three-dimensional computer environments. *International Journal of Human-Computer Studies*. 44: 829-847