EFFECTIVE VISUAL CUES FOR WAL

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ABSTRACT

The purpose of this paper is to demonstrate my current work in the area of discovering what constitutes an effective visual cue in web screen design. The screen designer should provide for user orientation and ease of navigation within the network of hyper-linked information which constitutes the web-based computer assisted learning environment.

Investigations into different visual cues in interface design, include an analysis of the benefits and shortfalls of the existing web navigation methods. These navigation methods include the provision of hyper-links embedded within the content text, indexed lists, and visual maps of varying complexity. Accepted CAL interface design principles include the use of consistency, simplicity and positioning to enhance communication with the user, but how well do existing guidelines on screen design transfer to screen design for web based applications?

Users need to be able to find the metaphoric 'signposts' within an information space, and from those signposts be able to easily understand their current position in that information, their possible interaction alternatives, and the usefulness and appropriateness to their task of the various navigation paths on offer from that point.

The objects and widgets in the interface providing this information are know as the visual cues, and it is my intention within the scope of my PhD investigations to analyse the effectiveness of the different elements of the visual screen layout which can contribute to the user's sense of where they are, and where they can go. This investigation is being limited to flexible teaching and learning applications, within the virtual university paradigm.

The web is a rapid generation, easy update design environment, more so than the authoring environments traditionally used to created computer assisted learning packages. The question is, does this added flexibility offer the interface designer an opportunity to create a more functional and transparent interface for the learner, or will it simply add to the complexity of the human-computer interaction?

KEYWORDS

Visual cues, navigation, screen design, human-computer interaction, CAL, virtual university.

1. INTRODUCTION

The purpose of this paper is to demonstrate my current work in the area of discovering what constitutes an effective visual cue in web screen design to provide for user orientation and ease of navigation within the network of hyper-linked information which constitutes the web-based computer assisted learning environment. It is my intention within the scope of my PhD investigations to analyse the effectiveness of the different elements of the visual screen layout which can contribute to the user's sense of where they are, and where they can go.

Investigations into different visual cues in interface design, will include an analysis of the benefits and shortfalls of the existing web navigation methods, and address useability issues in respect to the interface design, and the effect on the complexity of the human-computer interaction. This investigation is being limited to flexible teaching and learning applications, within the virtual university paradigm.

2. MULTIMEDIA SCREEN DESIGN

2.1 VISUAL CUES

Screen design, for the purposes of this study, is defined as the organisation of those visual elements of the interaction between machine and human which are displayed on the computer screen. The functionality of the screen should have a close relationship to the visual form. The visual appearance of the system should support the functionality of the software (Paay, 1995).

For the purpose of this study, visual cues are those visible elements of the screen design, in the human computer interaction, which provide orientation and navigation information to the users of computer assisted learning systems which are design to be delivered using the world wide web.

The visual sense is the most important in human information processing, and yet it is interesting to note that our eyes supply detail for only a small portion of our total field of view (Bartram *et al,* 1995). Only those objects which we have focussed our attention on are detailed, the peripheral objects are being registered but remain indistinct. It is that peripheral information which provides the context for the objects of our current interest. Our peripheral vision also provides us with visual cues which we use to orientate ourselves, and scan for information about navigational options when we require to move through physical space.

There are dimensions to these visual cues which help establish our perception of our current space. These cues when defined can provide us with rendering techniques for reproducing the effect of three-dimensional space in two-dimensional mediums such as painting, architectural drafting, or computer screen design. Marcus (1992) explains that positional depth can be indicated by decreasing the size of objects, that parallel lines converge to a vanishing point, and that if textured surfaces increase in density they appear to recede. Light and dark shades can also be used to indicate edges or curved surfaces depending on their graduation. These techniques can be used to communicate more complex information using visual objects in the two-dimensional screen interface.

Visual cues provide a graphic set of symbols which can be used to indicate to the users navigational options and information about their current position in an information space, that is, they can provide both global and local orientation (Kahn, 1995). In the hyperspace of a web application this translates to giving the user information about the current node, information about any links to other nodes, as well as a sense of how this node fits in to the network of nodes which constitute the web assisted learning package they are currently using.

2.2 METAPHORS

The user's conceptual or mental model is the basis from which the user makes decisions on how to proceed within an interaction. It governs the user's interpretation of how the system works. The role of the interface is to help the user establish an appropriate model which will aid them in the interaction.

The user interface is often used to convey real-world objects and real-world information to a user, therefore designs that incorporate familiar analogies convey that information more clearly. Metaphors are appropriate in designing for the human computer interaction because communications between humans are filled with metaphorical references which help them to understand and remember things (Marcus, 1993). Examples of this kind of metaphor include: the use of road sign images to indicate directions such as go left (next) and go right (back); the Macintosh operating system volume level slider bar using direct manipulation to be used like

a mixing desk volume slider; buttons which resemble video recorder controls used in movie editing applications to do comparable operations such as play, fast forward and rewind; and the use of page wipes which resemble pages turning to reinforce the book metaphor. Metaphors are useful in navigation design for hypermedia systems because humans remember their way around physical spaces in terms of important features in the landscape. We use well-known landmark buildings in cities, or in the wilderness, we also use sounds to know where we are. This close connection to our physical experience brings with it the problem that screen designers need to be aware that social and cultural conventions of a target audience can influence the acceptability and functionality of different metaphors (Stevens and Stevens, 1995).

User Orientation and navigation can be supported by specific metaphors, which are designed to communicate a sense of place, or to enhance movement between screens. Marcus (1994) states that "Metaphors provide the underlying images, terms, and concepts that make communication possible at all".

2.3 HYPERMEDIA

When people communicate with each other, they do so through multiple channels. The web uses a number of communication channels and data dimensions to impart relevant information to users, making it an excellent communication tool. Hypermedia delivered on the web can therefore encourage a larger variety of information seeking activities than is conventionally available.

Hypermedia systems can be large information spaces, depending on the depth and breadth of information that they contain. This information needs to be structured in some way, both in terms of the physical files that make up the network, and in terms of the user's mental model of how the information is organised. Hypermedia gives system designers the freedom to provide a rich interactive and navigational experience for users, allowing them to move freely along many paths throughout the information space. The risk with providing multiple paths is that users may become frustrated when they are unable to complete their task, because they cannot easily find the information that they need (Stevens and Stevens, 1995).

To facilitate orientation and navigation within the hyperspace, users need to be able to grasp the overall topological structure of the information, which they are often unable to do, resulting in 'wayfinding' problems (Darken, 1995). In CAL applications, and therefore WAL (web assisted learning) applications, are often set up with a hierarchical organisation of information. This is because they are developed based on the hierarchically organised paper based lecture material, traditionally delivered in face-to-face mode.

3. WAYFINDING

Disorientation is still the major problem in hypertext and hence hypermedia systems, even though it is a problem which was recognised over a decade ago, when the term 'lost in space' was first used (Zizi and Beaudouin-Lafon, 1994) (Mohageg *et al*, 1996). Consequently, there is much research currently being done trying to find suitable structures for hyperdocuments and looking at the visual tools which can help users navigate.

The term 'wayfinding' is one which applies to real world navigation, but is also currently being applied to navigating hypermedia systems. In wayfinding it is important that the user is able to conceptualise the space as a whole (Darken, 1995). Some researchers examine the environmental information that is necessary in the physical environment for wayfinding, and make direct analogies to aid them in the creation of navigational tools such as maps (Darken, 1995). Alternatively, other researchers question whether it is appropriate to apply physical world analogies to computer-based applications and make the point that the sense of overall context available in real world navigation at a glance, is not available in computer-based navigation (Mohageg, 1996).

Wayfinding incorporates both the issues of orientation and navigation. Orientation of users requires a stable anchoring device while navigation requires a dynamic device that facilitates exploration. The analogies to real world travel given by Toms (1996) illustrate the different types of visual cues required for each of these. Toms contrasts the stabilising influence of mileage signs, which act as landmarks for orientation, with the diversions provided by signs which indicate roadside attractions, which act as links to new locations for navigation. Physical cues in the real-world, such as those of a book, ie. page numbers, how thick the book is, alphabetic organisation, table of contents, index, bookmarks, dog-eared pages, etc., need to translate to similar place finders in their electronic equivalents. Users need to be able to judge the general size and organisation of a hypermedia application to get a contextual overview of where they are, and where they can go (Stevens and Stevens, 1995).

The effectiveness of metaphors to support navigational design can also be determined by the type of task that the user is trying to complete. Searching, browsing, and exploration are all activities which could conceivably be part of the requirements of a WAL course, but may each require a different type of navigational aid.

3.1 USER ORIENTATION

The screen designer should provide visual cues which aid user orientation and ease of navigation within the network of hyper-linked information that is the web-based computer assisted learning environment. According to Stevens and Stevens (1995) the main challenges for interface designers are providing for user orientation, focussing user attention, and providing contextual understanding of the scope of information in an application.

In the physical world, orientation is dependant on the recognition of landmarks. Headings, illustrations, and other visual screen elements can act as landmarks in interface design of electronic applications (Simpson and McKnight, 1990)(Stevens and Stevens, 1995). These screen elements can be designed to support the useability of an application, where their design grows out of the functionality of the application. If they are included in an interface design simply to provide visual excitement and variance within that application, then this can lead to user confusion and frustration if they no longer support the user's sense of place (Marcus, 1994).

3.2 NAVIGATION

Navigation is defined by Stevens and Stevens (1995) as "the process of locating and displaying new information in an application". In hypermedia applications, this is done by following links through the network of information nodes. To navigate effectively, users need to be able to find the metaphoric 'signposts' within that information space, and from those signposts be able to easily understand their current position in that information, their possible interaction alternatives, and the usefulness and appropriateness to their task of the various navigation paths on offer from that point. The way that information is structured within an application and the type of navigational aid provided by the designer, does influence the user's success in browsing through an application (Toms, 1996).

According to Stevens and Stevens (1995), the goals of good navigational design are to keep users from getting lost, to direct user attention to relevant tasks, to facilitate users in gaining an overview of the information content of the application, and to provide access to information, instruction, advice and media options within that application. To this end, the past decade of research, which has been addressing the issue of users being 'lost in hyperspace' has put forward many possible solutions to the navigation and orientation problems that users experience in a hyperlinked information space.

The web poses additional problems in that the available navigable information space, the world wide web, is much larger than the designed educational content of a particular application. Users can become lost by simply moving outside of the WAL application, and by being unable to find their way back. Some users don't even realise that the transition has occurred. Designers of web hypermedia applications need to consider the issues of containing the user within the intended information space and designing visually identifiable contexts to their applications.

Visual elements of the screen design can aid users in navigating information content, such as: interactive maps, links, indexes, search engines, multiple windows, electronic bookmarks, overview diagrams, footprints, menu trees, maps, guides, suggested default moves and the consistent placement of labels or headings.

The success of these different methods can be measured in terms of the extent to which the user gets sufficient cognitive assistance from these tools to create a mental map of the information space which allows them to find the information that they need to complete their task. “Links, maps and other screen objects can be combined to support user navigation through information and maintain user orientation while using a program” (Stevens and Stevens, 1995).

3.2.1 Navigational Links

The visual and physical properties of a hyperlink can contribute to useability of an application. Links can appear in an application as buttons, hot-text, or graphical objects such as icons. The creation of navigational link families, which have shared visual appearance, consistent operation, and have a consistent screen location throughout the application, can facilitate the user’s understanding of how to navigate within that application. The use of graphical links, or icons, once learned, can speed user understanding and use of links (Stevens and Stevens, 1995).

The annotation of hyperlinks is a web design guideline. Text hyperlinks, such as ‘hot’ words embedded in text, should use meaningful words, and where appropriate the URL, or even better a description of where the link will take the user (Pfaffenberger, 1997). The adaptive hypermedia system introduced by Brusilovsky (1995) is a system developed for educational hypermedia, based on the premise that the visual annotation of links can enhance the users ability to navigate in a system. This system annotates and presents links according to current user knowledge, and assessed educational goals for that user. Text supplied with links is dynamically tailored with adaptive comments. This provides the user with additional information about the links which are also presented in order of the most relevant first. This supports user navigation by limiting the browsing space within which they are likely to ‘get lost’.

Icons are a widely used visual cue, which communicate information to the user by virtue of the inherent physical characteristics. Icons look like the objects they are representing. Icons and symbols can be used as the graphical objects which are clicked on to effect a link to another part of the application. The icon or the symbol should be designed to give information to the user about the link. Graphical links can provide the user with a more effective mental representation of the information that they are about to access.

3.2.2 Navigational Maps

The standard solution to the ‘lost in space’ problem is to provide a map of the information space to help users orient themselves (Mohageg, 1996). Maps provide a visual representation of the structure of a hypermedia information space, illustrating in graphical form, the relationship between different nodes of information in the network.

To be able to navigate a large information space, users need some way to ‘view’ that information space, which is made difficult by the limitation imposed by the physical size of a computer screen. Relating it to the physical world analogy, it is not possible to fold out a large paper map, the most we can achieve is to view any large map in segments, or to look for visual representations which compress that map while still supplying the user with a useful level of detail where required. Several visual techniques have been developed to give the user an overview of the information space and to make chunks of information available in context. These include: dynamic interactive maps, fish-eye overview diagrams, use of windowing techniques, hierarchical menus and ‘hot’ maps (maps with embedded links).

Maps have been called the ‘guidepost through the electronic forest’ for application users (Stevens and Stevens, 1995). They can be used to visually orient a user to their current location, to help diagram the relationships between different pieces of information, and they indicate to the user their progress through the application. Well designed maps which provide an overview,

can be of great help to users (Zizi and Beaudouin-Lafon, 1995). Maps provide users with an understanding of the relationships between information in an application, and facilitate navigation by providing a contextual overview of the structure of the application.

Hierarchical overview maps are especially relevant for educational and instructional material which is traditionally structured by semester weeks and lecture blocks, or by content topics and sub-topics. These hierarchical diagrammatic representations can also provide a recommended path that users should take through the information space, just as a teacher would structure the delivery of material using didactic teaching methods. The hierarchical overview map can be combined with a history map, which illustrates the current and past locations of the user, indicating visually what could be described as an 'electronic breadcrumb trail'. Combine this with a 'hot' map (a map with embedded hyperlinks to the sections, chapters and topics diagrammed on the map) and the user is provided with direct navigation to required information and is orientated within the application.

One solution, based on web browsing problems, it to use the metaphor of web pages as decks of cards, where each deck is a meaningful group of related information, and decks can be shuffled to present the information of interest at the top of that deck (Brown and Shillner, 1995). Using a multiple window technique, several decks are visible on the screen at one time, allowing the user to make analytical comparisons between information groups.

The fish-eye technique for displaying maps is another method used to represent detail within its larger context. An overview of the entire information space is available, with detail displayed at the current focus point. This technique however can result in some user disorientation due to excessive distortion of the focus area, and the transition between views can also confuse users (Bartram *et al*, 1995).

One of the innovations in map design is the idea of the interactive dynamic map (IDM). This type of navigational map can be automatically computed and produced in response to user's needs (Zizi and Beaudouin-Lafon, 1995). The design theory behind the development of the IDM was based on the metaphor of navigation in the real world, and adapted from the conventions used in the design of geographical maps. The structure of the web is conveyed in terms of regions, cities and roads, where regions represent groups of related documents, and cities represent documents. If two cities are close together on the map then they represent documents which contain semantically related information. These maps indicate where the user currently is, where they are going, and where they have been. They are able to dynamically add new documents, provide direct navigation to selected documents, provide the user with an overview of a large number of documents and can be custom-made in response to a current user query. This navigational paradigm combines multiple access methods, including history maps, link maps, fish-eye views, zoom maps, landmarks (in the form of user annotations) and multiple windowing techniques.

Darken (1995) also supports the application of environmental design principles to virtual world design, claiming similarity between virtual and physical space. He claims that if designs are based on spatial orientation theory, they can reduce wayfinding problems, suggesting that for maps to be effective, they must directly correspond with the environment that they are representing by dividing it into clearly connected, manageable pieces, with landmarks, and frequent directional cues to aid orientation of users.

Opponents of this use of physical world analogy, such as Mayes *et al* (1990) claim that the use of visual metaphors and spatial maps for user disorientation problems are not appropriate models for navigating in conceptual space. They claim that conceptual space has no natural topology, and that in exploratory learning models, hierarchical structure of information is unavailable and in essence undesirable, claiming disorientation as part of the learning process. The process of the user continually trying to create their own cognitive maps of the information helps the learners to discover their own framework of understanding. Mayes *et al* also claim that learning to navigate hypertext is a mutually exclusive activity to learning the instructional material.

Research into three-dimensional representation of hypermedia spaces is also being undertaken. These solutions are designed to help users to visualise network systems of hundreds and thousands of nodes and hyperlinks using layout algorithms, 3D graphics and animations, where users explore a virtual three dimensional space which has communities or galaxies of documents to search for wanted information (Eick, 1996) (Regan, 1997).

4. EDUCATIONAL ISSUES

This investigation is being limited to flexible teaching and learning applications, within the virtual university paradigm, as part of the Virtual Class project at the University of Tasmania, aiming to improve the quality of teaching and learning and to improve the access to higher education for both on-campus and off-campus students (Choi and Yeom, 1996). Web-based interactive multimedia CAL modules, delivering unit materials are an important part of this project. Unit material which is currently delivered in the traditional university didactic lecturing mode, will need to incorporate both information and interaction design principles to create an effective electronic teaching tool. The issue of designing learning environments which integrate different modes of delivery and different degrees of interactivity to determine the most suitable approach for each component of the subject material is considered as part of the overall project (Gibson and Paay, 1996).

Navigational design can be influenced by the educational objectives of the WAL application. In 1988, Halak stated that completely free exploration of networks of nodes and links would be 'sub-optimal' for learning (Mayes *et al*, 1990). In more recent times, researchers have embraced hypermedia as providing support for the learner oriented constructivist exploratory approach the learning. Laurillard (1994) claims that the optimum approach would be 'learning through guided discovery', which means that the teacher and the student act as collaborators in the learning process. Sims (1994) in his discussion about the links between learner control, interaction and navigation, classifies the network configuration and hyperlink interactivity as 'free interactivity'. He describes the problem of navigating through a maze of information and recommends that developers need to define, maintain and integrate appropriate links so that learners are not left wandering undefined paths. Constructivist design is not just about letting users wander aimlessly, it is about creating a supportive learning environment to help learners develop an understanding of the information.

Different types of users, with different learning philosophies need to have different navigational designs, implemented with different tools. Applications can be either instructional or reference, they can be designed to support either objectivist or constructivist learning theories, they can be design for either novice or expert users, and they can try to cover any mix of the above dimensions. The interaction designer can either create a set path through the material, make suggestions about a recommended path through the material, or allow free interactivity throughout the information space. The problem with the latter is that some research studies have shown that when users are given control over instructional sequencing, they make choices which are personally interesting to them, but are not necessarily instructionally relevant or productive (Stevens and Stevens, 1995).

A good constructivist design environment should support the learner, allowing them to interpret the information, and to form their own instantiation of the knowledge, within the educational context. Coherence of information in a hyperlinked environment is based on the user's ability to make cognitive connections between a variety of individual nodes within the distributed information (Vora *et al*, 1994). The design of the hypertext network can support different levels of learning (Ross, 1993).

5. USEABILITY ISSUES

The success of the human computer interaction is largely judged by the useability of the system. The web is a more dynamic design environment than the authoring environments traditionally used to created computer assisted learning packages. The question is, does this added flexibility offer the interface designer an opportunity to create a more functional and transparent interface for the learner, or will it simply add to the complexity of the human-computer interaction?

For a hypermedia application to be useable, it must provide effective navigation mechanisms. The user must be aware of their location in the information space, and they should be able to use their mental model of how the system works to envision their next destination, and the steps that they must take to get there. The design of the information space should be user centred in its approach, that is, the organisation of information should be based on the user's conceptual or semantic model of the information rather than being influenced by the structural or syntactic organisation of documents within the system (Vora *et al*, 1994).

Metaphors, mental models, navigation schemas and the look and feel of an application are all elements which can help the users to gain rapid access to the information content of hypermedia systems, while ensuring that users still understand and link that information in context. All of these elements which support the useability of the system, and improve user productivity, manifest themselves as part of the visual communication of the screen design (Marcus, 1993).

In an attempt to overcome navigational problems some systems incorporate multiple navigation methods and as a result they can suffer from what Toms (1996) calls an "excess of 'featuritis' ", which in effect, reduces their useability. There has also been research providing evidence against the provision of multiple access methods to information, claiming that it does not provide assistance to the user, and may even reduce navigational predictability (Vora *et al*, 1994).

User centred design methodologies are the key to the development of effective and useable hypermedia. As Marcus (1993) states, "If developers take the time to conduct interviews, users' own words and diagrammatic figures usually convey the verbal terminology, visual imagery, and the concepts through which they understand their roles, tasks, functions and data."

6. HCI GUIDELINES

Accepted CAL interface design principles include the use of consistency, simplicity and positioning to enhance communication with the user, but how well do existing guidelines on screen design transfer to screen design for web based applications?

The aim of design guidelines is to produce systems which are simple, easy to use and which communicate with the user. Guidelines exist to govern visual effects relating to object positioning, screen colours, textures, sounds and use of metaphors. General screen guidelines cover issues such as the consistent location of screen objects, making them easy to find and use, and minimising screen clutter.

Guidelines which related to navigational elements, such as links or icon buttons include: being consistent in the way they operate; locating user control buttons/links in the same place; creating link/icon families which are similar in visual appearance and have similar function; using visual/audio effects consistently to communicate navigational transitions; using labelling and visual appearance to communicate function (Stevens and Stevens, 1995) (Pfaffenberger, 1997). These guidelines aim to support the user's understanding of system navigation.

Few guidelines have been developed for designing maps for computer hypertext structures (Zizi and Beaudouin-Lafon, 1994). However, the general principles of physical map design can be applied in the virtual map situation. Some suggested guidelines are: to show all organisational element and principles; to always show observer's position; and to orient the map for forward up reading (Darken, 1995).

Guidelines for metaphors used in interface design all suggest that metaphors need to be familiar to the user, and facilitate user understanding of how the system functions. Marcus suggests that metaphors within an application be limited to Miller's magic number, 7±2, of different metaphors (Marcus, 1993).

7. CONCLUSION

There is a need for further investigation of the different navigational tools introduced in this paper. This paper illustrates the diversity of methodologies which are being explored in attempts to solve the problem of user navigation and user orientation in hypermedia applications. It also addresses related issues which might influence the effectiveness of those navigational schemas. The next step

in the process is to isolate those elements of the visual interface design which constitute the visual cues to navigation and orientation, and to determine exactly what qualities of those elements facilitate communication with the user. That investigation should lead to the development of screen design guidelines appropriate for use by designers of the visual navigation and orientation elements of screen design, in web-based educational hypermedia applications.

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