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Multimedia Design Decisions, Visualisations and the User's Experience

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1. Introduction

This chapter analyses of the types of design decisions that have been made in interactive multimedia and large Internet resources, and how these designs affect both how users navigate through the package, and the information they obtain from using the resource. The chapter starts with an introduction of its scope and content and its relationship to the rest of the book. The literature on multimedia design and use are then reviewed, concentrating on navigation tools, design elements and human computer interaction. The chapter will then look at design decisions and how these affect users, before outlining good quality and more problematic design decisions. Visualisations of how users have used the software and the navigational tools used will follow, before recommendations for design and user assistance and finally a way forward for designers is proposed.

The chapter contains screen views of parts of multimedia packages and an assessment of what elements of the design have been successful. It will also investigate designs where the user has misinterpreted what the designer portrayed and how that has led to a misuse of the full potential of the package. The research in the chapter reflects back on doctoral work of the researcher which involved assessing over 100 multimedia products to ascertain which navigational methods the packages allow, how the users employ these, and how they should have been designed to make full use of all the features and the full resource.

Several of the examples are from the Open University and the BBC which were both used in the research. The Open University produces large quantities of excellent educational material and the design decisions process there could be used to assist other designers. Commercial software producers have also been included as some of the popular commercial packages would have benefited from more careful design decisions.

The chapter will review the literature on multimedia and Internet resource design, investigate how design decisions affect how the resource is used, give examples of good and poor quality design and give recommendations for future design decisions. An aspect of the research in this area that will be covered is the use of visualisations in how people approach the software, and this is augmented with both comments and information on the navigation methods and tools used. The chapter will give detailed information on specific packages and how designs have encouraged or prevented the development of good techniques in their usage. Examples of the type of package used will include: Medieval Realms, Carbon Cycle, Homer, Encarta, and Eyewitness History among others.

2. Aim of the chapter

The aim of the chapter is to investigate navigational patterns employed by users while exploring multimedia and Internet resources. The objectives of the chapter are:

- To investigate which navigational patterns are used and the best methods of utilising the resource,
- To encourage the use of newer or more efficient methods of navigating and visualising resources,
- To promote a toolkit of specified navigational tools as a transferable toolkit or palette for users,
- To demonstrate how visualisation techniques can inform users, tutors and software designers of the methods used to interrogate resources.

3. Scope and content of the chapter

The scope and content of the chapter is aimed at students using educational resources and designers of software, who can objectively look at the research that has been done and begin to apply it to their own design work. Designing multimedia and resource packages for different groups of people involves many different processes. However the key process is to test it with groups of users of similar age and ability to those that are expected to use the resource, and to keep doing this. Educators also need to be made aware of some of these issues, so that the resource is used to its most effective presentation, that the students or adults are given sufficient introduction in its usage but also to allow for some self discovery and personal opinions. Interestingly trying out novice users on a new resource, most people would investigate it initially to see if it contained something they knew a lot about. This seemed to ground them in their opinion of the package, so first impressions were important, and successful initial searches usually meant a greater involvement with, and use of, the package. This chapter is a practical review of the work on the designing of multimedia and of design decisions that were made for specific projects. Analysing these decisions and seeing the reaction of students when using them, have given greater insights into multimedia and large internet resources in terms of their structure, navigation methods, use of the material and areas of little use. This sort of analysis should enable designers to create better, user friendly and informative resources and give educators additional knowledge in how using the resource affects the amount of information searched for and found, the receptiveness of the user and it's learning potential.

4. Background to the research

It is important to first ground this in the research literature. Researchers such as O'Malley (2002) have stated that the designs need to be transparent. This means that the tools needed to use the software and the way users navigate within the package should be naturalistic and intuitive, i.e. they should not find the controls or navigation methods intrusive and they should be easy to use and learn. One solution to this problem is to develop a generic tool kit that could be used for a number of different multimedia resources. This means the user would not have to re-learn how to use specific tools – such as how to navigate within the package, how to follow specific routes, how to return to previous searches, the quickest way to specific information, the structure of the package and so on.

Another area that needs more design work is computer games software. Much of the software has been developed to provide high quality graphic images and relatively little design time has been spent on exactly how they will be used. Many games designers do not actively test the product with users within the targeted age group and a more sensitive design brief would overcome many of the initial problems in using the package. What should be straightforward design decisions, if wrongly interpreted, can adversely affect the take-up of commercial software and there is a real need to fully developed the testing, redesign and audit trail procedures for this type of product. Giving designers an insight into how packages are used in educational settings, the skills required to use them and the learning processes used may make the designers more aware of the design constraints and the real need to fully test the resource with users.

5. Literature review of the area

A review follows of the available literature on multimedia design and use, in thematic areas such as navigation tools, design elements, and human computer interaction.

5.1 Digital natives

The research on Digital natives (user who have grown up using digital materials), was started by Prensky in 2001 when he stated that the Digital Natives had "spent their entire lives surrounded by and using computers, videogames, digital music players, video cams, cell phones, and all the other toys and tools of the digital age" (Prensky, 2001, p.1). Prensky proposed that the Natives exposure to digital culture and environment had changed the way they think: "It is now clear that as a result of this ubiquitous environment and the sheer volume of their interaction with it, today's students think and process information fundamentally differently from their predecessors." (p.1). Prensky's digital natives are meant to: prefer receiving information quickly; be adept at processing information rapidly; prefer multi-tasking and non-linear access to information; have a low tolerance for lectures; prefer active rather than passive learning, and rely heavily on communications technologies to access information and to carry out social and professional interactions. Prensky had a view on these student's educators, called Digital Immigrants – foreigners in the land of the Net Generation. Prensky's view, supported by other researchers such as Oblinger (2003) and work by Frand (2000) along the same lines was, that educators need to adjust their pedagogical models to suit these new kinds of learners. Students according to Prensky are already "adopting new systems for communicating (instant messaging), sharing (blogs), buying and selling (eBay), exchanging (peer-to-peer technology), creating (Flash), meeting (3D worlds), collecting (downloads), coordinating (wikis), evaluating (reputation systems), searching (Google), analysing (SETI), reporting (camera phones), programming (modding), socializing (chat rooms), and even learning (Web surfing)" (p8).

Many researchers are now harnessing the technologies that students are finding more comfortable. These include the expected mobile technologies, social networking software such as Facebook and MySpace, sharing digital files and web usage. However, the information on producing (rather than reading) blogs, RSS feeds usage, and conferencing is more variable and may have different skill levels. It is arguable that students have better skills at the social software and less developed skills with the more work/education oriented systems such as virtual learning environments, immersive environments, virtual

reality, role play, strategy games (such as economic modellers), interviewing skills and intelligent tutors. If Prensky is to be followed completely we as educators may overestimate the abilities and skills of the Digital Natives and their skill at accessing and manipulating software which may camouflage their reduced ability to understand and be creative within a totally new environment. Having the prior knowledge of a range of software may though lessen the learning curve and enable rapid uptake of any new technology, and students may not necessarily judge which technology is best for a specific purpose or to be able to assess how useful a new technology is for a specific educational activity.

5.2 Design decisions

The design decisions that will be reviewed in this chapter concern the choices that designers of multimedia and large resources have to make. There are generally in terms of the restrictions they place on movement, the structure of the package and what the user is allowed to do within the package. There is a great deal of work in the human computer interaction field that investigates and researches on these areas. Examples of good current thinking in this area are Shneiderman, the textbook by Dix, Finlay, Abowd and Beale, and that of Benyon, Turner and Turner. These core works move on from the earlier work of gurus such as Norman and Jacob Nielsen who were the original proponents of the need to organise the resource properly. Neilsen thought that all designs need to be tested – early and often, rather than the industry norm of testing once the design is complete.

Donald Norman's work involves the advocacy of user-centered design. His books all have the underlying purpose of furthering the field of design, from doors to computers. Norman has recently been controversial in saying that the design research community has had little impact in the innovation of products, and that whereas academics can help in refining existing products, it is technologists that accomplish the breakthroughs.

An example of Neilsen's work in this area is the 'Test your design' paper where he takes a basic web site and works with the designers to improve it. The changes he makes are usually quite simple, for instance, the overall impression is less cluttered, especially with text. Nielsen is adamant with clients that they need to rethink their approach to textual communication on Web sites and emphasize powerful headlines, summaries, and bullet points, not long blocks of text that annoy and put off readers. Gouma's notes: "On the original version, you'll note that there are hundreds more words. There's a quarter of the words and number of ideas on the newer site. That was definitely based on feedback." There were a series of other changes:

- The colour of the navigation bar and words on it shifted to a more readable blue, and the language was changed to become clearer.
- More effort was made to distinguish in different places between registration, which is aimed at first-time visitors, and log-in, which is for returning visitors.
- The testimonial photograph was made smaller and dropped on the page, and the eyes are averted to keep from trapping users' eyes.
- It's clear from the headline and the treatment of the top left-hand box that that's where one "starts" on this page.
- Finally, one change (not apparent here) went to the heart of the process by which users were guided through the site. Originally, Ideas.com featured "wizards" that used

shortcuts based on user responses to various questions. However, the wizards did not test well. "We learned they actually made it too simple," says Goumas. "Users wanted more hand-holding and walking-through the process."

Work by Shneiderman has further revolutionized specific areas in particular that of health and health records. Since 1991 his major focus has been information visualisation, beginning with his dynamic queries and starfield display research that led to the development of Spotfire. Shneiderman developed the treemap concept which inspired his research and commercial implementations. The University of Maryland's Treemap 4.0, developed in cooperation with Catherine Plaisant, remains available for educational and research purposes. Shneiderman advised Smartmoney which implemented the widely used MarketMap for stock market analyses. Later information visualisation work includes the LifeLines project for exploring a patient history, and its successor project, PatternFinder, which enables searches across electronic medical records. Searching for patterns in numerical time series data was enabled by three versions of TimeSearcher, which was applied for stock market, auction, genomic, weather, and other data.

The Hierarchical Clustering Explorer supports the discovery of features in multi-dimensional data, especially for gene expression data, using the powerful rank-by-feature framework. Three current projects focus on network visualisation: Network Visualisation by Semantic Substrates, SocialAction, and NodeXL. These tools are being applied for citation analysis and social network analysis, especially for the iOpener project, STICK (Science Technology Innovation Concept Knowledge-base), and ManyNets (explores & visualises many networks at once) projects. A new direction is based on applying social media to national priorities such as the 911.gov article in Science, which led to work on emergency and disaster response: Community Response Grids. Raising awareness of the need for expanded research was accomplished by the iParticipate report.

5.3 Navigational patterns research

Research on navigational patterns investigated patterns that other researchers had recognized with users in multimedia, hypertext and Internet resources. Research undertaken by Horney (1993), and Canter, River and Storrs (1985), both recorded and discussed the navigational paths of individual users. Research by Simpson and McKnight (1990) on how users preferred to navigate looked at different structures within a hypertext system. They varied the structures and cues for the subjects from alphabetical indexing to hierarchical structuring, using typographical cues and giving provision for position indicators. Their results showed users had preferences for hierarchies. When researching different navigation methods, Henderson (1993) commented that the prevalent characteristic of the modern worldview was the dependence on the conceptual view of information as being hierarchical, and that this conflicted with an alternative conceptual view, that of time, which produced a linear and sequential pattern. It was this dichotomy that Henderson considered made the investigation of multimedia packages more difficult, as users wanted to use the resource hierarchically, but moved through it sequentially. The user's perspective and gradual acquisition of navigational skills and awareness were emphasised by McKnight, Dillon and Richardson (1990): "Acquisition of navigational knowledge proceeds through several development phases from the initial identification of landmarks in the environment to a fully formed mental map" (p.69).

This area brings in another area of my research that of using landmarks within multimedia and Internet research, so that users can navigate within the resource and be aware of their physical place within this resource. This is in much the same way as a games user can fix their position in a game either by geographical landmarks or by placing themselves within a maze or 3D map. The concept of a mental map related to navigation patterns to the mental processes involved in working through software, and with physical awareness of where the user was in the package. Shum (1990), discussing navigating in multimedia and the user's acquisition of spatial knowledge as a two-step process, produced similar results to Simpson and McKnight (1990). Shum explained the first step as the acquisition of route knowledge, where the information was context dependent, and the second step as the acquisition of map knowledge, in which the individual understood the global spatial relationships, navigation was then world centred.

Using audit trails or server log files it is possible to back up this more esoteric research with objective behavioural data however, the data files are not easy to capture, analyse and interpret. The greatest problem to these scanned and audio files though is the time that it takes to analyse these sufficiently in order that robust statements can be made backed by actual data. This problem has been recognized by other researchers (c.f. Spiliopoulou, et al. 1999) who developed methodological procedures for visualizing and analysing log file data for data mining purposes. However, there are a few methods that have been developed which would enable the navigational behaviour of individuals to be analysed using the methods of the psychological researcher, such as using a range of different task demands and conditions (Unz & Hesse, 1999).

6. Investigating navigational patterns

Research was conducted into the methods users employ in navigating through multimedia and internet resources. The three elements of the research into these patterns consisted of:

A taxonomy of multimedia packages – concentrating on the navigation paths and available tools

A First Study – of school pupils using multimedia packages (2-3 packages for each pair – 23 pairs)

A Second Study – of adults using a specific encyclopaedic multimedia resource – 20 individuals.

The taxonomy was useful as it revealed how the design of a range of multimedia packages affected how these resources could be used. The second study on schoolchildren fits in well with the scope of this chapter as the children could be termed digital natives but as they were young, they had not experienced the full effect of the digital revolution, in terms of access to and use of computers, mobile devices and the Internet. The third study looked at adults and although they ranged from novice to expert, they ranged from being digital natives to the digital immigrant range of Prensky's work (2001). An interesting point here is that novices were able to benefit from the more experienced experts and it is possible that digital immigrants could learn usage and navigation techniques from digital immigrants in the same way. The other key aspect of this research is the nature and amount of learning that took place and how the navigation patterns used affected what information was retrieved and the sections that were used within the resources. The most important of these three areas of study for this chapter is the last of these. In this research, each user was given

three tasks within the same extensive encyclopaedic package. For each of these tasks a 2D chart was produced. From these navigation charts (60 in all) each users navigation patterns and preferences were assessed.

These charts also enabled comparison of different users across each task. Using the scanned records of each user's progression through the software and these navigation charts, it was possible to create a range of the different types of navigation pattern found. The list of navigation types was then compared to the other patterns, which are shown in the list below. From these scanned records or audit trails of each user and the subsequent charts it was possible to build taxonomy of navigation patterns. These included nine main types (with several sub types).

7. Recognising navigational patterns

The following navigation patterns were recognised from the initial empirical work and these were then further tested in the second study. These navigational patterns were put into a definitive list and a graphical version of the patterns was prepared.

1. Linear - path on one level, using tools e.g. index, time line, or word search, one direction
2. Linear extra - paths lead away from basic linear pattern, returning to the linear path, usually at the same place or the next node to their original leaving point.
3. Circular - initially recognised as linear, but circular if completed, one/two-way dependent on software design, may be represented by an ellipse/multifaceted shape e.g. an octagon.
4. Star - movement initially linear but implies a change in level, going into second level areas from the first level and returning, one way or two way.
5. Star extra - a development or extension of the star pattern, movement into the second or third level of the package, i.e. into an additional level, beyond the usual star pattern, one or two way, and the extra depth may only be used for part of the route.
6. Hierarchical - movement down the hierarchy, with a possible return along the same path, to go down one or more branches of a tree structure. Progressing one way down the structure and across to the next branch of the tree, can be two-way, can return to the original starting point, retracing path.
7. Hierarchical - extra - movement along multiple hierarchies usually with different subject/themes, usually in the same way, returning to the same tree or continuing onto a linked or associated tree.
8. Complex - Chaotic - movement follows a series of different paths, usually in rapid succession, random and erratic navigation, frequent changes of route and searching method, may be a mixture of the above types.
9. Complex - Planned - sequence of moves following established path, sometimes including definite patterns, using a mixture of different types, but following an ordered route.

The list of navigational patterns above shows all the subdivisions of each pattern type, these should mean that the navigational patterns are clear and that the classification can be used with many different types of digital resources. This is especially useful for educational resources when the user may not be aware of how the package/ resource are structured or how to find the information required.

8. Recognising design decisions and the effect of these on how users use the software – Good design practice and problem designs

8.1 British Library Medieval Realms

The excellent British Library's package has been developed over a long period to include: historical information, real documents, music, arts and poetry but had a complex interface. Aimed at school pupils, the package assumed knowledge in many of these specific fields in order to be able to select information. During testing of the package with the planned age group this knowledge was not apparent and they spent a lot of time trying to work out how to find the material. Giving the developers an idea of how complex they found the package, and the types of searches or information the users needed, allowed a total redesign of the interface. Keeping the high quality underlying information base meant that the redesign was specifically targeted at the interface. The redesign made the resource easier to use and with far greater hit rates for the relevant searches.

Fig. 1. Screen shot from Medieval Realms, British Library

Perseus is an interactive guide to Classical Greece which includes various items such as maps, photographs of sites, datasets of coins and sculpture, as well as texts in Ancient Greek and translations. This has been designed for university students, but again the sources are very text based. The resource has now been developed into a website, called the Perseus Digital Library.

Perhaps one of the problems of moving from a library or text resource is how to make the resource more interesting and the methods of linking different types of media to make a full multimedia product.

There are many other multimedia packages with a historical or archaeological theme. One of these is Viking World produced by the York Jorvik Centre as a commercial venture. This uses a large image database but presently has little information on each of the artefacts. Other products from the British Library include Inventors and Inventions, The Patent Express Jukebox and the Electronic Beowulf. The latter of which has received critical acclaim.

8.2 The Open University Carbon Cycle

The Carbon Cycle software was part of a larger Science introductory course from the OU comprising over 100 CD's. The carbon cycle was receiving mixed responses as users had spent a long time exploring all the options before eventually going through the one correct route to achieve the required completion of the task. Redesigning the interface meant that the majority of students followed the most suitable route and much less time was taken to complete the section of the work.

The chapter includes the detail of both the initial design and of how the improvements affected the usage, together with tips for future design decisions. It is intended that some visualisations of how users have navigated through specific packages will be included, as well as visual images of different methods of designing the package to allow easier navigation and use.
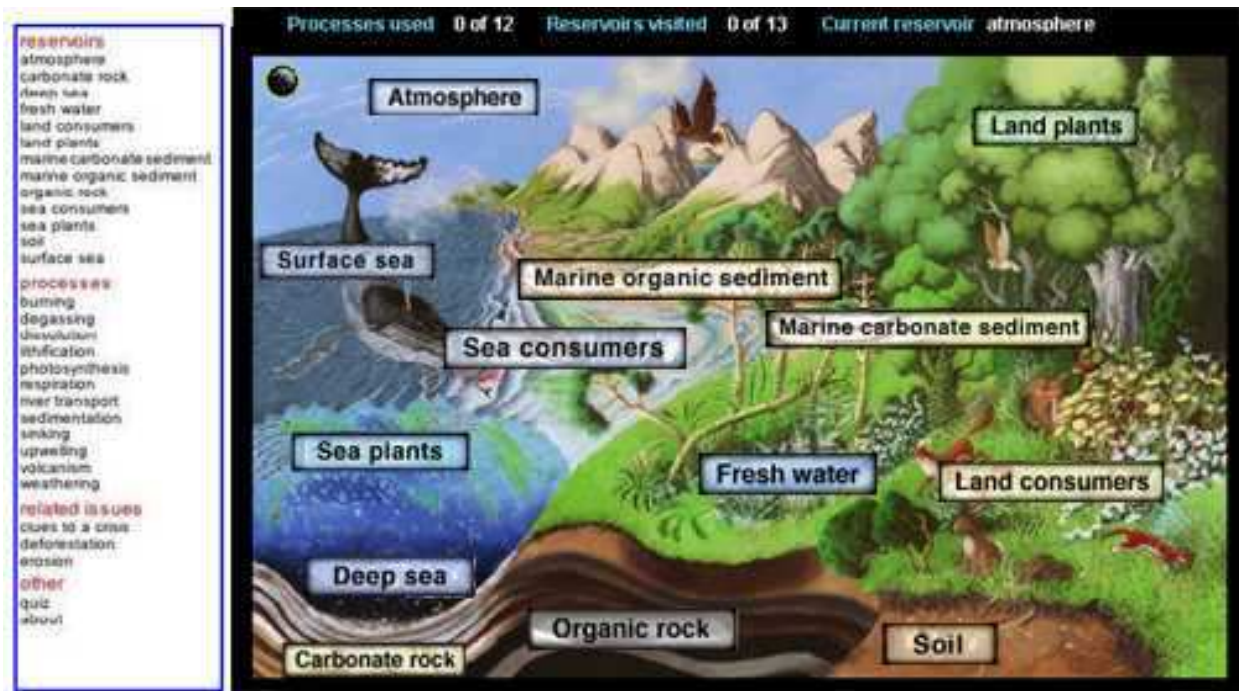

Fig. 2. Screen shot from the Open University Carbon Cycle

8.3 The Homer package

The Open University have developed a multimedia package for the course 'Homer: Poetry and Society', which looks at the nature of the relationship between the Homeric poems and the archaeological data on Ancient Greece.

The course is taught currently through print (poems, commentaries, essays, study guide), video (of archaeological sites, site plans, excavations, material objects) and audio (readings of poetry, expert discussions). In the format of these narrative media, a section of the teaching will have quite a complex structure, with different media (printed study guide, video of archaeological site, students' notes, published text) carrying different parts of the storyline. An example of this would be, for example:

1. Hypothetical question – in the Guide
2. Critique of assumption – in the Guide
3. Presentation of evidence - view the Video
4. Elicited student's response – put into the Notes
5. Interpretation of evidence – checking in the Guide
6. Contradictory evidence – reading about other evidence - Text
7. Interpretation of evidence – reviewing interpretation - Guide
8. Synthesis at higher level – being able to synthesise the information - Guide

Fig. 3. Screen shot from A295 Homer: Poetry and Society

From the illustration of the Homer multimedia package it can be seen that the structure of the work packages relates to each week of the course and these have been organized as an introduction and then six weekly sessions.

The icons under the Trojan horse image are links into other areas of the package. These include detailed archaeological tools, showing the user how these are employed and the methods used with them, maps and bird's eye views of the sites, notes and historical information as well as all the poems and associated works. This resource is an amazing, complex resource for Homer. However the way it has been designed with a controlling tutorial workload restricts the use the student can make of it. For instance only the tools which are needed for each week are introduced and certain areas are restricted until the course has arrived at this stage. This limits the amount of serendipity for the student and puts all the resources in the hands of the programme director. This also effectively blocks re-use as it would be necessary to go through the course again. This would have been better designed with the information resource available and the course as a prescribed route for first time users. I would suspect that the majority of the users would do this the first time but not be prepared to go through this again, hence limiting the use and usability of the package. The amount of work which has gone into developing it is therefore wasted and should have been allowed to augment and support the learning rather than control it.

8.4 The Sonoran Desert

The Sonoran desert multimedia package has been produced by the BBC and is advertised as being able to 'Explore one of the world's most fascinating deserts, accompanied by an experienced desert guide'. The Desert multimedia has been arranged as if the user was going on a multimedia field trip to the Cactus Desert of Arizona, south western United

States (2010). The software consists of over 400 desert scenes, with narrated information, images, sound clips and video. The Gila field centre allows the user to discover more about the desert including ecology, climate and geography. The user can learn what you should take with you on a field trip, conduct experiments, look up information and run their own slide show. The CD also features 100 video sequences from the BBC Natural History Unit, 800 sound clips and narrated tours, 1,300 photographs and illustrations and allows both a scrapbook and print option as well 'satellite links' to other deserts and laboratory experiments

This package was designed with a strong route defined basis. The routes were selected from a compass point system. The user could choose to start off North, South, West or East. However as most users are very organised into a top to bottom and left to right orientation in terms of movement through material, the most popular initial route was North. Giving people a choice without being aware of their natural preferences is not helpful, as in this instance introductory information was given for each of the routes. If everyone using the package is going to select a first route, i.e. North then this route and this route only, could have the introductory information. Giving multiple repetitions of the basic information (or even of similar interfaces) is likely to either annoy the user or to totally put them off using the package further.
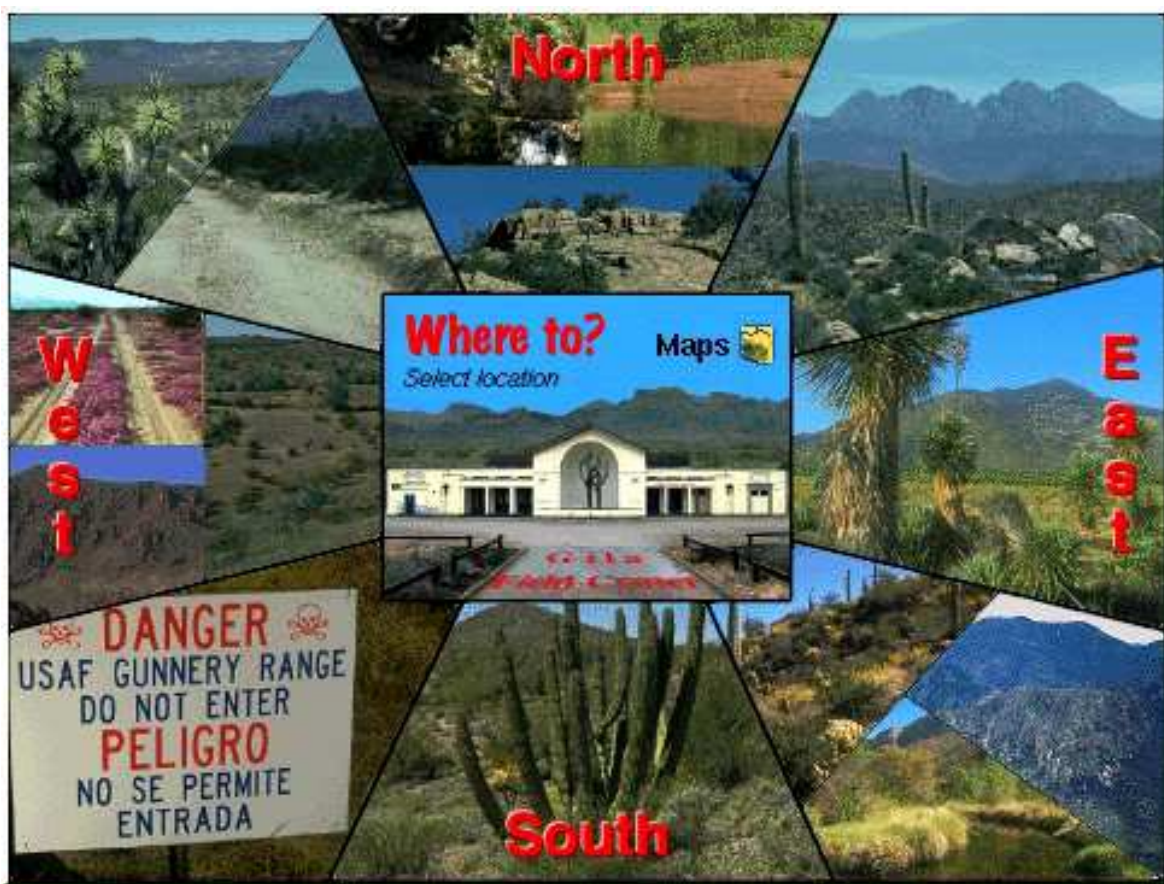

Fig. 4. Screen shot from the Sonoran Desert

An alternative design would be for the introductory section to appear which ever route is chosen first, but not repeated in subsequent route choices. This though would involve

getting the student/user to register with the package before using it. Most of the people using educational packages would be doing this as part of their courses this might not be an issue, but for courses where a high throughput is needed this might create a time delay. This sort of decision is particularly important for software designed for younger children, who might spend some valuable time filling out a form and have less time in the interactive package. In primary schools where pupils need to share limited resources this could be difficult balance to resolve. Obviously if the package performs some sort of testing or assessment then the registering of the user is important, or in some cases essential, as with online or lifelong learning courses where progress is measured electronically. However in these cases it should be possible to keep the registration required to a minimum.

9. Problems with design decisions

This section deals with examples of software where the design of the package has caused problems or significantly affected how the resource is used.

Investigating large resources has highlighted a series of problems that are common with both multimedia and large resources generally. Both of these resources need to be fully indexed and it is necessary to be able to search for and find, specific items reasonably accurately and quickly. Many of the problems of using the resources are based in the slow speed of searching and the poor quality of the results obtained. Much of this is due to the key wording and other selection techniques, but some is due to poor structural design of the package. In examples such as the British Library Medieval Realms, the initial package was very difficult to navigate and the detail involved did not match the age range of the material it was targeted at. Hence areas within the resource such as the Black Death which were taught to second and third year secondary students required a real knowledge of the period and the events and people in order to access the information. Giving feedback to the British Library meant that they went through a period of testing and then of redesigning the original interface to make it more comprehensible to the pupils it was meant to help.

The other main issue of any large and rich resource is that of serendipity. Rather than going to a specific area of the resource it is helpful for beginners to obtain an idea of the wealth and depth of the resource. Allowing students to browse or offering a quick tour, or better still a random review of the material may allow them to view or be interested in something they might not otherwise have discovered. One of the issues with using specific software in a school context is both the limited number of computers with the software – which restricts the amount of time they can spend on it, but also the time constraints of having to find the right material to answer the questions as quickly as possible. The result of this is that each student's experience of using the resource is likely to be similar, hurried and very rapid with no browsing or discovery time.

10. Visualisation

Another area of interest in this research is visualisations of how the users have approached the software, comments on these and developing tools for visualisation.

In the main research work each of the pairs and the individuals were mapped using the software. This was done by recording a scanned progress of the user through the software so that each step they took and the time taken on each screen was recorded. Additionally

interviews were held with the users to determine why they decided to follow a specific route and to ask questions such as had they found what they were looking for, was there sufficient depth and if they were aware of specific types of routes they were using. One interesting outcome of this was that the younger children thought they had investigated a large proportion of each of the resources they had used, whereas in fact they had been through relatively small amounts of the whole resource.

In some resources a key issue was whether or not the resource was at the right level or had sufficient content to both interest them and hold their attention. In some packages notably the Eyewitness series the information stopped at the point where they were becoming most interested – so it was rather too shallow. If this is likely to be the case then linking the resource to more detailed web pages or sites may be an answer, allowing the keen student to develop their knowledge further. In some cases the front end (the interface) was too simplistic – such as the Peanuts cartoon interface on a math resource. Younger students liked the cartoon interface, but found the math underneath too difficult, and getting the answers wrong repeatedly meant they rapidly dropped out of the package. In the opposite way – a too simple front end with complex information underneath – the resource The Way Things Work, again had a cartoon front end and simple cartoon like diagrams of how they worked, but the physics described was of a much higher standard. This package also had a workshop front end which made a series of noises – very upsetting to students trying to work nearby and causing laughter and playful behaviour from its devotees! Again testing this in a school environment would have immediately shown up these problems – even the children were aware of them and stated that it was interesting but noisy.

11. Navigational tools – Investigating navigation tools

Further development of the navigation tools would necessitate knowing information on each node and where the information is found within the resource. This information proved difficult to find for commercial resources and so a new resource would need to be developed around this basis. Research by McGuffin and Schraefel (2003) called Hyperstructures has involved representing information on the web. Hyperstructures which include component models such as Zzstructures and mSpaces are described using graph theory. These structures use hypertext structures like the web and hypertext links to show links between pages but also the multiple relationships between information within the pages. The INTENTS project from the University of Dublin (2007) involves the design of a series of intelligent knowledge based tools to assist in the construction, navigation and management of hypertext documents. Examples of these tools are 1) Creation of a framework which gives conceptual structure to a document corpus which can then be interrogated by an intelligent hypertext browser or 2) A knowledge based browser, using metadata from other tools in the series, as well as document management and authoring tools, and user behaviour tools. Developments of this nature would allow further exploration of individual's preferences and behaviour when using navigation tools.

The next part of the research was to develop a list of the most essential navigational tools to be used by designers in the construction of multimedia/Internet resources. This list gives an overview of the necessary component parts of good quality interactive multimedia. These resources are a good example of how digital natives could be used to determine the nature and extent of what they would prefer to have in their own toolkit.

1. Navigational tool Diagrams or Map
2. Known material
3. History
4. Audit Trails - navigational paths
5. Time line
6. Activities - Worksheet/ Task
7. User Levels

8. Individual student records/histories
9. Customobility issues
11. Curriculum research
12. Off-line facilities
13. Internet links
14. Expert guide, tour, induction/ tutorial
15. Intelligent Tutor

This list can be used by designers as a check to ensure that as many of these as feasible are built into the new software package. Some of these are reasonably straightforward but other items such as the intelligent tutor involve more detailed construction and facilities and substantial input from the tutor(s) to make this effective. If the navigation tools are produced as a series of device independent software tools then these could be added onto each resource and the user allowed to select from the available palette.

12. Navigational tools – and how these relate to the resources used – Producing new navigation tools

The newer navigational tools consist of the following: beacons, landmarks, breadcrumb trails, searchlights, intelligent agents, 2D and 3D maps and interactive guides. Beacons allow significant items or areas to be highlighted or lit up for particular students, or for whole classes or for specific search areas. Landmarks relate to the resource in the same way as physical resources, by providing points at which users can recognise that they have been there or they have gone past this point. These can be colour markers or set up as points within the resources so that users can find them again easily. A simple map could involve reproducing a schematic image of these and putting these landmarks on to a virtual map of the entire resource. Searchlights can be used with or without a search engine and can highlight just the relevant section or be used within areas where specific references are made to the search term. Breadcrumb trails enable a series of markers (with the breadcrumbs left at strategic points, i.e. whenever a user flags this area or screen, or would want to return to it. These trails could be set up either with different markers/ objects or colours or for specific trails. For instance, while searching for a particular set of images the user may find several that are useful for another project and they could then use several different breadcrumb trails while researching in the same resource. The example used is of a geographical resource with breadcrumb tails in different colours. It should be possible to create a similar navigation tool within a multimedia or internet based resource so that individual routes through the resource are detailed as a distinct route and can then be viewed on an overview map. New technologies such as geo-location, the facilities of smart phones and usage knowledge by digital natives could all be used to make learning more interesting, relevant and available ubiquitously and whenever needed.

13. Recommendations – General

New research using this information on preferred navigation and tools usage, together with the visualisation of the routes has been applied to new resources. The large catalogue of Arts and Humanities material created by the Intute project based at Oxford has created a large body of Internet accessible web sites with information on their quality and content and their applicability to UK HE courses. This resource is now being made available to a community

for further enhancement and expansion. This community is based on lecturers and researchers in the arts and humanities area. The Arch project is now developing this resource further, to include both an interface for the community to add and develop content, but also a series of demonstrators to show what is possible when using large resources. The project also brings together research on tools and suitable software packages.

The demonstrators for this project, include an outline of the tools presented, but also an interactive reconstruction of a house/museum format to store the exhibits. Previous work on the use of metaphors in multimedia has shown that although there are problems in using familiar structures such as a house that some users fail to realise that each room has a different function. The aim of this project is to help with the navigation and visualisation of the information resource but to make this discovery process interactive. The research will include both diagrams and images of these navigational routes, but also how these tools can be used and the type of structure for the resources that would aid discovery and usage in education.

Analysing multimedia and Internet resources has highlighted several problems, which were common across many resources. These include: insufficient or inadequate capabilities for navigation, the lack of awareness of where the user is in the package, and misconceptions of the amount of the resource they had investigated. Many of these problems could be resolved with better interfaces and more adequate testing; however allowing the users to develop navigational skills and providing them with a toolkit to do this may have longer term and more developmental benefits. These navigation tools are also meant to give an ability to the user to navigate on a physical level, and to do physical actions such as they might do in exploring a physical resource. Common actions in this environment would be walk, look around, zoom, pan, orbit, examine (as well as pick up/ inspect) fly – or bird's eye view, and turntable. Using this type of physical approach may lessen the need for specific navigational tools but support a toolbox or palette of navigational tools approach and the time investment needed is reduced if these tools are re-usable over a wide array of resources.

The standard types of navigational tool hence include indexes, search engines, maps, plans, timelines, histories and directional devices. There is however, a whole range of more innovative tools that could be developed for multimedia and Internet resources. The development of Open Source software has meant that it would be possible to develop a set of tools, which conform to XML or Java formats. This would mean that these tools could be freely available and added in with the minimum of effort. The newer tools include breadcrumbs, searchlights, beacons, landmarks, 3-D mapping, trackers, location finders, compasses, and route maps. Breadcrumbs are paths selected by the user of the key screens they have visited and can be set up to record different aspects of the search or information retrieval, Searchlights and beacons allow selected searches to be highlighted. There are ranges of direction/ map finders from games software where compass type location finders, and 2-D plans of the whole resource, help locate the user and allow them to find specific areas of the resource.

14. Recommendations for design and user assistance

The previous sections detailed current research on navigation patterns, new navigation tools and an outline of possible directions in visualizing these with some visualisation examples across a range of disciplines.

These new areas of research in visualisation which would have significant impact when applied to multimedia and internet resources and these techniques would allow an expansion of the possible views or investigations possible within interactive media resources. Much of this work is being done in the field of social networking. In this research the connections that people make over work or research is mapped and different methods of visualising these as maps, charts, patterns etc. give a different perspective on potential analysis methods. The key point of the chapter is the need to assess navigation abilities of students, even of digital natives, to develop their skills and abilities in this area and to give them a set of device independent navigation tools that they can use in many different resources.

The benefits of the visualisations are that these are easy to understand and to remember and a graphical image is easier to retain in the memory. Allowing students to link work areas together and to see the benefit of the work they have done is very important. The Internet will remain a source of information resources and users need to be fully equipped to use these and to make the best use of limited time. Allowing them the facility to re-use information and skills is equally essential and developing an appropriate set of tools into a tool bag or palette would be a useful skill set to take with them into employment or further study.

15. Conclusions and a way forward for designers

The conclusions from the research described in this chapter cover several areas, such as user preferences, potential navigation routes, testing designs and providing both flexibility and generic tools to assist the user.

Firstly, in the user preference areas, the research has shown that each individual user has very distinct preferences in how they navigate. Most users would perform some sort of linear route and most would do some hierarchical searching. Some users wanted to complete every section, or to cover all the screens in a particular sector, however the expert users were usually less systematic and would search for exactly what they wanted. It is therefore important to design different routes and paths through the resource.

Secondly the potential navigation routes in some multimedia and Internet resources were very restricted often with only one main route, forcing users to go through the resource in a specific way. This may be acceptable for introductory sessions but becomes very limiting in terms of exploring or self discovery modes. Ideally several different ways of navigating should be built in to the resource, with at least linear and hierachical routes being available.

Thirdly echoing Neilsen's work it is essential that developers test the design and the resource at every stage of its development, with the same age and experience for the target audience.

Finally producing a palette or toolkit of suitable navigation and visualisation tools that could be generic would be very useful for most users. Using the same tools over a series of resources would be less time consuming and far more productive, as users would not have to relearn another method of navigating. Ideally these tools should be created to work with a whole range of different software packages.

Following these recommendations would mean that better, more user oriented software would be produced that was easy and intuitive to use and allowed rapid and successful searches in the minimum of time.

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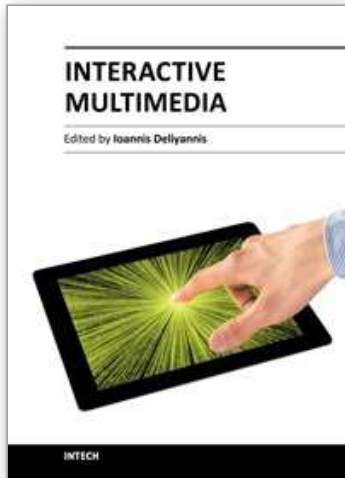
Interactive Multimedia

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Interactive multimedia is clearly a field of fundamental research, social, educational and economical importance, as it combines multiple disciplines for the development of multimedia systems that are capable to sense the environment and dynamically process, edit, adjust or generate new content. For this purpose, ideas, theories, methodologies and inventions are combined in order to form novel applications and systems. This book presents novel scientific research, proven methodologies and interdisciplinary case studies that exhibit advances under Interfaces and Interaction, Interactive Multimedia Learning, Teaching and Competence Diagnosis Systems, Interactive TV, Film and Multimedia Production and Video Processing. The chapters selected for this volume offer new perspectives in terms of strategies, tested practices and solutions that, beyond describing the state-of-the-art, may be utilised as a solid basis for the development of new interactive systems and applications.

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