

A Study of Portable Computers and Interactive Multimedia as a New Tool for Interpreting Museum Collections

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Glossary of Terms

Application	A term used to describe a computer program or piece of computer software
Audio Guide	A device which provides additional audio interpretation of Exhibits. Early systems were based the audio cassette, modern systems the audio-CD or solid-state electronics.
Browser	A software program which facilitates the viewing of WWW pages created in HTML. The two most popular browsers are Netscape Navigator and Microsoft Internet Explorer.
Case Study	The in-depth investigation of an individual case, employing multiple research methods and a qualitative approach.
CD-ROM	A silver plastic disc which is identical to an audio compact disc, but contains data which can be accessed by a computer.
Client-Server	A model for the computerised storage and distribution of data. The data is stored on the Server and transmitted on demand to the Client.
Closed Questions	Questions where respondents must select an answer to questions from several pre-determined responses.
Codified	A structured approach with predetermined categories which is suited to the collection of quantitative data.
DVD	Digital Versatile Disc (DVD) is a high storage capacity evolution of the CD-ROM. Initially DVDs are being used for movies, however they can be used with computers to provide programmes with high levels of interaction.
Exhibit	A single object, interactive or case with the whole gallery.
Exploratory Research	Initial research conducted to gain an appreciation of the area of enquiry and to identify topics for further research.
Frequency	A count of how often a variable occurs in the data.
Focus Group	A research methodology where a group of individuals discuss or are interviewed regarding a topic or set of topics.

Geographic Positioning Systems (GPS)	A technology which can accurately calculate the geographic position of the unit using information from satellites.
Heritage Attraction	A site or building visited by the general public which makes reference to a heritage theme or story, and includes museums.
HyperText Mark-up Language (HTML)	The text based language used to create WWW pages.
Infrared Transmitter & Receiver	A system for identifying position/location using a receiver and network of infrared light transmitters.
Interaction History	A computerised record of interactions with an application. Can be used to tailor the information provided to visitors based upon what they have already seen.
Interaction Log	A text file produced by an application which records the visitors interactions. Frequently used to analyse visitor interaction with multimedia application.
Interactive Multimedia	The combination of some or all of the elements of text, graphics, sound, animation, video and interactivity.
Internet	The communications backbone which supports network applications including e-mail and the WWW.
Interpretation	The process of selecting appropriate media and approaches to effectively communicate information about artefacts and their importance to visitors.
Interviews	A method of collecting data by asking individuals questions, which may be conducted either face to face or over the telephone.
Kiosks	A substantial structure, typically of similar proportions to a small wardrobe which houses a computer, monitor and input device.
Laserdiscs	A large silver disc, that is similar in appearance to an audio compact disc, but with approximately twice the diameter. Laserdiscs can store images, sound tracks and video information.
Metaphor	A term used within multimedia design to describe a method of structuring information within an application in such a way that it links to concepts and structures already familiar to the user.

Non-Probability Sampling	A sampling approach often employed for small scale surveys where the likelihood of each unit being selected is not known.
Observation Schedule	A codified record sheet, which assists researchers in recording observed behaviours.
Open Questions	Questions where respondents are free to provide answers in their own words.
Palm Top Computer	A portable computer, which resembles a conventional laptop but is approximately half the size. Typically these computers use the Windows 95/98 operating system and run the majority of Windows applications.
Panel Survey	A research method where focus groups meet on several occasions over time, and is frequently used during market research to assess trends.
Personal Digital Assistants (PDA)	A handheld touch screen electronic device. Early examples were based on electronic organisers, however recent models are significantly more powerful and run the Windows CE operating system.
Plug-In	A small software application that extends the functionality of a Browser, typically adding the ability to display additional multimedia content.
Portable Computer	A computer, typically the size of a clip board, which has the functionality to a laptop combined with a touch screen interface.
Probability Sampling	Sampling approach often used for large scale surveys where the likelihood of each unit being selected is known.
Qualitative Research	A research method which adopts a holistic and in-depth approach, and is concerned with understanding views and options.
Quantitative Research	A research method which adopts a numerical approach, and is concerned with statistics and generalising results.
Questionnaire	A method of collecting data based upon individuals responses to questions. Questionnaires can be administered by an interviewer or completed independently by the respondent.
QuickTime Virtual Reality (QTVR)	The creation of a virtual reality environment by stitching a series of photographs together to form panoramas or objects.

Quota Sampling	A sampling approach where interviewers are given a quota of individuals with certain characteristics. By combining the results from a number of quotas, a representative picture of the target population can be formed.
Random Sampling	A sampling approach where each unit or individual has the same probability of being selected.
Record Sheet	A structured research instrument with predetermined and codified categories which assists a researcher in recording the responses to questions.
Survey	A research method which uses the results from a representative sample to predict or generalise for the whole population.
Systematic Sampling	A sampling approach where individuals are selected at equal and regular intervals.
Touch Screen	An input device which fits in front of or is incorporated into a computer monitor. The touch screen calculates the position where the screen was touched and this information is used to make on-screen selections.
Tracker Ball	An input device that resembles an oversized upside down mouse. The ball is used to manipulate an on screen cursor and make selections.
Triangulation	The combination of several research methods or data collection techniques, also referred to as multi-methods.
User Profile	A model of users preferences and interests.
Virtual Reality (VR)	The creation of a three dimensional, computer generated world or object that can be explored and/or manipulated.
Virtual Reality Modelling Language (VRML)	A text based language, which resembles HTML, and is used to create Virtual Reality objects and environments which can be accessed over the WWW.
Windows CE	A cut down version on the Windows 95/98 operating system designed specifically for portable devices.
Wireless Network	Similar to a conventional computer network except that it uses radio transmitters/receivers instead of cables to transport data between computers.
World Wide Web (WWW)	The most rapidly expanding element of the Internet. To view the WWW a computer requires a Browser to display the HTML files as pages containing text and images.

Abstract

A Study of Portable Computers and Interactive Multimedia as a New Tool for Interpreting Museum Collections

James A. Evans

Over the last two decades the introduction of interactive multimedia applications complimenting existing interpretative techniques in museum displays has become a widely accepted practice. Indeed fixed interactive multimedia applications can communicate large amounts of often complex information in a user friendly and accessible way. A drawback is their fixed position. This research project identified the potential of using a portable computer with an interactive multimedia application manipulated through a touch screen interface. This thesis describes the results of a series of empirical studies to design and test the effectiveness of a portable computer as a new tool for interpretation in a museum gallery.

The central aim of the research, funded by the GEMISIS 2000 initiative, was to examine potential innovative applications of new interactive technologies for heritage attractions and museums. Exploratory research progressed from discovery and gaining insights into the diversity of interactive multimedia applications in heritage attractions to the dynamics of interactive multimedia as a powerful communication medium. The main study fell into three distinct yet complimentary research pathways namely 1) to design an interactive multimedia application for a portable computer, 2) to examine the use and effectiveness of the portable computer with museum visitors, 3) to assess the application as a new tool for interpretation in a museum setting. The conclusions of this research project are based upon the results of a rigorous and comprehensive evaluation study, which combined a questionnaire survey, structured unobtrusive observation and interaction logging.

As the research project was initiated there were few other projects in this field of study, and no formal evaluation had been published. At the completion, four research projects were identified and are detailed in the conclusion.

The results of this research project have confirmed the hypothesis that a portable computer with an interactive multimedia application has the potential to enhance interpretation and to become a new tool for interpreting museum collections. As the number of homes with multimedia capable computers equipped with CD-ROM drives and connected to the Internet grows and exposure to computers at work and at school increases, visitors are well prepared to handle the new technology. The project's results show ease of use and an increased recall of exhibits by visitors. Visitors experienced discovery based learning at their own pace facilitated by a portable touch screen computer.

Limitations of the project are discussed and future research topics identified. These included expanding the interactive multimedia application to cover the whole gallery, exploring alternative interaction models, evaluating the impact of age and gender, evaluating the portable computer within other categories of museums, to evaluating location aware positioning systems and to investigating Personal Digital Assistants as a potential hardware platform.

Chapter 1

The Research Project: A Background and Context

Chapter 1 The Research Project: A Background and Context

The central aim of this research project funded by the GEMISIS 2000 initiative was to examine innovative applications of new interactive multimedia technologies for heritage attractions. GEMISIS 2000 is a collaboration between the University of Salford, Cable and Wireless Communications, the City of Salford, the City of Manchester and the Manchester Training and Enterprise Council. The objectives of GEMISIS 2000 are to promote economic regeneration, to forge links between the public and private sectors, to improve the quality of life for the community and to provide test-bed sites for multimedia initiatives. A vital element of GEMISIS 2000 was the establishment of an inter-disciplinary program supporting thirty postgraduate doctoral research students, undertaking innovative research projects. The research areas are cross-disciplinary and include; Government, Education, Medicine, Industry, Society and the Information Superhighway (GEMISIS). This research project was endorsed and funded by GEMISIS 2000.

Over the last two decades the introduction of interactive multimedia applications complementing existing interpretative techniques in museum displays has become a widely accepted practice. Indeed fixed interactive multimedia applications can communicate large amounts of often complex information in a user friendly and accessible way. A drawback is their fixed position. This research project examined the feasibility of using a portable computer with an interactive multimedia application manipulated through a touch screen interface. This thesis describes the results of a series of empirical studies to design and test the use and effectiveness of a portable computer and interactive multimedia application as a new tool for interpretation in a museum gallery.

Exploratory research progressed from discovery and gaining insights into the diversity of interactive multimedia applications in heritage attractions to the dynamics of interactive multimedia as a powerful communication medium. The main study fell into three distinct yet complementary research pathways namely 1) to design an interactive multimedia application for a portable computer, 2) to examine the use and effectiveness of the portable computer with the museum visitor, 3) to assess the portable computer and interactive multimedia application as a new tool for interpretation in a museum

setting. The conclusions of this research project are based upon the results of a visitor evaluation study, which combined a questionnaire survey, structured unobtrusive observation and interaction logging.

This research project provides a new contribution to knowledge as this is the first time that a portable computer and interactive multimedia application have been used within a museum gallery to provide additional interpretation, and they have been formally evaluated.

The hypothesis was that it was feasible to employ a portable computer and interactive multimedia application to enhance interpretation and to become a new tool for interpreting museum collections.

The term portable computer covers a wide range of products from Personal Digital Assistants (PDA's) to Notebook and Laptop Computers. In this instance, a portable computer is a piece of specialist computer hardware measuring approximately 30cm x 22cm x 4cm, with a 26cm colour touch screen display running the Windows95 operating system.

Interpretation is the process of selecting appropriate media to communicate information about artefacts and their importance to visitors. A tool is an instrument, which assists an individual in accomplishing a task. In the context of the research, the tool is the portable computer and interactive multimedia application, which assists the museum in communicating the meaning and significance of exhibits to visitors.

It was the intention that the research would provide an indication of whether it was feasible for a portable computer and interactive multimedia application to be used by visitors to a museum gallery to provide additional interpretation. The criteria for success were: visitors spending longer in the gallery, increased recall of exhibits by visitors, and that visitors found the portable computer and interactive multimedia application both easy to use and enjoyable.

The results of this research project have confirmed the feasibility of using a portable computer with an interactive multimedia application to enhance interpretation and to become a new tool for interpreting museum collections.

The project's results show ease of use and suggest a significantly increased recall of exhibits by visitors. Visitors experienced discovery based learning at their own pace facilitated by a portable touch screen computer.

The findings provide an original contribution to knowledge in the field, and the study reflects the researcher's background in information technology and an interest in innovative applications of new technology. The research project also reflects the aims and objectives of the GEMISIS 2000 initiative. Although the research by its very nature has explored methods of interpretation, visitor studies and the critical and interpretative design dimension of museums and heritage attractions, it is not directly concerned with these disciplines.

The research provides an insight into an innovative application of new interactive multimedia technology and its use in a museum gallery. The findings of this research project will provide a sound basis upon which future studies can build.

1.1 Background and Context for the Research

This chapter provides a background and context for the research. The diverse range of interactive multimedia technologies currently employed in heritage attractions is critically reviewed, and a selection of the more innovative applications and installations are described. Innovative applications within the context of the research included new technologies and new applications of existing technologies. The chapter concludes with a classification framework of interactive multimedia applications within heritage attractions and identifies potential areas for further research.

For the purpose of this research project a heritage attraction is defined as a site or building visited by the general public which makes reference to a heritage theme or story. Thus the term heritage attraction is wide ranging and includes museums, heritage centres, urban heritage parks, restored docklands and theme parks. (Sterry 1994)

Over the last two decades the use of interactive multimedia to support interpretation in heritage attractions has grown widely and is an increasingly successful practice. Almost all visitors to heritage attractions have the opportunity to interact with and to experience sophisticated interactive multimedia exhibits. (Garfield, Cassedy and Roth 1992, Jones 1992, Koester 1993, Lydecker 1993)

In the context of this research project interactive multimedia includes exhibits which are under the control of visitors, and encompasses audio guides, interactive multimedia kiosks, CD-ROMs/DVDs, Virtual Reality environments and World Wide Web (WWW) sites. Interactive multimedia is defined as the combination of some or all of the elements of text, graphics, sound, animation, video and interactivity. (Bunzel and Morris 1994, Lopuck 1996, Prochak 1990, Vaughan 1994) The term 'Hypermedia' is used where interactive multimedia is combined with a hypertext navigation system, similar to that used on the World Wide Web and moves away from linear interaction models. (Alsford 1991, Nakano 1995, Signore 1995, Tschritzis and Gibbs 1991)

Interactive multimedia applications are being used to provide interpretation, yet this is still a relatively new discipline for heritage attractions and particularly for museums, when compared to more established interpretation mediums. (Alsford 1991, Heinecke 1995, Thomas 1993, Visser 1993) The successful use of interactive multimedia in museums has coincided with changes in the design management of museum exhibitions. No longer are museums merely custodians of artefacts in glass cases, as many now provide vibrant displays with interactive multi-sensory experiences. Therefore a museum visit is no longer a passive experience, but one in which the visitor participates. (Besser 1997, Hunter 1996, Lewis 1991, Valls 1994) The first International Conference on Hypermedia and Interactivity in Museums (ICHIM) was held in 1991 and the first International Conference on Museums and the Web as recently as 1997, illustrating the growing interest in the two disciplines. (Bearman 1991a, Bearman and Trent 1997b, www.archimue.com)

Heritage attractions are clearly committed to investing in new interpretative technologies, developing larger and more sophisticated exhibits, which are becoming central to the design of new galleries. (Bearman 1993, Emmett 1998, Thomas 1993) A recent survey found that almost 80% of attractions surveyed including museums were planning to develop new interactive multimedia exhibits in the next two years, with projected budgets ranging from under £10,000 to in excess of £250,000. (Farnell 1997d) These findings were supported by a report into "The Current and Projected use of New Media within UK Museums", which found that 25% of the 400 museums surveyed were planning new multimedia installations in the next year, accounting for 10-50% of their budget. (The Visual Arena 1998, Terry 1998) Although it is unclear as to whether this

figure refers to the museums total budget, or a specific budget for an individual gallery or exhibit.

Recognition of the effectiveness of interactive multimedia as a new medium for communication with visitors, in comparison with traditional media is of crucial importance, (Beniger 1987, Fahy 1995, Gwaltney 1991, Koester 1993) and museums are by their very nature multimedia environments. (Bearman 1991, Gordon 1995b, Koester 1993, Laetsch et al 1980) Interactive multimedia can present complex information in a dynamic, entertaining and easily understood way, which empowers visitors to access the information they require at their own pace. (Dube 1997, Hoffos 1987, Martlew 1990, Winterbotham 1994) Interactive multimedia can complement existing interpretative techniques, can place objects in their social and historical context and are undoubtedly popular with visitors. (Allison and Gwaltney 1991, Nakano 1995, Swift 1997) Swift has identified several studies where interactive exhibits have repeatedly been identified by visitors as the most enjoyable and most memorable. (Swift 1997) Allison and Gwaltney conducted research into the application of multimedia interactives with the 'Information Age' gallery at the Smithsonian Institution, USA. It is recognised that this gallery was not representative of all museum galleries, as its theme was communication, and the gallery included 62 computer workstations, 44 laserdisc players, 7 projectors, 20 video monitors and a 12 screen video wall. Based upon their research they concluded that interactive multimedia exhibits are a powerful communication medium, which is a valuable addition to traditional displays, and are very popular with visitors. (Allison and Gwaltney 1991) Research by Nakano has identified that interactive multimedia exhibits can assist in displaying exhibits in context. (Nakano 1995)

Interactive multimedia exhibits are now of crucial to the visitor experience of new attractions and galleries as it is recognised not only how effectively they communicate to visitors, but also how they can complement more established interpretative formats. (Bearman 1995, Martin 1996f, Valls 1994) Allison & Gwaltney discovered that visitors who used computer interactives spent longer in the gallery looking at other exhibits than they would otherwise have done. (Allison & Gwaltney 1991) Research at the Haverfordwest Town Museum revealed that the museum was using interactive multimedia to extend the range of interpretative materials available to visitors, to

supplement the existing information provided on graphic panels and to make it a more engaging and interactive experience for the museum visitor. (Martin 1996f)

The appeal of multimedia exhibits can distract visitors from other exhibits. (Martin and Frazer 1997a, Hoffos 1987, Winterbotham 1994) However as seductive as new interactive technologies are, they are just another tool for the exhibition designer, they will not replace the physical objects which they strive to interpret, nor are they intended to. Therefore it is essential that the designer does not focus on the technology, which is not an end in itself. (Gleeson et al 1996, Lydecker 1993, Mintz 1990, Prochak 1990) This has been recognised by a number of leading commentators such as Mintz and Gleeson et al who advise that museums must be careful not to “be seduced by the technology.” (Gleeson et al 1996, Mintz 1990)

Society is becoming increasingly computer literate. As the number of homes with multimedia capable computers equipped with CD-ROM drives and connected to the Internet grows and exposure to computers at work and at school increases, visitors are expecting and demanding more from the museum experience and are well prepared to handle the new technology. MacDonald and Alford, and Lydecker have speculated that in the near future visitors to museums will have grown up within a technological environment. Beniger called it the “Information Society” where interactive multimedia has a major influence on their lives, at school, at work and during recreation. (Beniger 1987, Dube 1997, Lydecker 1993, MacDonald and Alford 1997)

The WWW has expanded rapidly in recent years, as have the numbers of heritage attractions and museums with Web sites. Campbell and Wells explain that in “recent months, the use of the Internet as a communications tool has grown exponentially.” (Campbell and Wells 1996) Morrison, Bowen and Bennett expand that the Internet is almost doubling in size every year. (Morrison, Bowen and Bennett 1997) Jonathan Bowen, founder of the Virtual Library Museum Pages (VLMP) explains that “currently several museums a day are joining the Internet around the world.” (Bowen 1996) Noack expands that “almost every museum in the world now has a Web page.” (Noack 1995)

The WWW is seen as being important because it provides a new channel of communication with both actual and potential visitors and a way of enhancing their

perceived image. (Clutton 1996, Daniel 1996, Gollow 1996) Museums are using their Web sites to provide general visitor information (e.g. admission times and prices) through to on-line interactive multimedia exhibits. (Duffy 1995, Noack 1995, Standage 1995, Zorich 1997) An attraction's virtual presence on the Web will become of increasing importance as access is not restricted only to those with a computer, it is now possible for everyone to have easy access to the Web from their living room just like subscribing to another satellite or cable television channel. This has been achieved using cheap and in most cases free, easy-to-use set-top boxes, which can provide access to the Internet and the Web through a standard television. (Kirwan 1997c, Look 1997, Woods 1997, Youlgreave 1997, www.cwcom.com, www.ntl.com)

However the World Wide Web is not the only medium available to heritage attractions and museums wishing to communicate with the public beyond the physical boundaries of their site. Several television channels dedicated to history and science are already available through satellite and cable television subscriptions, including The History Channel, National Geographic and The Discovery Channel. With the launch of Digital TV in the United Kingdom during October 1998 and the potential for broadcasting over 200 channels, and with producers looking for quality programme content, museums with their extensive collection are in a prime position to contribute as content providers. (Bearman 1989, Friedlander 1993, Gordon 1995b, Hoekema 1991)

Exploratory research revealed that there have been few studies addressing the impact of interactive multimedia applications on the visitor experience. (Garfield, Cassedy and Roth 1992, Heinecke 1995, Hilke 1996, Hilke et al 1988, Koester 1993, Lydecker 1993, Martlew 1990, McMannas 1987, Reid 1997) A number of commentators have observed that many museum professionals are unimpressed by the majority of interactive multimedia exhibits and are unconvinced of their educational or interpretative benefits. (Garfield, Cassedy and Roth 1992) This situation is further explored by Heinecke and Koester who found that there are few studies of interactive multimedia exhibits to date. Lydecker is emphatic in that no studies have yet proved quantifiable benefits. This confirms the view that there is potential to explore further the complexity and impact of such applications in museums further. (Heinecke 1995, Koester 1993, Lydecker 1993)

The following section, critically reviews the range of interactive multimedia technology currently being employed at heritage attractions and museums. Its purpose is to provide

a context for the subject area and reviews the strengths and weaknesses of each interactive technology.

1.2 Interactive Multimedia Technology: A Critical Review

For some visitors it appears that a multimedia application is a natural extension of the museum, which have traditionally presented themselves as multimedia experiences. (Alsford 1991, Bearman 1991, Koester 1993, Laetsch et al 1980) The most frequently encountered interactive multimedia applications are Audio Guides, Laserdiscs/DVDs and Computer Based Interactives.

The following sections will critically review the varied range of interactive multimedia applications found in heritage attractions and museums, although it should be remembered that these are not discrete groups and that there is often a blurring of boundaries between categories.

1.2.1 Audio Guides

The audio guide has become an established interpretative device within many attractions especially art galleries and temporary exhibitions. These systems do not require visitors to read lengthy descriptions from guidebooks or labels, and are often available in multiple languages for overseas visitors. However, the functionality of audio guides based on the audio cassette are limited to providing a linear commentary, following a fixed, pre-defined route through the gallery or exhibition. (Kelly 1997, Martin, Frazer and Wilson 1997, Whittington 1997, Wilson)

This limitation has led to the development of two more sophisticated technologies, one based on solid state electronics and the other on the audio CD format. The solid state device, looking rather like an oversized mobile telephone, stores the audio data digitally in memory, whereas the audio CD based unit uses specially recorded CDs which are played on modified personal CD players. When the visitor locates an exhibit, which they are interested in, they enter the three-digit code displayed next to the exhibit and the corresponding audio commentary is played. Both systems free visitors from the linear constraints of the cassette based audio tour and afford the visitor greater freedom to explore the museum or gallery in any order and at their own pace. (Martin 1995, Martin 1998, Serrell 1998, Wilson 1996b)

The solid state system also has the facility to monitor and record which commentaries the visitor accessed and in which order they were accessed. This information can be invaluable to exhibition designers in monitoring visitor circulation and evaluating if some areas to the gallery that are not generating the anticipated levels of interest from visitors and thus, may need to be revised. An additional advantage of the solid state system that results from the commentaries being stored digitally in memory, is that it is relatively straight forward and cost effective to change or update the commentaries. This is not the case with specially recorded cassette tapes or CD's.

However, one limitation, which applies to the audio guide systems discussed, is that one visitor can only use each system. However it is acknowledged that InfraRed and Sound Cone systems can facilitate group participation. This is not ideal, as most people visit heritage attractions and museums as part of a social group. (Alison & Gwaltney 1991, Falk and Dierking 1992, Wood 1996, McMannas 1988) If this group is divided into individuals, each using a personal audio guide, each member must tour the exhibitions in isolation. However, this may also be a strategy employed by attractions in order to generate maximum revenue by charging each visitor to use an audio guide. The Tower Bridge Experience (London), the Bank of England Museum (London), The National Gallery (London) and the Conservation Centre (Liverpool) have all used audio guides to enhance the existing interpretation within their respective galleries.

1.2.2 Laserdiscs

Laserdiscs have proved to be popular for interpretation within heritage attractions and museums because of their large storage capacity (100,000 images or 30 minutes of video) and reliability. The systems are extremely reliable, because there is no physical contact between the media and the playback head. Therefore they can be used, almost indefinitely without the degradation in quality associated with videocassette tapes when used repeatedly. (Bearman 1989, Cash 1988, Roberts 1988, Rumbold 1995) However, bespoke laserdiscs which are produced to individual museums requirements are expensive to manufacture and cannot be updated should revisions be required at a later date. (Beniger 1987, Binder 1992, Hoffos 1987, Mintz 1990)

It appears that even when coupled with a computer to control playback, laserdiscs can provide only limited interaction for the visitor. Therefore laserdiscs are particularly suitable for the continuous playing of looped audio or video sequence or for

installations where visitors can select to view one of a number of video features. However laserdiscs are not appropriate where a higher level of interaction is desirable.

Laserdiscs can be found in virtually every museum that features video footage, examples include the National Museums and Galleries on Merseyside, the Thames Barrier Visitor Centre, the Museum of the Moving Image, the Natural History Museum, the Science Museum, the Imperial War Museum and the Museum of Science & Industry in Manchester.

In the last year Digital Versatile Discs (DVDs) have found favour with heritage attractions and museums which have found their combination of storage capacity, reliability and affordability to be well suited to the tasks previously performed by laserdiscs.

1.2.3 Computer Based Interactive Multimedia

The limitations of audio guides and laserdiscs, combined with a move towards greater participation and interaction within galleries have hastened the introduction of computers and interactive multimedia applications for interpretation within heritage attractions and museum galleries. (Alsford 1991, Koester 1993, Martin and Frazer 1997a, Swift 1997) Advances in computer performance, reductions in cost and the availability of multimedia authoring packages, (Besser 1991, Lydecker 1993, Oker 1991, Valls 1994) have promoted a move to computer based interactive multimedia, which is considered a promising interpretative format for heritage attractions and museums. (Dube 1997, Hilke et al 1988, Lewis 1991, Visser 1993)

Interactive Multimedia exhibits are excellent tools, they can provide large amounts of often complex information in a user friendly and interesting way which is easily understood and enjoyable for the museum visitor. (Allison and Gwaltney 1991, Fahy 1995, Hoffos 1987, Lewis 1993) These interactive exhibits can empower visitors, putting them in control of the information they access, how they access this information and at what pace, making for a more rewarding and richer experience. (Lydecker 1993, Swift 1997, Visser 1993, Winterbotham 1994) Interactive multimedia exhibits are not a replacement for traditional interpretation methods, but complementary, and can assist in placing exhibits and artefacts in their historical and cultural context, and never tire of repeatedly answering the same question. (Cooper 1993, Gleeson, Vicars-Harris,

Griffiths and Willrich 1996, Martin 1996f, Nakano 1995) These applications can also help to overcome the physical space and access constraints that museums face when trying to provide public access to collections while at the same time preserving the individual artefacts. (Dube 1997, Francis, Grigg, Nairne and Pring 1992, Martlew 1990, Valls 1994) Research by Swift and other leading experts has found that interactive exhibits are extremely popular with visitors and are frequently one of the most memorable parts of their visit to a heritage attraction or museum. (Koester 1993, Martin and Frazer 1997b, Reid 1997, Swift 1997)

However there are drawbacks associated with introducing interactive multimedia exhibits. Initially there is the cost of developing the exhibit, the average cost for a single multimedia kiosk (hardware and software) is between £5,000-£30,000 with much greater sums for larger and more sophisticated multiple installations. (Martin 1997c, Mintz 1990, Prochak 1990, Swift 1997) Once installed within the gallery there is the problem of robustness, interactive exhibits are subject to greater wear and tear than passive exhibits, so regular maintenance will be required, if out of order exhibits are to be minimised. (Bitgood 1991, Swift 1997, Winterbotham 1994, Visser 1993) The relative novelty of the interactive multimedia when compared to other techniques may result in the technology being the most memorable part of the visit, rather than the exhibit it was designed to interpret. Ideally multimedia interactives should be designed as an integral part of the exhibit from its conception and not grafted on as an after thought, with the technology and the user interface being transparent to the visitor. (Farnell 1996, Koester 1993, Martin and Frazer 1997a, Winterbotham 1994)

The installations typically found within heritage attractions and museums consist of either a Personal Computer (PC) secured to a desk or one housed within a custom kiosk. Exploratory research identified that kiosks are far more common, being observed in 17 attractions, compared to PC's which were observed in 8 attractions. This may be because the computer equipment is significantly more protected from potentially destructive visitors when housed within a kiosk. (Hoffos 1987, Oker 1991, Swift 1997, Woolsey and Semper 1991) Secondly, when the PC is housed within a kiosk it looks less like a computer and therefore may be less intimidating for technophobic or the non-computer literate visitors, however as society becomes increasingly computer literate this will be less of an issue in the future. (Dube 1997, Farnell 1997a, MacDonald and Alsford 1997, Martlew 1990) Examples of multimedia kiosks can be found at the Bank

of England Museum, the Croydon Clock Tower, the Imperial War Museum, the Natural History Museum, the Royal Armouries and the Tower Bridge Experience.

Touch screens and tracker-balls are the most common hardware interface between the museum visitor and the computer. (Driscoll 1991, Lewis 1991, Oker 1991, Preston 1996) Exploratory research identified that touch screens were present in 15 attractions compared to tracker-balls, which were present in 14 attractions. This is probably because, when compared to traditional computer interfaces (e.g. mice and keyboards) they are generally easier to use and much more resistant to harsh treatment. (Driscoll 1991, Lewis 1991, Oker 1991, Preston 1996) However, touch screens are not free from problems, finger prints on the screen can detract from the visual quality of the experience, as can reaching across the screen to make selections obscuring the view of other visitors. Tracker-balls too are not indestructible and can be susceptible to dirt and sweaty hands.

The use of joysticks was observed on relatively few occasions despite their robustness and ease of use. This may be due to their games playing roots, which is deemed inappropriate for the museum gallery. (Hoffos 1987, Oker 1991, Preston 1996) However joysticks are finding favour for the navigation of virtual environments. The National Museums and Galleries on Merseyside have adopted a different approach to their hardware interface design, which is consistent throughout each of their galleries. The interface is based around three buttons, Up, Down and Select. This simplistic interface utilises extremely robust buttons that are cheap to replace if broken, something which cannot be said of the other more sophisticated hardware interfaces. However, the interaction possibilities for the visitor using this interface are extremely limited and this may reduce their enjoyment and the educational potential of these interactives.

One problem which has been identified with multimedia interactives, is that only a relatively small number of visitors can observe the interactions, and fewer still can participate. A possible solution to this problem is to ensure that more visitors can observe the interactions taking place, this approach has been adopted by many attractions, and appears to be an acceptable compromise, as many visitors seem to be happy to watch while others participate. (Falk and Dierking 1992; Jones 1992, Lewis 1993, Martlew 1994) This result can be achieved by suspending large television monitors above the exhibit, often referred to as "slave monitors" or by projecting the

image from the computer onto a large screen rather than using a single computer monitor. (Bath 1996, Jones 1992, Koester 1993, Lewis 1991)

Examples of museums where these approaches have been adopted include the Science Museum, the Tower Bridge Experience, the Croydon Clock Tower and the Imperial War Museum. An alternative solution is to install multiple kiosks each running the same interactive multimedia application, examples of this approach can be found at The Natural History Museum, The National Gallery and the Croydon Clock Tower. This provides the opportunity for several individuals or small groups to participate simultaneously, however this will significantly increase the cost to the museum and the space required for such an installation. (Spicer 1996)

A potential problem facing museums is the pace at which technology advances (Hermann 1997, Martlew 1990, Oker 1991, Signore 1995), as it appears that systems which are state of the art today will be common place next year and redundant the following year, if not before. This is particularly evident in museums where galleries can have a life span of up to 25 years. (Roberts 1988) However, it is not necessary for museums to continually update their computer based interactives, as long as they still achieve their original aims. Although if applications rather than the hardware they run on appear to be outdated to the visitor, in terms of their speed or visual presentation then there is the danger that they will simply be ignored.

1.2.4 Interactive Multimedia Development

When considering the development of an interactive multimedia application, whether it is a touch screen kiosk, CD-ROM or Web site, heritage attractions face the decision of developing the application in-house or contracting out the development to an external consultant. (Koester 1993, Oker 1991, Patten 1996, Roberts 1988) This section discusses the strengths and weaknesses of each option.

The advantages of developing an interactive multimedia application in-house are that the individual or group undertaking the development will already be familiar with the heritage attraction or museum, exhibit or gallery, and will understand the unique demands of visitors to heritage attractions. The in-house developer is well placed to design and produce an interactive multimedia application which reflects the museum's objectives. However the in-house developer may lack the design experience and

technical expertise required to produce an interactive multimedia application of professional quality. (Driscoll 1991, Lydecker 1993, Oker 1991, Vanausdall 1986) Few attractions can afford to employ a full-time multimedia specialist, and typically buy in the expertise as needed on for each individual project basis. However larger museums are increasingly employing a permanent WebMaster to update and administer their Web site. Employing an external consultant or developer is the route chosen by the majority of heritage attractions which do not have the requisite in-house expertise in interactive multimedia development. Experienced consultants can design and produce interactive multimedia applications more quickly than in-house developers and typically of a much higher quality. However external may not understand fully the unique requirements of heritage attractions and their visitors. If heritage attractions fail to clearly specify their requirements then there is the danger that the external consultant may develop what they think the heritage attraction actually wants, not what the attraction actually needs. It is also recommended that the consultant should agree to train someone from the museum to perform maintenance activities, this is especially important for Web sites which require regular updates, but less of an issue with multimedia kiosks which once installed are seldom altered. (Prochak 1990, Roberts 1988, Vanausdall 1986, Velthoren and Seijdel 1996)

Interactive multimedia development is typically undertaken by a multidisciplinary team including interactive designers, graphic designers, animators, photographers, musicians, camera operators and video producers depending upon the demands of the project. A single individual typically does not possess all the required skills to design and develop an interactive multimedia application, although they may be multi-skilled. It is important not only that the development team possesses the appropriate skill set, but also that the team works closely with the heritage attraction or museum curator and designer, so that they clearly understand the unique requirements of the heritage attraction and the target audience. (Glushko 1991, Philips 1992, Vaughan 1994, Wolfgram 1994)

1.2.5 Portable Computers in Museums

With reductions in cost and increases in power and functionality there is an increased introduction of Personal Digital Assistants (PDA's) and Portable Computers into museums. (Beishon 1997, Broadbent and Marti 1997, Not et al 1997, Vodde 1997)

These units are being used primarily for visitor navigation and orientation however they may have more sophisticated interpretation applications in the future.

Screven expressed the view that "... it will be economically and technically feasible for visitors to carry handheld electronic clipboard-like screens with them throughout their visit ..." and that visitors would "... use the clipboard to obtain and keep track of routes personalised for visitors time frames and interests." He expands that "the clipboards may even evaluate (for museum use) visitor usage of exhibits during their visit ... each clipboard communicated via text, images, and/or audio in a variety of interactive formats." (Screven 1990)

Personal Digital Assistants are typically marketed as enhanced electronic organisers that run cut-down computer applications for word-processing, spreadsheets and databases. However, they can have useful applications within museums. For example, at the Deutsches Museum in Munich, one of the largest technology museums in the world, Wolfram Wach, a museum guide, uses a Psion Series 3a PDA during his guided tours of the museum. Not only does he keep agendas of tours on his PDA, but also the script for the tour and an additional database of facts and figures should it be required to answer questions from the visitors. (Beishon 1997)

At the Smithsonian they have taken a conventional audio tour, digitised it and made it available to visitors on a PDA, in this case an Apple MessagePad. Not only does the unit provide random access to the commentary to any exhibit by keying in a number on the touch screen, it also contains selected maps of the museum and limited text descriptions of some exhibits. The unit also captures information on the order in which visitors viewed exhibits, this can be used for evaluation and future exhibition planning. (Vodde 1997)

A similar system is currently being developed at the Civic Museum of Rovereto, Italy. The project utilises the Apple Newton Palmtop computer to facilitate what the developers call an augmented museum visit, by providing information based upon the visitors' current location and interaction history. Through the combination of an infrared receiver built into the headphones and a network of infrared transmitters located throughout the museum, the system can identify its position and access the relevant data stored on the hardware. The system primarily provides audio information

on the exhibits and with the addition of a map assists the visitor in navigating the museum. The prototype uses audio descriptions and directions which have been pre-recorded, however the developers have discussed the potential to create commentaries dynamically using natural language generation and speech synthesis technology. (Not et al 1997)

Useful and innovative as the above two examples are they are still limited in the information and interaction that they can provide to visitors due to the constraints of the hardware and development environment. Therefore it appears to be advantageous to use a portable computer with a touch screen interface as this has the performance and functionality closer to that of desktop PC, it should be relatively easy to use and can provide interactive multimedia interpretation to the museum visitor.

At the Museum of Santa Maria della Scala a “Location Aware Interactive Guide” is currently under development. (Broadbent and Marti 1997) The completed system will combine a touch-screen portable computer, a wireless network and Geographical Positioning System (GPS) to assist visitors in navigating the museum and to locate a gallery and/or specific exhibitions/objects within the gallery by the use of maps and audio instruction via headphones. As visitors approach an exhibit the system will provide personalised information by detecting the location of the visitor, based on previously supplied information. The unit contains minimal information, with the required data being transmitted on demand over a wireless network using the client-server model.

At the University of Lancaster, Dr Nigel Davies is leading a project to develop portable computers, to assist visitors in navigating their way around the historic town of Lancaster, which it is hoped will be introduced in the next couple of years. The system also combines a hand-held computer, GPS technology and a wireless network composed initially of nine transmitters, each with a range of 100 metres. It is the intention for the system to be not only location specific, but also time and weather specific. For example when the time is approaching lunch time the unit may suggest restaurants which are close by or when the weather is inclement may direct the visitor via an alternate covered route to their chosen destination. (Evans 1998c, http://www.ing.unisi.it/lab_tel/hips/hips.html, <http://www.comp.lancs.ac.uk/computing/research/mpg>)

1.3 Virtual Reality

With increases in computing power and a greater demand for interactive and immersive experiences by visitors, heritage attractions and museums are starting to realise the potential of Virtual Reality (VR) as a viable medium for interpretation. (Bevan 1996d, Emmett 1998, Stone 1997, Walser 1991a) Virtual Reality goes beyond the interaction of multimedia and can immerse visitors within an interactive, three dimensional computer generated world, which allows the visitor to explore and interact with virtual objects and the virtual environments in real-time. (Eddings 1994, Jacobson 1995, Lanier 1992, Traub 1991)

Gradecki explains that in his opinion there:

“... are two basic components that a *true* virtual reality program must contain:

- A first-person user viewpoint that has complete movement at will in real time
- The ability to manipulate and/or change the virtual environment in real time”

(Gradecki 1994)

Jacobson expands upon this definition, explaining that:

“Virtual reality refers to the experience of interacting with a computer system that presents a ‘virtual world’ of simulated sights and sounds. The virtual world is not prerecorded; it is generated on-the-fly by the computer. You can navigate and interact with the virtual worlds and its contents at will. Based on your action – where you look, what direction you move, what objects you manipulate – the image display responds accordingly.” (Jacobson 1994)

There are two broad classifications of Virtual Reality systems, Immersive and Desktop. Eddings explains that “*Immersion* refers to the system’s ability to make a person feel ‘immersed’ in the computer-generated simulation.” (Eddings 1994) Immersive VR requires additional peripherals, including visual display (e.g. Head Mounted Display (HMD), Fakespace BOOM), input device (e.g. Dataglove, SpaceMouse, Joystick) and a Position Tracker to completely immerse the user within the virtual environment. Whereas Desktop VR uses a conventional computer with no additional hardware, the monitor acts as a window into the virtual world, which is navigated using a mouse or keyboard. (Hedberg 1995, Helsel 1997, Kalawsky 1994, Lantz 1992) Cave Automatic Virtual Environments (CAVEs) and Camera-VR systems, are two other types of

immersive Virtual Environments. CAVEs were first developed by the Electronic Visualisation Laboratory (EVL) at the University of Illinois (USA). A CAVE resembles a cube, which surrounds the user, with projection screens on three sides, the floor and the ceiling. Camera-VR uses blue screen chroma-key technology to place the user in a virtual world. "Videoplace", developed by Myron Krueger was the first Camera-VR exhibit, and opened in 1984 at the Connecticut State Museum of Natural History. (Brill 1994b, Fernstom and Bannon 1997, Hsin 1997, Krueger 1991, www.evl.uic.edu/evl/vr/systems.html#cave)

Virtual Reality can bring the past to life and can assist visitors in understanding historical objects, environments and events. VR has been particularly useful for large scale architectural reconstructions and visualisations, outstanding examples include Stonehenge (VR Solutions) and the Colosseum (Infobyte). (Bevan 1997, Kennedy 1996, SGI 1998, Stone 1997, www.infobyte.it) In addition to interpreting historical buildings and events the technology can also be used to explain concepts and principles to visitors. Virtual Reality also makes it possible to visit places that would be inaccessible or otherwise be too dangerous for visitors. For example inside a volcano or a nuclear reactor, or to shrink down so that it is possible to examine objects at the atomic level or to grow so that you can hold the universe in your hand. (Crabb and Laver 1996, Lantz 1992, Mahoney 1998, Traub 1991)

VR can also improve access to collections and historical sites, an additional benefit derived from members of the public not physically visiting sites is reduced impact from erosion, a common problem at historic monuments. This also applies to artefacts, if the number of times they are transported or handled is reduced then the wear and tear on fragile and valuable objects, and the chances of accidental damage can be reduced. (Bevan 1996a, Breaks 1993, Kennedy 1996, Stone et al 1991)

Another variation of Virtual Reality called Augmented Reality superimposes a virtual, computer-generated image over the users view of the real world. The most familiar example of Augmented Reality is the Head-Up Displays (HUDs) used in military aircraft to display navigation and targeting information to the pilot. Two types of Head Mounted Displays (HMDs) are used for Augmented Reality, Optical and Video based. The optical system allows the user to look directly through the display, with the virtual images being overlaid using semi-transparent mirrors. The video system uses a small

video camera positioned above the headset. The visor of the headset, which the user cannot see through, contains two LCD screens. The computer-generated images are superimposed with the images from the video camera before being displayed on the LCD screens. Both approaches have advantages and disadvantages, and the individual application will dictate which approach is most suitable. Both systems require accurate positioning systems if the real and virtual worlds are to be accurately aligned, and as with VR, latency can also be a problem. If it takes too long for an image to update then the user may become disoriented or the virtual object may appear to float in space. (Bevan 1996c, Mahoney 1999a, Mahoney 1999b)

The concept of creating Virtual Humans has also been discussed, in the future it may then be possible to tour a historic building guided by a prominent figure from history. Leading research in this area is currently being undertaken by Professor Nadia Thalmann, head of Miralab at the University of Geneva. At the Virtual Heritage '96 conference Professor Thalmann demonstrated a simulation which brought two soldiers from the terracotta army to life. However a large amount of additional research and investment will be required before interactive virtual humans appear at heritage attractions and museums. (Bevan 1997, Kennedy 1996, Statham 1993, Traub 1991) Thalmanns research has concentrated primarily on developing images and animations, however research by Badler at the Centre for Human Modelling and Simulation and the University of Pennsylvania, USA has focused on simulating behaviour, and development of the 'JACK' software application. JACK is a human modelling and simulation system which provides an interactive 3D environment where a detailed human model including behavioural controls can be manipulated. The software enables the evaluation of tasks, collision detection and avoidance scenarios. (www.cis.upenn.edu/~badler/home.html)

There is currently a small but growing number of VR exhibits installed in museums. When a VR exhibit was introduced at the Strong Museum in New York (USA), visitors queued for over two hours before the doors opened to get a free ticket to experience the VR exhibit, and attendance doubled when compared to the same period twelve months earlier. (Brill 1994b, Goetcherian 1997, Schafer 1995, Stone et al 1991)

The majority of VR installations in museums have not fulfilled their initial promise, (Eddings 1994, Emmett 1998, Mahoney 1999, Statham 1993) and there are a number of

obstacles facing the wide spread adoption of immersive VR by heritage attractions and museums. Firstly the computer hardware and peripherals are prohibitively expensive, although as prices continue to fall the equipment will become more affordable. (Bevan 1996a, Bevan 1996d, Kalawsky 1994, Walser 1991a)

A second, and potentially more difficult problem to overcome is that these expensive, state of the art exhibits can typically only be used by one visitor at a time. As with multimedia kiosks several museums have installed overhead monitors or large projection screens so that visitors who are not actively participating can be part of the experience. (Jones 1992, Emmett 1998, Koester 1993, Nadis 1998) The exceptions to these are the simulator capsules frequently found at theme parks such as Universal Studios and Disney MGM Studios. These installations are now finding their way into museums, especially science museums, including Science Museums (London) and the Museum of Science and Industry in Manchester. (Bevan 1995b, Gilling 1997a, Jarratt 1997, Van Meter 1996) In most cases they are a way to generate additional revenue, however their educational value is questionable. Unfortunately as the number of visitors participating increases, the level of interaction for each visitor decreases, until you are left with little more than a stationary hydraulic roller-coaster. However there are some good examples of where these systems have been used effectively. A large capsule is located within the Flight gallery at the Science Museum in London where visitors can experience the sensation of flying in a Harrier Jump Jet, whilst at the same time learning about the principles of flight. (Hine 1999) MaxFlight, a company specialising in the development of simulator capsules and the video entertainment features shown within them, is beginning to develop educational features for museums and science centres.

Gary Arvedon the marketing director describes one such feature:

“... invite your visitors to experience the history and feel of flight. Start with the Wright Brother’s first ride down the sand dunes of Kitty Hawk. The experience continues in a WWII spitfire, F-16 fighter jet up to the space shuttle docking in space.” (Hine 1999)

There is clearly a need to develop more educational experiences for simulator capsules if they are to move away from the image of entertainment attractions and revenue generators. (Bevan 1996a, Gilling 1997a, Jarratt 1997, Van Meter 1996)

A third problem with VR is the robustness of the equipment, with HMD's being particularly susceptible to damage and being dropped as they are taken on and off by visitors. One solution to this problem is to use a Binocular Omni-Oriented Monitor (BOOM) developed by Fakespace. The BOOM provides the visitor with the feeling of exploring the world through a scuba mask, whilst holding the handles on either side of the mask. The expensive and delicate headset is supported on the end of a telescopic arm, which has restricted motion and therefore the chances of accidental damage occurring can be minimised. (Brill 1994, Emmett 1998, Helsel 1997, www.fakespace.com) Additionally with immersive VR exhibits there is also the requirement that the exhibit is permanently staffed, not only to protect the exhibit from potentially destructive visitors, but also for the health and safety of visitors. (Emmett 1998, Schafer 1995, Statham 1993)

The final problem with VR exhibits is that the novelty of the technology can be so intriguing to visitors that it overshadows the objects or building which they are designed to interpret. (Emmett 1998, Lewis 1998, Statham 1993)

1.3.1 3D Digitisers

For the Virtual Reality experience to be realistic it is vital to have accurate computer models of the objects or buildings. It is possible to reconstruct these from plans or photographs, however this can be very time consuming and particularly frustrating when you have the original object to hand. The solution in these cases is to use a 3D digitiser, which can convert an object into an accurate computer model, which can then be manipulated within the Virtual Environment.

Two types of 3D digitisers are available, contact and non-contact systems. The contact systems use a probe that is manipulated by the user and take point references covering the surface of the object, whereas non-contact systems use a beam of laser light to collect the geometry information. By using a combination of Red, Green and Blue lasers it is possible not only to build an accurate model of the object, but also its surface colouring and texture. The non-contact digitiser has three significant advantages over the contact system. Firstly it is advantageous for digitising fragile objects, especially soft ones that could be damaged by the probe. Secondly it is up to 100 times faster because it collects data in strips rather than points. And finally it can also collect data on surface colour and texturing, something which the contact system is unable to

accomplish, however these non-contact systems are still expensive. (Baribeau, Rioux and Godin 1995, Isdale 1998, Standage 1995, Wohlers 1997, www.3dscanners.com, www.immerse.com)

1.3.2 QuickTime VR (QTVR) & Surround Video

Two other VR formats have also emerged, QuickTime Virtual Reality (QTVR) developed by Apple (MAC), and Surround Video from Black Diamond Software and Microsoft (PC). QTVR and Surround Video are both created in the same way, and have two types of files, panoramas and object files. The panorama files are created by fixing a camera in a stationary position, and taking a series of photographs at equal intervals as the camera is rotated through 360°. These panoramas are frequently used for exterior views and galleries. Whereas when creating object files the camera remains fixed and the object is rotated through 360° again with photographs being taken at equal intervals. These object files are frequently used to allow visitors to view and manipulate artefacts, as small as a coin or as large as a car. In both cases the series of photographs are then stitched together to form a seamless image before being converted into the appropriate file format. Additionally a number of panoramas (nodes) can be linked together to enable the visitor to navigate within the virtual world so visitors are no longer limited to spinning around and zooming in or out. (Crabb and Laver 1996, Eccles 1998, Toomey et al 1997, Voyce 1996, www.apple.com/quicktime/qtvr/index.html, www.bdiamond.com)

When compared to true Virtual Reality (Immersive or Desktop) QTVR and Surround Video restricts the freedom of movement for the visitor, however this can have positive benefits, as visitors have been observed walking into walls and getting stuck in corners in systems where they have complete freedom of movement. However, the main advantages of QTVR and Surround Video over traditional forms of VR are their photorealistic quality, which is in excess of the real time VR images generated on all but the most powerful computer workstations. (Crabb and Laver 1996, Eccles 1998, Joseph 1997, Voyce 1996)

1.3.3 Virtual Reality on the World Wide Web

QTVR and Surround Video files can also be distributed over the World Wide Web with the addition of the appropriate plug-ins for the browser, however other interactive desktop VR systems are available for the World Wide Web, the most popular being

Viscape and the Virtual Reality Modelling Language (VRML). Viscape is a propriety format developed by Superscape, which can only be created using their development environment, whereas VRML is an open standard that resembles HTML and can be created without any special development software, although these do exist. The principles and results for both Viscape and VRML are similar, however the main advantages of using Viscape are that the development environment is more sophisticated than those currently available for VRML, (although this situation may change in the future) and the files generated are smaller and thus download faster. Superscape also claim that the viewer/plug-in has a faster redraw rate on the same machine meaning the virtual worlds will update quicker and more smoothly as the visitor explores them. The main advantage of VRML is that it can be created by anyone, without the requirement for an expensive development environment. (Bevan 1997, Hsin 1997, Mahoney 1998, Roehl 1996, www.cosmosoftware.com, www.superscape.com, www.vrml.org)

1.4 World Wide Web

In recent years there has been a rapid expansion of the World Wide Web (WWW) and the emergence of museum Web sites, also referred to as Virtual Museums. The number of heritage attractions and museums with a Web site has grown dramatically, with increasing numbers establishing an on-line presence every day. (Bowen, Yardley and McKenna 1996, Campbell and Wells 1996, Johnson 1997a, Noack 1995)

The World Wide Web is important because it offers heritage attractions and museums a new channel of communication with visitors, both actual and potential, beyond the physical boundaries of the attraction. As increasing numbers of people get connected to the Internet, a Web site is becoming a vital part of the museum's marketing strategy and can dramatically enhance its perceived image. (Daniel 1996, Gollow 1996, Jellinek 1998, Martin 1996c)

Heritage attractions and museum Web sites typically contain visitor information including opening times and admission prices alongside complete interactive multimedia exhibitions containing electronically digitised artefacts, photographs, video clips and links to other virtual museums and historical resources around the world. (Duffy 1995, Jackson 1997, McKenzie 1997, Standage 1995) Unfortunately most Web sites are little more than electronic leaflets often referred to as "brochure-ware", and are

not making the best possible use of this new communications medium. (Bowen, Bennett and Johnson 1998, Glasser 1997, Tupholme 1996, Zorich 1997)

Some heritage attractions and museums are fearful of establishing an on-line presence because they assume that by making collections available on the Web the number of visitors coming through their doors may be reduced and subsequently the attractions revenue. However the experience of many museum professionals suggests that, far from reducing the number of visitors through the door, virtual heritage attractions and museums will encourage more people to seek out the real attractions and their collections. (Carrington 1996, Morrison, Bowen and Bennett 1997, Standage 1995, Sudbury 1996)

Many people who wish to visit museums and heritage attractions throughout the world or even in the same county are often prohibited from doing so because of the expense of travel and time constraints. However, the World Wide Web can provide a fast and low cost method for the access of heritage information throughout the world. (Falconer 1996, Gordon 1995b, Tsichritzis and Gibbs 1991, Standage 1995) Providing visitors with access to their collections is a problem faced by the majority of physical museums, typically only a small proportion of the museum's collection is on display to the public at any one time due to space and conservation requirements. However a virtual museum is not subject to the same physical or opening time constraints and can therefore make a much larger proportion of the museum's collection available to the general public at all times. (Bowen 1996, Davies 1998, Gordon 1995a, Martin 1996c) The provision of Web access to collections and heritage sites for visitors and researchers can also reduce the requirement to ship artefacts to different museums for exhibitions or research, thus minimising the chances of artefacts being damaged whilst in transit, or environmental erosion or damage occurring to an archaeological site by physical visitors. (Bowen 1995, Breaks 1993, Duffy 1995, Stone 1997)

As communication and transportation links improve, the use of the Web to market an attraction to potential visitors from foreign counties is becoming a reality and of great benefit. For example, if a potential visitor is planning a trip to another country and can visit the Web sites of heritage attractions including museums and see an artefact of interest, then they are more likely to actually visit that attraction when they are in the country. Some heritage attractions and museums are also developing multilingual sites

to provide access to non-English speaking visitors. (Bowen 1995, Mason 1995, Standage 1995, Strimpel 1995)

A Web site can also assist the heritage attraction museum in achieving its educational role, and is particularly suited to pre-visit and post-visit educational activities. With the advent of the National Grid for Learning, increasing numbers of museums are providing educational material on their Web site, which links to the National Curriculum. (Bowen 1995, Falconer 1996, Fernstom and Bannon 1997, Lewis 1997a)

For many visitors one of the most enjoyable features of a heritage attraction or museum Web site is the ability to interact with objects and exhibits, something they can rarely do in the physical site where artefacts are usually placed in glass cases or out of reach of the public in order to protect them. However with advanced Web technologies (e.g. Dynamic HTML, JavaScript, Java, Shockwave, VRML, QuickTime VR) the potential for visitors to interact with objects over the Web in the future is enormous. (Daniel 1996, Hsin 1997, Jackson 1997, Noack 1995)

Heritage attractions and museums can also use their Web site to communicate information to potential visitors and researchers throughout the world, without the associated costs of printing and distributing associated with paper based media, which would make it prohibitively expensive. (Bowen, Bennett and Johnson 1998, Bowen, Yardley, and McKenna 1996, Gordon 1995b, Tupholme 1996)

Limited demographics of visitors to heritage attraction Web sites, and each page accessed can be monitored by Web-Counters and Web-Trackers, to provide detailed data for free. Similar data gathered in the museum would be expensive and time consuming. (Borland and Wongse-Sanit 1997, Gordon 1995b, Winslow 1997)

Accessing a heritage attraction Web site is not without its drawbacks. Often the network connections between computers connected to the Internet do not have sufficient bandwidth to provide users with the speed of service they require, this is particularly important for people connecting from home with a modem over conventional telephone lines. (Daniel 1996, Falconer 1996, Mason 1995, Gollow 1996)

A concern expressed by many heritage attractions, and in particular museums, regarding their presence on the Web is that of protecting their intellectual property right and preventing infringement of copyright, particularly of images and photographs of artefacts from their collections. It has been suggested that using available technology invisible digital signatures could be embedded into the actual electronic image, however probably the simplest solution is to use low-resolution images, which are suitable for displaying on Web pages, but are inadequate for reproduction in a printed publication. (Berghel 1997, Chu 1997, Fry 1997, Sherwood 1995)

The development and maintenance of a virtual museum is resource intensive, the main cost in developing a system is that of time. It is also vital that heritage attractions realise constructing a Web site is not a one-off activity, to be effective and generate repeat visits it will require frequent updates and revisions. (Dietz 1997, Glasser 1997, Gordon 1995a, Tupholme 1996)

1.5 Innovative Interactive Multimedia Installations

This section reviews eight interactive multimedia installations considered by the author to be among the most innovative in heritage attractions and museums. Their innovation lies in the use of leading edge technologies or original applications of existing technologies.

1.5.1 Croydon Clock Tower: Lifetimes

The Lifetimes exhibition, winner of the 1995 British Interactive Multimedia Association (BIMA) Award and 1995 Interpret Britain Award opened in March 1995. The exhibition is particularly unusual, having the interactive multimedia content central to the whole function of the museum. There are no labels or text panels within the gallery, therefore visitors cannot fully experience the museum without using the multimedia interactives. A multimedia touch-screen kiosk is positioned in front of each of the six displays. As a visitor selects an object on screen the object is also highlighted in the display by spotlights. Larger monitors are positioned above the kiosks so that other visitors not using the kiosks have the opportunity to view the multimedia applications and the interactions being made by other visitors. On a mezzanine level there are an additional twelve kiosks (two running each of the six applications) with seating provided. This enables visitors to explore the various levels of information in greater detail, in a quieter and more relaxed environment. Lifetimes was developed as part of

the £30m Croydon Clocktower project, costing a total of £600,000 of which £108,000 was the cost of interactive multimedia development. (Davies 1995, MacDonald 1996a, MacDonald 1996b, Martin 1996d, Martin 1998, Martin and Frazer 1997a, Valls 1994, www.croydon.gov.uk)

1.5.2 The National Gallery: Micro Gallery

The Micro Gallery opened on 21st July 1991, and is composed of 12 touch screen computers located in a separate room on the first floor of the gallery. The application was designed to provide visitors to the gallery with an informative and easy to use system to discover more about the works of art on display. The multimedia application developed by Cognitive Applications, allows the visitor to search for paintings by Artist, Geographical Location/Time Period, Picture Type (e.g. Portrait, Landscape, Nude) and a General Reference (e.g. Painting Styles, The Names of Paintings, Painting Terms). When an artist is selected the visitor is presented with an overview and thumbnails for each of the artists painting on display at the gallery. Touching a thumbnail will load a larger image of the painting. A “See Also” button provides links to similar works, either by the same artist, subject or style. Using the application visitors are also able to create a personalised tour of selected paintings which can be printed out. The use of the computers and printing of the map is free of charge. However the computers can also print out colour images of paintings from the application for an additional charge. Subsequent systems have been created for the San Diego Museum of Art, the National Gallery of Art and most recently the new Manchester United FC Museum. (Martin and Frazer 1997a, Matthews 1999, Morrison 1995, www.cogapp.com)

1.5.3 Virtual Stonehenge

Virtual Stonehenge has been developed as a joint project between VR Solutions and English Heritage, and is composed of two elements. A Web site allows visitors from all over the world to explore the site through the various historical stages of its development. There is also a larger and more highly detailed VR model which is designed to provide visitors with an immersive VR experience and may be incorporated within the new Stonehenge visitors centre. (Bath 1996, Kennedy 1996, Stone 1997, www.intel.com, www.connectedpc.com/cpc/ecs/stonehenge)

1.5.4 The Natural History Museum: Virtual Endeavour

The Natural History Museum has developed a virtual reality exhibit, entitled the "Virtual Endeavour" designed to evaluate the visitor's response to VR exhibits. A digital replica of Captain Cook's ship was created and populated with virtual objects from his voyage. Visitors explore the virtual reality ship, which is projected onto a large screen using a joystick, virtual objects within the ship link to supplementary multimedia information explaining different elements of the voyage. The project is also being used to test the feasibility of distributing high quality interactive multimedia over a broadband network to a Natural History museum in Belgium. (Bevan 1997, Bloomfield 1997, Breaks 1993, Johnson 1997, Mansell-Lewis 1997, Naughton 1997, www.nhm.ac.uk)

1.5.5 National Museums and Galleries on Merseyside: Conservation Centre

The Conservation Centre, winner of the 1997 Gulbenkian Prize and 1997 Interpret Britain Award has daily sessions where visitors can observe the work that goes on behind the scenes to conserve and in some cases restore historical artefacts. Because some of the chemicals used are highly toxic and there is the potential risk of damage or theft of objects, tours of the workrooms are limited to one tour of twelve people each week. However, visitors seated within an auditorium incorporating a large projection screen can also gain access via a live video conference link. A facilitator equipped with a microphone stands at the front of the auditorium and talks to the expert in the workroom, relaying questions from the audience. The expert can talk directly to the audience and has three cameras to help explaining their work. In this particular case the audience is only a couple of floors above the workroom, however it could potentially be anywhere in the world. (Carrington 1997, Forrester 1997, Forrester 1998, Martin 1996e, Nightingale 1997)

1.5.6 BT Touchpoint & Magic Touch Kiosks

In the summer of 1997 BT installed a network of 200 Touchpoint multimedia information kiosks throughout London. The kiosks included an entertainment guide, a sports desk, a street index and access to local, national and international news. A similar scheme of 'Magic Touch' kiosks has been installed in Manchester and provides access to information targeted at the unemployed, homeless, elderly and the disadvantaged. However, there is the potential that in the future these kiosks could provide public access to the collections of museums and art galleries. (Boarman 1997,

Clarke 1996, Dudman 1997, Kirwin 1997b, Snodgrass 1997, Sturridge 1997, www.bt.co.uk/internet/products/touchpoint.html)

1.5.7 Science Museum: Information Kiosks

During the summer of 1998 a pilot test of five “Information” kiosks sponsored by Toshiba were installed at the Science Museum, London as part of the Visitor Information Network Evaluation System (VINES) project. The objective of the kiosks was to assist visitors in navigating the museum, it is not an exhibit or collection database, but has been designed to complement the existing maps and navigation information. Visitors can select any exhibit or gallery and the kiosk will provide directions, or visitors can select to follow one of a number of tours (Quick Adult Tour, Quick Child Tour, Quick Family Tour, What’s New Tour or Highlights Tour) by accessing a series of kiosks. The information displayed by the kiosk is location specific, meaning that each kiosk knows where it is located within the museum, which is vital when giving directions to visitors. The information is also time specific, therefore if a visitor enquires what tours or activities are available it will only display future events and exclude events which have taken place previously that day. An initial evaluation revealed that the kiosks were popular with visitors and most visitors were able to follow the directions provided by the kiosks. Upon completion of the pilot study and evaluation the museum plans to introduce a total of 30 kiosks throughout the museum during the summer of 1999. (Evans 1998b, Gilling 1998b, Rofe 1998)

1.5.8 Carnegie Museum of Natural History: Robot Tour Guide

On 22nd May 1998 the world’s first robot tour guide started work at the Carnegie Museum of Natural History (USA). The robot guides visitors on a 15 minute programmed tour of the dinosaur gallery. The 4ft (1.3m) high robot includes a screen which shows video clips as it moves around, it can also detect the presence of obstacles so it does not bump into visitors, and can also ask visitors to move out of its way. Currently the robot only delivers a predetermined script, however its creators hope that in time, and with the addition of speech recognition software, the robot will be able to have interactive conversations with visitors and develop its own personality. (Butlin 1998, www.clpgh.org/cmnh/news/98-apr-jun/980522robot.html, www.sunday-times.co.uk)

This section has examined eight of the most innovative interactive multimedia installations within heritage attractions and museums. The following section will review a classification framework of interactive multimedia in public spaces.

1.6 Classification Framework

A classification framework of interactive multimedia applications within public spaces, which includes heritage attractions and museums has been developed by Woolsey and Semper and provides an appropriate starting point and context to the present research project. (Woolsey and Semper 1991)

The framework described by Woolsey and Semper has the following eight categories:

- 1. Passive Presentation** Characterised by limited choices and extended passive periods. Examples include audio guides and computer controlled Laserdisc players
- 2. Guided Experiences** Providing a guided tour through a gallery or location, providing directions and background information. Examples include audio guides and PDAs.
- 3. Interactive Browsing** Facilitating a visitor in browsing a database of textural information supplemented by audio-visual media before deciding to explore the additional levels of information available from the application. Examples include multimedia kiosks, CD-ROMs and multimedia databases.
- 4. Direct Creation** Activities where the visitor interacts and manipulates the media directly. Examples include computer simulations.
- 5. Adjunctive Resource** A reference and research resource for visitors, frequently located in a separate room away from the gallery. Examples include multimedia databases.
- 6. Mediated Experience** An interactive multimedia workstation which provides additional information in the direct context of the gallery and surrounding exhibits. Examples include multimedia kiosks and laserdiscs.
- 7. Exhibit** In some installations the interactive multimedia installation becomes the exhibit as opposed to supporting the interpretation of surrounding exhibits. Examples include multimedia kiosks and immersive Virtual Reality experiences.
- 8. Takeaway Experience** The production of media elements to be purchased and taken home by visitors. Examples include Audio/Video Cassettes, CD-ROMs and Laserdiscs.

The eight categories in the classification framework provide a useful guide to the broad range of interactive multimedia installations found within heritage attractions and provide a initial framework for the evaluation of such exhibits. Section 6 of the framework, the 'Mediated Experience' was considered to have significant potential within which to explore potential innovative applications of interactive multimedia for heritage attractions and museums.

The final section of this chapter reviews three areas, which have been identified as being worthy of further research.

1.7 Selection of a Research Area

Having completed a survey of UK Heritage Attractions and Museums, Museum Web sites in the UK and USA, and an exploration of existing interactive technology, three potential areas for further research were identified:

- The development of an interactive interpretation pavilion
- The development of a Web site as an educational resource
- The development of a portable computer and interactive multimedia application for interpretation

1.7.1 Interactive Interpretation Pavilion

The concept of an interactive interpretation pavilion was inspired by the Co-Operative Bank which has erected several pavilions in and around town centres where banking services are required but is not financially viable to operate a branch. These pavilions which resemble an octagonal greenhouse or conservatory (figure 1.1) contain a cash point machine and videoconference link to a call centre.

Interactive interpretation pavilions could be located in areas where tourists and visitors require interpretation of an historical site for example, but where the limited number of visitors makes the establishment of a full scale heritage attraction or permanent guide impractical. A potential site within the Greater Manchester area would be the Castlefield Urban Heritage Park, where interpretation and signage is poor. The pavilion could be designed to complement the heritage site, yet strongly constructed to withstand the elements and vandals. Visitors wishing to use the interpretation pavilion would Purchase a smart card at the local tourist information centre, which would then open the

door to the pavilion. Once inside, the pavilion would resemble a small, but high-tech museum gallery containing state of the art multimedia interactives to enhance the interpretation of the heritage site.



(Figure 1.1 : Co-Operative Bank Pavilion)

1.7.2 Education Focused Museum Web Site

Few of the museum Web sites surveyed, with the exception of the Science Museum, London included educational material and fewer still interactive on-line educational activities. Therefore it was feasible to develop an educational resource for a local museum using a Web site. This Web site could include education resources for teachers and work sheets for children, designed to be used in conjunction with the on-line multimedia interactives. The content of the site could be tailored to support the National Curriculum and the National Grid for Learning.

1.7.3 Portable Computers for Interpretation

The third proposal was to develop the concept of using portable computers and interactive multimedia applications to enhance the existing interpretation within a museum gallery. A museum gallery was felt to be preferable to other types of heritage attraction because of the need to interpret artefacts in a new and innovative way. Previously identified research projects examining the use of portable computers in

museum galleries (see section 1.2.5) primarily focused on navigation, and provided information based upon the visitor's location. However it was clear that there was potential to develop a portable computer and interactive multimedia application for enhanced interpretation with more direct user interaction. The hypothesis was that portable computer and interactive multimedia application could combine the best attributes of the guidebook, audio guide and multimedia kiosk into a single portable multimedia guide, which could be carried by visitors as they toured the museum, and be manipulated through a touch screen interface, with the potential to become a new tool for the enhanced interpretation of museum collections.

1.7.4 Selection of a Research Area

Each of the three potential areas identified for research were discussed and their viability as a Ph.D. research project considered.

The interactive interpretation pavilion was an innovative and original concept with real potential for geographically remote heritage sites and/or where the number of visitors is limited. However it was felt that this project was of too great a magnitude for a single postgraduate researcher to undertake. There would have been the need to secure considerable funding and/or sponsorship for such a project, and therefore this concept was discounted.

The development of educationally focused resources on a museum Web site was not as innovative as the other two proposals, as there was a general trend in this direction with museums creating additional educational resources as they gain a better understanding of the technology and its potential.

The third option of developing a portable computer and interactive multimedia application to enhance interpretation within a museum gallery was both innovative and original. Initial research established that there were no major research projects completed or nearing completion in that research area. There were other research projects using portable computers, however the proposed project was different in that it would be designed to foster a high level of direct user input and interaction and would be assessed in a museum gallery. Portable computers are expensive, at the leading edge of mobile technology and have potentially innovative uses. It appeared that this research area held the greatest potential and would fulfil the central objective of the

research, assess the feasibility of using a portable computer and interactive multimedia application to provide additional interpretation within a museum gallery.

This chapter has provided a background to the research and reviewed a range of interactive multimedia technologies currently employed by heritage attractions including museums. This was followed by a summary of the most innovative multimedia installations and a review of a classification framework of interactive multimedia installations in public spaces. The chapter concluded by reviewing three concepts identified as having potential for further research, and the reasons for selecting to develop a portable computer and interactive multimedia application for enhanced interpretation.

The following chapter provides a summary of research methodologies relevant to the research undertaken, details the exploratory research undertaken and provides a brief review of the evaluation study conducted.

Chapter 2

Research Methods

Chapter 2 Research Methods

This chapter discusses the aims and objectives of the research, provides a synopsis of the exploratory research undertaken and critically reviews the range of research methodologies employed at each stage of the project. The first section examines the original aims of the research, the development of subsequent additional aims and the overall objective of the research project. The second section discusses the exploratory research conducted. It describes a range of research methods conducted as part of the study including a critical literature review, a heritage attraction field survey, a study of heritage attraction World Wide Web sites and a review of interactive multimedia technologies in the marketplace. The final section details the evaluation study, which employed a multi-method approach using a single case study to assess the effectiveness of a portable computer and interactive multimedia application as a new tool for interpretation in a museum gallery. The evaluation study is considered separately in Chapter 4: Visitor Evaluation Study.

2.1 Research Aims

The original aim of this research project as approved by the GEMISIS Academic Supervisory Panel (G.A.S.P.) was:

- To examine the potential applications of new technologies especially interactive multimedia, the world wide web and virtual reality for heritage attractions and museums

Initial exploratory research revealed that although a significant number of heritage attractions and museums were currently making limited use of interactive multimedia, many of those installations varied widely in terms of quality and sophistication. The variable nature of interactive multimedia applications within heritage attractions and museums was so diverse it warranted further investigation. This led to the establishment of an additional aim:

- To identify existing interactive multimedia applications used in heritage attractions in order to provide a foundation for the research

Identification of the interactive multimedia applications currently installed within heritage attractions and museums was crucial in order to gain an insight and a necessary base for the research. At the same time other interactive multimedia technologies in the market place were identified that might have potential interpretative applications for heritage attractions today and in the future. Thus the following aim was added:

- To explore the full range of innovative interpretative applications of interactive multimedia technologies in order to identify concepts for further development and evaluation

If a potentially innovative interpretative application of interactive multimedia was identified, in that it would provide a method of delivering interpretation previously untried in a museum gallery, it was the intention to develop that concept into a fully functional application to be tested as part of this research project. This led to the formation of an additional aim:

- To design and develop an innovative interactive multimedia application to enhance existing interpretation methods at a heritage attraction

Interactive multimedia appears to be a promising interpretative medium for heritage attractions and museums, and some examples are already complementing existing interpretative techniques. Increasingly designers of heritage attractions and museums use multimedia kiosks within galleries, which are proving to be popular with visitors. However there has been little published research to evaluate the use of these interactive multimedia installations on the museum experience. (Heinecke 1995, Koester 1993, Lydecker 1993) Therefore it was crucial to test the proposed innovative application of interactive multimedia and to evaluate its feasibility in a heritage attraction. Thus a final aim was added, and the aims of this research project thus evolved to become:

- To identify existing interactive multimedia applications used in heritage attractions in order to provide a foundation for the research
- To explore the full range of innovative interpretative applications of interactive multimedia technologies in order to identify concepts for further development and evaluation
- To design and develop an innovative interactive multimedia application in order to enhance existing interpretation methods at a heritage attraction
- To evaluate the use and effectiveness of the portable computer and interactive multimedia application with the museum visitor

Each of these aims builds upon the findings of the previous ones as the investigation progressed. The objective of the research project was:

- To explore, design and evaluate an innovative interpretative interactive multimedia application in a heritage attraction

When undertaking a research project of this nature it is necessary to identify the range of research methods available from which to select those most appropriate for the area of inquiry. Clearly with a research project of this complexity and scale covering a variety of disciplines from initial exploratory research of the subject area, through to the development of an interactive multimedia application and concluding with an evaluation study, it was evident that a triangulation of research methods would be required. The individual demands of each research stage were considered and the research method or combination of methods deemed most appropriate were selected. The following section reviews the exploratory research which was undertaken during the investigation of the field of interactive multimedia in heritage attractions and the range of research methods which were investigated in parallel.

2.2 Exploratory Research

It was important to acquire an awareness of the diverse range of heritage attractions and the ways in which they were approaching the introduction of interactive multimedia technologies. Sterry had identified and developed a taxonomy of heritage attractions which is appropriate for the purpose of this research. (Sterry 1994) A heritage attraction is described as:

“A wide-ranging term which covers a broad spectrum of places visited by the public in general, which are open all year or seasonally, and which have a ‘Heritage’ theme, story, or reference to the past. This need not be a factual past, but can include elements from ‘a sense of the past’, or indeed of a fantasised past. Heritage Attractions can function simply for local and community needs or have a wider dimension in terms of entertainment, education, tourism and urban regeneration. Thus heritage attractions range from theme parks, to heritage centres to museums and to places such as restored docklands and warehouses”. (Sterry 1994)

The initial exploratory study for this research project therefore encompassed all heritage attractions in the range as described by Sterry. (Sterry 1994)

The initial area of enquiry began with a wide ranging and critical literature review. At the same time a field survey of heritage attractions identifying and recording the interactive multimedia technology installed within them was undertaken.

At the beginning of the research project in 1996 a number of heritage attractions and in particular museums were beginning to explore the potential of the World Wide Web. In addition, it was important to therefore explore the concept of a 'Virtual Museum', and to examine the ways in which heritage attractions approached this new medium. The term 'Virtual Museum' has been used for over ten years, and has covered a range of approaches and technologies, however in recent years it has been used primarily when referring to museums WWW site.

Identifying the range of interactive multimedia technologies and applications currently employed within heritage attractions and museums would not have provided a complete picture of the current situation without including a review of the range of interactive multimedia technologies available in the market place. Initially this technological review focused on those products targeted specifically for heritage attractions and museums. However as the review progressed the area of enquiry broadened to encompass the disciplines of computer based interactive multimedia, virtual reality, the Web and audio-visual equipment, all of which had the potential applications for heritage attractions.

A literature review, field survey visits to heritage attractions and a survey of heritage attraction Web sites coupled with a review of the available interactive multimedia technologies therefore formed a solid and comprehensive research base for the rest of the research project.

The exploratory research focused on four key areas, namely:

- A critical review of the Literature
– (Section 2.3)
- A study of Heritage Attractions and Museums
– (Section 2.4)
- A survey of Heritage Attraction and Museum Web Sites
– (Section 2.5)
- A review of interactive multimedia technologies in the marketplace
– (Section 2.6)

2.3 A Critical Review of the Literature

A literature review is important because it enables the researcher to gain an understanding of the field of enquiry and an overview of the existing research in the subject area or discipline. Blaxter explains that a critical literature review "... helps place your work in context of what has already been done, allowing comparisons to be made and providing a framework for further research..." and provides "... insights into aspects of your topic which might be worthy of detailed exploration." (Blaxter, Hughes and Tight 1996)

The multidisciplinary literature search was critically reviewed in order to achieve the following objectives:

- To understand the diversity of heritage attractions including museums and the theoretical critique of heritage in contemporary society
- To gain an understanding of research methodologies
- To gain an appreciation of the range of interactive multimedia technologies currently installed within heritage attractions and museums
- To gain an insight into the range of innovative interactive multimedia technologies with potential applications for heritage attractions and museums
- To gain an understanding of methodologies for the design and development of interactive multimedia applications

New literature published in the area was reviewed, by the researcher throughout the research project in order to remain at the forefront of current developments in the field.

In addition to the literature review other expert opinion was consulted including museum professionals (museum directors, education officers, designers and in-house interactive developers) and organisations supplying products, services and expertise to the heritage attraction and museum sector. Each individual or organisation was contacted either by written correspondence, telephone conversations or through face to face discussions.

The literature reviewed came from a number of sources including:

- Books
- Journals
- Conference Proceedings
- Newspapers
- Postgraduate Dissertations
- World Wide Web (WWW) Sites
- Company Product Literature and Brochures

As the research progressed the subject areas expanded to include:

- Exhibit Interpretation
- Visitor Studies and Evaluations
- Leisure and Tourism
- Computer Based Education
- Methods of Testing Cognition and Learning
- Interactive Multimedia Design
- Multimedia Development Methodologies
- Portable Computer Hardware

Research methods in general were studied in parallel with the critical literature review and exploratory surveys to facilitate an understanding of the range and appropriateness of methodologies available, and the variety of data collection techniques available. The majority of the texts consulted in the course of this investigation were from the discipline of social science. However additional sources from museology, leisure and tourism, education and computing disciplines were helpful in identifying the research methodologies that were appropriate and which had been applied successfully in other research projects or studies.

Research methods appear to fall into the two distinct but complementary fields of qualitative and quantitative approaches. Qualitative research is primarily concerned with the deeper understanding of events and opinions through the collection of rich information, typically from small scale studies. (Bell 1993, Blaxter, Hughes and Tight 1996, Ragin 1994, Veal 1992) Quantitative research focuses on the collection of numeric data, frequently from large scale studies, and the scientific analysis of the relationships identified within the data, with the aim of forming generalisable conclusions. (Allan and Skinner 1991, Bell 1993, Blaxter, Hughes and Tight 1996, Bryman 1992) Qualitative and Quantitative research both have advantages and disadvantages depending upon the area of enquiry, however they can be particularly effective when combined towards a common goal. (Blaxter, Hughes and Tight 1996,

Veal 1992, Cook and Reichardt 1979, Bryman 1992) Cook and Reichardt explain that when "... using a combination of qualitative and quantitative methods ... together for the same purpose, the two methods-types can build upon each other and offer insights that neither one alone could provide". (Cook and Reichardt 1979)

Research methods investigated included surveys, experiments and case study research, (Allan and Skinner 1991, Bryman 1992, Moser and Kalton 1985, Yin 1993) combined with an exploration of data collection techniques including interviews, observation and questionnaires and a review of sampling approaches. (Judd, Smith and Kidder 1991, Kellehear 1993, Oppenheim 1992, Robson 1993)

As this chapter progresses the appropriate research methods considered at each stage of the research project will be identified and the justification for their selection provided.

2.4 A Field Study of Heritage Attractions and Museums

The literature review revealed the range of different interactive multimedia technologies currently being utilised in heritage attractions and museums across the United Kingdom. (Lewis 1993, Davies 1995, MacDonald 1996, Francis 1992) To gain knowledge of current developments a number of leading shows and conferences were attended, including Virtual Heritage '96, the Museums & Heritage Show '97 & '99 in London, the Trends In Leisure and Entertainment (TILE '97) Conference in Strasbourg, France and the International Cultural Heritage Informatics Meeting (ICHIM'99) in Washington D.C., USA. In this way the researcher gained an appreciation of all aspects of interactive multimedia and current developments.

It was also important to gain knowledge and an understanding of the different types of heritage attractions and the various categories of interactive multimedia applications currently being installed within them. A field study to complement the literary search was planned.

The primary purpose of the field study was to quantitatively identify the categories of interactive multimedia installed within heritage attractions. The secondary purpose was for the researcher to make additional qualitative assessments of the design of the user interface, the robustness of exhibits and to see if visitors were interacting with the existing multimedia applications in groups or individually.

A report on "The Current and Projected use of New Media within UK Museums" had been compiled by The Visual Arena via a postal questionnaire, and was useful to the research project at this stage. The report provided data on two main areas. The first concerned each of the 212 heritage attractions as a whole, including the nature of the attraction, the number of visitors and the subject matter. The second section dealt with issues concerning interactive multimedia, particularly the types of multimedia and/or audio-visual displays used, and the current/projected spending on interactive multimedia. The report identified that of those attractions developing new exhibits utilising interactive multimedia, the WWW, CD-ROM, video or slides, each were spending approximately 10% of their project budget on each area where they were investing or planning to invest in the future. The exception to this was Virtual Reality exhibits, where significantly fewer attractions were investing. Most replied that they had a fair understanding of interactive multimedia although there was a broad spread from very poor to very good. (The Visual Arena 1998, Terry 1998)

This report aided understanding of the area of enquiry of this research project. However as with many secondary data sources the information was useful but did not fulfil the exact requirements of the research. Therefore a study generating primary data was needed to fulfil the first aim of the research project. Both field research and desk research approaches would have been appropriate for this area of investigation. The field research approach would involve the researcher visiting each attraction personally to gather the required data through observation and/or interviews with a representative of the attraction. On the other hand if desk research was employed the data could be elicited remotely either through the use of telephone or postal questionnaires.

If the field research approach was selected and the researcher visited each heritage attraction personally it would be beneficial as a range of information could be obtained and the researcher could explore the heritage attraction. However it was also anticipated that difficulties and delays may have been experienced in attempting to arrange a large number of interviews with representatives of each heritage attraction and that more productive use could be made of the time and more accurate unbiased data could be collected through observation. It was recognised that not consulting representatives from heritage attractions may have limited the interpretation of the data collected, and would not identify why certain technologies were selected. However it was envisaged that interviews with a representative from a selection of heritage

attractions and museums would be employed at a later stage in the research project to elicit more detailed and specific information once the study had been completed and issues for further exploration identified.

Observation involves the watching, recording and analysis of events and can reveal insights into the behaviour of groups or individuals that would otherwise be difficult or impossible to discover. The main advantage of observation is its directness, rather than asking people for their views as with questionnaires and interviews the subject is observed directly. This overcomes the potential problem of people saying one thing and doing another. Observation is a powerful investigative approach, which has a vital role to play in most research and complements other data collection techniques, (Diamond 1986, Hooper-Greenhill 1996, Lindgaard 1994, Miles et al 1998) however interpretation of the data collected can be both difficult, time consuming and fraught with interpretative problems.

There are three distinct disadvantages to the use of observation as a data collection technique. Firstly the observer must be impartial and consistent through the observations, otherwise the results may be biased by the observer. Secondly the presence of an observer may cause a change in the behaviour of the subject, therefore the observer should attempt to be as unobtrusive as possible, however the effect of the observer has been shown to wear off over time. When undertaking observation as with conducting experiments the researcher must be aware of the ethical issues relating to this technique. (Bull 1994, Kellehear 1993, Lindgaard 1994, Robson 1993)

The use of observation was deemed appropriate because it is a direct and systematic method of data collection, and could have revealed information and insights not only on the presence of particular technology but also how visitors used the interactive technology, for example in groups or singularly. (Binks and Uzzell 1996, Jacobson 1991, Robson 1993, Veal 1992)

Field research and gathering primary data through observation also had the advantage of allowing the researcher not only to gain an enhanced understanding and experience of heritage attractions and museums. It would also allow him to make additional qualitative observations of the site, the technology and the sophistication of those interactive multimedia application within it. Something which the desk research

approach would not have facilitated. (Czaja and Blair 1996, Judd, Smith and Kidder 1991, Oppenheim 1992, Robson 1993)

Desk research utilising either telephone or postal questionnaires would have been relatively cheap to administer, certainly in comparison to visiting the sites in person and a telephone survey would unquestionably have been much quicker to complete. (Binks and Uzzell 1996, Czaja and Blair 1996, Moser and Calton 1985, Oppenheim 1992)

Questionnaires whether administered through the post or over the telephone are a widely used and effective way of obtaining large amounts of information relatively quickly and cheaply and are suitable for geographically dispersed populations. The results are based upon individuals responses to set questions, however it is sometimes difficult to tell if a person is telling the truth, there is often a discrepancy between what people say and think or do. (Binks and Uzzell 1996, Miles et al 1998) An additional complication of not visiting the sites in person may have occurred if the representative of the heritage attraction or museum attempted to make their site look more technologically advanced by indicating more types of technology were present than was actually the case, thus compromising the accuracy of the data.

The main problem with postal questionnaires is a low response rate. A postal questionnaire will not be subject to interviewer bias, however the low response rate may bias the results, as individuals with certain characteristics may not respond and may therefore be under represented in the sample. The initial cost of postal questionnaires including printing and postage is significantly lower than questionnaires administered by an interviewer in person or over the telephone. However the response rate for postal questionnaires may be so low that the actual cost per completed questionnaire may be higher than for interviews. When compared to questionnaires administered by interviews, postal questionnaire have several disadvantages, the researcher is unable to control who answers the questions, control the order of questions or supplement the respondent's responses by observation. Postal questionnaires are unsuitable for some groups (poor literacy and visually impaired), and questionnaires completed without supervision are not completely reliable, as the researcher is unable to control who completes the questionnaire and may also receive incomplete forms where respondents have skipped a question they did not understand or did not wish to answer. (Czaja and Blair 1996, Heinecke 1995, Judd, Smith and Kidder 1991, Oppenheim 1992)

Questionnaires administered in person by an interviewer have the advantage of being able to explain the purpose of the research and generally have a much higher co-operation rate than postal questionnaires. The use of skilled interviewers means that questions can be clarified if the respondent is unsure of the meaning, they can maintain control over the order in which questions are answered and responses can be supplemented by observations. When compared to postal questionnaires those administered by interviews are more expensive and time consuming, particularly for geographically dispersed studies where the interviewers travel expenses must be covered as well as paying them for their time. Apart from the expense the main disadvantage of employing interviewers to administer questionnaires is that of interviewer bias, or that of various biases across a group of interviewers. An interviewer may by their attitude or actions influence a respondent into making certain responses they would otherwise not have made. (Bell 1993, Binks and Uzzell 1996, Moser and Kalton 1985, Oppenheim 1992)

On reflection the need for the researcher to gain a more in-depth understanding of the subject area, to gather accurate data, and to make additional qualitative observations, (e.g. the number of visitors who were able to view or participate with interactives) confirmed that visiting the sites in person was the most suitable approach.

The primary function of this survey of heritage attractions was to gather both quantitative and qualitative data about different types of interactive multimedia installed at these sites, this had the following advantages:

- The resulting primary data would provide a base for the research project
- It would enable the researcher to gain an appreciation of the different types of technology being employed in Heritage Attractions and Museums
- Also to gain experience and an understanding for the varied range of Heritage Attractions
- Codified data would be straight forward to analyse and evaluate

2.4.1 Observation Procedure

The observation of a phenomenon can be approached using either a structured or unstructured methodology. Structured observation is a systematic way of recording

observations, which typically utilises a recording instrument. On the other hand unstructured observation, which encompasses participant observation and ethnographic research, involves the researcher observing events and then recording them afterwards. Conducting observations requires skilled observers, and can be expensive and time consuming both for the observation and analysis in order to obtain the best results.

The research instrument employed in structured observation is called an observation schedule, typically a checklist or coding system, which assists the observer in recording the frequency and/or duration of behaviours or events. An observation schedule simplifies the recording process and reduces the amount of time required to record and analyse observations. However the use of an observation schedule may reduce the detail and flexibility of this data collection technique, therefore it is important to make contingencies for any unanticipated occurrences or behaviours. (Heinecke 1995, Hilke 1988, Kellehear 1993, Slavin 1984)

Structured observation was selected for the study, and a record sheet was developed to function as the observation schedule. A record sheet was employed because it can assist in simplifying the observation process, can reduce the amount of time required to record and analyse observations and are well suited to the highly codified quantitative data produced by structured observations. (Bell 1993, Blud 1990, Kellehear 1993, Moser & Kalton 1985) An example of the record sheet used can be found overleaf in figure 2.1 and figure 2.2.

A consistent observation approach was employed at each heritage attraction and museum visited.

If a particularly innovative interactive multimedia exhibit was encountered then the researcher interacted with the exhibit first hand and an additional qualitative evaluation was made of the exhibit and the technology utilised. In addition photographs were also taken to provide a permanent record, (Albrecht 1985, Veal 1992, Webb et al 1981) and this added to the range of research data collected.

Before leaving the heritage attraction the researcher briefly visited the shop if one was present, to identify if any multimedia gifts or souvenirs were being sold. This provided an additional qualitative measure of the attractions use on interactive multimedia by

<h2 style="margin: 0;">Heritage Attraction Multimedia Survey</h2>	
Name	<input style="width: 95%;" type="text"/>
Date	<input style="width: 95%;" type="text"/>
Address	<input style="width: 95%; height: 60px;" type="text"/>
Admission Fee	<input style="width: 95%;" type="text"/>
Visitor Types	
<input type="checkbox"/> Single	<input type="checkbox"/> Couples
<input type="checkbox"/> Families	<input type="checkbox"/> Groups
<input type="checkbox"/> Children	<input type="checkbox"/> Adults
<input type="checkbox"/> OAP's	
Location	Open
<input style="width: 95%;" type="text"/>	<input type="checkbox"/> All
	<input type="checkbox"/> Seasonal
Notes	
<input style="width: 95%; height: 40px;" type="text"/>	
• Passive Technology	
Visual	
<input style="width: 95%;" type="text" value="TV / Large Screen / Video Wall / LCD / Projector (Flat Screen / Wall / Special Screen)"/>	
Showing	
<input style="width: 95%;" type="text" value="Video / Animation / Slides / Computer Animation (2D/3D)"/>	
Audio	Exhibits
<input style="width: 95%;" type="text" value="Speakers / Headphones / Handsets"/>	<input style="width: 95%;" type="text" value="Animated / Rotating / Diorama"/>
Playing	
<input style="width: 95%;" type="text" value="Music / Narration / Sound Effects / Heritage Sounds"/>	
Others	
<input style="width: 95%;" type="text" value="Smells / Laser Lights / Dry Ice / Explosions / Holograms / 3D-Glasses / Animatronics"/>	
Notes	
<input style="width: 95%; height: 40px;" type="text"/>	

(Figure 2.1 : Record Sheet - Page 1)

<h2>• Interactive Technology</h2>				
Interaction				
Presentations / Videos / Exhibits / Kiosks / Computers / Video Games				
Using				
Touch Screen / Keyboard / Joystick / Tracker Ball / Space Ball / Barcode Readers / Mouse / Graphics Tablet / Simple Controls / Speech & Gesture Recognition				
Notes				
<h2>• Immersive Technology</h2>				
Immersion				
VR (Headset / Glove / Suit) / Simulator Cabinet / Time Car / Fixed Track Carriage / Cable Cars / Motion Chairs / Moving Walkways / Role Playing / Rides				
Notes				
<h2>• Misc. Information</h2>				
Networking	Standalone / Networked / External Link	Home Page	Yes / No	
Robust	All / Some / None	Volume of Visitors	Low / Medium / High	
Participation	Single / Pair / Small Group / Large Party			
Take Home Technology	Yes / No	Clear Instructions	Yes / No	
Notes			Supervised	Yes / No

(Figure 2.2 : Record Sheet - Page 2)

visitors both on site and at home or in the classroom. Finally the researcher collected any leaflets, guides or other promotional material on the attraction to add to the existing database of material.

2.4.2 Initial Heritage Attraction Field Survey

A diverse range of heritage attractions, including theme parks were included in the field survey. It was felt that discovering the types of interactive multimedia that were currently being used in theme parks

could reveal valuable information and insights about technologies that may also be appropriate and have potential interpretative applications for heritage attractions and museums.

Before undertaking a large scale survey it is advisable to test and refine the research instruments and procedures with a pilot study. (Blaxter, Hughes and Tight 1996, Clark and Causer 1991, Jones and Ott 1983, Lindgaard 1994) A pilot survey of 10 heritage attractions in the Greater Manchester area was undertaken, a figure which has been found to be appropriate in other studies. (Blud 1996, Miles 1994) This choice of sites had the advantage that there were a wide diversity of attraction types located within walking distance of the University of Salford and thus they were all easily accessible. The heritage attractions visited in the Greater Manchester are listed in figure 2.3 below.

Castlefield Urban Heritage Centre	Museum of Science & Industry in Manchester
Granada Studios Tour	The Pump House: Peoples History Museum
Manchester City Art Galleries	Salford Museum & Art Gallery
The Manchester Museum	Salford Quays Heritage Centre
Manchester United Museum & Tour	Whitworth Art Gallery

(Figure 2.3 : Heritage Attractions and Museums visited in Greater Manchester)

2.4.3 United Kingdom Heritage Attraction Field Survey

Following the completion of the initial survey of heritage attractions and museums in the Greater Manchester area, it was the intention to undertake a similar survey of attractions across the United Kingdom. However, the initial pilot study had revealed that few heritage attractions and museums visited had installed interactive multimedia technologies. Therefore to make the most productive use of the time available the main

survey was focused on those attractions which had installed interactive multimedia applications or exhibits.

First it was necessary to identify those heritage attractions including museums which had already installed interactive multimedia. Every tourist board in the United Kingdom was contacted either by letter or telephone and requested to provide a list of tourist attractions in their area. Following these requests a large quantity of leaflets, marketing material and supplementary information was received. These were collated into groups and systematically searched for appropriate information regarding the presence of interactive multimedia exhibits. This information supplemented by the literature search enabled the identification of potential attractions to be visited.

It was identified that the majority of attractions utilising interactive multimedia were concentrated in or around major towns and cities. Attractions located in or close to cities in the north-west of England (York, Leeds, Bradford and Liverpool) were selected because they were close to the University of Salford, the researcher's base. Additional sites close to the researcher's home in Oxfordshire and Warwickshire were also targeted. However, by far the largest concentration of heritage attractions and museums selected to be visited was found in the Greater London area. Visiting attractions in London was particularly important as the principle museums, in terms of size, visitation, budget and designated status, are located there and even more importantly there is the highest concentration of visitors in the UK. Therefore attractions in London may have larger revenues that could potentially be invested in new technology. Also the competition to attract visitors within London is more intense, so technology might have been used to promote the attraction, therefore differentiating it from its competitors. A few additional sites apart from these already mentioned were visited if they were identified as having interactive multimedia exhibits of particular significance.

This approach of visiting several attractions clustered around major cities meant that several sites could be assessed in one day and because, with the exception of London, it was only necessary to visit the cities for one day, the study could be conducted quickly with travel and accommodation costs minimised. (Judd et al 1991, Moser and Kalton 1985, Oppenheim 1992, Robson 1993) Figure 2.4 on the following page details the heritage attractions visited.

Once the main survey had been completed, heritage attractions and museums which had made particularly effective or innovative use of interactive technologies, were contacted by written correspondence and were asked to provide details regarding the design, use, content and concept behind using interactive multimedia exhibits.

Figure 2.5 identifies those heritage attractions and museums contacted who were deemed to have made effective use and/or innovative use of interactive multimedia. Whilst awaiting replies from these heritage attractions and museums, the data contained within the completed record sheets was transferred into a computerised spreadsheet for

London	York
Bank of England Museum	Jorvik Viking Centre York
British Museum	National Railway Museum York
Design Museum	York Castle Museum
Imperial War Museum	York Dungeon
Legoland Windsor	York Minster
Lifetimes (Croydon Clock Tower)	York Story
London Planetarium	Yorkshire Museum
London Transport Museum	
Museum of the Moving Image	Leeds
NAMCO Wonder Park	Harewood House
Natural History Museum	Royal Armouries
Rock Circus	
Science Museum	Oxfordshire & Warwickshire
Thames Barrier Visitor Centre	The Heritage Motor Centre
Trocadero (inc. SEGA World)	The Oxford Story
Tower Bridge Experience	Warwick Castle
Tower Hill Pageant	The World of Shakespeare
Victoria & Albert Museum	
Liverpool	Bradford
The Beatles Story	Museum of Photography, Film and Television, Bradford
The Conservation Centre	
The Liverpool Museum	Others
Merseyside Maritime Museum	Alton Towers (Staffordshire)
Museum of Liverpool Life	Quarry Bank Mill (Cheshire)
	Wigan Pier (Wigan)

(Figure 2.4 : Heritage Attractions and Museums visited during the UK Survey)

analysis, this was a straight forward operation due to the highly codified nature of the record sheets as discussed in section 2.4.1.

The Bank of England Museum	The Tower Bridge Experience
Design Museum	Natural History Museum
Granada Studios Tour	Science Museum
Imperial War Museum	Royal Armouries Museum
Lifetimes (Croydon Clocktower)	V & A
London Transport Museum	Museum of Science and Industry
National Museums and Galleries on Merseyside (inc. Liverpool Museum, Merseyside Maritime Museum and Museum of Liverpool Life)	in Manchester

(Figure 2.5 : Heritage Attractions and Museums contacted)

Swift (1997) recently explored exhibits within heritage attractions and identified that each exhibit could be placed in one of three categories, Passive, Reactive and Interactive. He explains that:

“Traditionally, most museum exhibits are *passive* – they are static and do not involve visitor input. Exhibits that are activated by visitors (for example pressing a button) and carry out a set routine are *reactive*. In contrast *interactive* exhibits have an open-ended outcome dependent on visitors’ input.” (Swift 1997)

This appeared to be a sound base of categories upon which to build the present exploratory findings and complemented the classification framework described in section 1.6. However a number of exhibits, including time cars, simulator capsules and VR environments, were observed in this research survey which did not readily fit into these categories. Therefore Swift’s original classification of exhibits was extended with the addition of an additional category, to take account of these exhibit types. This additional category, called Immersive, includes all exhibits where visitors are completely immersed within the exhibit. (Sumption 1999) This extended classification system was used as a framework for the present study of UK Heritage Attraction Surveys.

The preliminary analysis of the data contained within the spreadsheet illustrated the different categories of interactive multimedia (Passive, Reactive, Interactive or Immersive) and the technological elements within each of those categories and were clearly of initial interest to the researcher. However as analysis progressed it was the differences between classes that became of prime importance, as it was felt this may aid the understanding of the relationship between funding, level of interaction and group size. For example, did the interactive multimedia exhibits become more interactive and sophisticated as the admission prices increased or did the size of the group in which visitors can participate reduce as the level of interaction increases.

The findings of UK Heritage Attraction Field survey are presented in Appendix A. The survey contributed to the researcher's understanding of the current applications of interactive multimedia in United Kingdom heritage attractions and museums. However the limitations of the survey were recognised, as the survey included a limited sample of heritage attractions and museums which were not representative of all attractions in the United Kingdom and had been specifically selected by the researcher.

2.5 A Survey of Heritage Attraction and Museum Web Sites

The literature review had revealed that the Internet and the World Wide Web were becoming of increasing importance to heritage attractions and museums. The 24-Hour Museum Web site was launched with the backing of the Department of Culture, Media and Sport during May 1999, and provides a gateway to the Web sites of museums in the UK. (Nightingale 1999, Stiff 1999, www.24museum.org.uk) Stiff explains that the "first phase of the 24-Hour Museum will concentrate on enabling access to web sites and encouraging the educational use of museums. A museum locator will allow users to find museums with specific types of collections or facilities within a given geographical area." (Stiff 1999) He expands that in "the longer term, the 24-Hour Museum aims to provide a framework for museums to make their collections databases available on-line. This will allow museums to combine to form what will, in effect be a huge encyclopaedia to support the lifelong learning of UK citizens. (Stiff 1999)

The term "Virtual Museum" was frequently being used to describe a museum's Web site, however it should be noted that some "Virtual Museums" do not have a physical presence in the real world and have been created solely on-line. (Bowen, Yardley and McKenna 1996, Campbell and Wells 1996, Clutten 1996, Valls 1994) Heritage

attractions and museums were typically using their Web sites to provide general visitor information (e.g. admission times and prices) through to complete on-line interactive multimedia exhibits. (Johnston 1998, McKenzie 1997, Noack 1995, Standage 1995) Noack explains that “Almost every museum in the world now has a Web page, although they vary in content. While the best Internet museums provide a rich array of online exhibits, many museum pages function mainly as online brochures and offer only basic information for visiting the home museum.” (Noack 1995)

The Web is a rapidly evolving channel of communication, which has potential benefits for heritage attractions and museums. It was therefore important to conduct a study to clarify the current level of development and sophistication of heritage attraction and museum Web sites. Initially the research focused on the Web sites of heritage attractions and museums located within the United Kingdom, the research then expanded to include Web sites of attractions based in the USA.

2.5.1 United Kingdom Heritage Attraction Web Site Survey

The purpose of the UK heritage attraction Web site survey was to generate quantitative data, primarily to identify which technologies were employed and secondly to identify what information and facilities were provided for visitors to the attractions site. A comprehensive listing of UK heritage attraction and museum Web sites is provided on the Virtual Library Museum Pages (VLMP) (<http://www.cs.reading.ac.uk/vlmp/uk.html>) and this was useful as a foundation for the research. The VLMP contained links to the Web sites of both heritage attractions and museums, although as its name suggests the majority of links were to museum sites. It is recognised that the VLMP did not provide a totally inclusive listing of every heritage attraction and museum Web site. However it provides a comprehensive and respected listing which is regularly updated and was considered a suitable starting point for this element of exploratory research.

Each of the 136 Web sites listed on the VLMP (April 1997) was visited and assessed, with the features present being recorded directly on a computerised spreadsheet. An additional benefit of this approach was that it also enabled the researcher to make additional qualitative assessments on the technical implementation, the structure of the sites, the quality of the material available and the aesthetic design of the sites based upon the researcher’s experience, in addition to the gathering of quantitative data.

2.5.2 United States Heritage Attraction Web Site Survey

The purpose of the USA survey was also to identify the technologies employed and information provided, to make an additional qualitative assessment of the presentation, and to provide a comparison with the UK survey. The USA was chosen in preference to any other country because, as explained by Spearman “of the ‘thousands’ of museums world-wide listed in the directory more than half are in the US”. (Falconer 1996)

Initially it had been planned to undertake a similar study of the Web sites of heritage attractions and museums located in the United States of America as had been completed for the United Kingdom. However it was not feasible for a single researcher to visit and assess each of the 393 Web sites listed on the VLMP for the USA, especially with the well known slow downloading of the sites from the USA to the UK, particularly in the afternoon. (Mason 1995)

It was therefore decided to use the VLMP of the USA (<http://www.cs.reading.ac.uk/vlmp/usa.html>) as a sampling frame, and to include a 10% sample of the sites listed, comparing these with the results of the UK survey.

Regardless of the research methodology or data collection technique employed it will rarely be possible to include everyone in the population and therefore some form of sampling will be required. Sampling is most commonly associated with surveys where a representative sample of the population is selected, surveyed and the results generalised for the population. The two categories of sampling techniques available to the researcher are Probability and Non-Probability sampling.

Probability sampling requires that the likelihood of each selection is known, this requires a sampling frame, listing all units within the population. Whereas with Non-Probability sampling a sampling frame is not required and the probability of selection is unknown, however this means that the results are not statistically generalisable beyond the surveyed sample. Probability sampling is advantageous because it is more likely to produce representative samples, reducing bias and enabling accurate generalisations to be made. However Non-probability sampling is often employed where probability sampling is impractical or unnecessary, for example where a sampling frame is unavailable or the researcher does not wish to generalise from the sample, and therefore representativeness is less important. Non-Probability sampling is often used for small

scale surveys, because it is typically easier to manage and cheaper to administer than probability sampling. (Blaxter, Hughes and Tight 1996, Moser and Kalton 1985, Robson 1993, Veal 1992)

As a sampling frame exists in the form of the VLMP listing for USA based attractions, and for the reasons outlined above probability sampling was selected. There are several probability sampling techniques available, these include simple random sampling, systematic sampling, stratified sampling and cluster sampling. (Blaxter, Hughes and Tight 1996, Oppenheim 1992, Robson 1993, de Vaus 1986)

When employing simple random sampling, units from the sampling frame are chosen at random and each has an equal chance of being selected, thus removing any selection bias. This technique is most appropriate when the population within the sampling frame is not geographically spread, or you are not planning to collect the data in person, otherwise the time and travel expense can be prohibitively costly. (Miles et al 1998, Oppenheim 1992, Slavin 1984, de Vaus 1986)

When employing systematic sampling, the population size is divided by the required sample to produce a sampling fraction. (e.g. Population=100, Sample=20, $100 \div 20 = 5$, Sampling Fraction=5) A starting point between zero and the sampling fraction is then selected at random, thereafter every n^{th} unit is selected, where n is the sampling fraction. Only the first unit is chosen at random, after that not everyone has an equal chance of being selected. However this method is approximately equivalent to random sampling as long as there is no pattern within the list. For example if the list was ordered; husband – wife – husband – wife, and the sampling fraction was an even number then the entire sample would be of the same gender. The use of systematic sampling removes the interviewer's or observer's ability to select individuals thus removing a major source of selection bias. (Blaxter, Hughes and Tight 1996, Heady 1984, Robson 1993, Smyth and Ayton 1985)

Stratified sampling is often used for practical reasons to obtain a random and representative sample. Stratified sampling divides the population into a number of strata, each defined by a set of characteristics, individuals are then selected at random from each strata. Typically the number of individuals selected from each strata should reflect the size of that strata in relation to the whole population. However information

on the characteristics used to define the strata is often unavailable. (Moser and Kalton 1985, Robson 1993, Slavin 1984, de Vaus 1986)

Cluster sampling divides the population into a number of groups or clusters which are frequently geographically based. Clusters are then selected at random and form sub-populations from which units are selected. It is also possible to divide those sub-populations into additional clusters, this is termed multi-stage cluster sampling. (e.g. the selection of regions then counties then district then streets then households) For practical reasons cluster samples are often used for large scale surveys, because they can reduce the travelling expenses associated with random and stratified sampling for geographically spread populations. (Blaxter, Hughes and Tight 1996, Judd, Smith and Kidder 1991, Oppenheim 1992, Robson 1993)

From these four alternatives simple random sampling was selected because it was straight forward to conduct, produces results which can be generalised and as the survey would be conducted from a computer at a desk the drawbacks associated with this approach when surveying a geographically dispersed population were of no consequence.

To apply the simple random sampling approach sets of three digits were taken from a table of random numbers by working systematically down each column. Repeated numbers and numbers greater than 393 were discounted. This process was repeated until 39 (a 10% sample) random numbers had been generated. The WWW sites on the VLMP were listed in alphabetical order and numbered 1 through 393, therefore it was a straightforward process to survey the sites that had been randomly selected. As for the study of UK attractions each Web site was visited and the presence of technologies and information were recorded quantitatively with additional qualitative assessments of the technical implementation and aesthetic design of the site also being made.

Having completed a study of the Web sites of all heritage attractions based in the UK and listed on the VLMP and a survey of the Web sites of 10% heritage attractions based in the USA, the next stage in this enquiry was to examine the most successful, innovative and advanced heritage attraction Web sites and virtual museums on the Internet. The purpose of the study was to qualitatively observe and identify what could be achieved, in terms of state of the art Web technologies identified through a

combination of Web surfing and journal articles, design and historical interpretation. It was decided to visit and assess each of the VLMP top virtual museums in the USA as nominated by virtual visitors. The USA was chosen in preference to the UK or any other country because they are at the cutting edge of Internet technologies, and as Spearman has observed the rest of the world is “five to ten years behind the US” when it comes to the development of Web sites. (Falconer 1996) The results of the UK and USA Web site surveys and a comparison of the Web sites of heritage attractions based in the UK and USA can be located in Appendix A.

At this stage interactive multimedia employed by heritage attractions, both on-site and on-line, had been identified, fulfilling one of the stated aims of this research project.

2.6 A Review of Interactive Multimedia Technology in the Marketplace

In the context of the research and to fulfil the aims of the project it was important not only to ascertain which heritage attractions were employing certain categories of interactive multimedia, but also what types of innovative interactive multimedia technology were available, even if they were not currently being utilised. The exploratory research clearly identified two classifications of interactive multimedia technologies, namely Heritage Specific and Computing Based. The heritage specific technologies includes all hardware and software technologies marketed specifically to the heritage sector. Computer Based interactive multimedia encompasses Audio-Visual equipment and includes the three sub-categories of, Interactive Multimedia, Virtual Reality (VR) and the World Wide Web (WWW). These three sub-categories of technology cannot be considered in isolation as there is a significant amount of cross over between them, for example a multimedia application could contain VR reconstructions of objects or buildings and be accessed over the Internet. However this broad classification will be used as it helps to simplify the technological discussion.

2.6.1 Heritage Specific Interactive Multimedia

To determine the types of interactive multimedia products that have been developed and marketed specifically to the museums sector, the Museums Yearbook 1996/97 and the Heritage Directory 1997 were consulted. These directories in conjunction with advertisements and features in a variety of museum journals and observations during the UK heritage attractions and museums aided the identification of companies and products worth exploring further. The organisations identified were contacted either by

letter or by telephone and asked to provide details of the products and/or services that they provide to the heritage sector. The information received built into what was by this time a comprehensive database of interactive multimedia in the heritage sector. Further knowledge and contacts were made by attending Trends In Leisure and Entertainment (TILE'97) Conference in Strasbourg, France, visiting the Museums and Heritage Show 1997 & 1999 in London and International Cultural Heritage Informatics Meeting (ICHIM'99) in Washington D.C., USA. Each of these gatherings are leading forums for the latest in development of interactive multimedia technologies applicable to the heritage sector.

2.6.2 Computer Based Interactive Multimedia

A variety of approaches were pursued in obtaining information on general computing based interactive multimedia that may have been applicable to museums, but not marketed to them specifically. Initially computing books and journals were consulted including the Multimedia Yearbook 96/97, together with searching and surfing the WWW. A number of specialist shows were attended including; Digital Media World '96, '97 & '98 and Multimedia '97 & '98, all of which were held in London. Additionally a one-week course was attended on Virtual Reality and Virtual Environments run by Dr. Nick Avis and Francesco Giarletta of the National Industrial Centre for Virtual Environments. The researcher also drew upon the experience gained in obtaining a first degree in Information Technology, including a final year dissertation on the development of interactive multimedia kiosks. This was supplemented by knowledge gained whilst working for "The Right Image", a specialist multimedia and graphic design unit within Unipart Information Technology (UiT), part of the Unipart Group of Companies (UGC).

Again relevant organisations were contacted, either by letter, telephone or in person at the conferences described above and a comprehensive database of information collated, and expanded for reference. In the case of information obtained from the WWW this was printed directly, the companies were only contacted if more detailed information than was provided on their WWW site was required.

The range of innovative multimedia technologies available to the museums sector both designed and marketed specifically to them and general computer based technologies encompassing Multimedia, Virtual Reality and the World Wide Web and Audio-Visual

equipment is continually expanding. Therefore this area was monitored throughout the whole of the research project in order to keep informed of the latest products and developments.

Thus it was felt that all avenues were explored for informing the early stages of the research. This fulfilled the aim of identifying innovative technology with potential applications for heritage attractions and museums. As discussed in section 1.7 three potential areas for further enquiry were identified, based upon the findings of the exploratory research and from these the concept of developing a portable computer and interactive multimedia application for enhanced interpretation was selected.

The following section explains how once the area of research was selected it was necessary to identify and source the appropriate hardware, to arrange a test bed site and to design and develop an interactive multimedia application to be used on the portable computer, thus fulfilling a subsequent aim of the research project.

2.7 Evaluating a Portable Computer for Museum Interpretation

The museum guidebook was one of the first portable interpretative mediums, followed by audio guides, initially linear cassette based units, which have now developed into sophisticated random access CD-ROM and solid-state digital units. These audio guides can free visitors from having to read text panels, allowing them to concentrate on the exhibits. However even the latest audio guides are limited to providing a single channel of information with limited interaction for the museum visitor. (Cooper 1997, Martin et al 1997, Serrell 1998, Whittington 1997) Interactive multimedia kiosks and CD-ROMs can provide the visitor with multiple channels of information and have a much greater level of interactivity than audio guides. (Lydecker 1993, Swift 1997, Visser 1993, Winterbotham 1994)

The potential of combining elements from each of these media into a single interpretative application was identified. The portability of the guidebook and audio guide, could be effectively combined with the level of interaction and media richness of CD-ROMs and interactive multimedia kiosks. The result of this fusing of technologies is a portable computer with an interactive multimedia application. This innovative use of new technologies also fulfils the aims of the GEMISIS 2000 project, in that it examined a potential innovative application of new interactive technologies for heritage attractions and provided test-bed sites for multimedia initiatives.

In order to evaluate the feasibility of a portable computer combined with an interactive multimedia application for interpretation within the heritage attraction, a number of key stages were identified. It was necessary:

- To arrange a test bed site for the research
- To identify and source the appropriate portable computer hardware
- To design and develop an interactive multimedia application
- To complete a evaluation using the portable computer
- To analyse the results of the evaluation study

2.7.1 Test Bed Site

Based upon the results of the exploratory research a shortlist of heritage attractions and museums in the region with whom there was the potential to form a partnership was developed. The proposed research project was discussed with representatives from each attraction and the relative merits of each site considered. From this shortlist the Museum of Science & Industry in Manchester was selected because it is a highly prestigious museum close to the researcher's base, and so was convenient to access, which would be increasingly important both during the development of the application and the evaluation study. As a science and technology museum they were interested in the potential of new technology for interpretation and were keen to be involved with the research project.

Other research studies underway using portable computers are being designed to assist visitors in orienting themselves and in navigation of an entire museum and in one case a historic town. (Broadbent and Marti 1997, Evans 1998c, Oppermann and Specht 1999) However the nature of this research project dictated that it would be impractical to develop the proposed interactive multimedia application for the whole museum so an area within a single gallery was selected as the test bed for the research and evaluation study. The Fibres, Fabrics and Fashion gallery in the Museum of Science and Industry in Manchester was selected because it was a recent major project, designed and planned to include the latest thinking and developments in gallery design and interpretation. (Harris 1997) It has an in-house design director and an interactives designer. The Fibres, Fabrics and Fashion gallery is a textiles gallery which contains a number of redundant textile machines together with exhibits on harvesting cotton, trading cotton,

exporting cotton, fashion, printing, dyeing. There are a number of hands-on interactives designed to show the properties of different fabrics. The layout of the gallery incorporates a raised area which allows visitors to walk around and view the textile machines on the lower level in the centre. This provided an ideal and discrete area in which to test and evaluate the effectiveness and feasibility of a portable computer and interactive multimedia application with museum visitors.

2.7.2 Portable Computer Hardware

Portable touch screen computers are a very specialised piece of computer hardware. A number of potential hardware platforms were identified by searching the WWW, consulting newspapers, general computing magazines and the specialist “Pen Computing” magazine.

Several demonstration units were obtained and tested, after careful evaluation it was decided that the Point 510 Portable Computer from Fujitsu was most suitable. The unit featured the Windows 95 operating system, large 10.4” hi-resolution touch screen, reasonably powerful Intel 486DX4/100MHz processor and was within the project budget at £2000 per unit. The only misgiving was its weight, as it was rather heavy. Portable computers are clearly an area of rapid development and at the completion of this three year research project lighter, smaller and more powerful portable computers are available.

The use of a positioning system, to make the computer aware of its location and thus able to provide information based on the visitor’s location was considered, however this was identified as not being feasible due to technical and budgetary constraints. The aim of the research project was to design and develop a system, with a high level of direct user interaction and involvement. Although the use of a positioning system could have been incorporated, it did not detract from the project in any way. If it is found that visitors can use the portable computers without such a system then heritage attractions and museums may find that expensive wireless networks and positioning infrastructure will not be required. However, if a museum wide system rather than the discreet and focused development discussed here is to be implemented then the importance of a positioning system may be more crucial to the success of the installation.

There are several interactive multimedia authoring packages currently on the market, of these Macromedia Director was chosen for the development of the application. The package was selected because it is the industry standard for interactive multimedia development, the researcher had over three years experience of using this software tool and the software had already been provided by the GEMISIS 2000 project. (Clarke and Swearingen 1994, Luppá 1998, Prochak 1990, Vaughan 1994)

Once a partnership with the museum had been formed, the computer hardware identified and sourced, the process of designing and developing the interactive multimedia application and planning the visitor study to evaluate the portable computer and interactive multimedia application as an interpretative tool could commence. The development of the interactive multimedia application is discussed in detail in Chapter 3: Design and Development.

2.8 Visitor Evaluation Study

Once the requisite portable computer hardware had been obtained, test bed site agreed and the interactive multimedia application developed, it was essential to evaluate it as an interpretative tool and to explore the impact upon the visitor experience. This section provides a brief overview of the evaluation study, which in conjunction with the research methods and data collection techniques selected are critically reviewed in Chapter 4: Visitor Evaluation Study.

The combination of research methods with a range of data collection techniques is often advantageous as each approach can complement the other and reveal insights that a single method alone would be unable to do. (Allan and Skinner 1991, Veal 1992, Yin 1993) Thus a multi-method approach, combining pre-visit and post-visit questionnaires, structured unobtrusive observation and interaction log recording were used to gather both quantitative and qualitative data.

2.8.1 Research Sample

Two groups were used in the study, a control group of 50 adults who experienced the gallery as it had originally been designed (control group) and a second group of 50 adults who experienced the gallery using the portable computer and interactive multimedia application (computer group). All were selected randomly and asked a series of

questions on entry and exit, and observed during their visit in the designated area of the gallery.

As this is the first study of its nature, combining a portable computer and interactive multimedia application with the aim of enhancing interpretation within a museum gallery it was important that the quality of the data was not compromised. With both qualitative and quantitative research findings it was felt that 50 respondents would provide enough evidence from which to draw conclusions. As the evaluation combined a number of research methods, observation, pre-visit and post-visit survey and interaction logging this provided a rich and varied range of data for analysis.

Two groups of visitors participated in the study. The first, a control group were asked a series of questions as they entered the raised area of the gallery. These visitors were then observed as they explored the gallery, before being asked a second series of questions upon the completion of their visit. The second group were also asked the same series of questions as they entered the gallery. These visitors were then given the portable computer to use during their visit, and observed as they explored the gallery and interacted with the portable computer and multimedia application. Upon completion of their visit these visitors were also asked a series of questions, although several additional questions were added to assess their experiences with the portable computer and interactive multimedia application.

2.8.2 Questionnaire Survey

In order to assess the impact of the portable computer and interactive multimedia application on the visitor's experience and understanding, visitors were questioned both before and after they visited the study area with a series of open-ended questions. It was necessary to pre-test the visitor's knowledge and experiences prior to their visit so that changes (if any) could be measured. It was perceived that visitors existing knowledge about an aspect of textile history could be recorded at the same time as exploring their opinions on the gallery. On entry visitors were shown a photograph of a textile machine and again after their visit and asked to identify it and the process it performed. Additionally they were asked to recall processes which take place in a textile mill, before and after their visit to the gallery. Both groups were also asked their opinions of the gallery, including the most and least liked elements. Visitors from the computer group were asked additional questions on their opinion of the portable computer and interactive

multimedia application and the impact, if any, it had had upon their visit and their knowledge of textile machines and processes.

2.8.3 Observation

Visitors were observed unobtrusively as they explored the gallery, because it was important not only to test how using a portable computer and interactive multimedia application affected their understanding and experience, but also how it affected their behaviour whilst in the gallery. Typically observations can record the frequency and/or order of behaviours. However for this study it was the duration of individual behaviours which was most important, as it was felt this would provide a more representative record of the visitor's behaviour and how they spent their time in the gallery. The researcher therefore used a second portable computer with an application designed to assist the observation. A preliminary observation was undertaken in the gallery to identify behaviours exhibited by visitors; these behaviours were recorded and used as the basis to construct the observation application.

The application was designed so that the researcher could observe the visitor's behaviour during their visit, for example looking at a textile machine, text panel or museum guidebook. The researcher would then touch the appropriate pre-set button on the screen, then when a different behaviour is exhibited the observer would touch that pre-set button on the screen. The observation program was designed so that it would record each behaviour to the nearest second and would save the file in a format, which could be imported, directly into a spreadsheet for analysis. By reducing the time the observer had to look away from the subject and removing the need to calculate and record the duration of individual behaviours, the accuracy of the data gathered was improved.

This methodology had been carefully developed through a pilot survey. Visitors were unaware that they were being observed.

2.8.4 Interaction Logs

A problem which arises when trying to evaluate an interactive multimedia application is analysing how the visitor actually interacted with the application. This is difficult to achieve without standing next to the visitors for the duration of the observation which was impractical and would effect the visitor's behaviour. Therefore an interaction log

facility was incorporated into the interactive multimedia application, itself. This recorded every section the user accessed and how long they remained on each screen to the nearest second. It was hoped this data would be useful for identifying which sections of the application were most popular with visitors and aid understanding of how they used the application. As with the observation application, data was saved in a format that could be directly imported into a spreadsheet for analysis. Again the visitors were unaware that the time they spent on each screen was being monitored and recorded.

A discussion of the evaluation study including the research methodology can be found in Chapter 4: Visitor Evaluation Study.

This chapter has explained in detail the aims and objectives of this research project and the main body of research methods used. This was followed by a review of the exploratory research undertaken, which included an extensive and critical literature review, and heritage attraction study, both in the field and on-line. This was followed by a summary of how the concept of a portable computer and interactive multimedia application for interpretation was developed. The final section of the chapter provided a brief overview of the evaluation study undertaken in order to assess the effectiveness of the portable computer and interactive multimedia application as an interpretative tool and its impact upon the visitor experience.

The next chapter will review the design and development of the interactive multimedia application used with the portable computer to enhance the existing interpretation with a museum gallery.

Chapter 3

Design & Development

Chapter 3 Design & Development

One key aim of this research project was to design an interactive multimedia application for a portable computer to be used in a museum setting. This chapter provides a detailed review of that process. The test site was the Fibres, Fabrics and Fashion gallery at the Museum of Science and Industry in Manchester (MSIM).

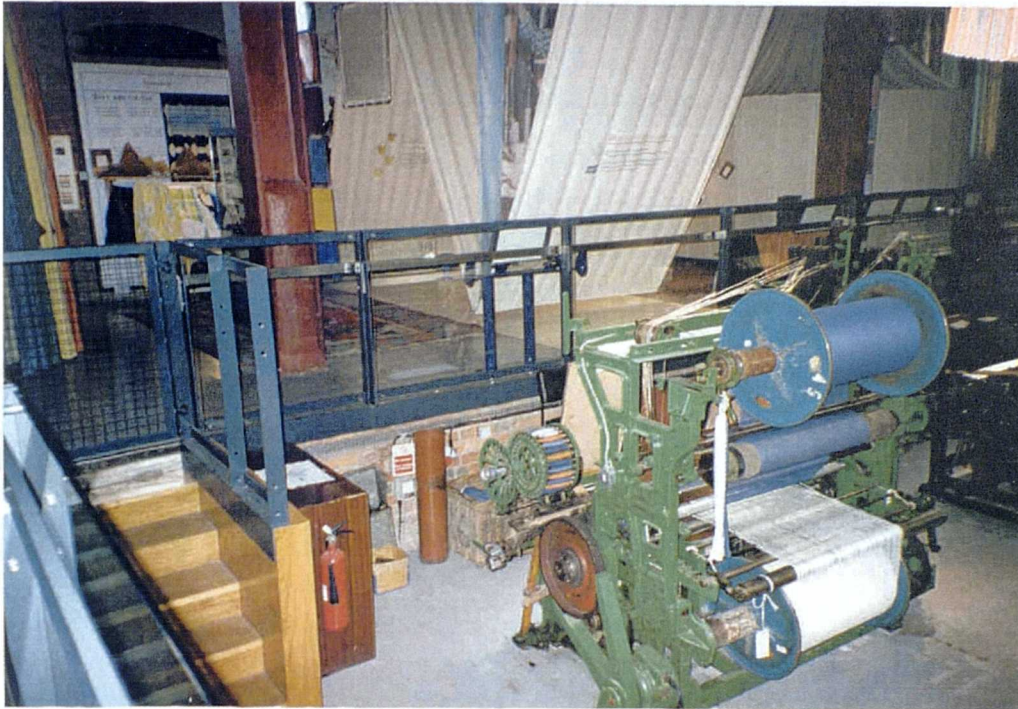
The chapter begins by detailing the area of the gallery where the research project would take place. Although the gallery is new there were a number of areas identified within it that would benefit from enhanced interpretation, these are discussed. In addition the development of interactive multimedia applications through the use of flowcharts and storyboards is explored. The main body of the chapter reviews in detail the design and development of the interactive multimedia application from formation of a design brief through to authoring and formative evaluation.

3.1 Selection of an Appropriate Test Area

Before the design stage could begin it was important to identify areas of the Fibres, Fabrics and Fashion gallery where there was potential for the portable computer and interactive multimedia application to enhance the existing interpretation. The recently opened Fibres, Fabrics and Fashion gallery was selected as the test bed for the research and visitor study. The layout of the gallery incorporates a raised area, which allows visitors to walk around and view the redundant textile machines on the lower central level. Two photographs (figure 3.1 and figure 3.2) of the gallery depicting the textile machines and split level structure of the gallery are shown on the following page. The existing interpretation of the textile machines exhibits is minimal, and limited to simple text panels including black and white photographs. Therefore this area would provide an ideal and discreet area in which to evaluate effectiveness of the portable computer and interactive multimedia application.

The appropriateness of the research project for this particular gallery was discussed at length with Professor James Powell (GEMISIS Director), Dr Patrick Green (Museum Director), Nick Dixon (Gallery Curator) and Tudor Gwynn (Interactives Designer) together with Vincent Newton, Raymond Watson and Rick Jacobs. (Textile Machine Demonstrators) These discussions were supplemented by observations made by the

researcher and Dr Sterry, the research supervisor. All agreed that there were potential benefits to the research taking place in this gallery. Even at this early stage there was a clear consensus that the textile machines would benefit from innovative interpretation, and the planned research project would be a leading edge development in interpreting museum collections.



(Figure 3.1 : Fibres, Fabrics and Fashion Gallery)



(Figure 3.2 : Fibres, Fabrics and Fashion Gallery)

3.1.1 Front-End Analysis

Typically front-end analysis is undertaken to establish a baseline of visitor behaviour, opinions, prior knowledge and/or misconceptions of the subject area, but can also assist designers in planning future developments. (Bicknell 1994, Economou 1998, Hayward and Loomis 1992, Walker 1989) Hayward and Loomis explain that Front-End Analysis is the "... analysis of the audience and their perceptions in order to inform the major conceptual decision in exhibit development." (Hayward and Loomis 1992)

A commissioned study on visitors to the former textile gallery was made available and used to provide useful current data on visitor's knowledge, expectations and perceptions. This survey had been undertaken in the former textile gallery at the MSIM by the Susie Fisher Group (Fisher 1995) to aid in the design and planning of the present Fibres, Fabrics and Fashion Gallery, the test bed for this research project.

Findings from Susie Fisher Group report revealed that:

- Visitors preferred to see textile machines working
- Demonstrations were infrequent outside of school and bank holidays
- Interpretation of the textile machines was limited without demonstrators
- The textile machines in the gallery were not displayed in their historical context which led to confused interpretation

These findings were taken as appropriate starting point from which to develop a design brief.

3.2 Design Brief

Based upon the findings of the Susie Fisher Group a design brief for the interactive multimedia application was developed, refined and approved by Professor James Powell (GEMISIS Director), Dr Patrick Green (Director MSIM), Nick Dixon (Gallery Curator) and Tudor Gwynn (Interactives Designer). All were fully appraised of the objectives and aims of the project and were involved in the development of the final brief.

A design brief is typically the first stage in developing an interactive multimedia application. Cathy Clarke and Lee Swearingen explain that a design brief is "... a proposal, or product specification, is the first step. It should be straightforward and

simple, including a project description along with a proposed budget, team, timeline, development resources and delivery platform.” (Clarke and Swearingen 1994) A design brief should also make reference to the audience, core message and purpose of the application. Ray Kristof and Amy Satran explain that a design brief “... is the beginning of any interactive project ... the process of definition ... it precedes any thoughts about what the screen will look like.” (Kristof and Satran 1995) The development of an interactive multimedia application is an iterative process. The product progresses through several cycles of refinement before being completed, however the design brief forms a base upon which to build, explore the concept and develop ideas. (Clarke and Swearingen 1994, Kristof and Satran 1995, Vaughan 1994)

Thus through a process of definition, refinement and further definition a design brief was developed as follows:

To design and develop an interactive multimedia application to run a Fujitsu Point 510 portable touch screen computer within a defined area of the Fibres, Fabrics and Fashion gallery. The application should innovatively enhance the existing interpretation of the textile machines, and bring them to life, using both video clips and computer generated animations. The interactive multimedia application should place the working textile machines in context, illustrating the former textile mills where they were once installed and the people who operated them. In addition the application should include the facility to monitor user interactions.

This was an important and essential stage and a vital constituent of the research project.

3.3 Interactive Multimedia Development Methodology

The development of interactive multimedia applications is a relatively new discipline when compared to other areas of software development and there are many methods for such development. A method combining flowcharts and storyboards (Bunzel and Morris 1994, Glushko 1991, Velthoren and Seijdel 1996, Wilson 1991) was the basis for the development of the present project. Each stage of the design and development is discussed in the following sections.

This section details the production of the interactive multimedia application based upon the initial design brief. Each stage is reviewed, from developing the application structure and screen design, media acquisition and content creation through to final

authoring. The interaction log facility incorporated into the application is also discussed.

3.3.1 Application Structure

It was not feasible, due to financial and logistical constraints, to use a positioning system which would enable the portable computer to automatically determine its position within the gallery. However it was essential that the visitor using the portable computer was able to correctly determine their position within the gallery if they were to gain the maximum benefit from using the interactive multimedia application. To overcome this problem it was decided to use two methods of aiding the visitor to determine their location within the gallery and each were incorporated within the application.

The first method utilised the existing text panels in the gallery. The approach was based on that employed by the latest digital random access audio guides, where special numbered labels within the gallery relate to the corresponding audio track for that exhibit. However in this application the visitor would use the text panels to determine which area of the gallery and which exhibits they were looking at. The visitor would select the matching section of the interactive multimedia application.

The second method provided a map of the gallery layout, depicting the location of various textile machines and other exhibits. To access the section of the application corresponding to their current position all the visitor had to do was to touch the screen map at the location where they were currently standing.

The interactive multimedia application used the rooms within the textile mill (Blowing Room, Carding Room, Spinning Room and Weaving Shed) as a metaphor to structure the information. This provided both a straight forward and easy way to use navigation system which would relate closely to the structure of the gallery and helped to place the exhibits in context.

The term “metaphor” is used within the multimedia design discipline to describe a method of structuring information within an application in such a way as it links to concepts and structures already familiar to the user. (Economou 1996) This can make an application easier to use and enable the user to learn the operation of the application

more quickly. (Applin 1997, Hoekema 1991, Hoekema 1992) The most familiar metaphor in computing is the Windows and Macintosh desktop, where information is organised and displayed in a way that mirrors the items found on an office desk. However it is recognised that there are limitations to the use of metaphors within interactive multimedia applications and that problems can occur when unsuitable metaphors are employed, or the metaphor does not replicate the functionality provided in the physical world. Laurel explains that:

“The problem with interface metaphors, as illustrated by folders and other aspects of the desktop metaphor, is that they are like reality only different. Why should this matter? Because we don’t know precisely *how* they are different. If we could really treat interface metaphors like metaphors, they might work.” (Laurel 1993)

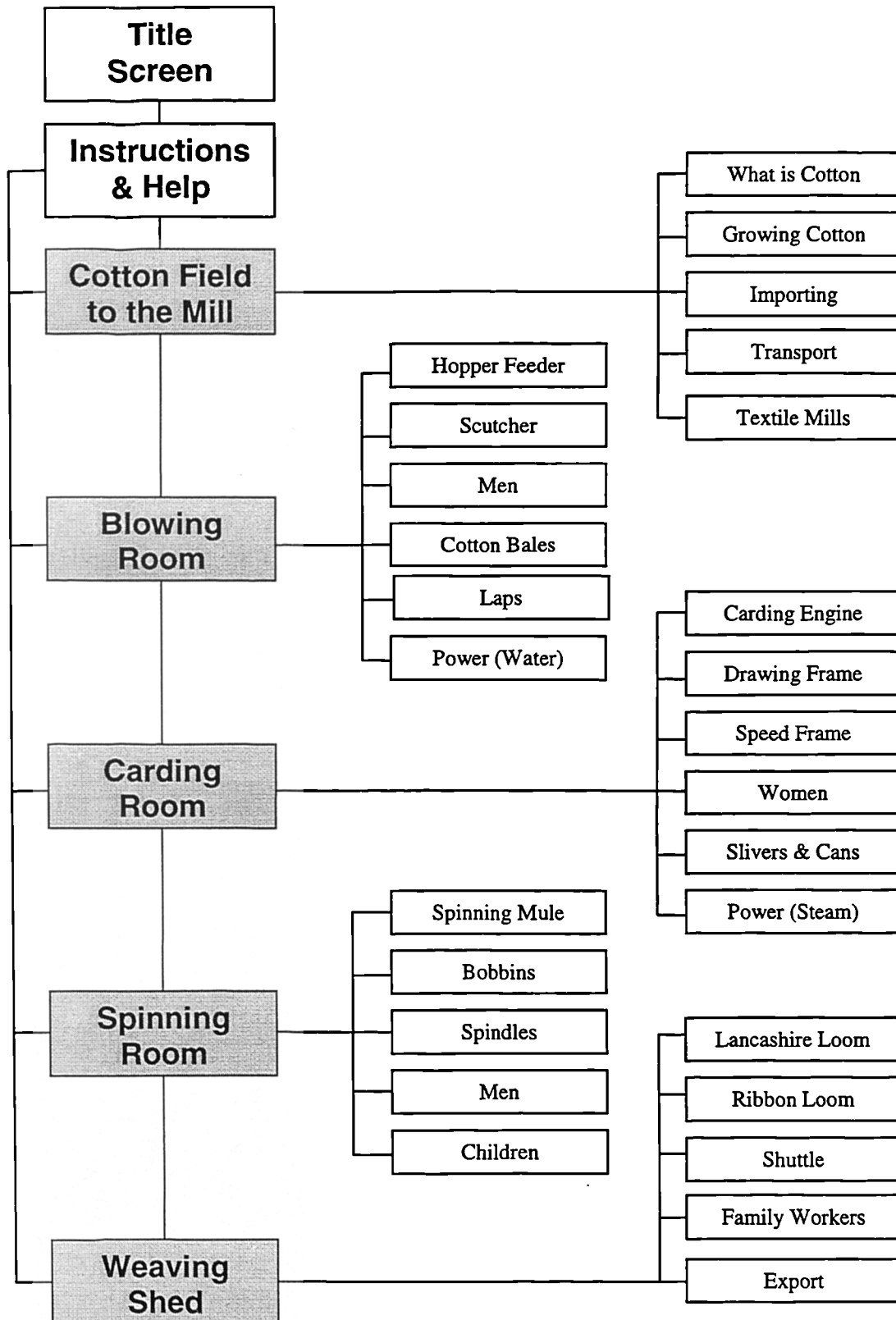
This method was used here and further enhanced by including a brief introductory screen for each room, with a short description of the processes, which were performed within it and an illustration depicting the current room’s location within the textile mill. Each of these rooms would provide links to supplementary information on the textile machines, people, and additional objects to be found within that particular room. The additional screen depicting each textile machine also included links to a video clip and computer animation of the textile machines working. Some mill rooms would also provide links to information on waterwheels and steam engines, which were used to provide power to the machines within the textile mills.

To further enhance interpretation of the textile machines and to place the exhibits in context an introductory section was also included, which explained what cotton was, where it came from and how it was transported to Manchester. This information had been carefully collated from the Fibres, Fabrics and Fashion gallery, the museum archive and from discussions with Nick Dixon the gallery curator.

At this stage this was potentially a difficult application for the museum visitor to use, as it required them to identify, in the first instance, their position in the gallery in order to use the computer effectively. To overcome any difficulties in use, visitors were directed to complete the instructions, which explained how to use the application. This in turn helped them to determine their position within the gallery and then to access the information contained within the application before they accessed the main application.

This information was also available again at any time should the users need to access it within a help section.

Figure 3.3 below documents the structure of the interactive multimedia application visually in the form of a flow chart.



(Figure 3.3 : Interactive Multimedia Application Flow Chart)

Flowcharting is the foundation of interactive multimedia design and is used to develop and document the structure of the interactive application. The flowchart is a visual blueprint used by the designers to show the order of screens and branching options available to the user. Flowcharts typically resemble a hierarchical layout of boxes and symbols representing the screens of the application and possible user interactions. (Bunzel and Morris 1994, Lopuck 1996, Philips 1992, Vaughan 1994) Vaughan explains that a flowchart is a “navigation map which outlines the connections or links among various areas of your content and helps you organise your content as well as a chart of the logical flow of the interactive interface.” She expands that a flowchart is “... a simple hierarchical navigation map ... where the subject matter of a small project is organised schematically. The items in boxes are not only descriptions of content but also active buttons that can take users directly to that content.” (Vaughan 1994)

The application begins with a title screen. This is followed by the instructions and the first screen of the application describing how cotton was transported from the cotton field to the textile mill. The five shaded boxes on the left are the main screens of the application, and with the exception of the first, each represents a room within the textile mill. The smaller boxes to the right show the sub-sections of additional information, which are available from each of these screens.

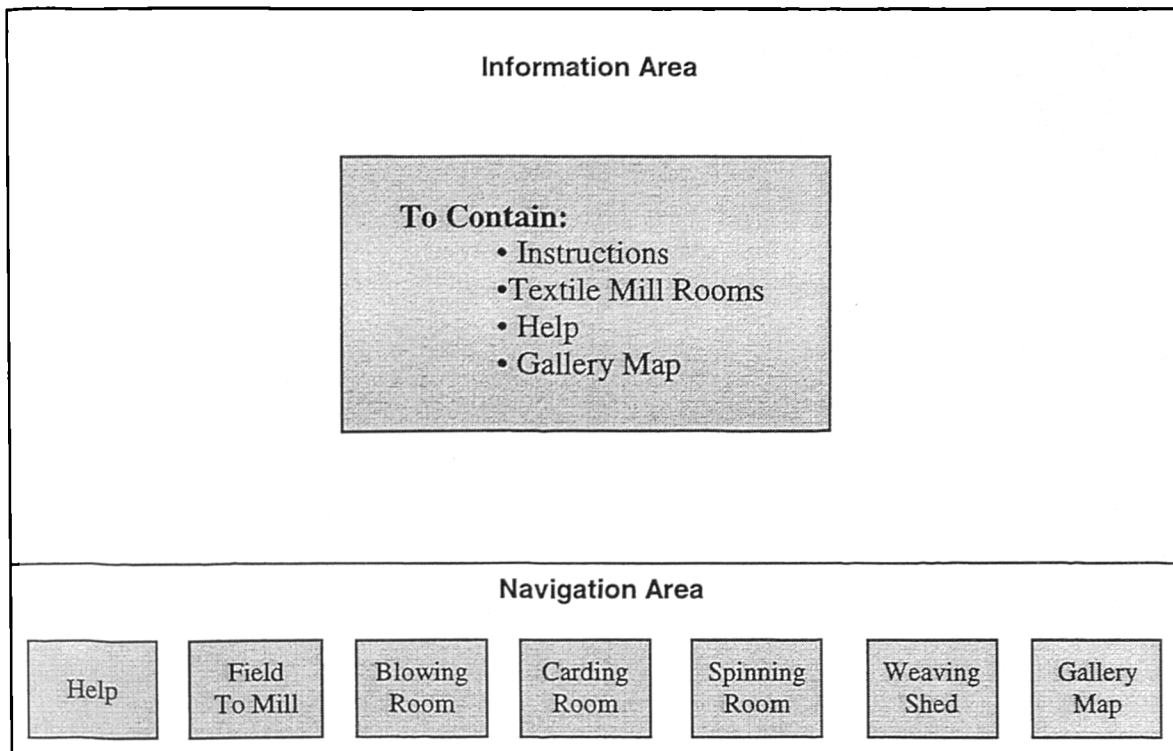
The flowcharts evolved through several iterations until the design reached the stage where application structure was finalised and attention could focus on the visual design of the application screens.

3.3.2 Visual Screen Design

Once the structure of the application had been finalised, attention turned to the layout and visual design of the application screens. As explained in the previous section it was the designer’s intention that visitors would identify their position within the gallery using the text panels already present and then touch a matching button on the application in order to access the corresponding section of the application. Access to the help section and gallery map was available at all times.

The basic layout of the screens were designed with a menu bar at the bottom of the screen containing the primary navigation buttons, with the corresponding room, help or gallery map shown in the larger upper area of the screen. The room buttons were placed

in order from the Blowing Room through to the Weaving Shed. This provided a structured progression from left to right through the rooms and the cotton process. The high level layout of the screens is shown below in figure 3.4:



(Figure 3.4 : High level screen layout)

To enhance the innovative concept of using a portable touch screen computer for interpretation, a discovery based interface was developed in preference to the highly structured menu button based interface found on the majority of interactive multimedia kiosks. (Roles 1995) This approach used an illustration or photograph of each room within the textile mill. The image of each room contained the textile machines, people and supplementary objects that would be located there, each item acted as a link to additional

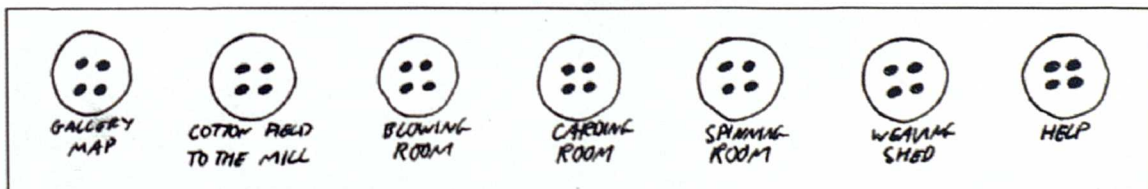
supplementary information. This provided visitors with the freedom to explore each room within the mill, by touching any machine, person or object on screen in which they were interested. The intention was to provide an application that was visually appealing, and both easy and enjoyable to use. These qualities have been noted by many commentators as best practice. (Hoekema 1991, Koester 1993, Serrell and Raphling 1992, Wilson 1991) For example Koester explains that applications with discovery-based or exploratory interaction model, can provide users with substantial

control over the information in the exhibit, and can increase motivation and the meaningfulness of the interaction. (Koester 1993) Hoekema concurs, stating that designers can expect users to have an interest in exploring an application and trying a couple of things to see what happens. (Hoekema 1991)

As the focus and prime interpretative theme of the Fibres, Fabrics and Fashion gallery is textiles it was necessary to capture this look and feel in the multimedia application. A fabric background was therefore added and bold hand written text used to maximise the readability and to minimise the computerised feel of the application. (Serrell 1996a) The visual theme was continued with the navigation buttons at the bottom of the screen, which were designed to look like real buttons which, had been sewn onto the background. The visual design of the screens was developed and documented using a series of storyboards.

Storyboards, which are commonly used within the film industry, are used to document the desired look and feel of the application screens and show where text, images and buttons will be placed. (Clarke and Swearingen 1994, Lopuck 1996, Vaughan 1994, Wolfram 1994) Vaughan describes storyboards as "... sketches and notes that describe in great detail each image, animation, movie segment, sound, text and navigation cue ... organised sequentially, screen by screen, and each screen is sketched out with design notes and specifications." (Vaughan 1994)

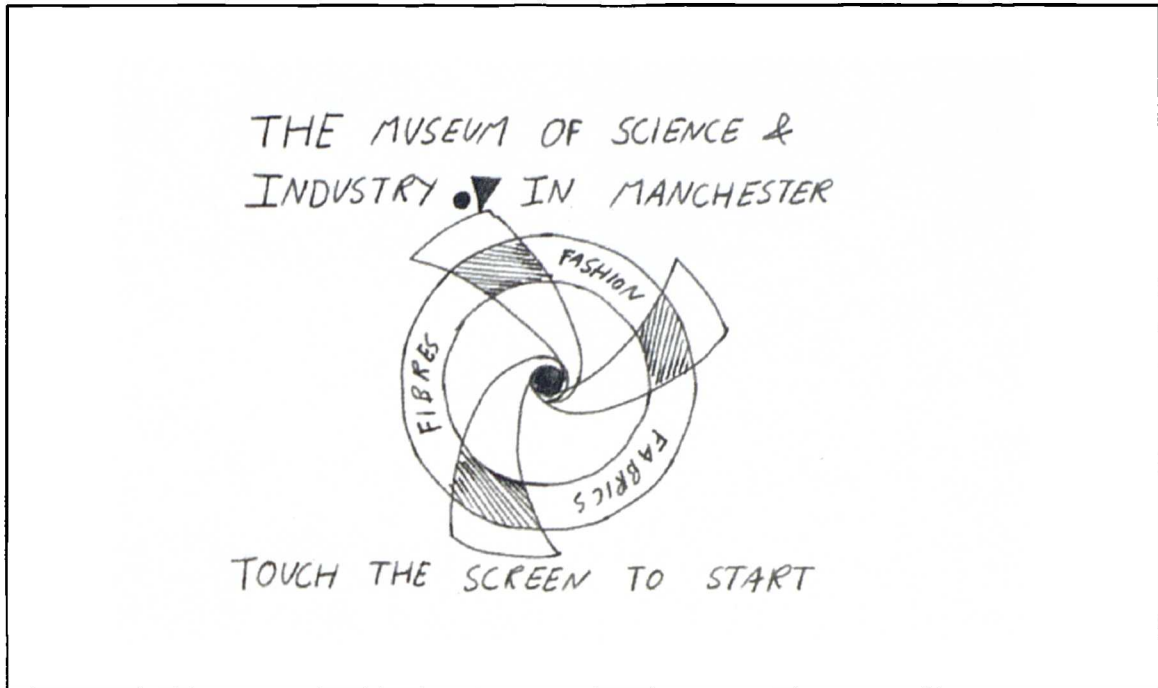
Examples of the original storyboards and the corresponding screen from the final application are shown below and on the following nine pages, figures 3.5 through 3.24:



(Figure 3.5 : Navigation Menu - Storyboard)



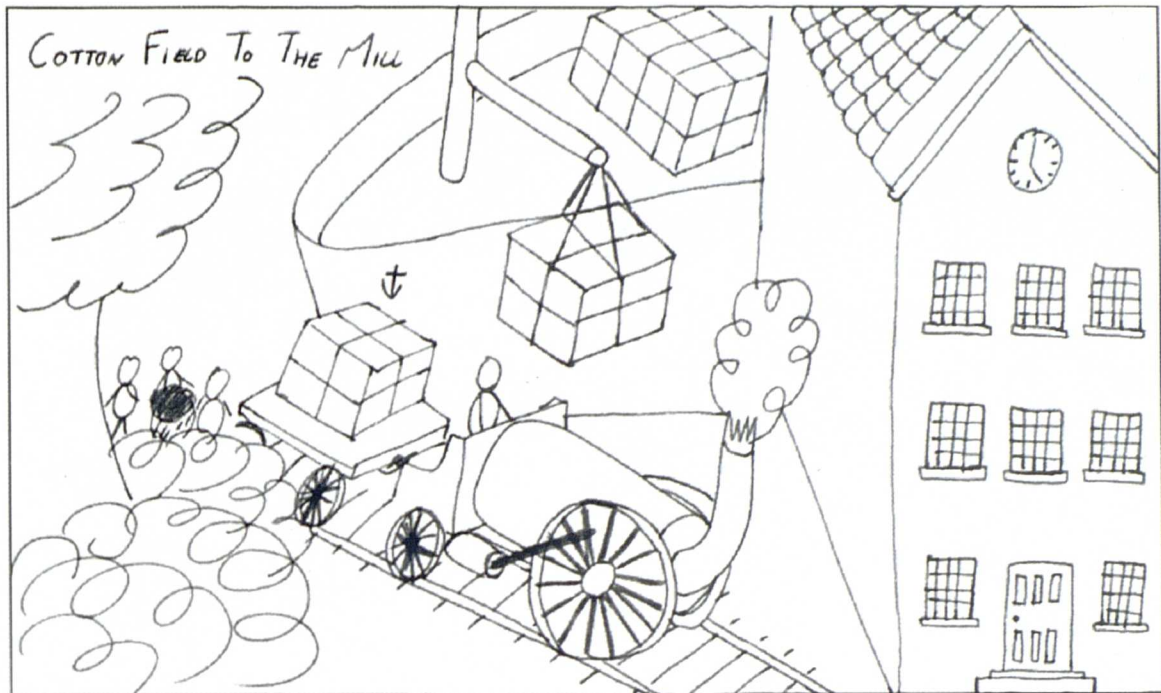
(Figure 3.6 : Navigation Menu – Actual Screen)



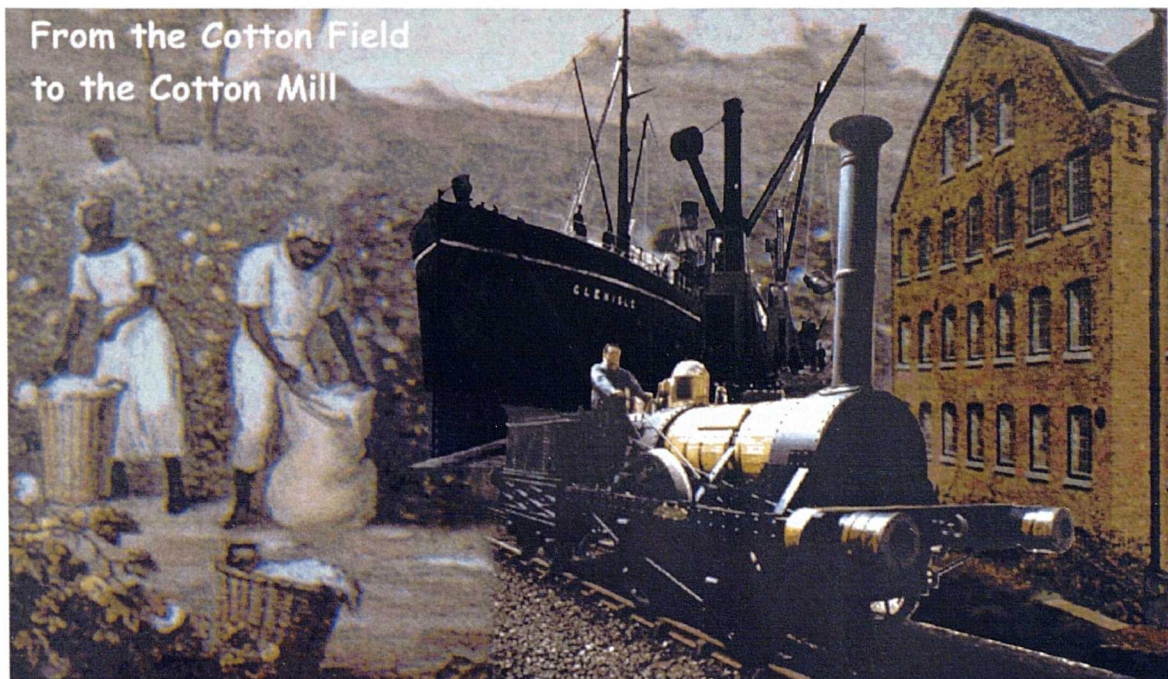
(Figure 3.7 : Title Screen – Storyboard)



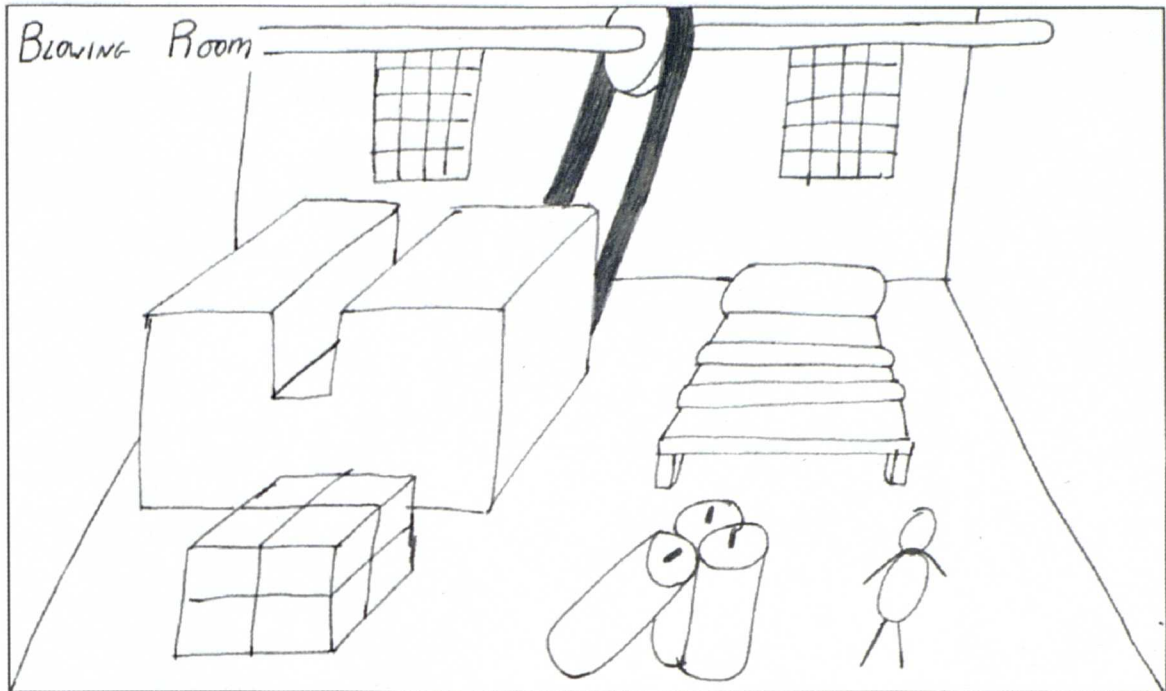
(Figure 3.8 : Title Screen – Actual Screen)



(Figure 3.9 : Cotton Field To The Mill - Storyboard)



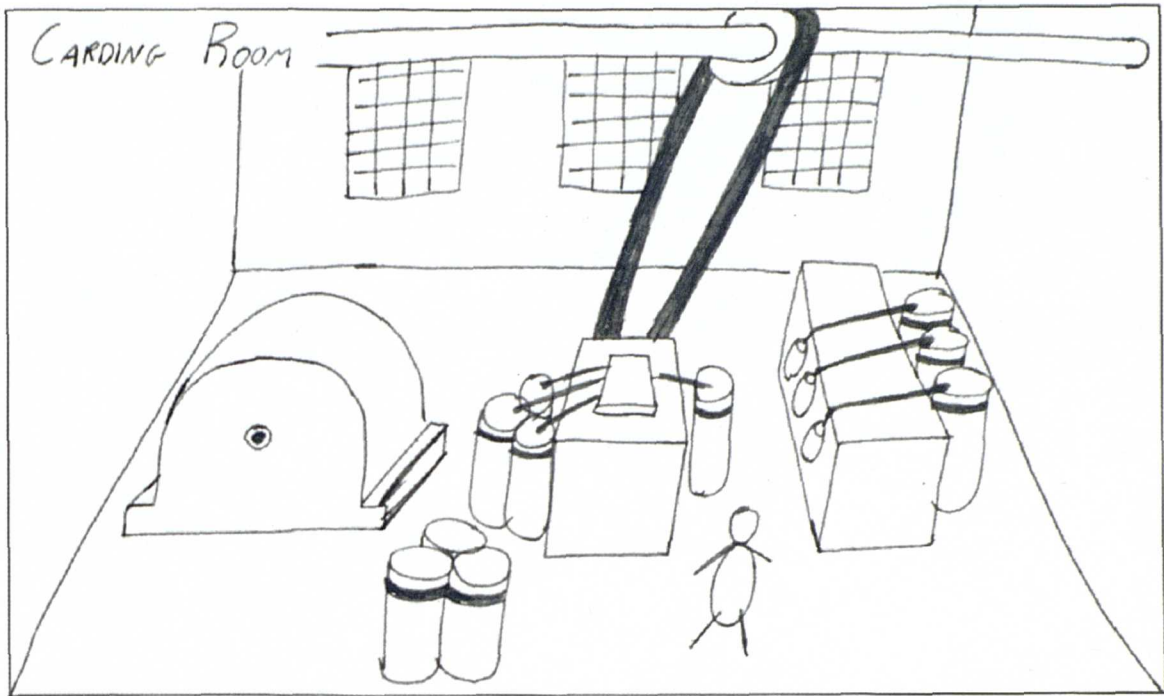
(Figure 3.10 : Cotton Field To The Mill – Actual Screen)



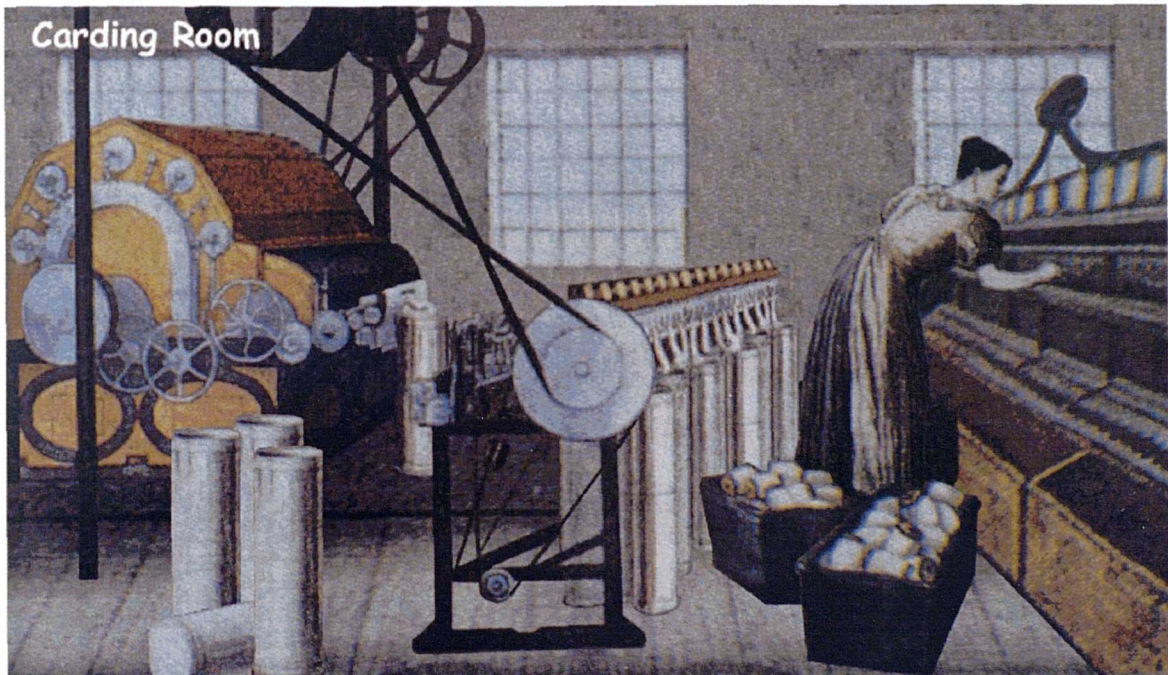
(Figure 3.11 : Blowing Room - Storyboard)



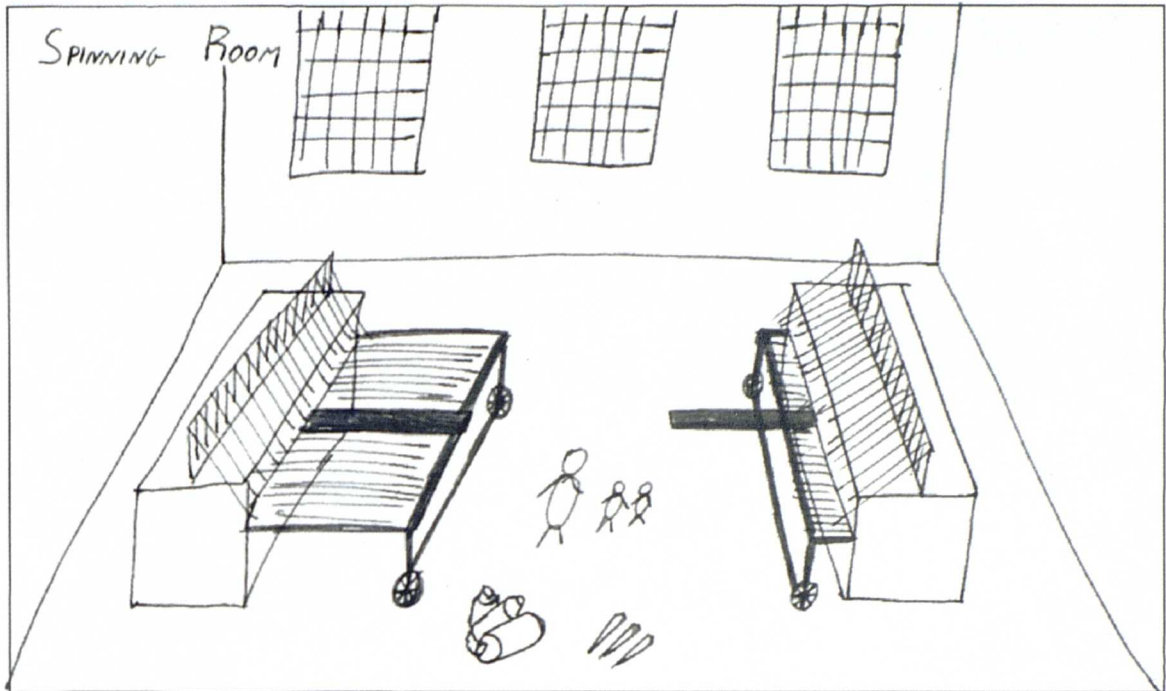
(Figure 3.12 : Blowing Room – Actual Screen)



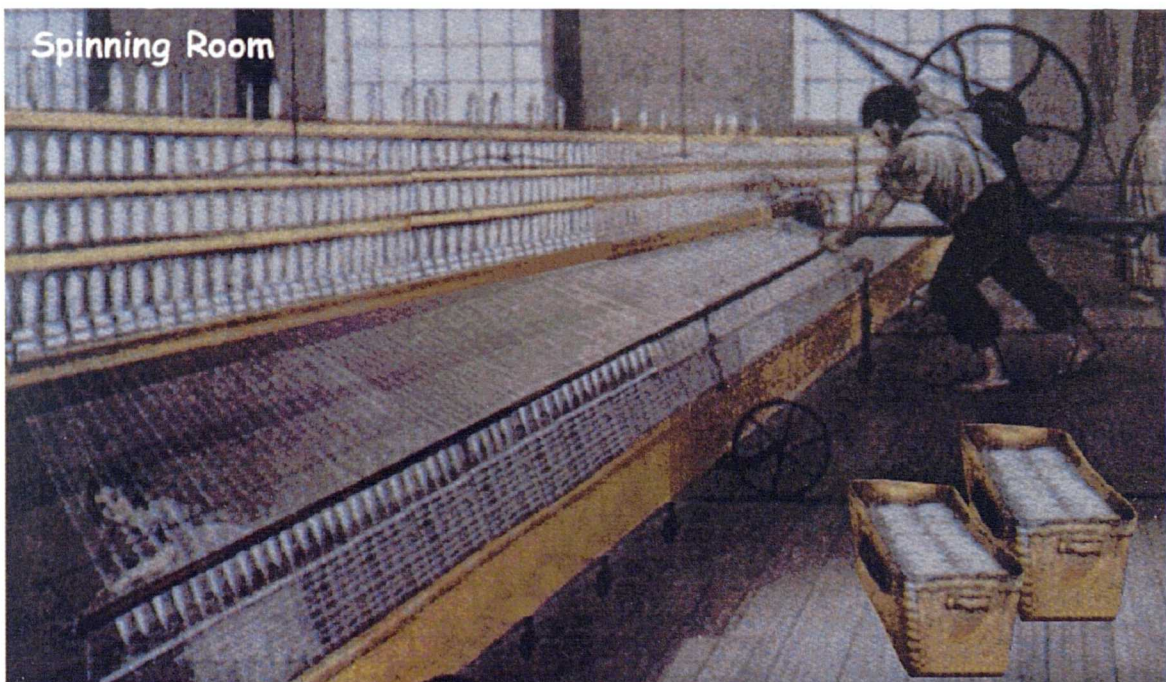
(Figure 3.13 : Carding Room - Storyboard)



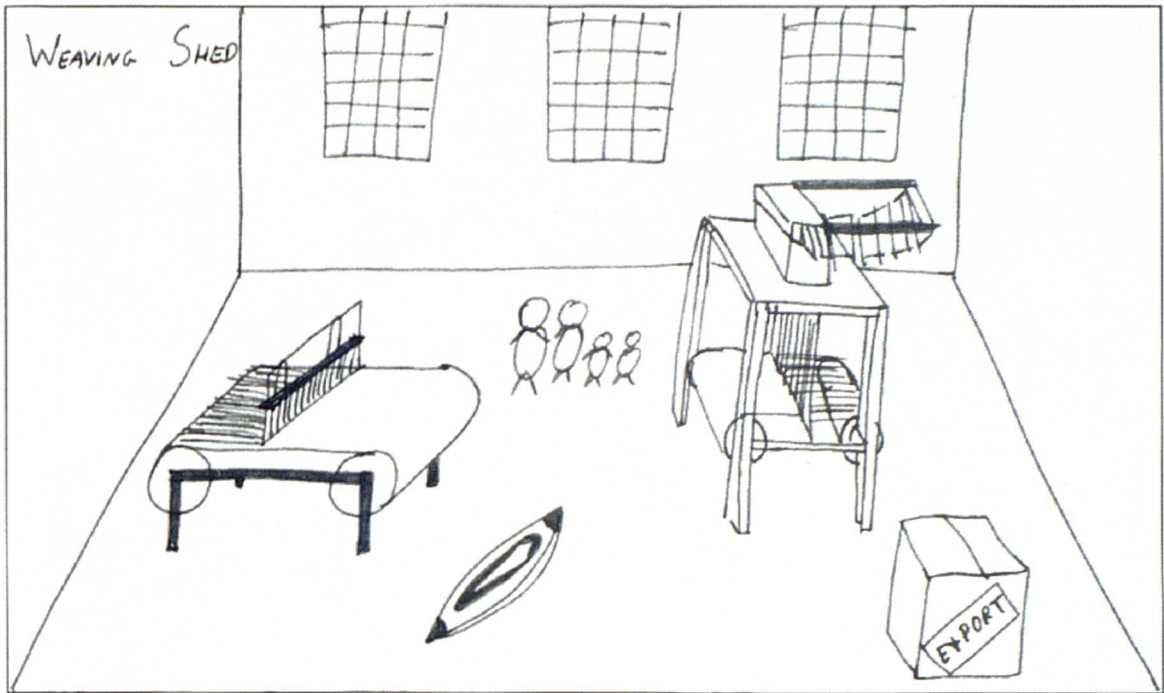
(Figure 3.14 : Carding Room – Actual Screen)



(Figure 3.15 : Spinning Room - Storyboard)



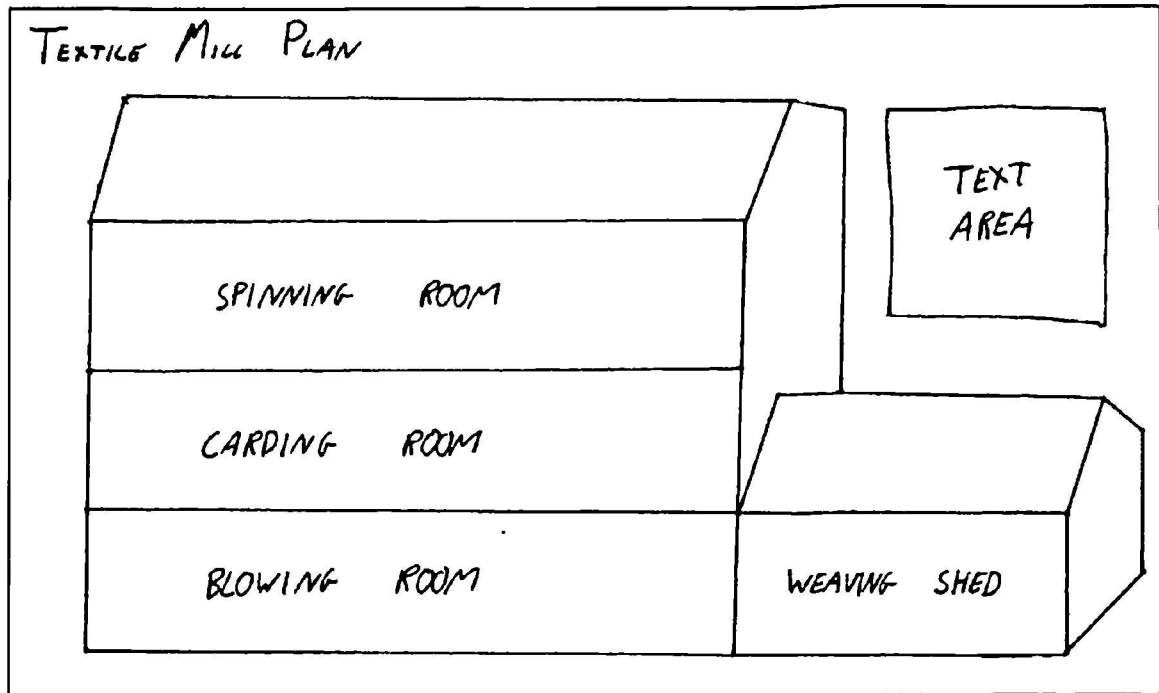
(Figure 3.16 : Spinning Room – Actual Screen)



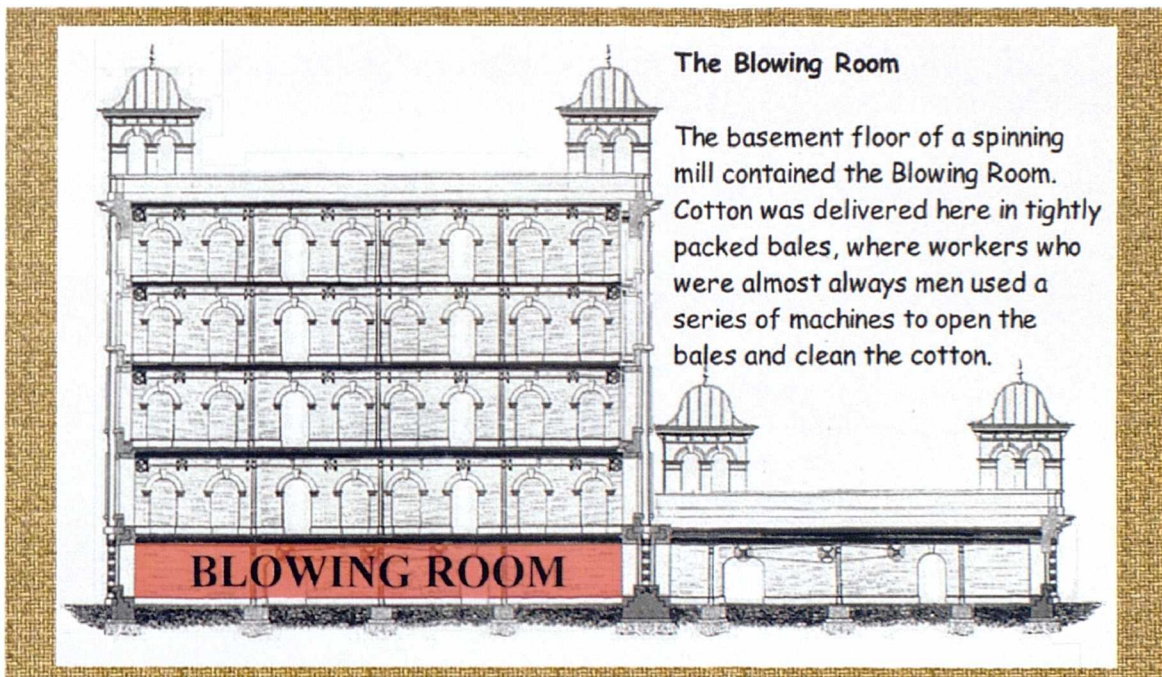
(Figure 3.17 : Weaving Shed - Storyboard)



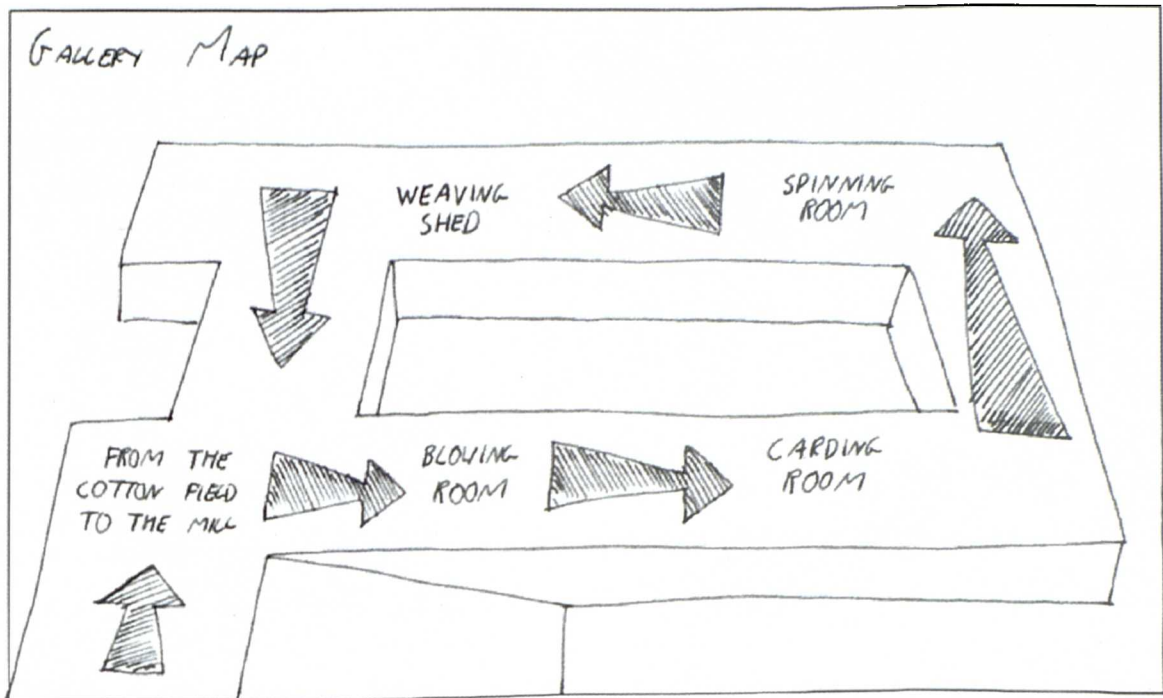
(Figure 3.18 : Weaving Shed – Actual Screen)



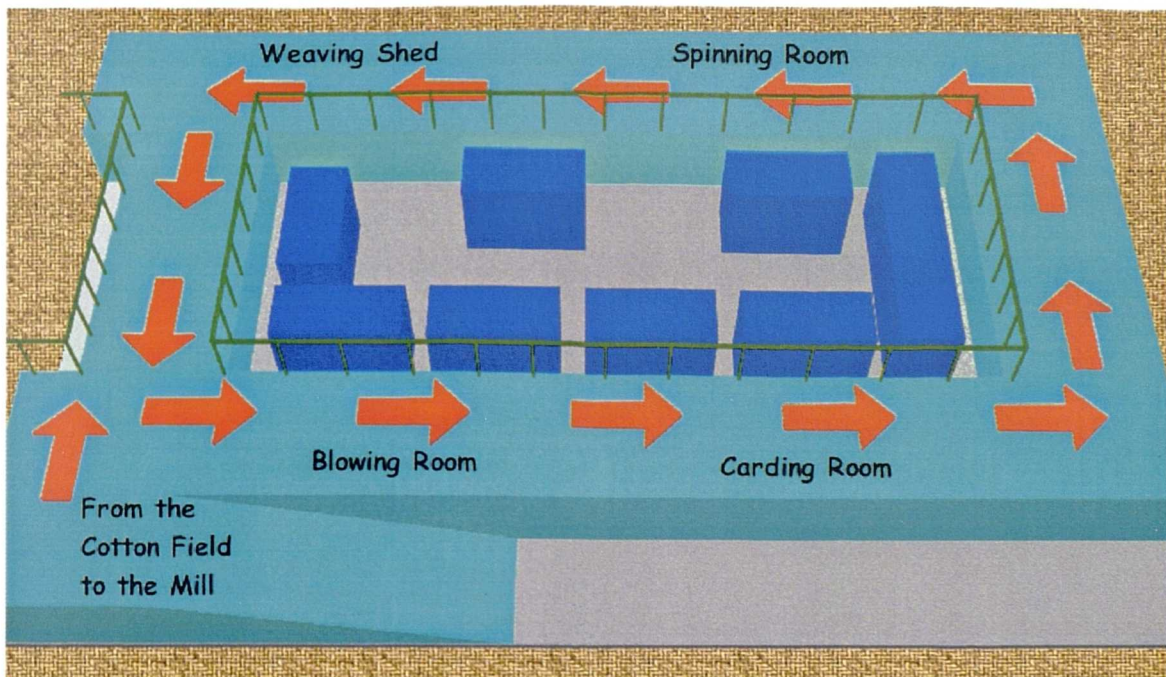
(Figure 3.19 : Textile Mill Plan - Storyboard)



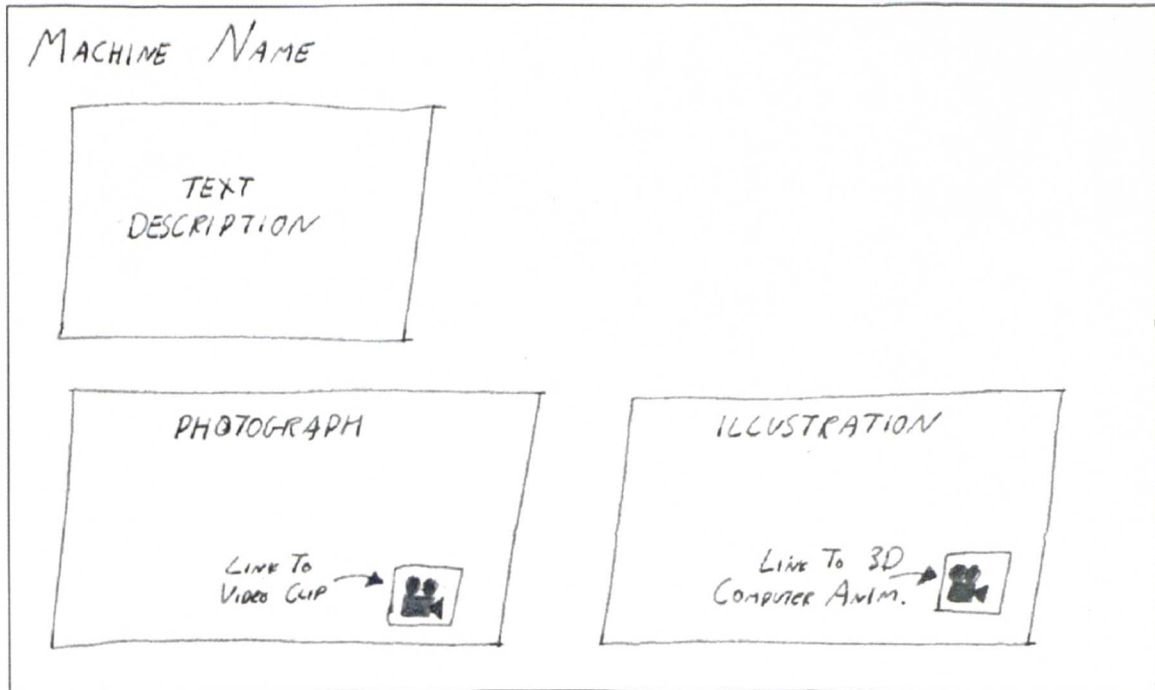
(Figure 3.20 : Textile Mill Plan – Actual Screen)



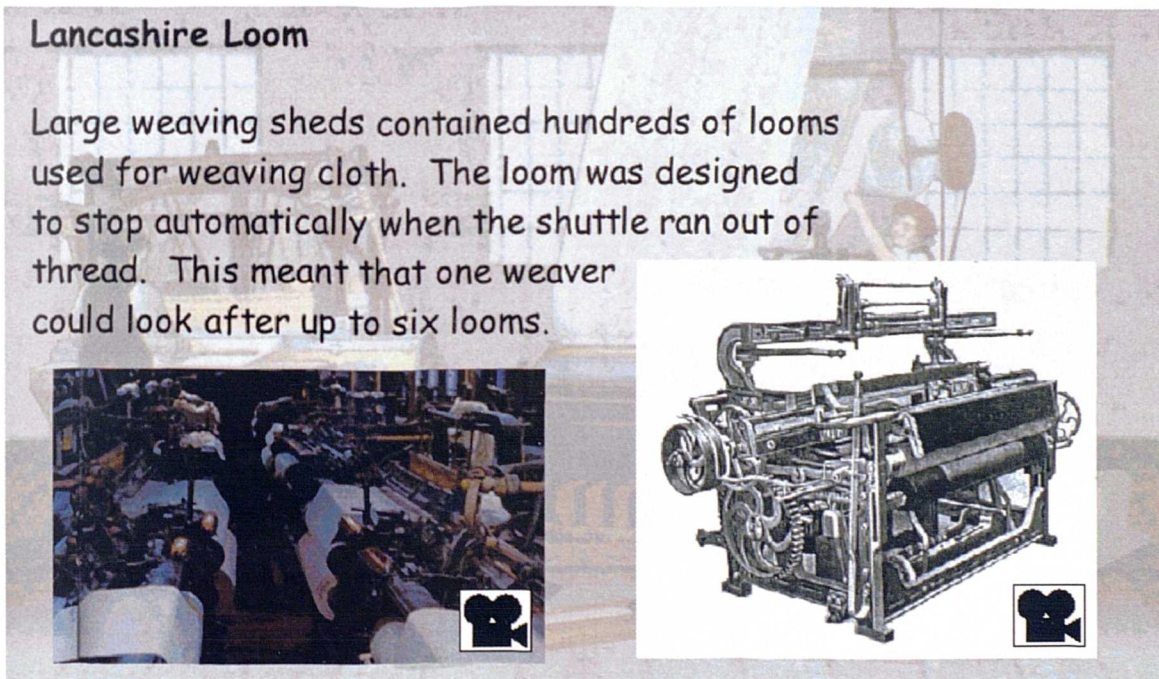
(Figure 3.21 : Gallery Map - Storyboard)



(Figure 3.22 : Gallery Map – Actual Screen)



(Figure 3.23 : Generic Textile Machine Information Page - Storyboard)



(Figure 3.24 : Lancashire Loom Information Page – Actual Screen)

3.4 Media Acquisition and Creation

Following the completion of the flowcharts and storyboards a media content list was produced. This document lists each media element; text, graphic, sound effect, audio narration, video clip and computer generated which was required for each screen of the application. This aided the identification of those media elements that could be acquired from the museum and those elements that would have to be created from scratch. A complete copy of the media content list can be found in Appendix B.

The majority of text used in the computer application was taken directly from the existing text panels in the gallery, with additional text written by Nick Dixon the gallery curator. This was done primarily to ensure that the text provided for visitors using the computer was as similar as possible to that already in the gallery. Secondly it would speed up the development process. If new text was used within the application it would have had to be reviewed by the museum management before it could be used with members of the public.

All illustrations and black and white photographs were scanned from books and journals held within the archive and reference library at the museum with copyright permission being given. A number of images already identified as being suitable were unavailable due to external copyright restrictions and additional images had to be located. The colour photographs used within the computer application were derived from the museums archive collection, or taken in the gallery specifically for the application, with several additional photographs provided with the kind permission of Quarry Bank Mill, a local working textile museum.

Video footage used within the computer application in the main was provided by the Museum of Science and Industry in Manchester. This footage had originally been commissioned as part of the collections digitisation project and was also to be used for a training CD-ROM to be produced in the future. Additional video footage was shot in the gallery by the researcher using a video camera before being transferred and edited on computer using Adobe Premier.

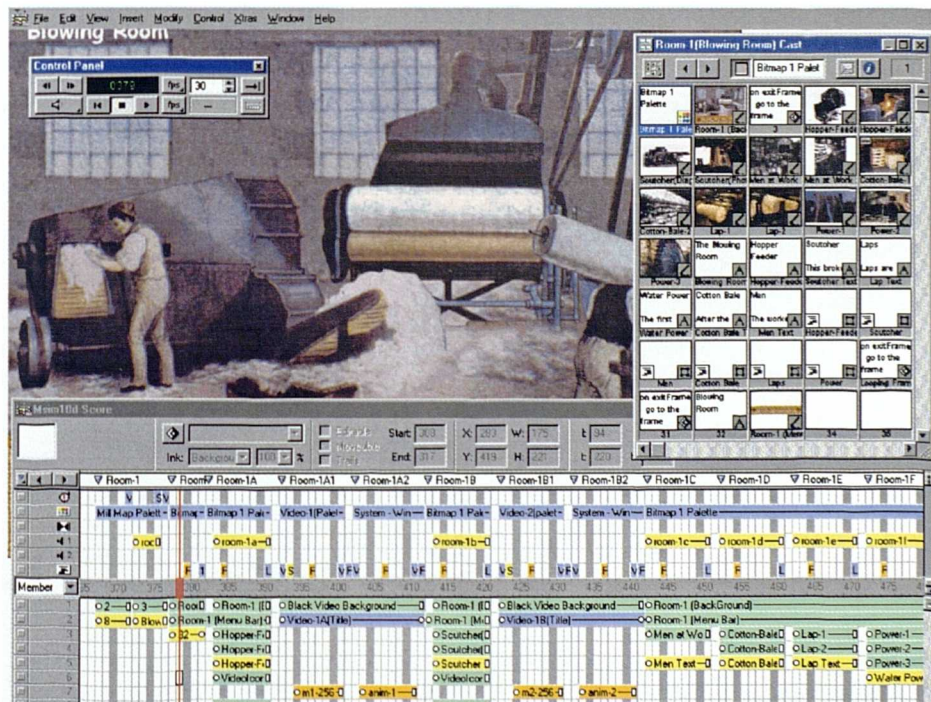
Computer generated animations were produced using Kinetix 3D Studio Max, (a 3D modelling and animation package) based upon detailed discussions with the museum demonstrators. A number of meetings and fact finding consultations were held by the

researcher with the demonstrators to enable full understanding of the workings of the textile machines. It was crucial that the multimedia application detailed the working textile machines accurately. Animations were designed to show close-up or internal workings of the textile machines chiefly to aid the visitor in understanding the process which each textile machines performed.

In keeping with the visual textile style of the application real buttons and fabric were scanned to produce the image of buttons and background texture used. Additional graphics such as the video icons were created using Adobe Photoshop.

3.5 Authoring

Initially the main structure of the multimedia application was developed, including each room and sub-section, and the media elements were inserted, as they were acquired or created. As each element was inserted it was crossed off the media content list ensuring that a current list of media elements outstanding was always available. Figure 3.25 below shows the Macromedia Director authoring tool during the development of the interactive. This is a complex software package enabling the creation of interactive multimedia applications for CD-ROMs, WWW Sites and Touch Screen Kiosks.



(Figure 3.25 : Macromedia Director authoring environment)

3.6 Interaction Logs

As outlined in the application brief the interactive multimedia application was developed with the facility to track and record the interactions of the visitor as they were using the portable computer in the gallery. Each screen of the application was given a four digit alpha-numeric code which would uniquely identify it. For example INST for instructions; GMAP for gallery map; R100 for the Blowing Room and R1B2 for the 3D Computer animation of the Scutcher.

When the application was initialised it created a text file on the hard disk of the computer, with the current date and time as the file name. When the user entered a new screen, a four-digit code and the current time were added to the text file. The format of the text file was designed so that it could be imported directly into an Excel Spreadsheet for analysis. By subtracting the time a user entered a new screen from the time they entered the current screen, the time when each screen was visible could be calculated. There is no guarantee that the visitor was looking at the screen for the whole time, but the calculated duration provides an indication of the visitors interaction with the portable computer and interactive multimedia application.

An example of a text file produced is shown below;

```
INST 10:07:28 R100 10:10:19 R1A0 10:11:48 R1A1 10:12:33 R1A0 10:12:54 ...
```

(Figure 3.26 : Sample Interaction Log)

The above example shows that the user spent 2min 51secs with the instructions (INST) screen visible, they then spent 1min 29secs with the blowing room (R100) screen visible, before spending 45secs with the Hopper Feeder (R1A0) screen visible, after which they spent 21secs with the video of the Hopper Feeder working (R1A1) visible.

The computerised observation schedule as discussed in section 4.4 was developed in the same way although the four-digit codes referred to behaviours rather than screens and the additions to the text file were made as the observer touched buttons on the screen rather than entering different screens of the application.

3.7 Formative Evaluation

Formative evaluation is crucial to the development of interactive exhibits, and is used to assess if an exhibit in prototype form functions as desired and to identify potential areas for improvement. The development of an interactive multimedia application is an iterative process, where typically several prototypes are developed and revised in light of previous findings. (Broadbent and Marti 1997) A prototype cannot reveal every aspect about the way the final exhibit will function in the gallery under real world conditions. However those exhibits which have undergone some form of formative evaluation during their development will generally function more effectively than those which have not. (Bicknell 1994, Economou 1998, Hayward and Loomis 1993, Lockett, Boyer-Tario and Emonson 1989) Economou describes the formative evaluation she conducted during the development of an interactive multimedia kiosk at the Ashmolean Museum in Oxford, United Kingdom. “Formative evaluation was carried out throughout the design of the prototype. This was organised in a number of ways with different users ... information collected from various formative sessions, led to changes and readjustments in the structure of the program, the language used, navigation and generally in the design of the user interface.” (Economou 1996) Her research also revealed that “even testing an unfinished prototype with small groups suggested useful changes before it was too late and provided ideas.” (Economou 1998)

During the development of the interactive multimedia application formative evaluation was carried out throughout the design and development and tested both by experts in the field and different user groups.

These can be organised into four main groups:

- Museum Visitors
- Museum Staff
- Multimedia Developers at the University of Salford
- Professional Experts in the Field

During the early stages of development, the application was reviewed at various stages by experienced interactive multimedia developers at the University of Salford in order to obtain constructive feedback on the initial structure, design and presentation of the

application. Adjustments and changes were made where these were considered appropriate. During August 1998 the application was shown to Damien Markey, Louisa Yong and Stuart Birchall all experienced interactive multimedia developers. The initial feedback was positive, with some minor improvements suggested such as adding audio and/or visual feedback when users touched a button or hotspot and enhancements to the visual presentation of the application, and these were implemented.

A review was made at this stage to match the aims and objectives of the project against the development of the interactive multimedia application to date. It is important to continually refer to the aims of the project so that a clear outcome results.

During this design and development stage of the interactive multimedia application a number of leading experts in the field of interactive multimedia design, development and research were asked to review the application. These included Professor James Powell (GEMISIS Director), Professor Bob Wood (GEMISIS Academic Co-ordinator), Simon Robertshaw (Course Leader M.A. Creative Technology) and David Bird (Lecturer Information Technology Institute and Director of a commercial interactive multimedia company). Each expert offered constructive criticism and suggestions for potential improvements and revisions. All advice was welcomed and acted upon. The overall opinion was that the interactive multimedia application had been well designed and created with excellent presentation and innovative interface, which made the application easy to use.

During 6th January 1999 the portable computer and interactive multimedia application was demonstrated for the first time in the Fibres, Fabrics and Fashions gallery to Nick Dixon (Gallery Curator) and Tudor Gwynn (Interactives Designer). Feedback and commentary was very positive with video clips and computer animations of the textile machines making a strong impression. The only concern was the rather cumbersome straps to support the portable computer and cables connecting the pen and headphones. Modifications were made to the case containing the portable computer so that the majority of the cables were routed inside the case and out of sight of the visitors. The in-house team at this stage were excited about the development and potential use of a portable computer and interactive multimedia application to enhance interpretation not only in the textile gallery, but throughout the museum.

Usability testing with visitors to the museum who are the target audience is most important during the development phase. (Raphling 1994, Lindgaard 1994, Lopuck 1996, Economou 1995) A usability test was conducted in January 1999 within the Fibres, Fabrics and Fashion gallery with a working prototype and portable computer. The test started when the museum opened and continued until ten visitors had used the portable computer and prototype application. Although the number of visitors in the usability test was small it was sufficient to obtain constructive feedback. Other research has found this to be a suitable number of visitors when conducting usability tests. (McMamara 1989, Miles 1994, Raphling 1994, Screven 1989)

After using the portable computer and interactive multimedia application visitors were asked a number of questions to establish if they could hear the narration clearly, if they could read the text on the screen and if the instructions were clear and easily understood. They were also asked a number of related questions, such as if they felt they were able to make selection on the screen accurately using the pen, if they could identify hotspots (textile machines, people and objects) and if they were able to determine their location within the gallery using both the text panels and the on screen gallery map. It was important that these questions were asked, in order to assess and refine the usability of the portable computer and interactive multimedia application with museum visitors.

The usability test revealed that all visitors responded positively to all of these questions with the exception of one visitor who had forgotten her spectacles and was unable to read the on-screen text. Additional feedback was also positive with visitors indicating that the computer was easy to use, made them take more notice of the information and was a good addition to the gallery. The only suggestion made for possible improvements was to revise the "HELP" section so that visitors could return to the main application without having to complete the entire "HELP" section first.

Formative evaluation with multimedia developers, museum staff and museum visitors therefore revealed that the structure and design of the application was easy to use and addressed the design brief. All advice for possible revisions from each group were evaluated, and changes made as appropriate. Thus the prototype was complete and ready for testing and evaluation with members of the public during the main evaluation study.

This chapter has reviewed the process of designing and developing the interactive multimedia application to be used with a portable computer. The chapter began by examining the selection of a site, front-end analysis undertaken and the formation of the initial design brief. The chapter progressed to provide a review of interactive multimedia development including flowcharts and storyboards. This was followed by a review of the application design, media acquisition and content creation through to final authoring. The chapter concluded by discussing the interaction log recording facility and the formative evaluation conducted during the development.

The next chapter will review the evaluation study and visitor survey conducted to evaluate the use and effectiveness of the portable computer and interactive multimedia application on the museum visitor and as a new tool for interpreting museum collections.

Chapter 4

Visitor Evaluation Study

Chapter 4 Visitor Evaluation Study

This chapter provides a review of the visitor evaluation study conducted within the Fibres, Fabrics and Fashion gallery to assess the use and effectiveness of the portable computer and interactive multimedia application upon the museum visitor.

The chapter is divided into six main sections. The first section details the range of research methods and data collection techniques appropriate to the evaluation study. The second section reviews the research methodology framework, highlights the aims and objectives of the visitor evaluation study, and identifies the revisions made in light of a pilot study. The third section details the procedures for administering the questionnaire survey and provides a review of the survey, the sampling approach utilised and procedures for conducting the visitor evaluation study. The fourth section reviews the visitor observation survey and the use of a computerised observation schedule and a second portable computer. The fifth section provides a brief overview of the interaction logging facility incorporated into the interactive multimedia application to record visitor interactions whilst exploring the gallery with the portable. The final section provides a brief summary of the data entry procedures.

4.1 Research Methods Appropriate to the Evaluation Study

Evaluation studies typically collect evidence using a range of data collection techniques. This section reviews the range of techniques available, including questionnaire surveys, interviews, focus groups/panel surveys, observation, case studies and examines the benefits of a multi-method approach.

4.1.1 Questionnaire Surveys

Surveys using questionnaires are a widely used and effective way of obtaining large amounts of information relatively quickly and cheaply, however typically a large number of responses are required for the results to be representative of the population. (Bell 1993, Blaxter, Hughes and Tight 1996) The results of questionnaires are based upon individuals responses to questions, however it is sometimes difficult to tell if a person is telling the truth, as there is often a discrepancy between what people say, and what they actually think or do. (Moser and Kalton 1985, Veal 1992)

Questionnaires may be employed in two main ways, either independently by the respondent in the form of a postal questionnaire or a self-completion questionnaire in the gallery, or a questionnaire may be administered by a researcher, either in person or over the telephone. (Bell 1993, Blaxter, Hughes and Tight 1996, Czaja and Blair 1996) Each of these approaches to the use of questionnaires has associated strengths and weaknesses and the appropriate one must be selected taking into account the nature and aims of the research project.

Postal questionnaires are mailed to respondents typically with a covering letter explaining the purpose of the research and a self addressed, stamped envelope for the questionnaire to be returned in. A postal questionnaire can target a large number of individuals who may be geographically dispersed relatively quickly, however the main problem with postal questionnaires is a low response rate. (Bell 1993, Blaxter, Hughes and Tight 1996, Robson 1993) Additionally the researcher has no clear idea of who might have filled in the questionnaire, thus this method is open to a number of biases. (Czaja and Blair 1996, Heinecke 1995, Judd, Smith and Kidder 1991, Oppenheim 1992) The initial cost of postal questionnaires (printing and postage) is significantly lower than questionnaires administered by an interviewer, however the response rate may be so low that the actual cost per completed questionnaire may be higher than for those administered by interviewers. A postal questionnaire will not be subject to interviewer bias, however the low response rate may bias the results, as individuals with certain characteristics may not respond and are therefore under represented in the sample. (Czaja and Blair 1996)

Questionnaires administered in person by interviewers or researchers are more expensive and time consuming, particularly for a geographically spread study where the research must cover the interviewer's travel expenses as well as pay them for their time. However interviewers are able to explain the purpose of the research and generally achieve a much higher co-operation and completion rate than postal questionnaires. The use of skilled interviewers means that they can maintain control over the order in which questions are answered and responses can be supplemented by observations. (Bell 1993, Blaxter, Hughes and Tight 1996, Robson 1993) Apart from the expense, the main disadvantage of employing interviewers to administer questionnaires is that of interviewer bias. An interviewer may by their attitude or actions influence a respondent into making certain responses which they would otherwise not have made. (Bell 1993,

Binks and Uzzell 1996, Moser and Kalton 1985, Oppenheim 1992) However it is possible to minimise this bias by the careful training of interviewers, however this in itself adds additional costs. More often today, heritage attractions employ professional consultants to conduct surveys, such as the Susie Fisher Group, as they are familiar with all aspects of training and delivery.

Questionnaires completed without supervision are not completely reliable, as the researcher cannot control who completes the questionnaire and may receive incomplete responses where respondents have skipped a question they did not understand. (Czaja and Blair 1996, Heinecke 1995, Judd, Smith and Kidder 1991, Oppenheim 1992)

Questionnaires typically contain two types of questions, closed questions, where respondents can select from a list of possible answers, and open questions, where respondents are free to answer in their own words. Closed questions produce quantitative data, which is more easily and quickly analysed than the qualitative data produced by open questions. (Allan and Skinner 1991, Bell 1993, Slavin 1984) Open questions are often employed where the researcher cannot know the answers, or wants to obtain quotes, or at the pilot stage to elicit a range of responses which can then be formalised as possible responses to closed questions during the main phase of the research. (Allan and Skinner 1991, Bell 1993, Blaxter, Hughes and Tight 1996, Robson 1993) Questions should be simple, straight forward and unambiguous to ensure that everyone completing the questionnaire understands them. (Allan and Skinner 1991, Blaxter, Hughes and Tight 1996, Moser and Kalton 1985)

4.1.2 Interviews

Interviews are widely used technique for obtaining information, although they usually involve smaller numbers, are slower and more expensive to administer than questionnaires and to obtain the best results require highly skilled interviewers. Both interviews and questionnaires are based on individuals responses to questions and can contain both open and closed questions. There are three broad classifications of interviews, structured, semi-structured and unstructured. (Bell 1993, Miles et al 1998, Moser and Kalton 1985) A structured interview closely resembles a questionnaire containing only closed questions, which are administered by an interviewer, the interviewee being limited in their responses to predetermined categories. Sanders explained that for some “structured interviews were questionnaires based on a

predetermined and standardised or identical set of questions.” (Sanders et al 1997) An unstructured interview is composed completely of open questions, the interviewee is free to provide answers in their own words and in some cases control the direction of the interview. As its name suggests a semi-structured interview falls somewhere between the other two. The interviewer will have several key areas or questions, which they wish to discuss and will direct the interviewee to these areas, but will not constrain the conversation or answers they may provide. Typically the more structured an interview, the larger the number of people who can be interviewed, and the quicker the interview can be conducted and analysed. (Hooper-Greenhill 1996, Miles et al 1998, Moser and Kalton 1985, Robson 1993)

Interviews can be administered by interviewers, either in person or over the telephone. Using the telephone has the advantages of being quicker and cheaper than face to face interviews, with the geographical location of respondents having little effect upon the cost when compared to personal travel. However there are disadvantages associated with using the telephone, not everyone has a telephone, there is the cost of the call and the interviewer will be unable to use visual aids and it can be inappropriate for non-english speakers. (Czaja and Blair 1996, Judd, Smith and Kidder 1991)

Conducting interviews in person has the advantage of being able to use visual aids and a higher response rate than telephone, although both have a much higher response rate than postal questionnaires. The disadvantage of conducting interviews in person is the expense, at least double that of telephone interviews, when both travelling and interviewing time are accounted for. (Blaxter, Hughes and Tight 1996, Czaja and Blair 1996, Judd, Smith and Kidder 1991, Oppenheim 1992)

There is also the problem of interviewer bias and possibility of interviewees to provide socially or politically acceptable answers, which may not represent their personal views or opinions, (Czaja and Blair 1996, Judd, Smith and Kidder 1991, Moser and Kalton 1985, Oppenheim 1992) however this does not apply to a study of this nature.

4.1.3 Focus Groups and Panel Surveys

Focus groups, which are also referred to as group interviews are frequently used in commercial and political research to measure consumers or voters attitudes towards products, promotions, candidates or policies, and are also being used increasingly as

evaluation tools within the heritage industry. (Anderson 1995, Fisher 1996, Miles 1994, Veal 1992)

Focus groups are detailed discussions of a particular issue or set of issues, which are held with a small group of individuals typically about ten, who are selected to be representative of the audience or a segment of the audience. Several focus groups each representative of a different segment are frequently combined to provide a more complete picture of the views and opinions of the audience as a whole. These group interviews typically take place in a separate room away from the gallery and last for a couple of hours. The sessions are usually facilitated by an interviewer, however the sessions are normally unstructured providing an open forum for discussion, with individuals able to express, discuss and debate ideas and opinions. The interviewer will guide the discussion and the participants towards predetermined topics for discussion, and must also ensure that everyone has the opportunity to contribute and that a single individual does not dominate the discussion. (Economou 1998, Fisher 1996, Miles 1994, Veal 1992)

Focus groups are suited to the collection of qualitative data, with the sessions typically being recorded for later analysis. However the task of analysing the qualitative data generated during each session should not be underestimated. (Miles 1994, Veal 1992)

Panel surveys have many similarities with focus groups, with the addition that participants meet on several occasions, and may receive a small financial reward for their participation. By collecting data from the same group or groups of individuals on several occasions, researchers can study trends and attitudes over time, and extrapolate cause and effect relationships. (Fisher 1996, Robson 1993, Moser and Kalton 1985)

Conducting a panel survey can be resource intensive, particularly where a number of groups are surveyed several times over an extended time frame. Therefore panel surveys are frequently beyond the reach and resources of small-scale surveys. However by surveying the same group or groups of individuals at several time intervals, a greater level of precision and accuracy is possible, than would be the case with a series of independent surveys at the same intervals. This approach also enables the identification of individual changes of opinion, preference or attitude with the group, rather than solely the net result. (Moser and Kalton 1985, Robson 1993)

A key problem identified with panel surveys is that of securing panel members. Most individuals will consent to answer a few questions on a single occasion but most are unwilling to commit to multiple sessions over an extended period of time. The second problem is the drop out of individuals from the samples. (Fisher 1996, Moser and Kalton 1985) Non-response is a problem encountered with many data collection techniques, particularly postal questionnaires, (Czaja and Blair 1996, Oppenheim 1992, Robson 1993) however the nature of panel surveys means that non-response is more crucial to the representatives of the population or audience. (Fisher 1996, Moser and Kalton 1985)

4.1.4 Observation

Observation is the most direct data collection technique, and involves the watching, recording and analysis of events and can reveal insights into the behaviour of groups or individuals that would otherwise be difficult or impossible to discover. Observation is a powerful investigative approach, which has a vital role to play in most research and complements other data collection techniques. (Diamond 1986, Hooper-Greenhill 1996, Lindgaard 1994, Miles et al 1998)

There are two main types of observation, structured and unstructured. Structured observation is a systematic way of recording behaviours and tracking movement, which typically utilises a recording instrument. On the other hand unstructured observation, which encompasses participant observation and ethnographic research is undertaken by the researcher who witnesses events and then records them at a later date. (Bell 1993, Blaxter, Hughes and Tight 1996)

Conducting observations can be expensive, requires skilled observers and can be time consuming, both for observation and analysis. The research instrument employed in structured observation is called an observation schedule, typically a checklist or coding system, which assists the observer in recording the frequency and or duration of behaviours or events. An observation schedule simplifies the recording process, reducing the amount of time required to record and analyse observations. However the use of an observation schedule may reduce the detail and flexibility of this data collection technique. (Heinecke 1995, Hilke 1988, Kellehear 1993, Slavin 1984)

There are two disadvantages to the use of observation as a data collection technique. The observer must be impartial and consistent throughout the observations, otherwise the results may be biased. Secondly the presence of an observer may cause a change in the behaviour of the subject. Therefore the observer should attempt to be as unobtrusive as possible, however the impact of the observer has been shown to wear off over time. When undertaking observation the researcher must also be aware of the ethical issues relating to this technique. (Bull 1994, Kellehear 1993, Lindgaard 1994, Robson 1993)

4.1.5 Case Study Research

Case study research is a flexible and focused methodology, which adopts a holistic approach and is typically employed to elicit detailed information and gain a deep understanding of events from a single case or small number of cases. Employing a single case study may be problematic, as the data generated may be unique to that individual case.

A feature of case study research is the triangulation of multiple data collection techniques, which can reveal insights which a single method would be unable to reveal, facilitates the cross-checking of results and enables the researcher to form a more accurate and conclusive picture of events. (Borun 1996, Fisher 1996, Jacobson 1991, Yin 1993)

Some evaluation studies are conducted using several case studies, combining and comparing the results from each. However in the context of this research project it was not feasible to use multiple cases studies due to the unique nature of the interactive multimedia applications which had specifically been designed and developed only for use within the Fibres, Fabrics and Fashion gallery. (Economou 1997a, Hayward and Loomis 1993, Thomas 1993) Therefore a single case study was clearly appropriate, and would provide an in-depth understanding of the use and effectiveness of a portable computer and interactive multimedia application within a specific museum gallery. However this would mean that the results cannot be directly generalised for all other cases. (Falk 1983, Robson 1993)

4.1.6 Data Collection Techniques

It has been recognised that a combination of data collection techniques using both qualitative and quantitative data can be advantageous, can reveal more insights and can allow results to be cross checked. (Kellehear 1993 Robson 1993, Yin 1993)

This is especially true for projects, which involve interactive multimedia, as Economou explains:

“There is no unique, perfect way to evaluate multimedia interactives. Ideally, a combination of different methods should be used to measure the effectiveness of the application at various levels, relating quantitative with qualitative results.” (Economou 1996)

The combination of multiple research methods to evaluate the use and effectiveness of the portable computer and interactive multimedia application with museum visitors, and as a tool to interpret museum collections, was clearly appropriate to this research project.

4.2 Research Methodology Framework

This section provides an overview of the aims and objectives of the visitor evaluation study, describes the selection of a case study approach utilising a single case, and reviews the development of a pre-visit and post-visit research framework. The revisions to the research methods and data collection techniques made following the completion of the pilot survey are discussed.

4.2.1 Aims and Objectives of the Visitor Evaluation Study

The central aim of the visitor evaluation study was to evaluate the use and effectiveness of the portable computer and interactive multimedia application with museum visitors. The objective of the study was to provide insights into the ways in which visitors interacted with this innovative aid to interpretation. (Economou 1997b, Lindgaard 1994, Nebenzahl 1993, Raphling 1994) The hypothesis was that a portable computer and interactive multimedia application has the potential to enhance interpretation and to become a new tool for interpreting museum collections.

It was the intention that the visitor study would enable the researcher:

- To draw a profile of visitors who participated in the survey
- To assess the effect of the portable computer and interactive multimedia application on visitor knowledge and understanding
- To assess the effect of the portable computer and interactive multimedia application on visitor behaviour
- To assess visitor opinion of the gallery
- To assess visitor opinion of the portable computer and interactive multimedia application
- To assess visitor use of and interaction with the portable computer and interactive multimedia application

The Museum of Science and Industry in Manchester as a test bed site for the study was an ideal location and an appropriate case study.

4.2.2 Pre-Visit and Post-Visit Surveys

Both a pre-visit and post-visit survey were necessary in order to compare and contrast visitors knowledge of textile machines and the cotton process, before and after their visit, and to evaluate the use and effectiveness of the portable computer and interactive multimedia application. A pre-visit survey is a recognised and appropriate research method used to elicit existing knowledge and opinions from visitors, (Alt 1980, Jones and Ott 1983, Koran et al 1996, Serrell 1996b) although this approach may impinge on visitors experience of the museum and raises ethical questions.

There are two potential problems associated with this approach. Firstly the pre-visit survey may sensitise visitors, making them aware of what is being assessed and as a result they may alter their behaviour, because they are expecting to be questioned again as they leave the gallery. Secondly a change in knowledge or understanding cannot be attributed solely to the portable computer and interactive multimedia application, if the changes which would have taken place normally within the gallery have not been assessed. (Badman 1994, Miles et al 1998, Oppenheim 1992, Slavin 1984)

These drawbacks may be overcome by employing a second group, typically referred to as a control group. The control group receives the same pre-visit and post-visit assessments, but are not invited to use the portable computer and interactive multimedia application. The control group acts as a benchmark for understanding what is a typical

visitor experience. As the control group and the computer group receive the same pre-visit survey they may both be sensitised to the purpose of the survey, however the effect should be equivalent for both groups and negligible in the net result. (Hilke 1996, Javlekar 1989, Moser and Kalton 1985, Oppenheim 1992) Although a pre-visit test may sensitise visitors, the results can be weighted during analysis to take account of any differences between the groups. (Veal 1992)

An alternative strategy employing a control group, a computer group and an additional benchmarking group was also considered. The benchmarking group would receive only the pre-visit survey, and based upon the results produce a benchmark of prior knowledge for all visitors who participate in the study. The control and computer groups would then only receive the post-visit survey, thus removing the pre-visit sensitisation effect. This approach utilising three groups was discounted, because this approach is only applicable where each of the three groups are equal, which would be difficult to ensure under real world conditions, and as it would have extended the duration of the visitor study by at least half. (Badman 1994, Koran et al 1996, Pekarik et al 1996, Slavin 1984)

A long-term retention test also was considered which would have attempted to assess how the portable computer and interactive multimedia application affected visitor's long-term understanding and recall of information about the exhibits. (Dierking 1996b, Koran et al 1996, Laetsch 1980, Oppenheim 1992) This approach was also discounted, as it was felt that asking visitors for contact details may have reduced their willingness to participate in the study and this would clearly have increased the duration of the research. The number of long-term responses received from visitors may also have been limited, thus diminishing the contribution of this element of the research and possibly introducing additional biases.

As the objective of this study was to provide an insight into the use and effectiveness of a portable computer and interactive multimedia application with museum visitors, a single case study combining a pre-visit and post-visit model and utilising a computer group and control group was considered appropriate.

It was clear that to evaluate the use and effectiveness of the portable computer and interactive multimedia application on the museum visitor and to fulfil the aims of the

evaluation study, a multi-method approach combining a range of data collection techniques would be both appropriate and necessary. A number of data collection techniques were appropriate for this, including questionnaires, interviews and focus groups.

Questionnaires were selected as being the most appropriate technique for the collection of information regarding the profile of visitors, their opinions on the use and effectiveness of the portable computer and interactive multimedia application, and their knowledge of the textile machines and the processes they performed, before and after their visit to the gallery. The development of the questionnaire and the specific questions contained within it are discussed in section 4.3. Questionnaires are a widely used and effective way of obtaining large amounts of information quickly and relatively cheaply based upon visitor's responses to questions. (Binks and Uzzell 1996, Miles et al 1998, Serrell 1996b)

Interviews were also considered as a data collection technique, but were discounted because when compared to questionnaires they would have taken significantly longer to administer and analyse, and to obtain the optimum results an experienced and skilled interviewer is required. As the researcher did not possess the appropriate skills to undertake the interviews himself, or the funding to employ a professional interviewer, interviewing was thus discounted. (Binks and Uzzell 1994) It was felt that future research projects could add this technique to broaden and enrich data from this emerging and highly innovative area of interactive museum interpretation. Also there were a number of other appropriate methods that would enrich the research findings

To examine visitor behaviour as they explored the textile gallery, observation techniques could be performed between the pre-visit and post-visit surveys. Observation was selected as the most appropriate method for the recording of visitor behaviours. The use of observation and the development of a computerised observation schedule are discussed in detail in section 4.4. Observation is a direct measure of behaviours, which involves the watching, recording and analysis of events of behaviours. Observation has a vital role to play in most research projects, it complements other data collection techniques, enables the cross checking of results and can reveal insights into the characteristics of groups or individual that otherwise would

be impossible to discover. (Bell 1993, Blaxter, Hughes and Tight 1996, Robson 1993, Veal 1992)

To examine visitor interaction with the portable computer and interactive multimedia application the researcher could have followed them around the gallery and looked over their shoulder and observed their interactions. However these observations would have been difficult to record and the presence of the observer would certainly have affected the visitors behaviour. Other research projects evaluating interactive multimedia exhibits have found that incorporating the facility to record visitors interactions into the application can produce valuable research data, in the form of an interaction log. (Economou 1998, Heinecke 1995, Lindgaard 1994, Nebenzahl 1993) The technique of using interaction logs was selected as being the most appropriate method of assessing visitor interaction with the portable computer and incorporated into the interactive multimedia application during its development. The implementation of the interaction log facility is discussed in section 3.6 and section 4.5.

The following section reviews the pilot survey and the refining of the research methods and individual data collection techniques based upon the findings of this initial survey.

4.2.3 Piloting the Survey

Pilot tests provide the opportunity for the researcher to test the research methods and check that they operate as intended, to detect possible flaws and to gain critical feedback to assist in refining the research methods. Conducting a pilot test can be time consuming and expensive, however not conducting a pilot test could be more costly in the long term, if it is discovered at a later date that there was a design flaw with one of the research methods. (Czaja and Blair 1996, Lindgaard 1994, Moser and Kalton 1985, Slavin 1984)

A pilot study with 10 visitors was conducted, with 5 visitors from a control group on the 14th January 1999 and 5 visitors using the portable computer on the 15th January 1999. Other studies have shown this to be an appropriate number of visitors for initial pilots of small scale surveys. (Blud 1996, McNamara 1989, Milles 1994, Ralphling 1994) Ralphling explains that "... the evaluator can give initial feedback ... with a small, cued sample (10 or fewer, depending on the proposed target audience." (Ralphling 1994)

The pilot test identified that some of the questions posed to visitors in the computer group required simplification.

Following the completion of the pilot test it was decided to add an additional question for those visitors who had used the portable computer and interactive multimedia application, asking if they thought they had learned more about the cotton process using the portable computer and interactive multimedia application than they would otherwise have done.

The pilot test was also used to develop codified answer categories for the questionnaires, to be used solely by the researcher. These assisted the researcher in recording the visitors answers, speeding up the pre-visit and post-visit questionnaires and because of their highly codified nature, simplified the data entry phase significantly. (Allan and Skinner 1991, Blaxter, Hughes and Tight 1996, Miles 1982, Moser and Kalton 1985)

The original intention was to observe the behaviour of visitors, whilst simultaneously recording which area of the gallery they were within. However during the pilot test it was discovered that this was impractical, even with the assistance of the computerised observation schedule. Therefore this function was removed, although the facility to record when a visitor left and returned to the area of the gallery which contained the textile machines was retained. Following the pilot test the position and labelling of some buttons was revised to enhance recognition thus improving the speed and efficiency with which the computerised observation schedule could be utilised by the researcher.

The pilot test also provided the opportunity to practice survey procedures and timing, and confirmed that starting at 10am each morning and surveying 5 visitors each day was an appropriate sample within time limitations.

Following the pilot test it was felt that at this stage the visitor survey procedures were working effectively, the research methods were appropriate to the study, and that a second pilot test was unnecessary. However if revisions have been made following a pilot test then it is advisable to re-pilot the revised research methods to ensure that they now work as expected. (Jacobson 1991, Oppenheim 1992) In light of this the decision

was made to use the first days of the visitor study as a second pilot, if after the first day for each group it was identified that further revisions were required, then those would be made before rescheduling the visitors study. However it was found that no further revisions were required, so the visitor evaluation study continued as scheduled.

4.3 Visitor Questionnaire Survey

This section provides a review of the visitor questionnaire survey, the decision to administer the questionnaires in person, the sample selection and the approach with which the survey was conducted.

4.3.1 Administering the Questionnaire Survey

Interviewer administered questionnaires were used at the pre-visit stage to establish the visitors gender, age, expectations of the gallery and prior knowledge of the textile machines and cotton process. Questionnaires were also used during the post-visit survey to compare and contrast changes in visitor knowledge of the exhibits and opinion of the gallery. Questionnaires were also used for the computer group to elicit additional information on their views on the use of the portable computer and interactive multimedia application.

The interviewer (the researcher) administered the questionnaires in order to explain the purpose of the research, to achieve an improved co-operation rate, and to ensure completion of all questions, in the correct order. This would not have been the case had the questionnaires been completed independently by the visitors themselves. (Bell 1993, Blaxter, Hughes and Tight 1996, Heinecke 1995) As the questionnaires are administered in person the interviewer could also supplement visitors responses with additional observations. (Blaxter, Hughes and Tight 1996, Czaja and Blair 1996, Judd, Smith and Kidder 1991)

The main disadvantage of interviewer administered questionnaires is the possibility that the interviewer may influence the responses made by interviewees and thus bias the results. (Bell 1993, Czaja and Blair 1996, Judd, Smith and Kidder 1991) This was identified as a potential source of bias in this project as the researcher had designed the application and was also conducting the visitor evaluation study. However this was also advantageous as the researcher was very familiar with the visitor evaluation study procedures, research methods, the portable computer and interactive multimedia

application, and could make observations which were appropriate to the study. (Economou 1997b) As the purpose of the visitor evaluation study was to evaluate the use and effectiveness of the portable computer and interactive multimedia application, this potential bias, once identified, was felt to be acceptable.

It is recognised that as the researcher selected the case study, developed the application and conducted the visitor evaluation study he may possibly have biased the results. However the researcher's familiarity with the research methodology and the portable computer technology means he may also have insights which other less experienced researchers may not. (Economou 1997a)

4.3.2 Sample Size & Selection

The visitor survey sample included 100 visitors, 50 in a control group and 50 using the portable computer. Other studies have shown that this is an appropriate size for this type of evaluation study. (Badman 1994, Heinecke 1995, Hilke 1988, Ralphing 1994) Badman explains that "There are several techniques for estimating sample group size, but a useful rule of thumb is that at least fifty results are needed for each group of data ..." (Badman 1994) This view is confirmed by the Tourism and Recreation Research Board who note that "... the conventional wisdom of statistical texts is to recommend that each sub-sample should contain 50-100 members." (Tourism and Recreation Research Board 1993) It was recognised that a larger sample may have produced a greater quantity of data but not necessarily a different set of results. This sample was used as a starting point, if it had become evident whilst the visitor survey was in progress that a larger numbers of visitors were required then this sample size would have been re-examined. As this focused study employed multiple methods of data collection, 50 respondents from each of the two evaluation groups was deemed to be an appropriate range.

Data from the initial observation conducted on 16th August 1998 revealed that 80% of visitors who were observed spent between 10 and 15 minutes in the gallery, the longest observed duration being almost 25 minutes. It was estimated that the pre-visit and post-visit questionnaires would each take approximately 10 minutes to conduct. Therefore it was calculated that from the initial approach to completing the post-visit questionnaire would take between 30 and 45 minutes, and probably longer for those visitors using the portable computer and interactive multimedia application as they had to familiarise

themselves with the computer and complete a longer post-visit questionnaire. Allowing time to select the next visitor, it was estimated that on average 1 visitor could be surveyed each hour.

The museum is open for 7 hours each day, from 10:00am each morning, therefore it was theoretically possible to survey 7 visitors each day, not allowing for any textile machinery demonstrations which may take place in the gallery during the day. The portable computer and interactive multimedia application was designed to be used by visitors when textile machine demonstrations were not taking place. Therefore the researcher waited for a demonstration to finish before approaching the next visitor. However if a visitor was being observed when an unscheduled demonstration took place then the visitor was permitted to complete their visit, and the post-visit questionnaire conducted as normal.

During a formative usability test conducted on the 11th January 1999, only 10 visitors were surveyed in the 7 hours the museum was open. These visitors were using an early prototype and no formal pre-visit or post-visit questionnaires were administered or observations made. Therefore in light of this experience it was decided that surveying 7 visitors each day would have been overly ambitious and it was decided that the researcher would attempt to survey 5 visitors each day, a figure which has shown to be appropriate to other studies. (Alt 1980, Binks and Uzzell 1994, Diamond 1986) This decision was tested during the pilot study as described in section 4.2.3 and if required would have been revised in light of findings from the pilot study.

As explained previously it was not practical to include every visitor to the Fibres, Fabrics and Fashion gallery in the study, so a sample of visitors was taken. Probability sampling, where the probability that each person will be selected is known is often the preferred approach as it is more likely to produce a representative sample, thus reducing bias and enabling accurate generalisations to be made. (Moser and Kalton 1985, Oppenheim 1992, Robson 1993, Slavin 1984) Probability sampling requires a sampling frame, a list of all units within the population under study. However for infinite populations such as museum visitors sampling frames do not exist, (Economou 1997b) and thus dictates the use of non-probability sampling. Non-Probability sampling is often used for small scale studies, and has the advantages of not requiring a sampling frame and being both cheaper and easier to administer than probability

sampling, however the results produced cannot confidently be statistically generalised beyond the surveyed population or sample. (Miles 1982, Miles et al 1998, Robson 1993)

Using quota sampling, a non-probability sampling method, where the interviewer selects visitors who fit into discreet predetermined groups was considered, as the stratified sampling groups can enhance the accuracy of the results. Quota sampling is straight forward to administer, however because visitors with certain characteristics have to be found it may be difficult for the interviewer to complete each quota and may take significantly longer to complete the survey. The non-random selection of visitors is the biggest weakness of quota sampling, as the interviewer may bias the results by the visitors they select. (Alt 1980, Oppenheim 1992, Pekarik et al 1996, Veal 1992)

Systematic sampling was selected, where the n^{th} person to pass a point is selected. This removes the interviewer selection bias and produces a representative sample of the target population. Systematic sampling is quick and easy to conduct, but is not statistically random as each visitor does not have $1/n$ chance of being selected. However this sampling method can be regarded as approximately random if it is assumed that there is no order in which visitors enter the gallery. (Heady 1984, Hilke 1989, Smyth and Ayton 1985, de Vaus 1986) As explained earlier in this section it was the intention to survey 5 visitors each day, as the time available was limited to 7 hours it was decided that systematic sampling where $n=1$ would be employed. This approach would remove interviewer selection bias, however it is recognised that this approach is not strictly systematic sampling or statically accurate. This meant that the first visitor to enter the observation area once the museum had opened would be selected and approached, once the post-visit questionnaire had been completed the next visitor to enter the observation area would then be selected and approached. A similar approach was implemented for visitors who declined to participate in the study, their refusal was noted and the next person to enter the observation area was then approached. (Alt 1980, Diamond 1986, Miles 1982)

Due to the fragility and expense of the portable computer hardware it was decided to exclude visitors below the age of 16, and to minimise the disruption to tour groups and families it was also decided to exclude all organised tours, school parties and lone

parents with young children from the visitor survey. (Alt and Shaw 1984, Hilke, Hennings and Springuel 1988, Smyth and Ayton 1985, Wilson 1991)

As has been explained in section 4.3.1 it was decided that 100 visitors would be included in the visitor survey, 50 as a control group and 50 using the portable computer. It had also been established that surveying 5 visitors each day was practical, therefore the evaluation was spread over 20 days. It was decided only to use weekdays to conduct the study, as larger numbers of families with children come to the museum at weekends. As the portable computer and interactive multimedia application had been designed to be used singularly by adult visitors, this would have disrupted their visits and may have made unobtrusive observation difficult. (Tourism and Recreation Research Board 1993) There were also many more textile machine demonstrations at weekends than during the week. The approach of using either weekdays or weekends has been employed successfully by other studies to minimise the differences between the study periods. (Alt 1980, Diamond 1986, Blud 1990) It was felt that it was more important that the study period for both groups were identical, rather than covering everyday of the week. Bank holidays and school holidays were also excluded as the profiles of visitors change during these times and are therefore not representative of general visitors to the museum during other periods of the survey. (Tourism and Recreation Research Board 1993)

Figure 4.1 below shows the dates on which the visitor survey took place during January and February 1999:

<p>Control Group Monday 25th January – Friday 29th January Monday 1st February – Friday 5th February</p>
<p>Computer Group Monday 8th February – Friday 12th February Monday 22nd February – Friday 26th February (excluding Wednesday 24th February) Wednesday 3rd March</p>

(Figure 4.1 : Visitor Survey Dates)

The week commencing Monday 15th February was excluded because this was a school half term holiday. Wednesday 24th February was also excluded because the researcher was attending the Museums Association seminar in London on “Making Sense of Multimedia”. To minimise bias resulting from this lost day, an additional survey of 5 visitors was undertaken the following Wednesday.

The visitor survey for the control group was conducted first, followed by the computer group, as this simplified the management of the visitor study. It had been considered that selected visitors should be alternately distributed between the control and computer group to increase the randomness of the study. However it was felt that this would have had a negligible impact on the results and would significantly increase the complexity of managing the visitor study and was thus rejected.

4.3.3 Conducting the Survey

As visitors entered the gallery, they were approached and the purpose of the study was explained, and if they consented to participate in the study, what this would entail.

The pre-visit questionnaire was identical for both control and computer groups and was divided into four sections:

- Gender & Age
- Prior Visitation to Textile Attractions
- Expectations of the Gallery
- Knowledge of the Subject Area

Open questions were used throughout the questionnaire apart from the age groups, because it was felt that this would obtain a range of natural responses. If closed questions with predetermined categories of answers or scales had been used, visitors may have felt constrained in their responses or have provided the answer they thought the researcher wanted, thus biasing the results. (Oppenheim, 1992, Robson 1993, Serrell 1996b, Slavin 1984) Following the pilot test, described in section 4.2.3 predetermined answer categories were formulated for each question. These categories were incorporated into the record sheet used by the interviewer to assist in recording visitors responses and to speed up the process of administering the questionnaires. However

these categories were not shown to the interviewee and provision was made to allow for responses which had not been anticipated. An example of a record sheet employed can be located in Appendix C.

Basic demographic information was required so that the results could be analysed at a later date, and used to evaluate gender and/or age of visitors and its bearing on how the portable computer and interactive multimedia application affected their experience of the gallery. The gender of the visitor was observed and recorded. To establish the visitor's age a card was given which displayed a series of age groups from A (16-20 yrs) through to K (65+ yrs) in 5 year increments. Visitors were asked to indicate which age group they were, which was recorded.

Visitors were asked if they had previously visited a textile mill or museum with a textile gallery if they said yes, they were asked to name them, and their answers recorded. Visitors were then asked if they had previously visited the Fibres, Fabrics and Fashion gallery, and their response recorded. Visitors were then asked their expectations of the Fibres, Fabrics and Fashions gallery, which were again recorded.

The final questions of the *pre-visit questionnaire* addressed visitors prior knowledge of textile machines and the process of transforming cotton from a raw material into a finished fabric, also referred to as the "Cotton Process". At this stage it was explained to the visitors that the following questions were to aid the researcher in understanding what they knew about the cotton process and it did not matter if they did not know the correct answers. Visitors were shown a card which had an illustration of a Weaving Loom on it, and asked if they knew the name of the textile machine and the process it performed. A copy of the illustration can be found in Appendix C. Finally visitors were asked if they could recall the stages which cotton goes through from being a plant to finished fabric.

That concluded the *pre-visit questionnaire* and visitors were asked to look around the gallery in their own time. They were informed that some additional questions would be asked once they had completed their visit to the gallery. Visitors from the computer group were given the portable computer and the interactive multimedia application initialised after they had completed the pre-visit survey.

The *post-visit questionnaire* contained the following three identical sections for both the control group and the computer group:

- Expectations of Gallery
- Opinions of the Gallery
- Knowledge of the Subject Area

After they had explored the gallery, visitors were asked a second series of questions, such as if the gallery had met their expectations, how and if not to explain why. This question was used primarily to clarify whether the gallery as it stood was meeting visitor expectations.

Additionally it was necessary to explore if using the portable computer and interactive multimedia application had affected visitor opinion of the gallery. Visitors were asked what were their favourite and least favourite elements of the Fibres, Fabrics and Fashions gallery, and their responses recorded.

To assess any changes in the visitors understanding of the subject area after their visit to the gallery, they were again shown the illustration of a textile machine on the visual aid and asked if they could identify it and the process it performed. Visitors were again asked if they could recall any processes which cotton goes through when being processed from a plant into a finished fabric.

That concluded the *post-visit questionnaire* for the control group. For those visitors who had used the portable computer and interactive multimedia application as they explored the textiles gallery the *post-visit questionnaire* was extended by three additional sets of questions to assess:

- Visitor Enjoyment and Ease of Use of the Portable Computer and interactive multimedia application
- Visitors opinion of their Depth of Exploration and Learning
- Visitor Opinion of using the Portable Computer and interactive multimedia application

A copy of the extended questionnaire employed with members of the computer group can be located in Appendix C.

It was important to identify if visitors had enjoyed using the portable computer and interactive multimedia application, and had found it easy to use. Because no matter what the potential interpretation benefits, if the application was not enjoyable and user friendly it would be pointless developing it in this context. Visitors were asked if they liked using the computer and if they had found it easy to use. This was followed by a probing question to ascertain which features of the portable computer and interactive multimedia application had contributed in making it easy or difficult to use. Finally visitors were asked what were their most favourite and least favourite features of the portable computer and interactive multimedia application.

In light of the pilot study as discussed in section 4.2.3 it was decided to ask visitors if they thought that by using the portable computer and interactive multimedia application, they had explored the textile machines and cotton process more fully than they would otherwise have done. This was followed by a second question to assess if visitors thought they had learnt more about the textile machines and cotton process using the portable computer and interactive multimedia application than they would otherwise have done.

4.4 Visitor Observation

Visitors were unobtrusively observed between the pre-visit and post-visit questionnaires to assess and record their use of the portable computer and interactive multimedia application, and the duration of their visit. Structured observation was selected because it is a systematic way of recording behaviours, and is easier to both administer and analyse than unstructured observations. (Heinecke 1995, Jacobson 1991, Miles 1982, Noschka-Roos 1996) Research in museums has found that the time a visitor spends looking at an exhibit can be related to their interest in and effectiveness of the exhibit, and potentially the learning performed by the visitors. (Falk 1983, Haeseler 1989, Koran, Foster and Koran 1989, Peart 1983)

When undertaking structured observation the observer typically employs an observation schedule, usually a checklist or other coding framework to assist them in recording observed behaviours. An observation schedule simplifies the recording process and can reduce the amount of time required to record and analyse the observations at the

expense of flexibility. (Bell 1993, Blaxter, Hughes and Tight 1996, Slavin 1984) Existing observation schedules were consulted, and provided an initial framework of behaviours and an overview of the discipline of structured observation. (Blud 1990, Conger et al 1986, Diamond 1986, Hilke 1989) These observation schedules recorded the order and/or frequency of behaviours, however for this study it was the duration of behaviours which was of greater interest, as this was considered to be a more accurate reflection of how visitors spent their time within the gallery. It quickly becomes difficult to record the duration of observations with a stopwatch, pen and paper, (Conger et al 1986, Diamond 1986, Lindgaard 1994, Miles 1994, Werner and Schoepfle 1987) therefore a more innovative approach to structured observation was required. It was decided to use a second portable computer and to develop a computerised observation schedule, which would automatically record and calculate the duration of the observed behaviours.

Using a video camera to record visitor behaviour in the gallery was also considered. This had the advantage that a permanent record was available, and the tape could be reviewed several times when coding behaviours. The tape would also be available to be used by another researcher at a later date. However the computerised observation schedule was selected in preference because there would have been technical and logistical problems in installing a video camera within the gallery. The tapes would have taken a significant time to analyse, increasing the duration of the evaluation study as a whole, and there are also privacy and ethical concerns when video taping members of the public. (Economou 1998, Kellehear 1993, Lindgaard 1994, Webb et al 1981)

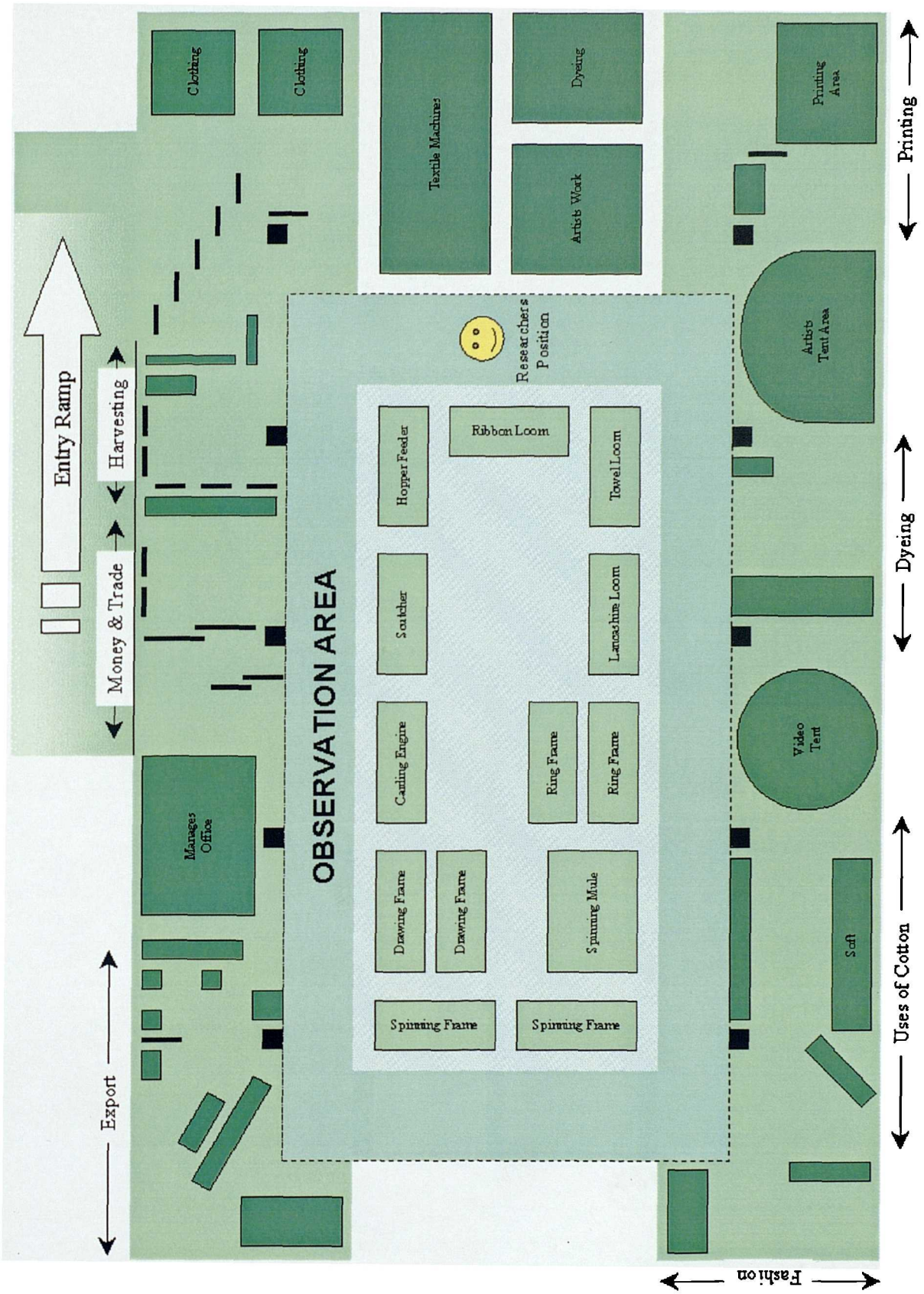
Before the development of the computerised observation schedule commenced, the behaviours exhibited by visitors had first to be identified. The interactive multimedia application on the portable computer given to visitors was designed to function within a specific area of the entire gallery. This was primarily for logistical reasons, as developing an application to cover the whole gallery would have significantly extended the development period and incurred other practical difficulties. It was identified that the area of the gallery which contained the textile machines had the greatest potential for enhanced interpretation using the portable computer and interactive multimedia application, and this area was designated the "Observation Area". It was decided to record the behaviour of visitors whilst they were within this observation area and to record only the time they spent outside this area. This decision was made to simplify

the observation procedure, the layout of the gallery would have made it difficult to observe the visitors unobtrusively as they explored these outer areas. The layout of the gallery, orientation of the observation area and the position of the researcher are shown in figure 4.2.

On the 16th August 1998 an initial unobtrusive observation of 10 visitors to the Fibres, Fabrics and Fashion Gallery took place. As the visitors explored the gallery the behaviours exhibited, total time spent in the gallery and the number of times visitors left the observation area were recorded. The behaviours identified were used as the foundation for the construction of the computerised observation schedule. The total time spent in the gallery and the number of times visitors left the observation area assisted the planning and scheduling of the main visitor survey. Two additional anticipated portable computer related behaviours were also added, to include using or looking at the portable computer and showing the portable computer to other visitors.

The computerised observation schedule permitted even less flexibility than a paper based one, so to allow for an unanticipated behaviour, a miscellaneous category was added. If a behaviour not listed on the computerised observation schedule was observed then this option would be selected and the behaviour documented on the pre-visit or post-visit questionnaire and the file updated later at the data entry stage.

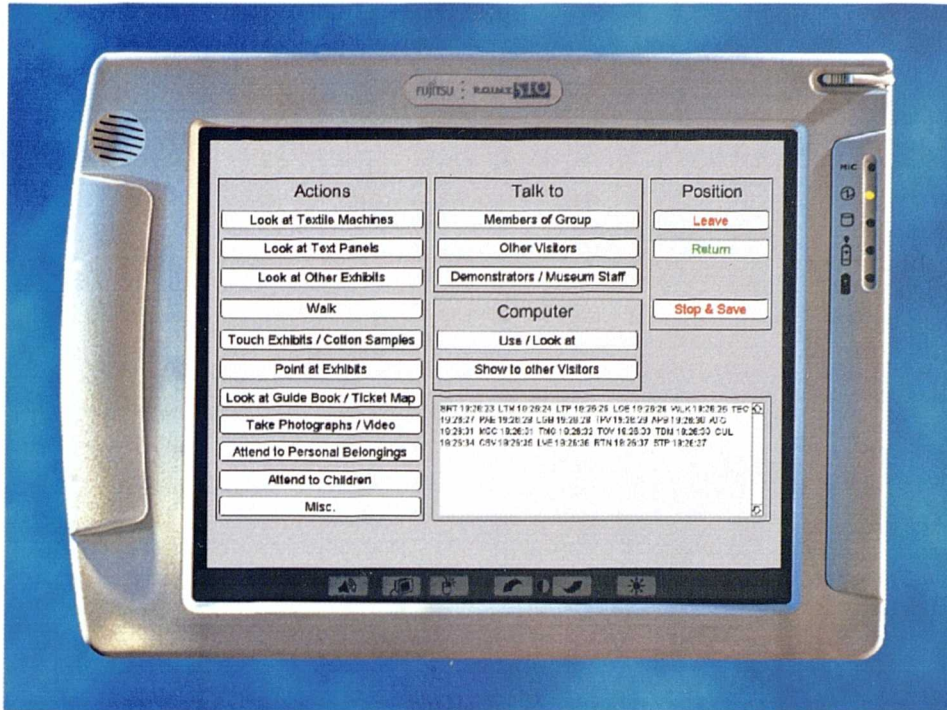
Additional options were added to record when a visitor left and returned to the observation area. It was the initial intention to record the area of the gallery in which the visitor was standing, to provide an additional measure of visitor behaviour. However as explained in section 4.2.3 the pilot test found this to be impractical for a single observer, even with the assistance of a computerised observation schedule, and this functionality was removed after completion of the pilot test. Finally a stop button marked the end of the observation and saved the file to the hard disk of the portable computer. The computerised observation schedule was developed using Macromedia Director, which was also used for the development of the interactive multimedia application as discussed in Chapter 3: Design & Development. Macromedia Director is primarily marketed for the development of interactive multimedia applications and CD-ROMs, however as the researcher had an in-depth knowledge of the software and had already developed a similar interaction recording system for the interactive multimedia application it was utilised. However an alternative software package, for example



(Figure 4.2 : Gallery Layout, Observation Area and Researcher Position)

Microsoft VisualBasic would be recommended had the computerised observation schedule been developed in isolation.

Figure 4.3 below shows the final version of the computerised observation schedule.



(Figure 4.3 : Computerised Observation Schedule)

The large white box in lower right-hand corner of the screen displays behaviour codes and time stamps as the behaviours are recorded, this allowed the observer to see the application was functioning correctly at all times.

The computerised observation schedule recorded observed behaviours to the nearest second, and to assist the data entry phase, saved the file generated to the hard disk of the portable computer in format which could be imported directly into a spreadsheet for later analysis. To ensure this procedure was straight forward a 3 digit coding scheme was developed for each of the behaviours as shown below in figure 4.4. Observations were performed unobtrusively whilst standing between the textile machines and the display of artists work. This location was chosen because it provided a clear vantage point across the whole gallery. It was important that the observations were made unobtrusively, if the visitors had become aware that they were being observed they may have altered their behaviour, biasing the results. However it has been found

Behaviour	Code
Looking at the Textile Machines	LTM
Looking at Exhibits outside the Observation Area	LOE
Looking at or Reading Text Panels	LTP
Looking at the Guidebook or Ticket Map	LGB
Interacting with Exhibits or Touching Cotton Samples	TEC
Taking Photographs or Videos	TPV
Pointing at Exhibits	PAE
Attending to Personal Belongings	APB
Attending to Children	ATC
Talking to Members of their Group	TMG
Talking to Other Visitors	TOV
Talking to Museum Staff or Demonstrators	TDM
Walking	WLK
Using or Looking at the Computer	CUL
Showing the Computer to Other Visitors	CSV
Miscellaneous	MSC
Leave Observation Area	LVE
Return to Observation Area	RTN
Stop (End Observation)	STP

(Figure 4.4 : Computerised Observation Schedule Coding Scheme)

that the effect of the observer wears off over time. (Judd, Smith and Kidder 1991, Lindgaard 1994, Miles 1994, Webb et al 1981) The use of a portable computer rather than a pen, paper and stopwatch to record the observed behaviours may also have made the observer less obtrusive.

4.5 Interaction Logs

To make an informed evaluation of the portable computer and interactive multimedia application, it was also necessary to assess how visitors actually used the interactive multimedia application. Other research projects evaluating interactive multimedia kiosks and exhibits have identified that incorporating a feature to record visitors interactions can produce valuable research data, in the form of an interaction log. (Economou 1998, Heinecke 1995, Lindgaard 1994, Nebenzahl 1993) Lindgaard explains that "Electronic data logging methods are the most accurate tools with which to measure ... time spent on a given screen ... it is generally wise to use electronic data

logging for obtaining additional data that supplements one's own observations ...” (Lindgaard 1994)

Therefore the interactive multimedia application was developed to include the facility to record visitors interactions for later analysis. Each time a visitor entered a different screen of the application an entry would be added to the interaction log, identifying the screen entered and the time, with the screen being indicated by a four digit code. The interaction log would yield valuable data allowing the researcher to analyse if the visitor had understood the instructions, to identify which sections of the application were of most interest to visitors and the duration for which visitors watched the videos and animations of the textile machines working. The development of the interaction log facility is discussed in detail in section 3.6.

A problem which has been identified with the use of interaction logs in other studies is that of determining when one visitor has completed their interaction and another visitor has started interacting with the application. This is often not apparent from the interaction logs and complicates the analysis process. (Economou 1997b) However, during the present evaluation study, the portable computer was reset by the researcher once the post-visit questionnaire had been completed, and the interactive multimedia application was designed in such a way that a new interaction log file was created for each visitor who used the portable computer.

4.6 Data Entry and Content Analysis

Once the visitor study was completed, the data obtained from the range of research methods was entered into a number of Microsoft Excel spreadsheets for analysis. The highly codified design of the questionnaires meant that the data entry was straight forward whilst the interaction logs and files produced by the computerised observation schedule were in a format which could be imported directly into five Microsoft Excel spreadsheets with the minimum of intervention, as listed below:

- Questionnaires – Control Group
- Questionnaire – Computer Group
- Observation – Control Group
- Observation – Computer Group
- Interaction Logs – Computer Group

Each spreadsheet contained 50 sheets, one for each visitor from that group, with an additional single sheet totalling the results. The main summarising sheet from each of these five spreadsheets can be located in Appendix D. These spreadsheets formed the basis of the data detailed in tabular format in Chapter 5 Visitor Evaluation Study: Findings, Analysis and Synthesis. A series of graphs were employed during the analysis of the data to identify trends and to aid the comparison of data, pre- and post-test of each group, and between the two groups. These graphs which are also located in Appendix D, assist in the analysis of the findings in the following chapter.

This chapter has provided a review of the major visitor evaluation study conducted to evaluate the use and effectiveness of a portable computer and interactive multimedia application as a new tool for interpreting museum collections.

The chapter began by detailing the range of research methods appropriate to the visitor evaluation study and the construction of a research framework. The aims and objectives of the visitor evaluation study were reviewed and an overview of revisions resulting from an initial pilot study identified. An overview was provided of the decisions made regarding sample size, visitor selection procedures, the way in which the study was conducted and timing of the study. The contribution of the interviewer administered pre-visit and post-visit questionnaires, unobtrusive structured observation and interaction logging was discussed in detail. The chapter concluded by providing a brief overview of the data entry phase of the research project. The following chapter details the findings and provides an analysis and synthesis of the visitor evaluation study.

Chapter 5

Visitor Evaluation Study: Findings, Analysis and Synthesis

Chapter 5 Visitor Evaluation Study: Findings, Analysis and Synthesis

This chapter provides an analysis of the data collected during the visitor evaluation study. The primary aim of the visitor evaluation study was to provide data to assess the use and effectiveness of the portable computer and interactive multimedia application. The hypothesis was that a portable computer and interactive multimedia application had the potential to enhance existing interpretation in a museum gallery and become a new tool for interpreting museum collections.

Serrell and Raphling had noted that "... exhibits need to contain computer interactives that work for real visitors." Their research focused on fixed computer stations, but the logic follows for portable computers. If the objective ultimately is to develop portable computers as a new tool for interpretation in a museum then they need not only to be user friendly, but also to inspire users to be actively involved, "so that learning can be the result of manipulation of both technology and content." (Serrell and Raphling 1992)

A sample of 50 visitors for the control group and 50 visitors for the computer group were randomly selected. Pre and Post-visit surveys were administered, and the data collected during the visitor evaluation study was entered into a series of Microsoft Excel spreadsheets. These spreadsheets and a series of graphs used during the analysis of the data can be located in Appendix D. The findings show that the majority of respondents from both the control group and the computer group had no expectations of the gallery prior to visiting, and had not entered the gallery with any particular thoughts in mind other than to have a general look around. Despite having recently opened after a major redesign, it was clear that the respondents had not come specifically to visit the Fibres, Fabrics and Fashion gallery. In fact the majority had come specifically to see the "Dinosaurs" temporary exhibition. This blockbuster exhibition featuring full size animatronic dinosaurs had opened the week prior to the evaluation study, and was attracting record visitor numbers. Over 70,000 visitors came to the museum during the nine days of the February half term. (Evans 1999c) The presence of the "Dinosaurs" exhibit in the adjacent gallery may therefore have increased the number of visitors who had paid their entry fee, visited the temporary exhibition, and were then just browsing to see what else was on show in the museum. Thus the sample was not biased towards visitors who might already had a good understanding of textiles.

It was the intention that the visitor study would enable the researcher:

- To study visitor use of and interaction with the portable computer and interactive multimedia application
- To assess visitor opinion and response to the portable computer
- To assess the effect of the portable computer on visitor behaviour
- To assess the effect of the portable computer on visitor knowledge and understanding

This chapter is divided into three main sections:

- Control Group: Findings and Analysis – Section 5.1
- Computer Group: Findings and Analysis – Section 5.2
- Synthesis of Findings – Section 5.3

The first two sections each contain a number of sub-sections which addresses a different aspect of the collected data. Each sub-section has the same format, with data presented in tabular form, followed by an analysis and summary of the findings.

The research methods used to survey visitors in the gallery was an entry and exit questionnaire, with visitors being observed as they visited the gallery and the interactions of the computer group using the portable computer recorded. There were ten parts to the research process:

- Visits to the Fibres, Fabrics and Fashion gallery to clarify the context and details of the visitor evaluation study
- Preparation of survey questionnaires
- Identification of behaviours and development of the computerised observation schedule
- Pilot study followed by coding of questionnaires and revisions
- Entry and Exit survey of both Control group and Computer group visitors
- Observation of both Control group and Computer group visitors
- Interaction logging for Computer group visitor
- Coding of open questions and Data Entry
- Content analysis
- Analysis and Synthesis of findings

This is the first time that a portable computer and interactive multimedia application have been used in a museum gallery as a method of providing additional interpretation of exhibits. It was important therefore that the portable computer and interactive multimedia application was tested on those who would benefit most, the museum visitors.

5.1 CONTROL GROUP: Findings and Analysis

The control group was used to compile a profile of the views, opinions, knowledge and understanding of typical visitors to the Fibres, Fabrics and Fashion gallery. The findings provided a body of evidence that could be compared against the findings of the computer group.

This section details findings of the data collected during the visitor evaluation study, and provides an analysis and summary for the control group. Specifically this section:

- Examines the classification and profile of the visitors who participated in the evaluation study
- Evaluates the findings of both the pre- and post-visit surveys used to identify visitors prior knowledge of the textile machines and the cotton process
- Examines visitor opinion of the gallery
- Assesses the observed behaviour of visitors whilst in the gallery

5.1.1 Visitor Classification and Profile

This section details findings and analyses the classification and demographic profile of museum visitors who formed the control group of the study.

5.1.1.1 A Profile of Visitor Demographics

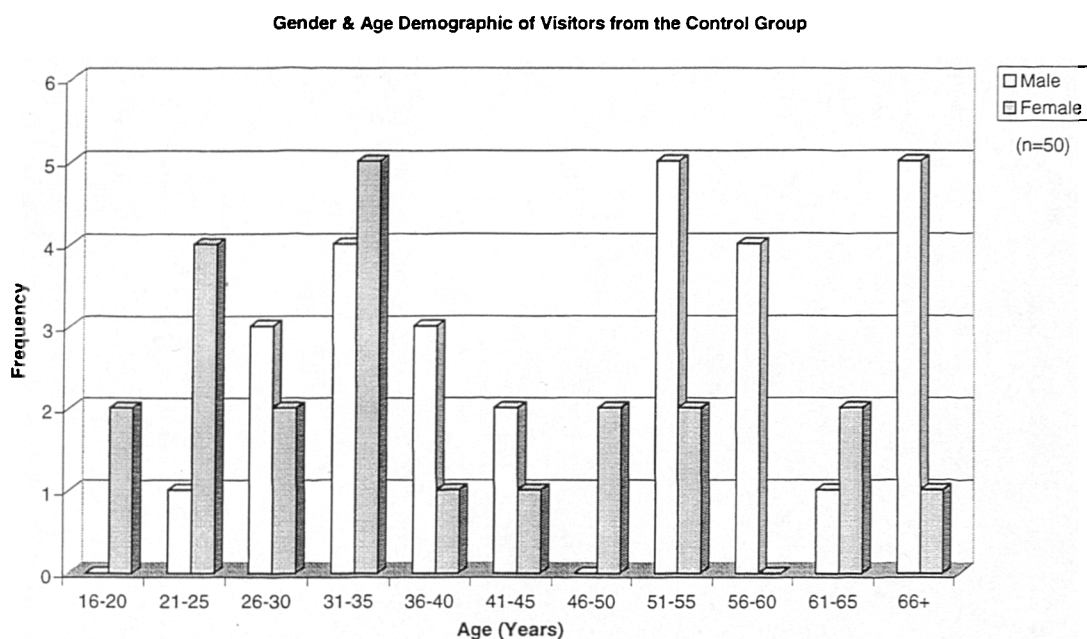
Figure 5.1 through 5.3 show the gender distribution within the control group, and the distribution of visitors across the spectrum of age ranges.

<i>Gender distribution of visitors</i>		<i>(n=50)</i>
Gender	Percentage	
Male	56%	
Female	44%	

(Figure 5.1 : Gender distribution of Visitors)

Age range of the control group		(n=50)	
Age Range	Male	Female	
16 – 20 years	0%	4%	
21 – 25 years	2%	8%	
26 – 30 years	6%	4%	
31 – 35 years	8%	10%	
36 – 40 years	6%	2%	
41 – 45 years	4%	2%	
46 – 50 years	0%	4%	
51 – 55 years	10%	4%	
56 – 60 years	8%	0%	
61 – 65 years	2%	4%	
66+ years	10%	2%	

(Figure 5.2 : Age range of the Control Group)



(Figure 5.3 : Age range of the Control Group)

5.1.1.2 A Profile of Textile Museums and Textile Heritage Attraction Visits

Figures 5.4 through 5.6 show the number of visitors who had previously visited similar museums with a textile gallery. They indicate which attractions had been visited, and also the number of visitors who had visited the Fibres, Fabrics and Fashion gallery before participating in the present study.

Prior visitation to a museum textile gallery or textile mill		(n=50)
Prior Visitation		Percentage
Had previously visited similar textile galleries		28%
Had not previously visited similar textile galleries		72%

(Figure 5.4 : Prior visitation to a museum with a textile gallery or textile mill)

<i>Textile museums and textile mills previously visited</i> (n=50)	
Textile Mill or Museum	Percentage
Quarry Bank Mill	14%
Helmshaw Textile Museum	6%
Macclesfield Silk Museum	2%
Others	10%

(Figure 5.5 : Textile Museums and Textile Mills previously visited)

<i>Prior visitation to the Fibres, Fabrics and Fashion gallery</i> (n=50)	
Prior Visitation	Percentage
Had previously visited	16%
Had not previously visited	84%

(Figure 5.6 : Prior visitation to the Fibres, Fabrics and Fashion gallery)

5.1.1.3 Refusals to Participate in the study

Six visitors refused to participate in the study, for the following reasons:

- Not enough time – 2 visitors
- Non-English speaker – 3 visitors
- Not willing to be involved – 1 visitor

5.1.1.4 Analysis of Visitor Classification and Profile

The control group was composed of approximately equal numbers of male and female visitors. Visitors from the control group were distributed over a broader range of ages, however male visitors were generally older than female visitors.

Approximately a quarter of the visitors from the control group had previously visited a textile mill or museum with a textile gallery, the most popular being Quarry Bank Mill followed by Helmshaw Textile Museum and Macclesfield Silk Museum, all local heritage attractions. This profile of prior visitation suggests that the majority of visitors who participated in the visitor evaluation study live in the region and have not travelled from further afield. This would support in-house visitor studies at MSIM, according to Vincent (Marketing Officer – MSIM) approximately three-quarters of visitors to the museum were from the North West region. (Evans 1999c)

Only one sixth of the control group had previously visited the Fibres Fabrics and Fashion gallery. This finding was supported by Vincent who confirmed that based upon the results of existing audience research conducted by the museum, approximately half

of the visitors coming to the museum had previously visited the museum on at least one occasion. (Evans 1999c)

5.1.1.5 Summary of Visitor Classification and Profile

The findings of visitor classification and profile for the control group are summarised below:

- Male 56% and Female 44%
- Broad distribution across age ranges
- 28% of respondents had previously visited a Textile Mill or Museum with a textile gallery, most frequently Quarry Bank Mill
- 16% of respondents had previously visited the Fibres, Fabrics and Fashion gallery

5.1.2 Visitor Recognition and Recall

This section evaluates the data collected during both the pre- and post-visit surveys used to evaluate visitor knowledge of textile machines both before and after visiting the gallery.

5.1.2.1 Recognition of a Textile Machine and Process

During both the pre-visit and post-visit surveys visitors were shown a black and white photograph and asked to identify the Textile Loom and the process it performed. Figures 5.7 illustrates the findings.

Recognition of a textile loom and weaving process		
	(n=50)	
	Pre-Visit	Post-Visit
Recognition of a Textile Loom	74%	82%
Recognition of the Weaving process	74%	82%
Visitors who could not recognise the machine or process	24%	14%
Incorrect recognition of the machine or process	2%	4%

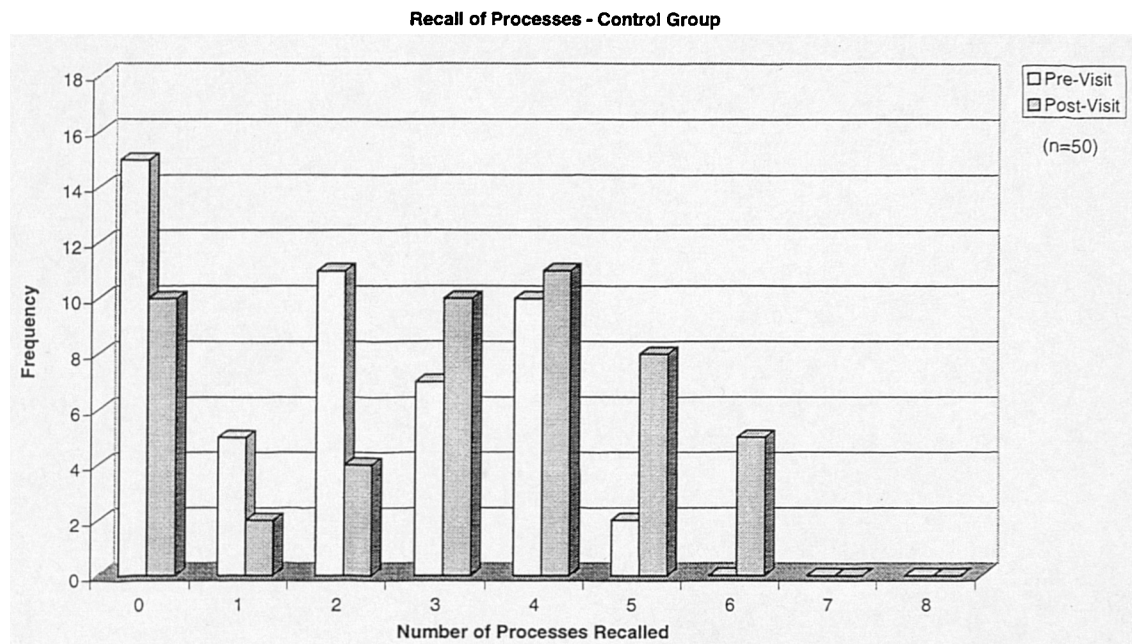
(Figure 5.7 : Recognition of Textile Machine & Process)

5.1.2.2 Recall of Processes

Visitors ability to recall the processes involved in transforming cotton from a raw material into a finished fabric, were also evaluated during the pre-visit and post-visit surveys. Figures 5.8 through 5.10 show the number of processes, which visitors correctly identified before and after their visit to the gallery, and the frequency with which individual processes were recalled.

Recall of process involved in transforming cotton (n=50)		
Number of Processes correctly recalled	Pre-Visit	Post-Visit
0	30%	20%
1	10%	4%
2	22%	8%
3	14%	20%
4	20%	22%
5	4%	16%
6	0%	10%

(Figure 5.8 : Number of Processes recalled)



(Figure 5.9 : Number of Processes recalled)

Recall of individual processes (n=50)		
Processes Recalled	Pre-Visit	Post-Visit
Spinning	46%	72%
Weaving	46%	64%
Carding	36%	54%
Washing or Cleaning	28%	34%
Drawing	18%	34%
Unpacking	8%	26%
Dyeing	8%	14%
Winding	4%	6%
Harvesting	0%	2%
Printing	0%	2%

(Figure 5.10 : Recall of Individual Processes)

5.1.2.3 Analysis of Visitor Recognition and Recall

The pre-visit questionnaire conducted on entry to the gallery revealed that almost three quarters of visitors from the control group were able to correctly identify the textile

machine from the photograph as a loom and the process it performed. The post-visit survey completed as visitors left the gallery shows the proportion of visitors from the control group who were able to correctly identify the textile machine and process increased from 74% to 82%, representing an 8% increase.

On average two textile processes were correctly recalled by visitors from the control group during the pre-visit survey. However during post-visit surveys visitors from the control group were able to recall an average of 3 processes. Before visiting the gallery 15 visitors from the control group were unable to recall a single textile process. After visiting the gallery, significantly 10 visitors from the control group were still unable to recall a single textile process, suggesting that little additional knowledge had been gained from their visit to the gallery. The textile processes most frequently recalled by visitors before and after their visit to the gallery were spinning, weaving and carding.

Analysis of the Graph F and Graph I in Appendix D and cross tabulation identified that gender had minimal impact upon the results, and that visitors who had not previously visited a textile museum showed a greater increase in their ability to identify the textile machine and the process it performed post-visit.

5.1.2.4 Summary of Visitor Recognition and Recall

The findings of visitor recognition and recall for the control group are summarised below:

- 74% of visitors could correctly identify the textile machine and the process it performed on entry to the gallery
- There was an 8% increase in visitors ability to identify a textile machine and the process it performs after their visit to the gallery
- There was an increase in average number of processes correctly recalled from 2 to 3
- 10 visitors were still unable to recall a single process post-visit
- The most frequently recalled processes were:
 - *Weaving*
 - *Spinning*
 - *Carding*

5.1.3 Visitor Opinion

This section reviews the visitors opinions of the Fibres, Fabrics and Fashion gallery.

5.1.3.1 Visitor Opinion of the Gallery: Post-Visit

This section examines visitor opinion of the Fibres, Fabrics and Fashion gallery on completion of their visit. Figures 5.11 and 5.12 detail features which were most popular and least popular with visitors.

What visitors liked best about the gallery		(n=50)
Liked Best	Percentage	
Textile Machines	40%	
Layout of the Gallery	16%	
Exhibits outside the observation area	16%	
Textile Process	14%	
Atmosphere of the gallery	10%	
Cotton Samples	6%	
Presentation & Design of the gallery	6%	
Demonstrations of the Textile Machines	4%	
Text Panels & Displays	4%	
Lighting	4%	
Hands-On Interactives	2%	
Educational Content	2%	
Nothing Specific	10%	

(Figure 5.11 : Features which were most popular with visitors)

What visitors liked least about the gallery		(n=50)
Liked Least	Percentage	
Could not see the textile machines working	12%	
Exhibits outside the observation area	12%	
Poor Explanation of Process	6%	
Confusing / Disorienting Sounds	4%	
Lack of Historical Information	2%	
No Modern Textile Machines	2%	
Not Sure Which Way to Walk Round	2%	
Too Quiet	2%	
Too Many School Children	2%	
Nothing Specific	64%	

(Figure 5.12 : Features which were least popular with visitors)

5.1.3.2 Analysis of Visitor Opinion

The most popular feature of the textile gallery was the textile machines themselves, followed by the layout of the gallery, which provided a good vantage point to view the textile machines.

Exhibits outside the observation area containing the textile machines were not high on the list of favourite elements with visitors from the control group. It was surprising that nobody mentioned the office display explicitly, which was highly regarded by the museum design team, or that so few visitors commented on the interactive element of the gallery, a key feature for the design and curatorial team.

When asked during the post-visit survey what they liked least about the textile gallery two thirds of visitors from the control group were unable to identify anything specific, which they disliked about the gallery. Several visitors commented that they “were not in a position to make a judgement, the museum designer/curator was the expert and knows what they should see”. This would suggest that for some visitors, a museum visit is still perceived to be a one way experience.

5.1.3.3 Summary of Visitor Opinion

The findings of visitor opinion for the control group are summarised below:

- Most popular elements:
 - *Textile Machines* - 40%
 - *Layout of the Gallery*- 16%
 - *Exhibits Outside Observation Area* - 16%
 - *Cotton Process* - 14%
 - *Nothing Specific* – 10%
- Least popular elements:
 - *Nothing Specific* - 64%
 - *No working machines* - 12%
 - *Exhibits Outside Observation Area* - 12%

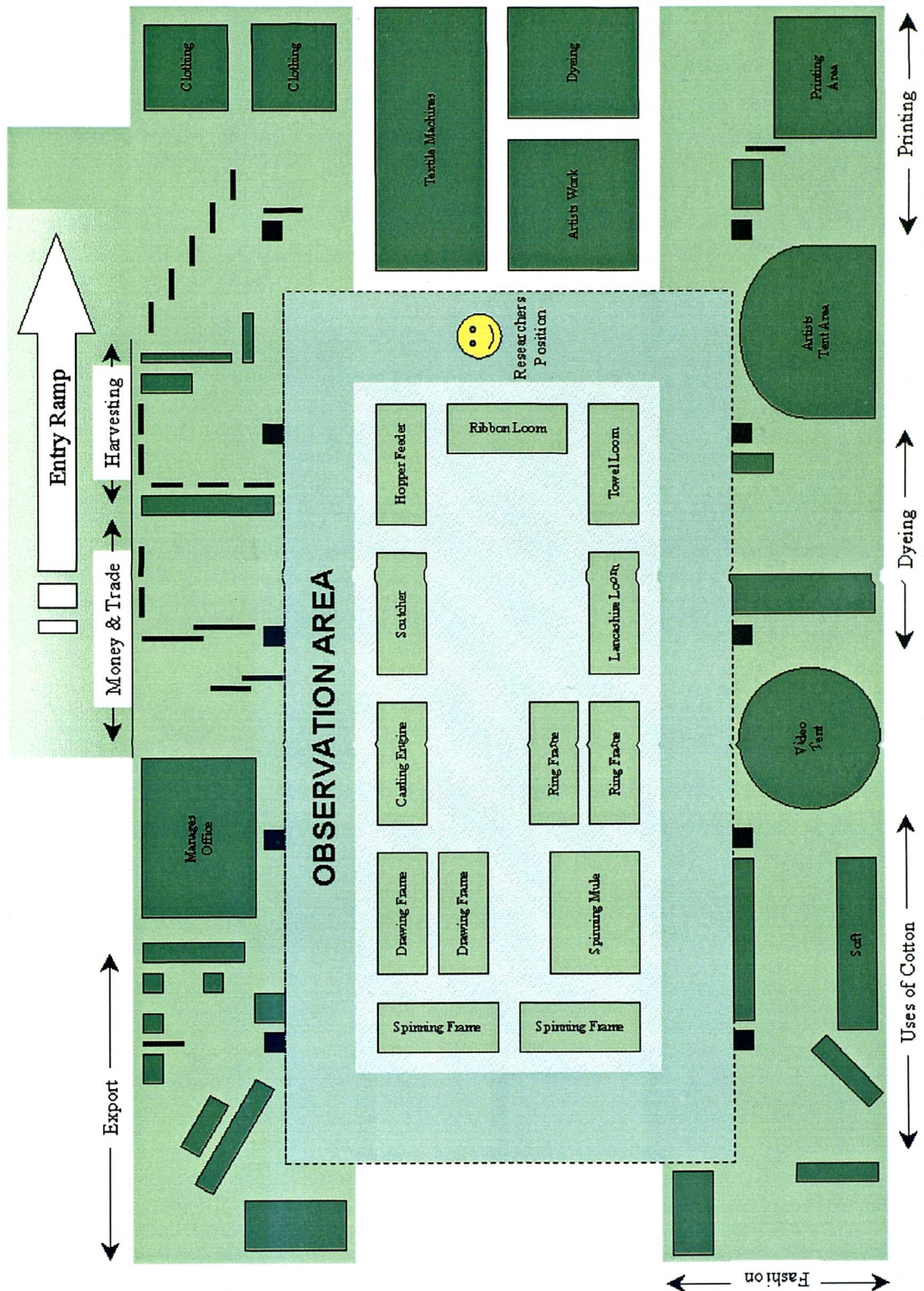
5.1.4 Observed Visitor Behaviour

As visitors from the control group explored the gallery they were observed. Individual behaviours were recorded within an accuracy of one second, using a second portable computer and computerised observation schedule. The term “Observation Area” is used to describe the area of the gallery immediately surrounding the textile machines. The layout of the gallery and the sections of the gallery enclosed by the “Observation Area” is shown in figure 5.13 on the following page.

5.1.4.1 Observed Time in the Gallery

Figures 5.14 through 5.18 show the average duration for which visitors were observed

in the gallery, and how visitors divided their time between those exhibits within and outside the observation area.



(Figure 5.13 : Fibres, Fabrics & Fashion Gallery Layout)

Observed total time in the gallery (n=50)	
Average Total Time in Gallery	Min : Sec
Average total time spent in the gallery	12 : 45

(Figure 5.14 : Observed Total Visitor Time in the Gallery)

Observed total time in the gallery (n=50)	
Average Total Time in Gallery	Percentage
1 – 5 Min	24%
6 – 10 Min	22%
11 – 15 Min	26%
16 – 20 Min	10%
21 – 25 Min	14%
26 – 30 Min	2%
30+ Min	2%

(Figure 5.15 : Total Time in the Gallery)

Observed time in the gallery (n=50)	
Area of the Gallery	Min : Sec
Average Time within the Observation Area	6 : 17
Average Time outside the Observation Area	6 : 28

(Figure 5.16 : Observed Visitor Time inside and outside the observation area)

Observed time in the gallery (n=50)	
Area of the Gallery	Percentage
Within The Observation Area	49%
Outside The Observation Area	51%

(Figure 5.17 : Percentage of Total Time spent inside and outside the observation area)

Visitors who left the observation area (n=50)	
Observed Behaviour	Percentage
Visitors who did not leave the observation area	4%
Visitors who left the observation area	96%

(Figure 5.18 : Percentage of Visitors leaving the observation area)

5.1.4.2 Observed Visitor Behaviour

Figure 5.19 shows the average duration of behaviours exhibited by visitors whilst within the observation area.

<i>Duration of observed behaviours</i>		<i>(n=50)</i>
Observed Behaviour	Min : Sec	
Looked at Textile Machines	2 : 05	
Looked at Other Exhibits	1 : 03	
Looked at Text information Panels	1 : 47	
Touched Exhibits or Cotton Samples	0 : 13	
Pointed at Exhibits	0 : 03	
Walked between exhibits	0 : 08	
Talked to a Member of their group	0 : 25	
Talked to Demonstrators or Museum Staff	0 : 30	

(Figure 5.19 : Duration of Observed Visitor Behaviour)

5.1.4.3 Analysis of Observed Visitor Behaviour

Visitors from the control group spent on average almost 13 minutes in the gallery between surveys. Almost a quarter of the visitors spent less than 6 minutes in the gallery. The majority of visitors from the control group divided their time almost equally between exhibits inside and outside the observation area. Therefore it would appear that visitors from the control group found exhibits inside and outside the observation area to be approximately of equal interest. When they were inside the observation area visitors spent most of their time looking at the textile machines, looking at other exhibits outside the observation area and reading the text information panels.

5.1.4.4 Summary of Observed Visitor Behaviour

The findings of observed visitor behaviour for the control group are summarised below:

- 12min 45sec Average total time in the gallery
- 49% of Total Time within Observation Area
- 51% of Total Time outside Observation Area
- 96% of visitors left the Observation Area
- 72% of visitors spent 1-15min Total Time in the Gallery
- 24% of visitors spent less than 6min in the Gallery
- Observed Behaviours:
 - *Looking at Textile Machines - 2min 5sec*
 - *Looking at Text Panels - 1min 47sec*
 - *Looking at Other Exhibits - 1min 3sec*

5.2 COMPUTER GROUP: Findings and Analysis

This section details findings of the data collected during the visitor evaluation study, and provides an analysis and summary for those visitors who experienced the gallery using the portable computer and interactive multimedia application. Specifically this section:

- Examines the profile of visitors who participated in the evaluation study
- Evaluates the findings both pre- and post-visit surveys used to identify visitors prior knowledge of textile machines and the cotton process
- Examines visitors opinion of the gallery
- Assesses the observed behaviour of visitors using the portable computer
- Examines visitor opinion of the portable computer
- Evaluates the visitors interaction with the portable computer based upon the data contained within the interaction logs

5.2.1 Visitor Classification and Profile

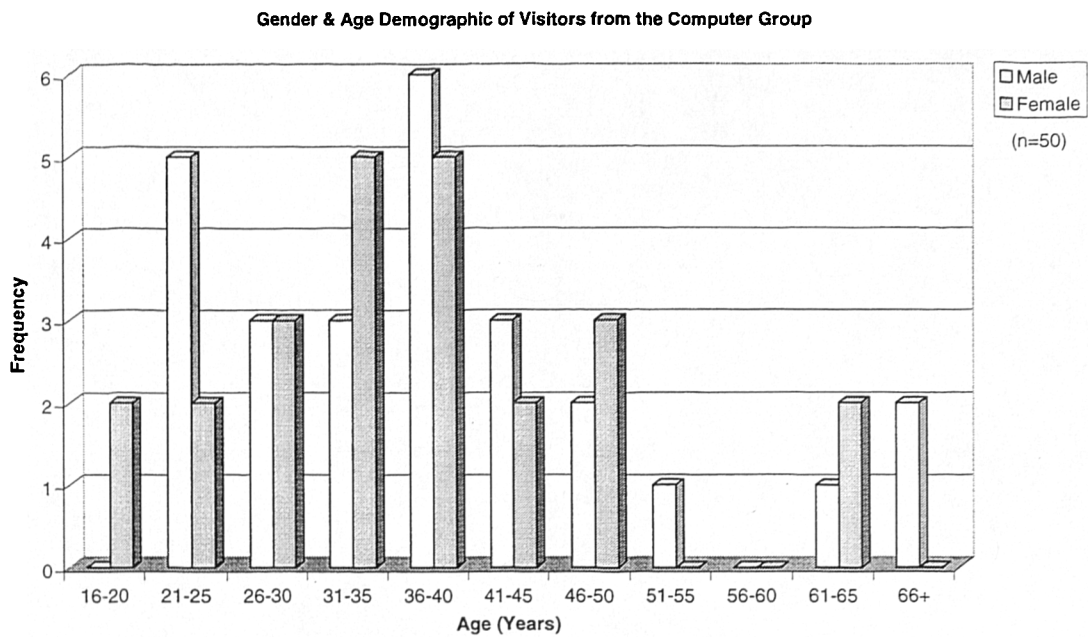
This section analyses the classification and demographic profile of the museum visitors from the computer group who participated in the study.

5.2.1.1 A Profile of Visitor Demographics

Figures 5.20 through 5.22 show the gender distribution within the computer group, and the distribution of visitors from each group across the spectrum of age ranges.

<i>Age range of the computer group</i>		<i>(n=50)</i>	
Age Range	Male	Female	
16 – 20 years	0%	4%	
21 – 25 years	10%	4%	
26 – 30 years	6%	6%	
31 – 35 years	6%	10%	
36 – 40 years	12%	10%	
41 – 45 years	6%	4%	
46 – 50 years	4%	6%	
51 – 55 years	2%	0%	
56 – 60 years	0%	0%	
61 – 65 years	2%	4%	
66+ years	4%	0%	

(Figure 5.20 : Age range of the Computer Group)



(Figure 5.21 : Age range of the Computer Group)

Gender distribution of visitors		(n=50)
Gender	Percentage	
Male	52%	
Female	48%	

(Figure 5.22 : Gender distribution of Visitors)

5.2.1.2 A Profile of Textile Museums and Textile Heritage Attraction Visits

Figures 5.23 through 5.25 show the number of visitors who had previously visited similar museums with a textile gallery. They indicate which attractions had been visited, and also the number of visitors who had visited the Fibres, Fabrics and Fashion gallery before participating in the present study.

Prior visitation to a museum textile gallery or textile mill		(n=50)
Prior Visitation	Percentage	
Had previously visited similar textile galleries	54%	
Had not previously visited similar textile galleries	46%	

(Figure 5.23 : Prior visitation to a museum with a textile gallery or textile mill)

Textile museum and textile mills previously visited		(n=50)
Textile Mill or Museum	Percentage	
Quarry Bank Mill	32%	
Wigan Pier	10%	
Helmshaw Textile Museum	8%	
Macclesfield Silk Museum	8%	
Science Museum (London)	2%	
Others	28%	

(Figure 5.24 : Textile Museums and Textile Mills previously visited)

<i>Prior visitation to the Fibres, Fabrics and Fashion gallery (n=50)</i>	
Prior Visitation	Frequency
Had previously visited	30%
Had not previously visited	70%

(Figure 5.25 : Prior visitation to the Fibres, Fabrics and Fashion gallery)

5.2.1.3 Refusals to Participate in the study

Nine visitors refused to participate in the study, for the following reasons:

- Not enough time – 6 visitors
- Non-English speaker – 2 visitors
- Not willing to be involved – 1 visitor

5.2.1.4 Analysis of Visitor Classification & Profile

The computer group was composed of approximately equal numbers of male and female visitors. The majority of visitors in this group were concentrated towards the younger end of the age range, under 50 years of age.

Approximately half of the visitors from the computer group had already visited a textile museum before, Quarry Bank Mill was the most popular, followed by Wigan Pier, Helmshaw Textile Museum and the Macclesfield Silk Museum, again all local heritage attractions.

5.2.1.5 Summary of Visitor Classification & Profile

The findings of visitor classification and profile for the computer group are summarised below:

- Male 52% and Female 48%
- 88% of visitors below 50 years of age
- Even distribution of Male and Female visitors over age ranges
- 54% of respondents had previously visited a Textile Museum, notably Quarry Bank Mill
- 30% of respondents had previously visited the Fibres, Fabrics and Fashion gallery

5.2.2 Visitor Recognition and Recall

This section evaluates the data collected during both the pre- and post-visit surveys used to evaluate visitor knowledge of textile machines both before and after visiting the gallery.

5.2.2.1 Recognition of a Textile Machine and Process

During both the pre- and post-visit surveys visitors were shown a black and white photograph and asked to identify the Textile Loom and the process it performed. Figures 5.26 through 5.29 illustrate the findings.

Recognition of a textile loom and textile process			(n=50)
	Pre-Visit	Post-Visit	
Recognition of a Textile Loom	52%	70%	
Recognition of the Weaving process	52%	70%	
Visitors who could not recognise the machine or process	40%	30%	
Incorrect recognition of the machine or process	8%	0%	

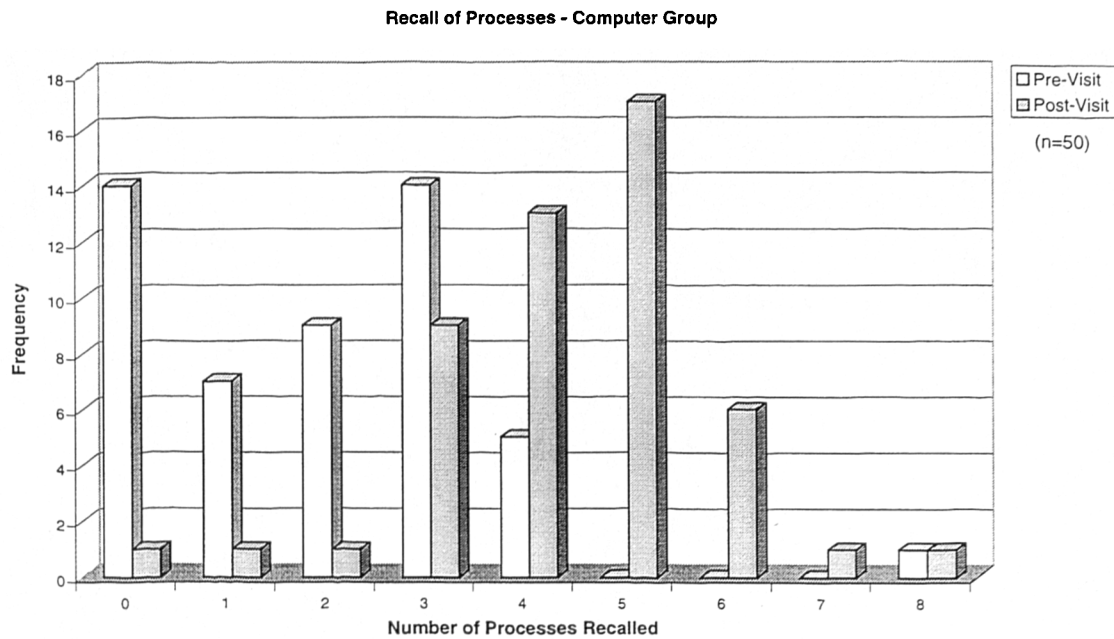
(Figure 5.26 : Recognition of Textile Machine & Process)

5.2.2.2 Recall of Processes

Visitor's ability to recall the processes involved in transforming cotton from a raw material into a finished fabric, were also evaluated during the pre-visit and post-visit surveys. Figures 5.27 through 5.29 show the number of processes, which visitors from both groups correctly identified before and after their visit to the gallery, and the frequency with which individual processes were recalled.

Recall of process involved in transforming cotton			(n=50)
Number of Processes correctly recalled	Pre-Visit	Post-Visit	
0	28%	2%	
1	14%	2%	
2	18%	2%	
3	28%	18%	
4	10%	26%	
5	0%	34%	
6	0%	12%	
7	0%	2%	
8	2%	2%	

(Figure 5.27 : Number of Processes Recalled)



(Figure 5.28 : Number of Processes Recalled)

Recall of individual processes (n=50)		
Processes Recalled	Pre-Visit	Post-Visit
Spinning	50%	92%
Weaving	48%	86%
Carding	32%	72%
Unpacking	2%	60%
Drawing	12%	44%
Washing / Cleaning	26%	36%
Dyeing	10%	22%
Winding	2%	12%
Harvesting	4%	6%
Printing	4%	4%
Bleaching	0%	2%

(Figure 5.29 : Recall of Individual Processes)

5.2.2.3 Analysis of Visitor Recognition and Recall

The pre-visit questionnaire conducted on entry to the gallery revealed that just over half of visitors from the computer group were able to correctly identify the textile machine from the photograph as a loom and the process it performed.

The post-visit survey completed on exit shows the proportion of visitors from the computer group who were able to correctly identify the machine and process increased from 52% to 70%, representing an 18% increase.

Further analysis identified that gender had minimal impact upon the results. It was noted that visitors from the computer group above the age of 41 years were frequently more able to identify the textile machine and process both pre- and post-visit.

On average two textile processes could be correctly recalled by visitors from the computer group during the pre-visit survey. However during post-visit surveys visitors from the computer group were able to recall an average of 4 processes. Before visiting the gallery 14 visitors from the computer group were unable to recall a single textile process. However using the portable computer in the gallery only one visitor was still unable to identify a single process, and 94% of visitors were able to recall at least 3 processes, suggesting the portable computer had had a significant impact on knowledge gains and recall.

The textile processes most frequently recalled by visitors from the computer group, before and after their visit to the gallery were spinning, weaving, carding, unpacking and drawing. Gender had little effect on the visitor's recall of processes.

The findings indicate increased recall of textile process by visitors during the post-visit questionnaire. However the limitation of this approach is recognised, as it measures short term recall gains, and it is acknowledged that a long term retention test may have produced different results.

5.2.2.4 Summary of Visitor Recognition and Recall

The findings of visitor recognition and recall for the computer group are summarised below:

- 52% of visitors could correctly identify the textile machine and the process it performed on entry to the gallery
- There was an 18% increase in visitors ability to identify a textile machine and the process it performs after their visit
- There was an increase in average number of processes correctly recalled from 2 to 4
- Only one visitor was unable to recall a single process post-visit
- Most frequently recalled processes were:
 - *Weaving*
 - *Spinning*
 - *Carding*
 - *Unpacking*
 - *Drawing*

5.2.3 Visitor Opinion

This section reviews the visitors opinions of the Fibres, Fabrics and Fashion gallery, the portable computer and how it may have affected the way in which they explored the exhibits and their level of learning whilst visiting the gallery.

5.2.3.1 Visitor Opinion of the Gallery: Post-Visit

This section examines visitor opinion of the Fibres, Fabrics and Fashion gallery on completion of their visit. Figures 5.30 and 5.31 detail features which were most popular and least popular with visitors.

What visitors liked best about the gallery (n=50)	
Feature of the Gallery	Percentage
Textile Machines	34%
Layout of the Gallery	24%
Textile Process	16%
Exhibits outside the Observation Area	6%
Information	6%
Educational Content	4%
Explanation of the Textile Industry	4%
Portable Computer	4%
Found the gallery Interesting	2%
Hands-On Interactives	2%
Presentation & Design of the gallery	2%
Audio	2%
Videos	2%

(Figure 5.30 : Features which were most popular with visitors)

What visitors liked least about the gallery (n=50)	
Feature of the Gallery	Percentage
Could not see the textile machines working	18%
Exhibits in other areas	10%
No Date Progression / Time Line	2%
Nothing Specific	70%

(Figure 5.31 : Features which were least popular with visitors)

5.2.3.2 Visitor Opinion of the Portable Computer

Visitors from the computer group were asked for their opinions of the portable computer and its ease of use during the post-visit survey. These findings are detailed in figures 5.32 through 5.37.

Popularity of use of the portable computer (n=50)	
Opinions of the portable computer	Percentage
Liked using the Computer	96%
Did Not like using the Computer	8%

(Figure 5.32: Popularity of the portable computer with visitors)

<i>Ease of use of the portable computer</i> (n=50)	
Opinions of the portable computer	Frequency
Found the Computer Easy to use	90%
Did Not find the Computer Easy to Use	10%

(Figure 5.33 : Ease of use of the portable computer)

<i>Popular features of the portable computer</i> (n=50)	
Feature	Percentage
Videos / Animations	44%
Information on the textile process	22%
Easy to Use	18%
Visual Screen Design	12%
Audio	10%
See what you want at your own pace	8%
Education / Learning	4%
Aids Understanding	2%
Places exhibits in context	2%
Makes you look at exhibits	2%
Convenient way to access information	2%
Flexibility of Program	2%
Personal nature of the experience	2%
New Technology	2%
Touch Screen	2%
Nothing Specific	6%

(Figure 5.34 : Features of the portable computer which were popular with visitors)

<i>Unpopular features of the portable computer</i> (n=50)	
Feature	Percentage
Heavy	46%
Distracts from Exhibits	14%
Not Easy to Use	4%
Not Sure which areas are Hotspots	4%
Repeated Commentary	4%
Wanted more information	4%
Didn't know what to do	2%
Not sure what animation show	2%
Text on Buttons was too small	2%
Video was too small	2%
Not Needed – Enough information already	2%
Too many levels to get to video	2%
Missing Room / Textile Machine	2%
Hard to locate where you are standing	2%
Poor definition between instructions & main program	2%
Nothing Specific	32%

(Figure 5.35 : Features of the portable computer which were unpopular with visitors)

Features which made the portable computer easy to use (n=50)	
Feature	Percentage
Touch Screen	56%
Flexible / Straight Forward Structure	12%
Clear Buttons	12%
Help System	8%
Gallery Map	8%
Instructions	6%
Screen Design	2%
Link from Room Illustrations to Machines	2%
None	2%

(Figure 5.36 : Features of the portable computer which made it easy to use)

Features which made the portable computer difficult to use (n=50)	
Feature	Percentage
Didn't know what to do	2%
Hard to find my location in the Gallery	2%
Hard to link (Exhibits – Text Panels – Computer)	2%
Not always sure which areas were hotspots	2%
Room illustrations did not match the gallery	2%

(Figure 5.37 : Features of the portable computer which made it difficult to use)

It is important to note that 2% of the sample represents just a single visitor.

5.2.3.3 Visitor Opinions on Depth of Exploration and Learning

During the post-visit survey visitors from the computer group were asked if using the portable computer had influenced how deeply they had explored the textile machine exhibits and what they had learnt about them. The results are shown in figures 5.38 and 5.39.

Visitor opinion on depth of exploration (n=50)	
Did the computer help you to explore the textile machinery and the cotton process more than you would have done normally?	
Depth of Exploration	Percentage
Explored in More Detail	84%
Explored in Less Detail	16%

(Figure 5.38 : Depth of exploration using the portable computer)

Visitor opinion on their level of learning (n=50)	
Do you think that you have learnt more about the textile machinery and the cotton process by using the computer than you would have done normally?	
Level of Learning	Frequency
Learnt More	92%
Learnt the Same	2%
Learnt Less	6%

(Figure 5.39 : Level of learning using the portable computer)

5.2.3.4 Analysis of Visitor Opinion

The most popular feature of the textile gallery with visitors from the computer group was the textile machines themselves, followed by the layout of the gallery, as it provided a good vantage point to see the textile machines and thirdly the cotton process itself.

Exhibits outside the textile machine area, were not high on the list of favourite elements for visitors from the computer group. Again it was surprising that no visitors mentioned the office or the interactive elements of the gallery.

Two visitors identified the portable computer as one of their favourite aspects of the gallery.

When asked what they liked least about the textile gallery the majority of visitors from the computer group were unable to identify anything specific.

Most visitors from the computer group commented that they liked using the portable computer and interactive multimedia application. The most popular elements noted were the videos and animations of working textile machines, the information provided, the ease of use, the visual screen design and audio narration.

Almost half of the sample identified the weight of the portable computer as the least liked element, as some found it rather heavy. Approximately a third of visitors expressed the view that there was nothing they could identify which they disliked about the portable computer and interactive multimedia application. A few visitors were concerned that the portable computer may have distracted their attention from other exhibits.

The majority of visitors expressed the view that the portable computer and interactive multimedia application was easy to use. Over half identified that the touch screen as the single element which most contributed to the ease of use.

The majority of visitors who had used the portable computer stated that in their opinion they had explored the textile machines in more detail and they had learnt more about the

textile machines and the cotton process using the portable computer than they would have done without it.

5.2.3.5 Summary of Visitor Opinion

The findings of visitor opinions for the computer group are summarised below:

- Most popular elements
 - *Textile Machines* - 34%
 - *Layout of the Gallery* - 24%
 - *Cotton Process* - 16%
 - *Nothing Specific* - 12%
- Least popular elements
 - *Nothing Specific* - 70%
 - *No working textile machines* - 18%
 - *Exhibits Outside Observation Area* - 10%
- 92% of visitors liked using the portable computer
- 90% of visitors found the portable computer easy to use, the touch screen being the main reason cited - 56%
- Most popular Features of the Portable Computer
 - *Videos & Animations* - 44%
 - *Information* - 22%
 - *Ease of Use* - 18%
 - *Nothing Specific* - 6%
- Least popular Features of the Portable Computer
 - *Heavy* - 46%
 - *Distracts from Exhibits* - 14%
 - *Nothing Specific* - 32%
- 84% of visitors thought they explored the textile machines in more detail using the portable computer
- 92% of visitors thought they learnt more about the textile machines using the portable computer

5.2.4 Observed Visitor Behaviour

As visitors from the computer group explored the gallery, the observed duration of their visit and individual behaviours exhibited were recorded within an accuracy of one second, using a second portable computer and computerised observation schedule. The term “Observation Area” is used to describe the area of the gallery immediately surrounding the textile machines. The layout of the gallery and the exhibits encompassed by the “Observation Area” are shown in figure 5.13.

5.2.4.1 Observed Time in the Gallery

Figures 5.40 through 5.45 show the average duration for which visitors were observed in the gallery, and how visitors divided their time between those exhibits within and outside the observation area. Upon completion of the post-visit questionnaire a number of visitors from the computer group remained within the gallery to examine exhibits outside the observation area, this additional observed time, is indicated by the term “Extra Time” in Spreadsheet D in Appendix D, but is omitted from the tables in this section.

Observed total time in gallery (n=50)	
Total Time in Gallery	Min : Sec
Average total time spent in the gallery	12 : 36

(Figure 5.40 : Observed Total Visitor Time in the Gallery)

Observed total time in gallery (n=50)	
Total Time in Gallery	Percentage
1 – 5 Min	2%
6 – 10 Min	44%
11 – 15 Min	30%
16 – 20 Min	16%
21 – 25 Min	6%
26 – 30 Min	2%
30+ Min	0%

(Figure 5.41 : Total Time in the Gallery)

Observed time in the gallery (n=50)	
Area of the Gallery	Min : Sec
Average Time within the Observation Area	11 : 34
Average Time outside the Observation Area	1 : 02

(Figure 5.42 : Observed Visitor Time inside and outside the observation area)

Observed time in the gallery (n=50)	
Area of the Gallery	Percentage
Within The Observation Area	92%
Outside The Observation Area	8%

(Figure 5.43 : Percentage of Total Time spent inside and outside the observation area)

Visitors who left the observation area (n=50)	
Observed Behaviour	Percentage
Did not leave the Observation Area	34%
Left During Observation Only	22%
Left After Observation Only	36%
Left During & After Observation	8%

(Figure 5.44 : Number of Visitors leaving the observation area)

5.2.4.2 Observed Visitor Behaviour

Figure 5.45 shows the average duration of behaviours exhibited by visitors whilst within the observation area.

<i>Duration of observed behaviours</i> (n=50)	
Observed Behaviour	Min : Sec
Looked at Textile Machines	1 : 53
Looked at Other Exhibits	0 : 31
Looked at Text Panels	1 : 20
Touched Exhibits or Cotton Samples	0 : 03
Walked between exhibits	0 : 01
Talked to a Member of their group	0 : 12
Used or Looked at the Computer	7 : 28
Showed the computer to other visitors	0 : 05

(Figure 5.45 : Duration of Observed Visitor Behaviour)

5.2.4.3 Analysis of Observed Visitor Behaviour

The majority of visitors left the observation area at some point during their visit, either whilst being observed or after the completion of the post-visit survey, spending approximately three-quarters of their time inside the observation area and the remainder of their time outside this area. Whilst inside the observation area visitors spent the majority of their time looking at or using the portable computer, looking at the textile machines, looking at other exhibits and reading the text panels.

5.2.4.4 Summary of Observed Visitor Behaviour

The findings of observed visitor behaviour for the computer group are summarised below:

- 12min 36sec average total time in the Gallery
- 92% of total time within Observation Area
- 89% of total time outside Observation Area
- 66% of visitors left the Observation Area
- 90% of visitors spent 6-20min total time in the Gallery
- 98% of visitors in the sample spent more than 6min in the Gallery
- Observed Behaviours:
 - *Looking at or using the Portable Computer - 7min 28sec*
 - *Looking at Text Panels - 1min 20sec*
 - *Looking at Textile Machines - 1min 53sec*
 - *Looking at Other Exhibits - 31sec*

5.2.5 Computer Interaction

Figures 5.46 through 5.51 indicate how many visitors accessed different sections of the interactive multimedia application, for what duration of time and which levels of the application they accessed.

Access to each section of the application (n=50)	
Section	Percentage of Visitors
From Cotton Field to Mill	98%
Blowing Room	86%
Carding Room	98%
Spinning Room	98%
Weaving Shed	88%
Instructions	98%
Help Section	12%
Gallery Map	28%

(Figure 5.46 : Number of visitors who accessed each section)

Average duration of access to each section (n=50)	
Section	Min : Sec
From Cotton Field to Mill	1 : 16
Blowing Room	1 : 25
Carding Room	2 : 37
Spinning Room	2 : 32
Weaving Shed	2 : 39
Instructions	1 : 58
Help Section	0 : 56
Gallery Map	0 : 58

(Figure 5.47 : Average duration of access per visitor to each section)

Percentage of each section accessed (n=50)	
Section	Percentage of Section
From Cotton Field to Mill	40.0%
Blowing Room	23.3%
Carding Room	30.1%
Spinning Room	47.7%
Weaving Shed	41.4%
Whole Application	37.2%

(Figure 5.48 : Average percentage of each section accessed)

Depth of access of the application (n=50)	
Depth of Access	Percentage of Visitors
Top Level Only + Sub-Levels 1 & 2	82%
Top Level Only + Sub-Level 1	8%
Top Level Only	8%
Did Not Use The Application	2%

(Figure 5.49 : Depth of Access)

<i>Duration of access to each sub-section type</i>					<i>(n=50)</i>
	From Cotton Field to Mill	Blowing Room	Carding Room	Spinning Room	Weaving Shed
Main Screen	47sec	29sec	49sec	55sec	45sec
Textile Machine	-	54sec	49sec	58sec	54sec
Person	-	19sec	34sec	29sec	17sec
Object	20sec	14sec	36sec	33sec	14sec
Video	-	29sec	24sec	38sec	34sec
Animation	-	10sec	14sec	26sec	20sec
Other	25sec	0sec	0sec	-	16sec

(Figure 5.50 : Average duration of access to each sub-section type per visitor accessed)

<i>Access to each textile machine section</i>		<i>(n=50)</i>
Textile Machine	Percentage of Visitors	
Hopper Feeder	18%	
Scutcher	32%	
Carding Engine	48%	
Drawing Frame	48%	
Spinning Frame	20%	
Spinning Mule	72%	
Lancashire Loom	34%	
Jacquard Loom	54%	

(Figure 5.51 : Number of visitors who accessed each textile machine)

5.2.5.1 Analysis of Computer Interaction

Analysis of the data generated by the interaction logs, found that all visitors accessed the instructions, with exception of a single visitor who returned the portable computer, unused. This visitor was male, aged 21-25, and had previously visited the Museum of Science and Industry in Manchester, but not the Fibres, Fabrics and Fashion gallery. Six of the sample accessed the help section once, on each occasion for approximately 1min. It was noted that almost a quarter of visitors accessed the gallery map.

Overall most visitors accessed about one third of the entire application and the majority accessed each main section. Generally a larger proportion of the later sections were accessed and for a longer duration compared to earlier sections, suggesting that as visitors become more familiar using the computer they gained confidence and explored further.

Further analysis of the depth to which each visitor explored the application, revealed that the majority of visitors accessed the full depth of the information available within

the application including the videos and animations showing the textile machines working.

Visitors spent the largest proportion of their time looking at the sections featuring the textile machines. The average duration times are similar for each textile machine, therefore it appears that all textile machines once accessed were of approximately equal interest to visitors. The most frequently accessed textile machines were the Spinning Mule and the Jacquard Loom.

On average visitors spent approximately 30sec watching the videos of the textile machines working, this compares with about 20sec watching the computer generated animations.

5.2.5.2 Summary of Computer Interaction

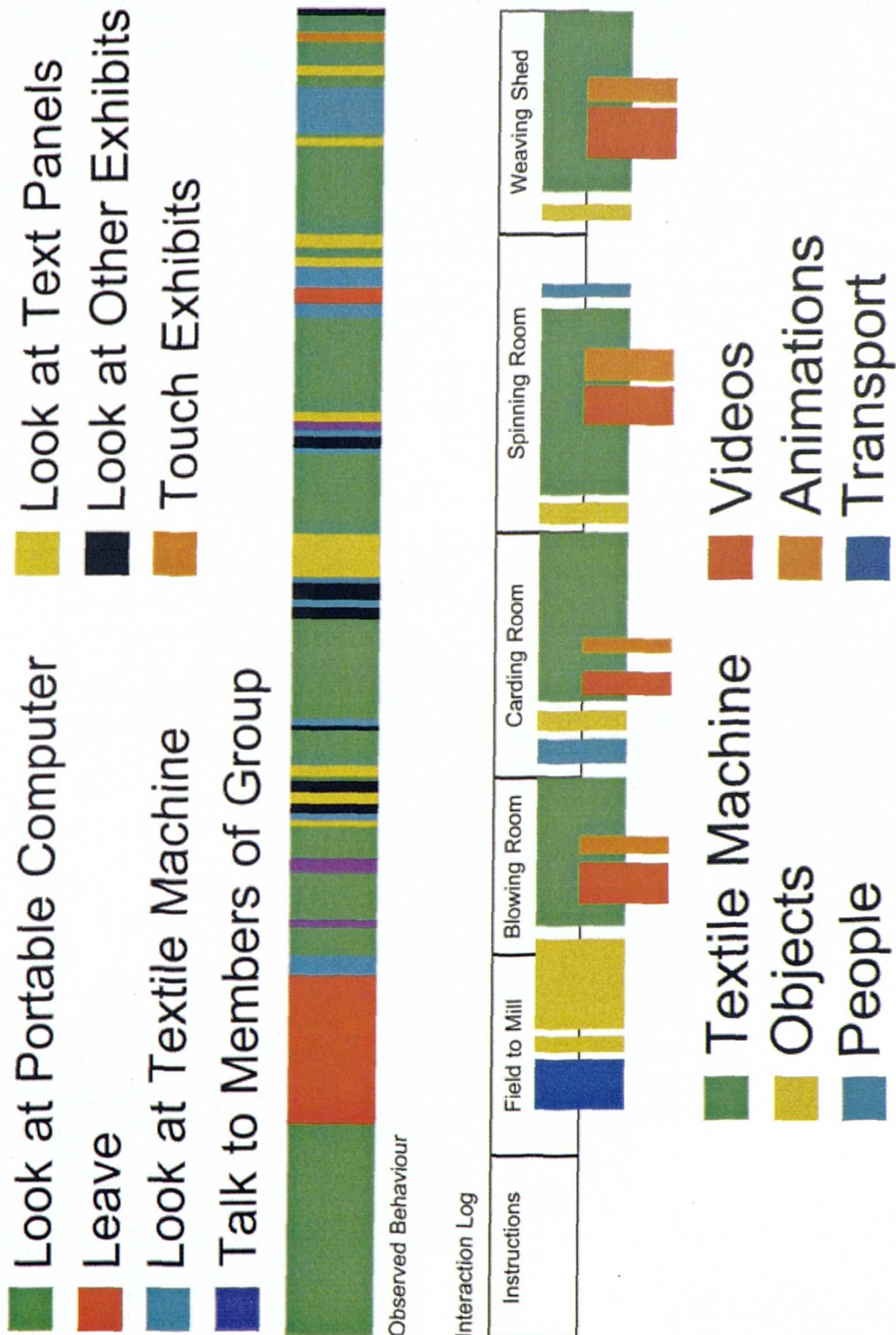
The findings of computer interaction for the computer group are summarised below:

- All main sections were accessed by over 85% of visitors
- An average of 37% of the whole application was accessed
- 82% of visitors accessed all levels of the application
- Average Time Spent in main sections
 - *Field To Mill* - 1min16sec
 - *Blowing Room* - 1min25sec
 - *Carding Room* - 2min37sec
 - *Spinning Room* - 2min32sec
 - *Weaving Shed* - 2min39sec
 - *Instructions* - 1min58sec
 - *Help* - 56sec
 - *Map* - 58sec
- Average Time Spent in sub-sections types
 - *Main Screen* - 45sec
 - *Textile Machine* - 54sec
 - *People* - 25sec
 - *Objects* - 23sec
 - *Videos* - 31sec
 - *Animations* - 20sec

5.2.5.3 Comparison of Observed Behaviour and Computer Interaction Logs

The data log times for each screen were potential maximums, as it could not be assumed that the visitor was actually looking at the screen for the whole of the recorded duration

for each screen. Therefore it was identified that comparing the data logs and observed behaviours may reveal valuable insights. A comparison of observed behaviour and recorded data logs is shown below in figure 5.52.



(Figure 5.52 : Comparison of Observed Behaviour and Computer Interaction Logs)

5.3 Synthesis of Findings

Central to this thesis was a consideration of the use and effectiveness of the portable computer and interactive multimedia application. The researcher, as the designer of the interactive multimedia application needed to be aware of the way in which visitors to the museum gallery used the portable computer and to assess its feasibility. It is intended that the analysis of survey data presented in this chapter will contribute directly to knowledge and will provide a sound basis upon which future studies can build.

Four key areas have provided a focus for the visitor evaluation study:

- Visitor use of and interaction with the portable computer
- Visitor opinion and response to the portable computer
- The effect of the portable computer on visitor behaviour
- The effect of the portable computer on visitor knowledge and understanding

5.3.1 Visitor Use and Interaction with the Portable Computer

As explained in section 3.3.1 the interactive multimedia application was designed so that visitors had to complete the instructions before entering the main application. Visitors who accessed the Instructions section did so for an average of 1min 58sec. It was calculated that the minimum time required to complete all the instructions was 1min 40sec. Therefore it appears that most visitors may have read or listened to the instructions before accessing the main application. Having completed the instructions a small number of visitors were still unsure of what to do at a point during their visit. However the interaction logs clearly show that those visitors were able to get the assistance they required in a single access to, and without completing the entire help section.

Almost a quarter of visitors looked at the gallery map. Therefore it would appear that after this the majority of visitors were able to orient themselves in the gallery and navigate the interactive multimedia application using the text panels in the gallery. A small number of visitors accessed the gallery map on several occasions indicating that they found it a useful way to identify their position in the gallery and relevant section of the interactive multimedia application. As only a single visitor commented that “they found it difficult to determine their location in the gallery”, it appears that the combination of text panels and gallery map provided visitors with effective ways to

orient themselves within the gallery and access the corresponding sections of the interactive multimedia application.

Overall, visitors accessed about one third of the entire application, with the majority of visitors accessing each main section. Generally, a larger proportion of the later sections were accessed and for a longer duration compared to earlier ones. Initially, visitors may have been familiarising themselves with the interactive multimedia application and the portable computer before later exploring in more depth. A number of visitors were observed walking past the exhibits contained in the second section of the application (Blowing Room) whilst still reading the instructions. This may also indicate that an alternative procedure to explain to visitors how to use the portable computer and interactive multimedia application may be preferential. One visitor suggested “that you could do with a quiet area where you could sit down, do the instructions and get used to it first before you walk round the gallery.”

Further analysis of the depth to which each visitor explored the application revealed that the majority of visitors accessed the full depth of the information available within the application, including the videos and animations showing the textile machines working. Approximately a tenth of the visitors accessed at least one sub-level displaying additional information relating to the selected textile machine, person or object. Almost another tenth of the visitors only accessed the main screens of the interactive multimedia application depicting the textile mill room illustrations, but no deeper. Only one visitor chose not to use the portable computer during their visit. Therefore, it appears that the majority of the visitors surveyed understood how to use the interactive multimedia application and accessed the full depth of the information available.

Those visitors who were surveyed spent the largest proportion of their time looking at the sections featuring the textile machines. The duration times are similar for each textile machine, therefore it appears that all textile machines once accessed were of approximately equal interest to visitors. The most frequently accessed textile machines were the Spinning Mule and the Jacquard Loom. Therefore it appears that the pre-visit recognition test using a weaving loom did not influence the most frequently accessed textile machines.

On average visitors spent approximately 30sec watching the videos of the textile machines working, this compares with about 20sec watching the computer generated animations. The animations were designed to loop continuously and typically have a cycle of only a couple of seconds. Therefore once a visitor has seen a few seconds of the animation they will not see any additional information if they continue to view the animation. However if visitors continued to view the video clips they would see additional information and angles of the textile machine at work, and this may explain the longer viewing duration for the video clips compared to animation. Several visitors also commented that the animations would benefit from additional information to explain what they were showing either in the form of audio narration or textural information. This may indicate that in some cases the animations were too abstract and require additional explanation, although during the design phase several people consulted, including the gallery curator had commented that the animations were one of the strongest points of the interactive multimedia application. It may also indicate that visitors simply wanted more information and therefore were more fully engaged and actively involved.

It is also interesting to note that visitors did not access sections in either the Blowing Room and the Carding Room. These sections contained information on how the textile machines were powered, including waterwheels and steam engines. This lack of access may be result of visitors not being interested in these subject areas. However, as not a single visitor accessed either section it is perhaps more likely that the visitors thought the hotspots for these sections were part of the background and did not realise they linked to additional information. Therefore, a method of making these hotspots more obvious to visitors may be required. However, as only a single visitor commented that they had had difficulty in identifying some of the hotspots, the exploratory visual design metaphor was otherwise successful.

5.3.2 Visitor Opinion of the Portable Computer

Two visitors from the computer group identified the portable computer as one of their favourite aspects of the gallery. The portable computer and interactive multimedia application was designed to be as transparent as possible (Morrison 1995) and to assist visitors in understanding the exhibits, not to replace them so this is a positive endorsement of the concept and the design of the interactive multimedia application.

Serrell and Raphling have commented that:

“Visitors are seeking the experience of technology, not content. Visitors are not really dying for more information. Their basic motivation is ‘What can this thing do?’ or ‘What can I do with this thing?’ Only if the program is really engaging will it be able to teach them something as they manipulate the technology.”

(Serrell and Raphling 1992)

For many visitors not seeing the textile machines working was the least liked feature of the gallery for both groups. It was anticipated that viewing video clips of the textile machines working on the portable computer would have overcome the disappointment of not seeing them actually working in the gallery. However, it appears that having seen the video clip of the textile machines working, visitors from the computer group were even more enthusiastic to see the machines working for real, or perhaps were more aware of what they were missing.

The majority of visitors from the computer group commented that they liked using the portable computer and interactive multimedia application. The most popular elements were the videos and animations of the textile machines working, the information provided, the ease of use, the visual screen design and audio narration. This was a clear endorsement that the design brief, which called for an application which would show the textile machines working, provide visitors with information, whilst being both easy to use and aesthetically appealing, had been achieved.

Almost half of the visitors identified the portable computer as being rather heavy. The weight of the unit had been identified early in the project as a potential problem and this was confirmed in use. However, no visitors returned the unit early saying it was too heavy to continue. Therefore the weight of the unit appears to be acceptable for use in a limited area. As this research project is reaching its conclusion smaller, lighter and more powerful portable computers are coming onto the market place and it is perceived that these units will be more suitable for the development of future hand held interpretative devices.

The majority of visitors surveyed noted that the portable computer and interactive multimedia application was easy to use. Over half identified the touch screen as the

single element which most contributed to the ease of use. However a touch screen is only one part of the solution as Koester explains:

“Easy to use interfaces actually refers to two design elements. One is the hardware interface, such as the touch screen on the computer and the other is the interface metaphor used, which refers to the navigation system incorporated into the screen design.”
(Koester 1993)

A high level of understanding and knowledge of interactive multimedia design and applications cannot be expected from the general museum visitor, and as such they could be expected to focus on the physical interaction interface. As most visitors enjoyed using the portable computer and interactive multimedia application, and had found them easy to use and had accessed the majority to the information available, it would appear that the discovery based interface metaphor of textile mill rooms made an effective contribution to the application’s ease of use. Serrell and Raphling explain that it is important to “Build in free choice and control for visitors”, and that it may be helpful to:

“Think of the visitors’ movement through the computer program as analogous to their movement through the entire exhibit or museum. Most visitors browse in museum exhibits, stopping at what catches their eye or piques their interest. Sometime they follow a sequence and move on to the next case, sometimes they quit and walk across the room. They know that they have the choice to move through an exhibit however they want. The same must be true for a computer environment.” (Serrell and Raphling 1992)

The majority of visitors who had used the portable computer stated that in their opinion they had explored the textile machines in more detail and they felt that they had learnt more about the textile machines and the cotton process using the portable computer than they would have done without it. Section 5.3.4 found a significantly larger increase in the number of visitors who used the portable computer, who could correctly identify a textile machine and the number of processes they could recall when compared to those who had not.

5.3.3 Visitor Behaviour

When the average total time spent by visitors was broken down into the time spent inside and outside the observation area, it was found that visitors from the control group divided their time almost equally between these two areas. It appears that visitors from the control group found the exhibits inside and outside the observation to be approximately of equal interest. However visitors who used the portable computer spent the majority of their time inside the observation area. This indicates that the portable computer had a significant impact upon the way visitors spent their time in the gallery, focusing their attention towards the area of the gallery for which additional interpretation was provided.

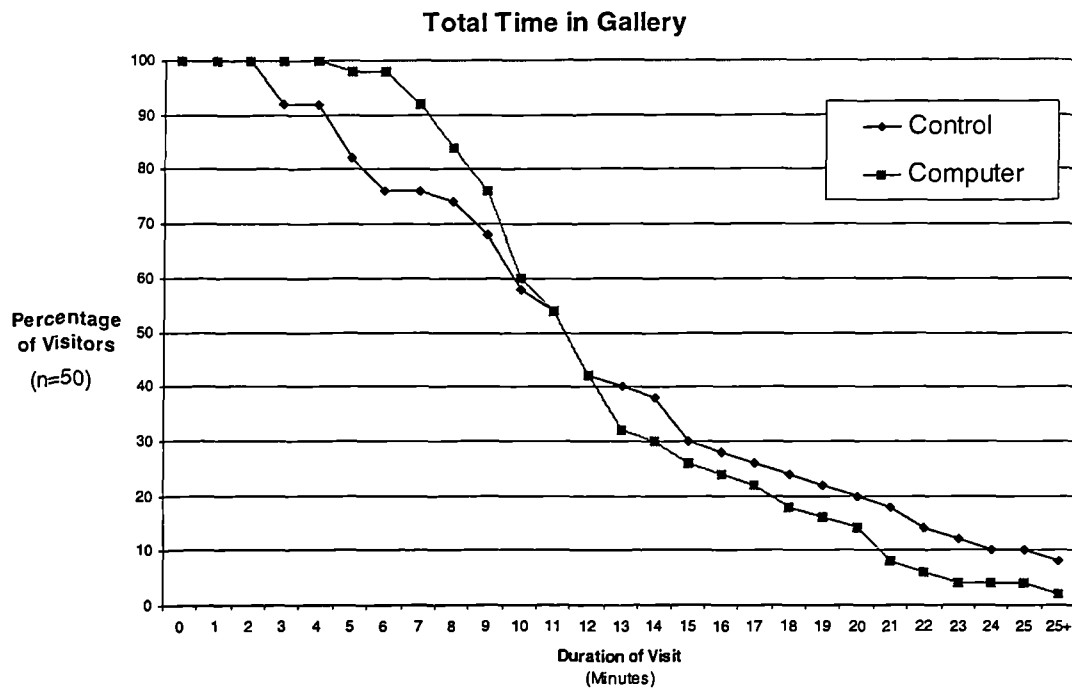
Visitors from both the control and computer group spent approximately the same average time looking at the textile machines. Visitors who used the portable computer spent less time than those visitors from the control group looking at or reading the text panels in the gallery. The interactive multimedia application on the portable computer contained the majority of the information displayed on the text panels in the gallery. Therefore it can be assumed that visitors were looking at the text panels in order to orient themselves in the gallery and to access the corresponding section of the interactive multimedia application, as was the intended approach.

Visitors from the computer group spending longer in the gallery and the observation area may indicate additional gains in knowledge about the textile machine exhibits was taking place. This was confirmed by the results of the pre-visit and post-visit survey discussed in section 5.3.4. These findings show clearly that visitors who used the portable computer spent longer in the textile gallery. A similar conclusion was drawn by Allison and Gwaltney based upon the results of their research into the effect of computer based interactives. They concluded that:

“... the time visitors spend with interactives seems to increase the normal amount of time they would have spent in the gallery if the interactives were not present.” (Allison and Gwaltney 1991)

Figure 5.53 shows that up to the average visit duration, approximately 12min for both the Control and Computer groups, a significantly greater proportion of the computer group remained in the gallery. However the proportion of visitors from the computer

group remaining in the gallery after this point was reduced when compared to the control group. For those visitors from the computer group, this may suggest a more



(Figure 5.53 : Total time in Gallery)

focused and consistent visit duration for all visitors, reducing the extremes of visitors staying for long times or leaving quickly. This may be advantageous, increasing the exposure and general quality of the visit for the majority of visitors. However it may also produce a homogenised experience, whereby the duration of the visitors exploration is constrained by the portable computer and interactive multimedia application. It is acknowledged that the majority of visitors from the computer group spending longer in the gallery may be significant of the additional orientation and familiarisation time required when exploring the gallery with the addition of a portable computer and interactive multimedia application.

Research into the effect of computer-based interactives and multimedia kiosks has identified a correlation between time spent in the gallery, exhibit effectiveness and learning. (Falk 1983, Haeseler 1989, Koran, Koran, Camp, and Donnelly 1996, Peart 1983) Harvey explains that "... spending more time in the hall ... is indicative of improved exhibit effectiveness." (Harvey et al 1993) Falk comments that the "... data strongly support the feasibility of using observable behaviour and time-at-exhibit as predictors of learning." (Falk 1983) or as Peart expresses it "... the longer visitors observed, the more they learnt." (Peart 1983)

The observation survey showed a distinct contrast between those visitors who used the portable computer and those who did not. In the observation area with its collection of redundant textile machines there was little to attract and hold the attention for visitors. On the other hand using the portable computer with its interactive multimedia application containing additional information, video clips and audio material, ensured full attention and interest.

5.3.4 Visitor Knowledge and Understanding

The pre-visit questionnaire conducted on entry to the gallery revealed that almost three quarters of visitors from the control group were able to correctly identify the textile machine from the photograph as a loom and the process it performed as weaving, compared to just over half of visitors from the computer group. This would indicate that visitors from the control group were initially more knowledgeable about textile machines and the cotton process than those visitors from the computer group. However after visiting the gallery those visitors who had used the portable computer showed a larger increase in the ability to identify a textile machine and the process it performed, than those visitors who had not.

A prominent difference between the two groups was also identified when examining those visitors who during the pre-visit survey were unable to identify a single process. Before visiting the gallery 15 visitors from the control group and 14 visitors from the computer group were unable to recall a single process. After visiting the gallery 10 visitors from the control group were still unable to recall a single process. This compares to the computer group where only one visitor was still unable to identify a single process, and where 47 visitors were able to recall at least 3 processes. Findings thus far indicate that using the portable computer may have contributed significantly to visitors ability to recall the names of textile processes irrespective of their prior knowledge. Importantly, it appears to be a particularly effective interpretative tool for visitors who had little or no prior knowledge of the subject area.

The research project has identified that those visitors who used the portable computer showed greater increases in their ability to recall the names of textile process than those visitors from the control group. However the limitations of this pre- and post-visit test are acknowledged, and the researcher is aware of the issues concerning short-term recall

and long-term memory and the differences between recall and knowledge, understanding or learning.

The textile processes most frequently recalled by visitors from both groups before and after their visit to the gallery were spinning, weaving and carding. This may be accounted for because the Spinning Jenny and the Weaving Loom are both well known textile machines. When visitors were asked to identify the textile machine in the photograph during the pre-visit and post-visit survey, the most frequent incorrect response or guess at identifying the textile machine was the Spinning Jenny. In fact it was the Weaving Loom, and thus may have increased the frequency with which the weaving process was recalled. It appears that carding is also a well known process, which many visitors may have seen demonstrated or even tried themselves at other textile orientated heritage attractions they have visited. Visitors using the portable computer frequently recalled the Unpacking and Drawing processes after their visit. The portable computer includes sub-sections on the Hopper Feeder, which unpacks cotton in the Blowing Room. Whereas the Hopper Feeder in the actual gallery is just a large metal box with minimal features for the visitor to observe, and it was the first exhibit inside the observation area which the visitor encountered. The researcher had noted that visitors from the control group frequently walked past this exhibit before stopping to examine other exhibits further inside the observation area.

The survey had identified that the prior visitation patterns of the control and computer group were different, with visitors from the computer group having previously visited substantially more textile mills and museums with a textile gallery than the control group. While it would be easy to assume that the computer group would have a higher level of knowledge of the subject area when they entered the gallery, in fact, more visitors from the control group correctly identified a textile machine and the process it performs from the photograph. However approximately the same number of visitors from each group recalled the same number of processes which take place in a textile mill. Therefore, it would appear that there was little previous knowledge gained from other textile attractions visited, and knowledge on entry to the gallery has no direct correlation with prior knowledge of the subject area within the findings of this research project.

It is interesting to note that the majority of visitors had visited similar venues and this may have had an impact on the results based on triggered recall. Almost one third of the computer group had previously visited the Fibres, Fabrics and Fashion gallery.

This research project has identified that the portable computer and interactive multimedia application may affect the duration of the visits, visitors observed behaviour and their ability to identify a textile machine and to recall textile process. It is acknowledged that any additional stimulus introduced into the gallery may have produced changes in visitor behaviour and recall. However was the intention that this research project would evaluate the feasibility of using a portable computer and interactive multimedia application to provide additional interpretation and not to prove that it is the definite interpretative tool for museums.

This chapter has provided an analysis and synthesis based upon the findings of a comprehensive visitor study. The chapter was divided into three sections, the first reviewed and analysed the findings for the control group and the second those findings for the computer group. The third and final section of this chapter provided a synthesis of the evaluation, high-lighting the key findings of the study.

The final chapter reviews the research project as a whole and draws conclusions based upon the findings of the evaluation study. Other recently identified research projects developing portable computers for enhanced interpretation within heritage attractions are reviewed. The chapter concludes by reviewing a number of issues raised by the research and proposing several areas identified as having the potential for future exploration.

Chapter 6

Discussion, Conclusions and Further Research

Chapter 6 Discussion, Conclusions and Further Research

The central aim of the visitor evaluation study was to evaluate the use and effectiveness of the portable computer with the museum visitors. The objective of the study was to provide insights into the ways in which visitors interacted with this innovative and novel interpretative device. The hypothesis was that a portable computer and interactive multimedia application have the potential to enhance interpretation and to become a new tool for interpreting museum collections.

This chapter presents a discussion of the research project and conclusions based upon the findings, and is divided into four main sections. The first, section 6.1 discusses the key findings and draws conclusions from the visitor evaluation study. The second, section 6.2 reviews other recent research projects with portable computers, examining the broader picture and placing the present research in context. This review culminates in the development of a taxonomy of portable computer research. The third, section 6.3 discusses the challenges, which face the introduction of portable computers into museum galleries. The fourth, section 6.4 discusses several areas, which have been identified as having potential for further research.

6.1 Key findings and Conclusions

The exploratory field survey identified the range of interactive multimedia applications in heritage attractions including museums in the United Kingdom, and provided a comprehensive survey of heritage attractions web sites. The exploratory research methods employed are discussed in Chapter 2: Research methods and the results of the exploratory research detailed in Appendix A. The body of the study fell into three distinct yet complementary research pathways, namely:

- To design an interactive multimedia application for a portable computer
- To examine the use and effectiveness of the portable computer on the museum visitor
- To assess the application as a new tool for interpretation in a museum setting

An interactive multimedia application was designed and developed for a portable computer, with the intention that together they would enhance the existing interpretation in a museum gallery, this process is discussed in Chapter 3 Design and Development.

The Fibres, Fabrics and Fashion gallery at the Museum of Science and Industry in Manchester was used as a case study and test bed site for the visitor evaluation study, which employed a multi-method approach as described in Chapter 4 Visitor Evaluation Study. A control group provided a body of evidence, which was compared with the findings from the computer group. However it was identified that there were significant differences between the profiles of the two groups, and this may have limited the conclusions which were drawn from the comparison of the two groups.

The findings of the visitor evaluation study facilitated an evaluation of the use and effectiveness of the portable computer with the museum visitors, and an assessment to be made of its potential as a new tool for interpretation museum collections. The conclusions drawn from the findings are detailed in Chapter 5 Visitor Evaluation Study: Findings, Analysis and Synthesis, with the key findings discussed in this chapter in section 6.1.1 through section 6.1.4. In assessing the potential of a portable computer as a new tool for interpreting museum collections a review of other recent research projects using portable computers is provided in section 6.2 and a discussion of the challenges facing the introduction of portable computers into museum galleries in section 6.3.

The findings are based upon data gathered during the visitor evaluation study, combining pre- and post-visit surveys, observation and interaction logging. This combination of multiple research methods has been found to be effective and successful in other studies of multimedia interactives in museum galleries. (Borun 1996, Fisher 1996, Jacobson 1991, Yin 1993) However there are limitations to this approach, as Lee explains:

“Whether it is called ‘informing’, ‘educating’ or ‘increased understanding’, the dominant aim of most visitor centres is to add to the knowledge of visitors. This is usually evaluated by questioning them on what they recall of the exhibits they have seen. Such approaches can be derided as ‘quiz questioning’. Taken alone, they certainly do not comprise a depth of understanding. But they can be valuable indicators, especially if carefully chosen to require comprehension of concepts as well as facts.” (Lee 1998)

The key findings from the visitor evaluation study fall into four main areas:

- Visitor use of and interaction with the portable computer
- Visitor opinion and response to the portable computer
- The effect of the portable computer on visitor behaviour
- The effect of the portable computer on visitor knowledge and understanding

Each of these areas is discussed in the following sections. However it should be remembered that the interactive multimedia application used for this research project and the textile gallery used as a test bed are both unique. Therefore it cannot be assumed that the results of this research would be true for other museums, although they may provide a strong indication of the results which can be expected. (Economou 1997a, Hayward and Loomis 1993, Thomas 1993)

6.1.1 Visitor Use and Interaction with the Portable Computer

Evaluation of the computer interaction logs suggested that the majority of visitors read the instructions, understood how to use the application and accessed the full depth of the available information. The sections relating to textile machines were accessed most frequently and for the longest duration.

Visitors from the computer group were observed reading the existing text panels within the gallery to determine their position and access the corresponding section of the interactive multimedia application. Analysis of the computer interaction logs revealed that some visitors may also have used the on screen gallery map for the same purpose. Although they may also simply be exploring the interactive multimedia application. Therefore it appears that a combination of using the existing text panels and an interactive gallery map was successful in enabling visitors to identify their location within the gallery, without the need for the installation of an expensive positioning infrastructure.

6.1.2 Visitor Opinion of the Portable Computer

The majority of visitors from the computer group commented that they had enjoyed using the portable computer and interactive multimedia application. The videos and animations of the textile machines working were particularly popular. Almost all

visitors found the portable computer and interactive multimedia application easy to use, thus it would appear that the discovery based interface metaphor, based around the rooms within a textile mill was an enjoyable and easy to use method of providing access to information.

Some visitors commented that the portable computer was rather heavy. However it would appear that the weight of the portable computer is acceptable, at least within a single gallery. As technology advances smaller, lighter, cheaper and more powerful portable computer will come into the marketplace and this potential barrier to use will be overcome.

6.1.3 Visitor Behaviour

Visitors from the computer group spent a significantly greater proportion of their time within the observation area where the textile machine exhibits were located, compared to visitors from the control group. This finding is supported by other studies, which have identified that visitors who used a computer based interactive or multimedia kiosk spent longer looking at exhibits for which the computer provided additional interpretation. (Allison and Gwaltney 1991, Economou 1996, Economou 1997a)

Similar research with multimedia kiosks has confirmed a correlation between visitors spending longer in the gallery, exhibit effectiveness and enhanced learning about the exhibits. (Falk 1983, Haeseler 1989, Harvey et al 1993, Peart 1983) An increase in visitor recall of the textile machines and the cotton process was identified for those visitors who used the portable computer. This may be a function of visitors spending longer within the area of the gallery, which contained the textile machines, and their interaction with the portable computer.

The time spent by visitors from both groups actually looking at the textile machine exhibits was similar, therefore it appears that the portable computer did not distract the visitors attention from those exhibits for which it provided additional interpretation. However visitors from the computer group spent significantly less time looking at exhibits outside the observation area, for which the portable computer did not provide additional interpretation.

This is important because as Koran explains:

“for an exhibit “... to be educationally effective it must first attract and maintain visitor attention ... attention is a critical factor in visitor learning from museum exhibits ...”, he expands that from the “attracting and holding power of exhibits ... researchers have inferred interest, attention and learning.” (Koran, Foster and Koran 1989, Koran, Morrison, Lehman, Koran and Gandara 1984)

The focusing effect identified may be a consequence of the portable computer only providing enhanced interpretation for a defined area of the gallery. Therefore developing an interactive multimedia application to cover a complete gallery and observing the resulting impact upon the behaviour of visitors and their duration within different areas of the gallery, may reveal additional insights into the attracting and holding power of the portable computer and exhibits within the gallery as a whole.

6.1.4 Visitor Knowledge and Understanding

Visitors who experienced the textile gallery using the portable computer showed a significantly greater increase in recall of the textile machines and processes on exiting from the gallery than those from the control group. Similar results were identified with another research project involving an exhibit explaining the uses of lasers, which included a static computer and interpretative multimedia application. Hilke found “... that visitors operating the computer could recall more uses for laser technology than any other sub-group.” (Hilke, Hennings and Springuel 1988) This would indicate that a portable computer and interactive multimedia application can enhance existing interpretation of exhibits and significantly increase the gains in knowledge made by visitors. (Koester 1993) This conclusion was confirmed by the findings of the present research project, as the perception of the majority of visitors who used the portable computer expressed the opinion that they had explored the textile machine exhibits in more detail and felt that they had learnt more about them using the portable computer than they would otherwise have done.

The results indicate that the portable computer and interactive multimedia application have the potential to provide additional interpretation within museum galleries, and it may be feasible to do so. Interpretation has been described as the process of selecting appropriate media to effectively communicate information about artefacts and their

importance to visitors. (Martin and Frazer 1997a, Veverka 1994) Leask and Yeoman explain that:

“In its literal sense interpretation describes how history, stories, artefacts and re-enactments are presented or ‘interpreted’ in the medium of the museum or heritage attraction, the degree of information available and the nature and quality of that information.”
(Leask and Yeoman 1999)

6.2 Current Research Projects using Portable Computers

This section reviews four other research projects recently identified that are using portable computers. It provides an overview of the HIPS project and the ICHIM’99 conference where handheld devices were the subject of discussion. This is followed by a taxonomy of portable computer research projects and a discussion of their key strengths and contributions to the field.

6.2.1 Broadbent - Italy

The Museum of Santa Maria della Scalla and the Piazza de Campo provide two potential test bed sites for a location aware portable computer currently under development as part of the HIPS project, discussed in section 6.2.6. The portable computer is intended to provide additional interpretation throughout the whole museum or site. The system will employ a wireless network using a client-server model to provide location aware adaptive content based upon a user profile and interaction history. The application has been designed to require minimal direct user interaction, with the visitor’s position, determined by a Geographic Positioning System (GPS) providing the primary interaction interface. The developers have discussed the potential for group interaction within the museum to be facilitated through portable computers, and a prototype is currently under development. (Broadbent and Marti 1997, www.archimuse.com/ichim97)

6.2.2 Davies – United Kingdom

A team from the University of Lancaster are currently developing a tour guide for the historic city of Lancaster called “GUIDE”, which will utilise a portable computer. A Geographic Positioning System (GPS) will enable the portable computer to identify its position and provide location aware information. It is planned that the system will provide information tailored to the user profile, which will also be adaptable to

environmental conditions. For example if it is raining the portable computer will direct the visitor to their destination via a covered route, or if it is close to a meal time the portable computer may suggest restaurants which are close by. Only the minimum of data will be stored locally on the computer. Additional data will be transmitted over a wireless network comprising up to 9 transmitters to be installed within the city. Initial evaluation field tests with members of the general public were planned to take place during 1999 using five Fujitsu TeamPad portable computers. (Davies 1998, Evans 1998b, www.comp.lancs.ac.uk/computing/research/mpg)

6.2.3 International Cultural Heritage Informatics Meeting (ICHIM'99)

At the recent International Cultural Heritage Informatics Meeting (ICHIM'99) held in Washington D.C., USA, and attended by leading practitioners in the field, portable computers and their potential interpretative applications for museums were critically reviewed. This international conference is the world's leading forum for the development of interactive multimedia applications for heritage attractions and museums. (www.archimuse.com/ichim99/)

The researcher presented a paper to conference entitled "Portable Computers & Interactive Multimedia: A New Paradigm for Interpreting Museum Collections". The paper reviewed the present research project in order to gain a professional insight and critique. It was well received and there was significant interest in the concept of developing a workable system in museums. The published conference paper can be located in Appendix E.

Reinhard Oppermann presented a paper during the same session entitled "A Nomadic Museum Information System with Adaptive Guidance", which described a portable computer he is developing in conjunction with a German art museum. The session was chaired by Maxwell Anderson, who discussed a similar portable computer research project which he has been involved with at the Whitney Museum of American Art. It was clear that these research projects are currently rare, and may prove to be a significantly contribution to knowledge in an emerging area of research.

6.2.4 Oppermann - Germany

An Art Museum in Germany is the test bed site for a location aware portable computer utilising an infrared infrastructure of transmitters/receivers and an electronic compass

developed as part of the HIPS project. The application employs a customised web browser based on a client-server architecture and wireless network, delivering adaptive content based upon a user profile and interaction history. The developer has actively tried to reduce the level of interaction required by the user, with the location of the visitor providing the primary interaction interface. The portable computer is intended to provide additional interpretation for the whole museum, and aims to enrich the understanding and enjoyment of the exhibits. The current system utilises a Toshiba Libretto palmtop computer, however the developers have also discussed the potential of using wearable computers and also for group interaction within the museum, facilitated by the portable computers. To date evaluations have been conducted with the museum curator and computer scientists. Additional evaluations with real visitors to the museum are planned. (Evans 1999a, Oppermann and Specht 1999, www.archimuse.com/ichim99/)

6.2.5 Anderson - USA

Anderson from the Whitney Museum of American Art is involved with the development of a project called "Gallery Explorer", an interpretative portable computer application in collaboration with the Intel Corporation and AntennaAudio. The portable computer in this case is manufactured by Mitsubishi, and is being developed to initially provide enhanced interpretation for just five works of art. This project also utilises a web browser interface, and has been designed as an extension of the audio guide format requiring the minimum of user interaction. A prototype is currently under development, which will have two distinctly different interfaces, one for adults and another for children. All the data required by the application is stored locally on the hard disk of the portable computer. Visitors are required to identify the work of art they are looking at in order to access the corresponding section of the multimedia application on the portable computer. An evaluation with 100 members of the public is planned in the future. (Evans 1999b, Mirapaul 1999, www.archimuse.com/ichim99/)

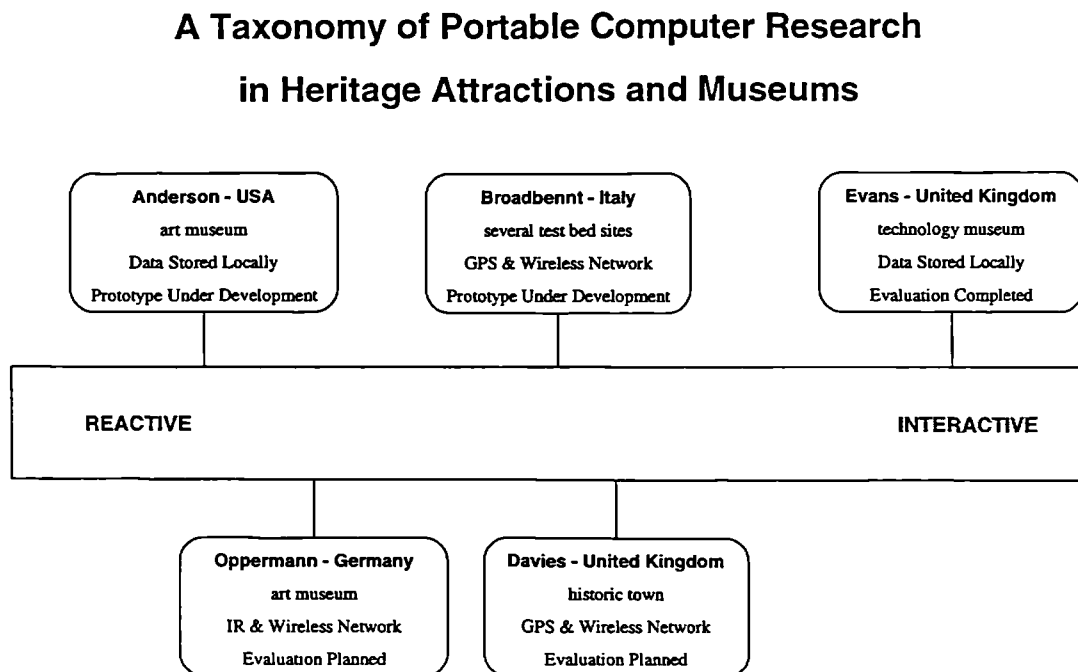
6.2.6 Hyper-Interaction within Physical Spaces (HIPS)

Two of the research projects reviewed in this section (6.2.1 and 6.2.4) are both part of a larger research project called Hyper-Interaction within Physical Space (HIPS). The main objective of HIPS is the development of new interaction paradigms for the simultaneous navigation of physical space and the related information space.

The HIPS project is primarily a technical research project developing the technology of portable computers, positioning systems and wireless networks. (Broadbent and Marti 1997, www.ing.unisi.it/lab_tel/hips/hip_pub.html) The application of tourists in museums and historic cities is one set of possible research areas and test bed sites, which could have been selected. Therefore initially at least the research is approaching the development from a technological standpoint.

6.2.7 Portable Computer Research Taxonomy

Based upon the various levels of user interaction identified within the computer research projects discussed in this chapter a taxonomy of portable computer research has been constructed and is shown below:



(Figure 6.1 : Taxonomy of Portable Computer Research)

This taxonomy illustrates the diversity of portable computer research projects and the level of interaction provided to the museum visitor. Those projects to the left of the taxonomy (Reactive) provide interaction of a similar level to that provided by a digital random access audio guide. Moving from left to right the level of interactivity increases, with those on the right (Interactive) providing a similar level of interaction to an interactive multimedia kiosk. The taxonomy also details the variety of heritage

attractions and museums providing test bed sites, the location of data storage, the use of a positioning system and the various stages of progression of each research project.

6.2.8 Comparison of Portable Computer Research Projects

This section provides a comparison of portable computer research projects and discusses the similarities and differences between them. There are four main themes:

- The level of user interaction required
- The techniques for visitors orientation
- The location of data storage
- The current project status

The interactive multimedia application developed for use within the Fibres, Fabrics and Fashion gallery was designed to require a high level of user interaction similar to that required by the touch screen interactive multimedia kiosk. However the other research projects have attempted to minimise the required user interaction, and are closer to the input required by a digital audio guide. Two possible reasons for these differences in interaction levels have been identified.

Firstly the application developed at the Fibres, Fabrics and Fashion gallery was only designed to be used within a defined area of one gallery. However the majority of the other research projects have been designed to provide additional interpretation for a whole museum, or in one case a historic town. The financial, logistical and time demands of developing a highly interactive multimedia application to cover a complete site or several sites are clearly prohibitive, and this may possibly explain the lower levels of user interaction facilitated by the other research projects.

Some of the other research projects are currently developing plans to include a method of information provision based upon a user profile and interaction history. Visitors may be required to answer a few questions before their visit, which would enable the application to create a user profile of the visitor's interests. Then as they explore the site the application would record those exhibits they have looked at. The application may then propose other exhibits, which based upon a user profile and interaction history

it calculates the visitor may be interested in. This technique may also influence the level of direct interaction required by the visitor.

Secondly the category of heritage attraction may also have a bearing on differing levels of interaction. For example at a science museum such as the Museum of Science and Industry in Manchester, the understanding of the process which machines performed is important. However at an art museum it is the works of art which are of primary importance and it is desirable that a device does not distract from looking at the work of art. Bond (Intel Education Technology Manager) who was involved with project at the Whitney Museum of American Art discussed previously, explained that it is important to:

“... remember, you’re standing in front of the artwork with this thing in your hand, and the natural inclination ... certainly among younger people ... is to keep your face buried into that screen.” He expanded “... we just figured people would get it, they would intuitively know when they should be looking at the screen and when they should be engaging the art work in front of them. Wrong, big wrong.”
(Mirapaul 1999)

The majority of the other portable computer research projects also employ a positioning system to assist visitors in orientating themselves within the site and navigating the interactive multimedia application. However the present research project was designed so that visitors were required to determine their position within the gallery using either the existing text panels or gallery map incorporated into the interactive multimedia application. Ideally the researcher would have utilised a positioning system, however budgetary, technical and logistical constraints meant this was not feasible. The findings of the research project clearly show that the majority of visitors were able to successfully navigate the gallery and interactive multimedia application without a positioning system within the limited area of the Fibres, Fabrics and Fashion gallery. However if the application was extended to cover the whole gallery or museum, then special additional text panels similar to those used for digital audio guides or a positioning system may be required to assist visitors in correctly identifying their location and to accessing the corresponding section of the interactive multimedia application.

All of the required data for the interactive multimedia application in the present research project, which provided enhanced interpretation for the textile machine exhibits, was held locally on the hard disk of the portable computer. However the majority of the other research projects have adopted an alternative approach. The minimum of data is held locally, and additional data is transmitted as required to the portable computer from a central computer over a wireless network. One explanation for this approach is the limited storage capacity available on some of the portable computers. (Broadbent and Marti 1997) The hard disk capacity of the Fujitsu Point 510 portable computer (2.1GB) was sufficient for the application developed and for all associated media files. If the application had been developed to cover a whole museum then the storage capacity would have been insufficient unless the number and duration of the video clips included for each exhibit and gallery was significantly reduced. However with advances in computer technology and storage capacity these limitations will be overcome. The main advantage of having the data stored centrally is the ease with which updates can be performed. Revisions or additional data needs only to be uploaded onto the central computer once, and not to each unit individually. (Broadbent and Marti 1997) However this can be problematical, should the central computer crash or the wireless network experience problems then all the portable computers will also cease to function.

This research project has progressed through a rigorous process of design and development culminating in a visitor evaluation study of the use and effectiveness of a portable computer in a museum gallery. The majority of other research projects are at the prototype stage and have not been formally evaluated with members of the public. Some of the other projects have also discussed the potential of interaction between visitors, facilitated by the portable computers, however these plans are still at the theoretical stage. (Broadbent and Marti 1997, Oppermann and Specht 1999)

Therefore it is clear that the present research project has taken a different approach to the other projects identified in developing a portable computer for enhanced interpretation. The portable computer and interactive multimedia application were designed to foster a high level of user interaction without the need for a positioning system or wireless network, has been the subject of a comprehensive evaluation, and is clearly at the forefront of research developments. The findings drawn from the multiple research methods, provide an original contribution to knowledge.

There are limitations to the coverage and depth of the information that can realistically be achieved. However the findings are of significance as they are a firm foundation for other research projects, and have illuminated the complex interaction, which takes place between a visitor, a portable computer and the exhibits on display. The research project has provided broad indications of how visitors use portable computers and the effectiveness of this new and highly innovative technology as a new tool for interpretation.

Inevitably the research study has raised as many questions as it has provided answers for. The research aims and objectives have been met and the project deemed a success by leading authorities. The following section discusses the potential challenges of introducing portable computers into museum galleries identified by this research project.

6.3 Challenges

Although this study indicates the effectiveness of a portable computer and interactive multimedia application as a new tool for enhancing interpretation, there are several issues and challenges facing the introduction of portable computers into museum galleries.

The cost of the hardware is a significant barrier. The Fujitsu Point 510 portable computers used during this research project currently retail in the region of £2000 per unit. If an approach utilising a positioning system and wireless network is adopted then this infrastructure will also require substantial additional investment. However with decreasing costs and rapidly advancing technological developments, portable computers will soon reach the mass market where it will be economically feasible for museums and other heritage attractions to develop portable computers for enhanced interpretative applications. (Broadbent and Marti 1997, Mirapaul 1999, Screven 1990)

There is also the cost of the software development, which must be taken into account. With an interactive multimedia kiosk application, which only provides additional interpretation for a specific exhibit or small area of a gallery costing upwards of £10,000 (Farnell 1997d, The Visual Arena 1998, Terry 1998), the cost of designing and developing an interactive multimedia application which could be used throughout the museum, may be prohibitive for all but the most affluent and well funded museums.

The cost of development may explain the more limited interaction afforded to visitors in the other portable computer research projects, as they are being designed to provide additional interpretation for whole museums or in one case a historic town. (Anderson 1999, Broadbent and Marti 1997, Davies 1998, Oppermann & Specht 1999)

The operational costs must also be taken into account. With an expensive piece of portable computer hardware there would probably be the requirement for an additional member of staff to be employed, in order to manage the loan and return of the units, in a similar way to which digital audio guides are handled. The danger of theft is ever present and may call for several measures in order to secure the safe return of the computers. Ian Richardson from Fujitsu Personal Systems explained that an internal alarm tag could be fitted so that if a visitor attempted to take the computer outside a designated area an alarm will sound. (Evans 1998a) However this may be ineffective unless additional security measures are implemented and additional personnel employed. It has been suggested that one possible method of attempting to ensure the safe return of the portable computer may be to ask visitors for a deposit, in the form of a credit card, passport or driving licence. However this may deter some visitors from using the portable computers and may exclude others. (Broadbent and Marti 1997)

Portable computers were originally designed to be used by skilled professionals in a commercial environment. Therefore, there are long term questions relating to the robustness when being used by potentially destructive members of the public. (Broadbent and Marti 1997, Fahy 1995, Woolsey and Semper 1991) However, during the present visitor evaluation study, portable computers were found to function reliably without incident, although the neck strap supporting the computer averted potential disaster on several occasions.

The research project described in this thesis had taken a different approach to and is clearly ahead of other research projects where portable computers are being developed to provide enhanced interpretation. This research project has shown that portable computers have the potential to enhance interpretation of museum exhibits and the visitor experience. Broadbent supports this view:

“... location aware mobile devices that permit the navigation of both a physical space and related information space at the same time represent a new interaction paradigm.” (Broadbent and Marti 1997)

6.4 Issues Raised

This research project has confirmed the feasibility of combining a portable computer and an interactive multimedia application to provide additional interpretation within a museum gallery. However, the research has also raised a number of issues, which other studies wishing to build upon the findings of this research should consider.

The first issue raised was differences between the control and computer groups: gender, demographic profile, prior visitation to textile mills or museums with a textile gallery and their prior knowledge of the subject area. It is clear from the data that at the pre-visit stage a significantly greater number of visitors from the control group were able to identify the textile machine from a photograph. Visitors from the control group were also able to name a greater number of processes which took place in the textile mill than those visitors from the computer group. Therefore, there was significantly greater scope for improvement within the computer group than the control group. It cannot be assumed that learning is a linear process; therefore this difference between the two groups may potentially have had a bearing upon the findings of the research. Future studies may attempt to ensure that the two groups are more closely matched in terms of their gender, demographics, and particularly, their prior visitation and prior knowledge in order to reduce potential discrepancies in the results.

Following on from this there is the issue of short term recall and how this relates to the understanding and knowledge of exhibits. The findings indicate that later processes were recalled with greater frequency than earlier ones this refers both to the order of the exhibits in the gallery and within the interactive multimedia application. This may suggest that short term recall may be a significant factor in the findings. While the intentions of this research project focused on the feasibility of using a portable computer and interactive multimedia application to provide interpretation, future studies examining the application of such systems may choose to focus on the complex interrelation between recall, understanding, knowledge and long term retention.

As stated previously, the purpose of the research project was to evaluate the feasibility of a portable computer and interactive multimedia application, not to develop the definitive interpretative tool for museums. It has been suggested that introducing any new interpretation medium into the gallery may produce an increase in identification and recall more is more. Therefore, future studies may investigate alternative

interpretative additions to a museum gallery and their impact upon visitor's experience of the gallery. For example, comparing the results of using the multimedia application on a portable computer or a series of stationary kiosks may reveal additional valuable insights into the value of a personal portable device.

The issues raised thus far have focussed primarily on technical or procedural issues, however, there are also a number of additional psychological issues which additional research may address. Firstly, there is the question of what motivates men and women to visit a gallery, and how differences in gender affect their use of interactive multimedia interpretation programmes, whether on a stationary kiosks or portable devices. Secondly, there are issues relating to how technophobic visitors interact with computer based interpretative devices, and the suitability of these devices, which if introduced may exclude some visitors from the complete museum experience. Finally there are ethical issues relating to the involvement of visitors in conducting research in museums. This is particularly relevant to the pre-visit and post-visit evaluation model employed, which may have had an impact upon the visitor's experience of the museum.

6.5 Further Research

This research project has provided an initial evaluation of the use and effectiveness of a portable computer and an interactive multimedia application to enhance the interpretation of exhibits within a museum gallery. During the course of the research several areas were identified as having potential for further exploration, they are:

- To expand the interactive multimedia application to cover the whole gallery or museum and evaluate its use
- To evaluate different interface interaction models and levels of interactivity
- To evaluate the impact of age and gender upon visitor interaction with the portable computer and interactive multimedia application
- To evaluate the effectiveness of the portable computer for other categories of museums or heritage attractions
- To implement and evaluate the contribution of a location aware positioning system on the use and effectiveness of a portable computer
- To investigate the potential of the latest generation of Windows CE based Personal Digital Assistants as a potential hardware platform

If the existing interactive multimedia application was extended to cover the whole gallery or museum, this would enable the evaluation whether visitors were able to use portable computer across a larger area without the requirement for a positioning system.

The interactive multimedia application developed in this research project employed a discovery based interface and required a high level of user interaction. Therefore it would be valuable to evaluate the effect of different interaction styles and level of interaction and to consider how this may impact upon use and effectiveness of the portable computer.

The research project discussed in this thesis has made an initial assessment of the feasibility using a portable computer and interactive multimedia application to provide additional interpretation. However subsequent research may enrich the current findings by exploring the complex relationships between age and gender of visitors and their interaction with portable computers in museum galleries.

The test-bed site for the present visitor evaluation study was a science and technology museum, where it was used primarily to provide additional interpretation for industrial exhibits. It would be invaluable to develop and test an application for use within an art museum, a natural history museum or a museum of social history for example.

The use of positioning systems would appear to have significant potential benefits for visitors, enabling them to correctly identify their position in the gallery or museum. Therefore it would be a useful contribution to knowledge to evaluate the effectiveness of positioning systems on the use of the portable computers within a museum gallery.

The latest generation of Windows CE based Personal Digital Assistants (PDAs) beginning to come onto the marketplace, for example the Casio Cassiopeia E-100 are significantly more powerful, have improved displays and larger storage capacities than those available at the outset of this research project. These units which are significantly smaller and lighter than the portable computers used during the present research, and may be a suitable platform for the development of future interpretative interactive multimedia applications in museum galleries.

These projects would enrich the findings of this research project.

Appendix A

UK Heritage Attraction

Field Survey

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The purpose of the UK Heritage Attraction survey was to gain an appreciation for the different types of heritage attractions and museums, and to identify the different types of technology which were currently installed. Other types of tourist attractions, not just museums and heritage sites were included in the survey, because it was felt that identifying the types of interactive multimedia technology that were being used in a comparable and competing market sector could reveal valuable information on possible applications for heritage attractions.

Each site was visited and the types of interactive multimedia technology observed. Additional information gathered through observation included the user interface, the robustness of exhibits and if the visitors were able to interact with the technology in groups or singularly. The observations were documented using a record sheet.

Before commencing on a comprehensive survey of heritage attractions and museums across the United Kingdom, an initial survey of 10 attractions in the Greater Manchester area was undertaken. The results of this preliminary survey are discussed in the following section.

1.0 Initial Greater Manchester Heritage Attraction Survey

The 10 heritage attractions surveyed in Greater Manchester were as follows:

Castlefield Urban Heritage Centre	Museum of Science & Industry in Manchester
Granada Studios Tour	The Pump House: Peoples History Museum
Manchester City Art Galleries	Salford Museum & Art Gallery
Manchester United Museum & Tour Centre	Salford Quays Heritage Centre
The Manchester Museum	Whitworth Art Gallery

The initial survey revealed that the use of innovative interactive multimedia or advanced technology in museums and heritage attractions in the Greater Manchester area was very limited. In general there was minimal visitor interaction. The two exceptional cases were, The Museum of Science & Industry in Manchester and Granada Studios Tour which both had a range of computer based interactive multimedia gallery interactives.

2.0 UK Heritage Attraction Survey

Following the successful completion of the initial survey of heritage attractions in Greater Manchester, it was intended to undertake a similar survey of attractions across the United Kingdom. However, the initial survey revealed that few heritage attractions and museums had installed interactive multimedia. Therefore it was decided to focus the main survey on attractions that had installed interactive multimedia technology.

The following attractions were visited during the UK survey:

London

British Museum
 Lifetimes (Croydon Clock Tower)
 Design Museum
 Imperial War Museum
 Legoland Windsor
 London Transport Museum
 Museum of the Moving Image
 NAMCO Wonder Park
 Rock Circus
 Science Museum
 The Bank of England Museum
 The London Planetarium
 The Natural History Museum
 The Thames Barrier Visitor Centre
 The Trocadero (inc. SEGA World)
 The Tower Bridge Experience
 Tower Hill Pageant
 Victoria & Albert Museum

Liverpool

The Beatles Story
 The Conservation Centre
 The Liverpool Museum
 Merseyside Maritime Museum
 Museum of Liverpool Life

York

Jorvik Viking Centre York
 National Railway Museum York
 The York Story
 York Castle Museum
 The York Dungeon
 York Minster
 Yorkshire Museum

Leeds

Harewood House
 Royal Armouries

Oxfordshire & Warwickshire

The Heritage Motor Centre
 The Oxford Story
 Warwick Castle
 The World of Shakespeare

Bradford

Museum of Photography, Film and
 Television, Bradford

Others

Alton Towers (Staffordshire)
 Quarry Bank Mill (Cheshire)
 Wigan Pier (Wigan)

It has been proposed that exhibits within heritage attractions and museums can be placed in one of two categories, Passive and Active, with the Active category having

two sub-classes, Reactive and Interactive. (Frazer 1997) This classification of exhibits was extended by the addition of an Immersive category of exhibits, and this extended classification system was used as a framework for the analysis of the data gathered during the UK heritage attraction field survey.

When analysing the data, it was the presence of different classes of technology and the elements within them that were of initial interest. However as the analysis progressed it was the differences between the classes of technology that became of prime importance. For example does the technology become more interactive and sophisticated as the admission prices increases or does the size of the group in which visitors can participate reduce as the level of interaction increases.

3.0 Location

The heritage attractions visited during this survey were located across the UK, with the majority of sites being located in or close to Manchester, Oxford and Stratford, Leeds, York, Bradford, Liverpool and Greater London, with over a third of the sites being located in Greater London.

4.0 Admission Price

Approximately one quarter of the museums surveyed were free for visitors to enter, with just under half the attractions charging under £5 for a single adult entry. The remainder of attraction charged between £5 and £10 pounds with only three of the surveyed attractions charging more that £10 for entry.

5.0 Classification of Technology

As explained in a previous section the technology identified in the heritage attractions were placed in one of four categories, Passive, Reactive, Interactive and Immersive.

Passive technology encompassing animated exhibits and videos were found in almost all of the sites surveyed. Reactive technology, where visitors push a button to start a video for example were present in approximately half of the attractions, as were Interactive technologies, including multimedia kiosks or hands on exhibits. Immersive activities, where the visitor is totally immersed within the exhibit, for example Fixed Track Carriages and VR Simulators Capsules, were observed in approximately a quarter of heritage attraction surveyed.

5.1 Passive Technology

The passive technologies most frequently identified were televisions, projectors with a flat screen, speakers, animated exhibits and dioramas, each being present in between half and three quarters of the sites. The other passive technologies were found in limited numbers, in about one quarter of the attractions surveyed.

5.1.1 Passive Visual Material

Televisions and Flat Screen Projectors accounted for the largest proportion of the passive technologies, of these about 80% were showing video footage, with animations, slides and computer graphics being displayed in approximately 20% of sites.

5.1.2 Passive Audio Material

The other significant passive technology was audio speakers. It was found that 70% of attractions featured Music or Narration, with Sound Effects and Heritage Sounds found at approximately 50% of attractions.

5.2 Interactive Technology

Interactive hands-on exhibits were found in over half the attractions, with multimedia kiosks being found in just over a third of sites and computers in about one sixth. Video games were found not just in the restaurant and shop area but also in some galleries, they featured in approximately a tenth of heritage attractions.

5.2.1 Interaction Interface

The way in which visitors interacted with the exhibits and technology was also examined whilst surveying the heritage attractions. It was identified that two thirds employed simple controls, for example buttons to press levers to pull and wheels to turn. The next most common interfaces were touch screens and tracker balls, each installed in one third of heritage attractions. The other interfaces including keyboards, joysticks and mice were each found in less than five heritage attractions.

5.3 Immersive Technology

The use of immersive technology was very limited, with the most common, Fixed Track Carriages including Time Cars as used at the Jorvik Centre and Oxford Story being present in just 7 attractions. The other types of immersive technologies, Virtual Reality, Simulator Capsules, CAVEs and White Knuckle Rides were each identified in between

1 and 4 sites. The related use of Heritage Actors to facilitate role playing by visitor was observed at 8 attractions, although this is not an interactive technology.

6.0 Exhibit Participation

At the majority of the exhibits observed during the survey, visitors could participate individually or in small groups. However only 20% of exhibits could be interacted with simultaneously by large groups of visitors.

7.0 Robustness of Exhibits

Of the reactive, interactive and immersive exhibits surveyed all were found to be operating correctly in 70% of attractions with some of the exhibits being out of order at the remaining sites.

8.0 Supervision of Museum Exhibits

At least one exhibit was supervised at over half of the attractions surveyed

9.0 Museums with WWW Sites

Over half of the attractions had their own WWW site.

10.0 Admission Price and Classification of Technology

The general trend across all museums and heritage attractions visited was that as the admission price increased the spread of technology moved from passive and reactive towards interactive and immersive.

11.0 Participation and Types of Technology

It was found that individuals and small groups had similar opportunities to interact with exhibits, be they passive, reactive, interactive or immersive. However the number of exhibits where a large group could interact with each type of exhibit was significantly reduced to about one fifth of the exhibits.

12.0 Heritage Attractions with WWW Sites and Admission Price

It was found that approximately half of heritage attractions that were either free to enter or which charged up to £10 had a WWW site. However all museums with an admission price of above £10 pounds had a WWW site.

13.0 Qualitative Observations

For many heritage attractions visited as part of this survey multimedia means audio-visual. However it is interactive multimedia on which this research project is focusing. By ignoring or not implementing interactive exhibits heritage attractions are not exploiting the full potential of this medium.

Frequently it was observed that attractions which have installed multimedia kiosks often place a slave monitor above the kiosk so that other visitor in the gallery can see what is happening even if not directly interacting themselves. It is also possible for other visitors to interact by making comments or suggestion to the visitor interacting with the application, who may become a facilitator for the group.

Some gallery interactives were very out of date, this is may be due to the following two reasons. Firstly computer technology advances very quickly so that what is state of the art today will be redundant next year. Secondly museum galleries typically have a life span of between 10-20 years and are generally not upgraded during this time. This is becoming an increasing problem with rising visitor expectations, especially from children who are growing up with computers.

Some museums, particularly the smaller ones have developed their multimedia gallery interactives in house, rather than contracting specialist multimedia developers to create the application. When developed in house it is typically the IT department who are more familiar with databases or the audio-visual department who are more familiar to linear films and sound tracks, not interactive experiences, who are requested to undertake the development.

The majority of heritage attractions seem capable of developing or commissioning laserdisks or videos and audio systems, however their experience with interactive multimedia is limited.

It seemed a good idea to make the interactive multimedia kiosk in the galleries also available in a quieter study area for more prolonged use. A good example of this is the Croydon Lifetimes gallery.

14.0 Conclusion

Museums are starting to move away from linear video passive presentation and to embrace interactive multimedia. However this may not be a quick transition as heritage attractions have invested significant amounts in audio-visual hardware and production equipment, and the skills set for designing and developing interactive multimedia is quite different. The quality of interactive multimedia applications was variable, some interactives less than one year old already looked out of date and poorly designed. Many attractions are installing one or two kiosks in a new gallery where there is funding available. However there are exceptions to this including Natural History Museum, Leeds Armouries, Croydon Lifetimes and London Transport Museum when a large number of interactive multimedia applications have been installed through out the attraction with good effect. Multimedia kiosks and gallery interactives are not essential for a visit to a heritage attraction to be rewarding, but they can engage visitors and make information and exhibits more accessible.

Appendix

GENERAL INFORMATION										PASSIVE TECHNOLOGY										SHOWING									
Heritage Site	Geographical Location	Date Visited	Admission Fee (Adult)	Single	Couple	Families	Visitor Types			Open All Year	Seasonal	VISUAL			Projector Wall	Special Screen	Video	Animation											
							Adults	Children	DAP's			TV	Large Screen	Video Wall					LCD	Flat Screen	Projector Wall	Special Screen	Video	Animation					
The Beatles Story	Liverpool	23/05/97	£5.45	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y											
Merseyside Maritime Museum	Liverpool	23/05/97	£3.00	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y											
Liverpool Museum	Liverpool	23/05/97	Free	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y											
Museum of Liverpool Life	Liverpool	23/05/97	£3.00	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y											
The Thames Barrier Visitor Centre	London	09/05/97	£3.40	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y											
Museum of the Moving Image	London	09/05/97	£5.95	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y											
Lagoland Windsor	London	09/05/97	£15.00	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y											
The Natural History Museum	London	13/05/97	£6.00	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y											
Victoria & Albert Museum	London	13/05/97	£5.00	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y											
Science Museum	London	13/05/97	£5.95	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y											
Imperial War Museum	London	09/05/97	£4.50	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y											
Croydon Clock Tower	London	09/05/97	£2.00	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y											
British Museum	London	08/05/07	£2.00	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y											
The London Planetarium	London	12/05/97	Free	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y											
Rock Circus	London	12/05/97	£5.65	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y											
The Trocadero (inc. SEGA World)	London	12/05/97	£7.50	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y											
NAMCO Wonder Park	London	12/05/97	£9.00	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y											
The Bank of England Museum	London	10/05/97	Free	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y											
London Transport Museum	London	14/05/97	Free	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y											
London Transport Museum	London	14/05/97	£4.50	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y											
Tower Hill Pageant	London	09/05/97	£6.95	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y											
Design Museum	London	09/05/97	£5.00	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y											
Tower Bridge	London	09/05/97	£5.50	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y											
Museum of Photography, Film and Television	London	29/04/97	Free	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y											
Alton Towers	Staffordshire	23/04/97	18.00	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y											
Royal Armouries	Leeds	13/04/97	6.95	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y											
Harewood House	Leeds	13/04/97	£6.50	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y											
The Conservation Centre	Liverpool	04/03/97	£1.50	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y											
The York Story	York	22/02/97	£1.80	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y											
York Dungeon	York	23/02/97	£4.25	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y											
York Castle Museum	York	23/02/97	£4.50	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y											
Yorkshire Museum	York	13/1/96	£2.25	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y											
Jonvik Viking Centre York	York	13/1/96	£4.95	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y											
York Minster	York	13/1/96	Free	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y											
Oxford Story	Oxford	25/11/96	£4.75	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y											
Castlefield Centre	Manchester	31/10/96	Free	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y											
Granada Studios Tour	Manchester	21/11/96	£12.99	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y											
Quarry Bank Mill	G. Manchester	30/11/96	£4.50	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y											
Manchester United Museum	Manchester	22/11/96	£2.95	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y											
Salford Museum & Art Gallery	Manchester	05/11/96	Free	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y											
The Museum of Science & Industry in Manchester	Manchester	09/11/96	£4.00	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y											
Manchester City Art Galleries	Manchester	31/10/96	Free	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y											
Whitworth Art Gallery	Manchester	31/10/96	Free	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y											
The Pump House: Peoples History Museum	Manchester	03/11/96	£1.00	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y											
The Manchester Museum	Manchester	11/11/96	Free	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y											
Wigan Pier	Wigan	02/11/96	£4.40	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y											
Salford Quays Heritage Centre	Manchester	31/10/96	Free	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y											
National Railway Museum York	York	31/10/96	£4.80	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y											
Heritage Motor Centre	Cowley	26/11/96	£5.50	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y											
Warwick Castle	Warwick	26/11/96	£8.95	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y											
The World of Shakespeare	Stratford	25/11/96	£4.00	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y											

UK Heritage Attraction

WWW Site Survey

CONTENTS

- 1.0 Introduction**
- 2.0 Results of the Survey**
 - 2.1 Features
 - 2.2 Technology
- 3.0 Other Observations**
- 4.0 Conclusion**
- Appendix**

1.0 Introduction

The purpose of the UK Heritage Attraction WWW site survey was to assess which WWW technologies were being employed and secondly which features and information were being provided for potential visitors to the attraction. Primarily this survey produced quantitative data, by visiting the heritage attraction WWW sites, observing and recording where particular technologies or features were present on a computerised record sheet. Heritage attraction WWW sites listed on the Virtual Library Museum Pages for the UK (<http://www.cs.reading.ac.uk/vlmp/uk.html>) were used as a sampling frame, with all 136 of the listed WWW sites visited and assessed. This survey method also enabled qualitative assessments of the technical implementation, quality of the resources available and aesthetic design of the sites to be made.

2.0 Results of the Survey

The Museum WWW Sites visited covered the full spectrum of museum types including Art Galleries, Science Museums, Natural History Museums and Stately Homes, and the WWW sites ranged from the most basic one page of text on plain backgrounds to fully interactive multimedia museums. The following sections will summarise the results of the UK heritage attraction WWW site survey, a more detailed site by site breakdown of the data can be located in the Appendix.

Features	Frequency
Access & Location	73
Contact Details	113
Admission Details	98
Site/Collection Details	100
View Site/Collection	78
Interactive Exhibits	4
Museum Tour	15
Schools Program	48
Special Events	65
Museum Shop	32
Q&A Quiz	4
Guest Book, Mailing List or Questionnaire	17

(Figure 1 : Summary of Features)

Technology	Frequency
Text	126
Images	120
Animated GIF's	14
Image Maps	9
URL Links	104
E-Mail	81
Frames	8
Forms	27
Visitor Counter	22
Site Search	21
Audio Clips	2
Video Clips	3
Streamed Audio	1
Streamed Video	0
QuickTime VR	3
Director Movies	2
VRML	4
JavaScript	2
JAVA	1
Plug-In Required	7

(Figure 2: Summary of Technology)

2.1 Features

Most sites included the basic information provided on their leaflet (Brochure-ware), Contact Details (Address, Telephone, Fax and often E-Mail), Admission Details (Opening Times and Prices) and Details of the Site and/or Collection.

Approximately half of the sites also provided directions of How to Find the attraction, frequently including a map of the local area. Approximately half the sites also provided the facility to View either the Site or Collection and details of special Events or future temporary exhibitions.

A Schools or Education Programme was included on about 35% of sites. Typically the Schools Programme was mentioned or detailed breakdown of programmes provided. Four museums that provided particularly good educational material were; the Hunterian

Museum and Art Gallery, the Mary Rose Maritime Museum, the Museum of Antiquities and the Science Museum.

The following points briefly summarise the Educational Programme of each museum:

- **Hunterian Museum and Art Gallery**

- Illustrated fact sheets for children on a comprehensive range of topics
- Q & A Page with Video Clip evidence
- Interactive Maps (Captain Cook: Voyages of Discovery)

- **Mary Rose Maritime Museum**

- Education Mission Statement
- School Visit Planning & Booking Information
- Details of on-site activities
- Resources Details - Worksheets (Pre-Visit, On-Site and Post Visit)

- **Museum of Antiquities**

- General Visit and Activity Information
- On-line information for teachers (inc. Key Stages & National Curriculum)
- Suggestions for Post-Visit activities

- **Science Museum**

- Description of Galleries designed for Children
- Overview of resources available - worksheets (On-site and Post-Visit)
- Details of Professional Development courses for Teachers
- Internet events and activities;
 - On-line Materials Conference for Schools
 - STEM Project (Educational materials on the WWW)
 - On-line Debate and Voting
 - On-line Galleries and Exhibitions
- On-line Experiments, Activities and Tutorial

Almost 30% of the museum sites also contained a section on the Shop. At the most basic level the shop was mentioned, through to a full visual catalogue of items for sale,

although at this time no on-line purchases were possible. A special mention must also go to the Science Museum (London) who provided a link to "The Innovations" on-line catalogue, this allows visitors to browse the products, request a paper catalogue and even order products over the Internet using a form and secure encrypted transfer of credit card details.

A Tour was provided by about 15% of the attractions, these constituted a structured approach and route through the museum, possibly allowing the visitor to choose their own route. A simple list of collections or galleries was not sufficient to be counted in this section. Frequently the Tour progressed room by room with the visitor clicking a next room, previous room or map buttons. The latter displaying a map of the attractions or current gallery so that the visitor can jump to a section of interest or join the tour at any point. A Museum Tour with a difference was provided by the Hunterian Museum, in addition an excellent Virtual Tour, there was a Guided Tour by one of the Museum Staff pointing out artefacts of special significance. In addition to the standard map, next and previous buttons an interactive timeline of events was also included, enabling the visitor to jump to at any point in history covered by the tour.

Over 15% of sites included a Guest Book so that visitors could leave comments or suggestion, a Mailing List to which they could subscribe, either paper or electronic and a Questionnaire that they could fill about the Museums WWW Site. All of these methods are superior to the simple "E-mail your comments..." type and provided an effective way for the attraction to receive feedback about it's WWW site or to create a database of visitor profiles that could be used for future direct mail marketing. Generally the less typing a user has to do the more they likely they are to use it, and the more structured the feedback is the easier it is for the museum to interpret the results. The best example of a structured Questionnaire was the National Army Museum (Chelsea).

Interactive Exhibits proved to be very uncommon, being found in less than 5% of the Museum WWW Sites surveyed.

A feature that was also present on only a few sites was an on-line Q&A Quiz, where a number of questions were posed, with the answers or information required to answer them contained somewhere within the heritage attraction WWW site.

2.2 Technology

The basic building block of every WWW site is Text and was used by every site visited. Almost all of the sites also used Images, typically of the museum buildings, galleries or collections. However Animated Gifs, Image Maps and Frames were used by comparatively few of the sites.

The majority of sites also provided URL Links, primarily these were to four types of WWW site, related museums & research, service providers, WWW Page Developers and sites where Browsers or Plug-In's can be downloaded.

The use of E-Mail was also popular, and often used for a point of contact or for basic feedback on the Museums WWW site, typically "Please E-Mail your Comments to..."

Forms, Visitor Counters and Site Search facilities were present on approximately 1/6th of the sites surveyed. The Forms were used for feedback, information requests and site searches. Visitor Counters which display the number of people who have previously accessed the site since a stated date, are probably more useful to the attraction in keeping track of the number of visits than for the visitors themselves. The Site Search is a useful addition to a WWW site, and provides the visitor with a quick and efficient way to locate resources or information contained within the site.

Other technologies, Audio and Video, both downloadable clips and streamed, QuickTime VR, Director Movies, VRML, JavaScript and JAVA were each identified within less than 5% of the WWW sites surveyed.

3.0 Other Observations

In general the WWW sites of most UK heritage attractions were rather disappointing, being little more than electronic leaflets constructed of text and static images. However a few attraction WWW sites did provide an interactive and educational experience above this.

Few WWW sites allowed the visitor to interact with the artefact above just looking at an image, there are three probable reasons for this. Firstly more advanced WWW technologies required to create interactive exhibits are more complex and the attraction may not have the skills to develop them internally or the funds to commission them.

Secondly the lack of application of these technologies may be attributed to the requirement for a Plug-In. Possibly it is felt that most users do not have the ability or patience to download and install. This was supported as less than 10% of the sites requiring a Plug-In to be installed. The final reason for this lack of interactive exhibits is that these technologies typically have larger file sizes and would be slow and expensive for individuals to download using a modem over telephone lines. However those museums that included Interactive Exhibits were superior, bringing the WWW site alive and engaging the visitor.

It was worrying to find that some of the information contained in the Events section was often out of date. It is important that museums realise that setting up a WWW Site is not a one off operation. All sites require maintenance and updating which can be both time consuming and costly.

A Q&A Quiz as described earlier appears to be a good method for assessing how much people have remembered of what they have read or seen on the WWW site, and an effective way of encouraging users to visit the whole of the WWW site searching for the answers.

Of the 136 UK WWW sites that it was intended to include in this survey, 10 had errors and could not be visited, this may be due to a change of URL address, the file server having gone down or other technical problems.

The design of the heritage attraction WWW sites was highly variable, from very amateur to highly professional. However the majority of sites were adequate but not outstanding. There is definitely then need for improved WWW site design for heritage attractions as with every other category site on the WWW.

The types of on-line Competition as used by the Museum of Science & Industry (Manchester) and the Museum of Scotland were interesting and a good way to attract visitors to your site, particularly if the competition runs over a period of months and requires several repeat visits to the WWW site, in order to enter.

Only the National Museums & Galleries of Wales made their WWW sites available in multiple languages (English & Welsh). With the importance of revenue from the

international tourists it is surprising that more museums, especially the larger internationally renowned ones did not take advantage of this function to attract potential overseas visitors. However this would be difficult for some languages that do not use the standard character set, for example Japanese.

A novel and unexpected use a WWW site was made by Museum of Scotland, which used its WWW site advertise for funding/donations and volunteers to help with the construction of the physical museum, which has not yet been built.

A selection of Museums provided alternative versions of their WWW sites, generally there was a graphically intensive site often, employing Frames and requiring Plug-In's, these sites are designed for the latest browsers and a fast connection to the Internet. The other site was typically less sophisticated with a lower graphic content, did not require Plug-In's, and was designed for older browsers and a slower connections to the Internet.

4.0 Conclusion

The WWW sites of the majority of UK heritage attractions are composed of basic text and graphics, with links to related sites, and provide basic information about the attraction and its collection. These sites often translate to little more than an electronic version of the attraction's leaflet. Even those museums that have employed some of the more advanced Internet technologies have only scratched the surface of what can be achieved. There is still much to be done to improved the presence of UK heritage attractions on the World Wide Web.

Appendix

UK WWW Site Survey (17/04/1997)		Technology											
Museum Name	Site Address	Text	Images	Animated GIF's	Image Maps	URL Links	E-Mail	Frames	Forms	Visitor Counter	Site Search	Audio Clips	Video Clips
1	1853 Gallery	http://www.clanwis.com/loc/hock.htm	1	Y	Y	Y	Y	Y					
2	The Abbey Museum	http://www.wessex.co.uk/abbey/	2	Y	Y	Y	Y	Y	Y				
3	Amberley Museum	http://www.m-ms.com/games/bag.html	3	Y	Y	Y	Y	Y					
4	Armagh Planetarium	(ERRORS)	4										
5	Ashmolean Museum	http://www.ashmol.ox.ac.uk/	5	Y	Y	Y	Y	Y					
6	Banchory Museum	http://www.aberdeenshire.gov.uk/banchory.htm	6	Y	Y	Y	Y	Y					
7	Bank of England Museum & Archive	http://www.bankofengland.co.uk/index.htm	7	Y	Y	Y	Y	Y	Y				
8	Bate Collection of Musical Instruments	http://www.ashmol.ox.ac.uk/BCMIPage.html	8	Y	Y	Y	Y	Y	Y				
9	Bedford Museum	http://www.museums.co.uk/bed/	9	Y	Y	Y	Y	Y					
10	Biggar Museums Trust	(ERRORS)	10										
11	Birmingham & Midland Museum of Transport	http://www.soinet.co.uk/bammol/	11	Y	Y	Y	Y	Y					
12	Black Country Museum	http://www.dudley.gov.uk/muse.htm	12	Y	Y	Y	Y	Y					
13	Bletchley Park	http://www.cranfield.ac.uk/CCC/BPark/	13	Y	Y	Y	Y	Y					
14	The Boat Museum	http://www.british-waterways.com/museum/ellesmereport/	14	Y	Y	Y	Y	Y					
15	Bodleian Library	http://www.bodleian.ox.ac.uk/	15	Y	Y	Y	Y	Y					
16	British Lawnmower Museum	http://www.bodley.ox.ac.uk/	16	Y	Y	Y	Y	Y					
17	British Library	http://portico.bl.uk/	17	Y	Y	Y	Y	Y			Y		
18	British Museum	http://www.british-museum.ac.uk/	18	Y	Y	Y	Y	Y	Y				
19	Bronte Parsonage Museum	http://www.virtual-pc.com/bpmweb/	19	Y	Y	Y	Y	Y					
20	Cabaret Mechnal Theatre	http://www.cabaret.co.uk/	20	Y	Y	Y	Y	Y					Y
21	Cadbury World	(ERRORS)	21										
22	Cambridge Museum of Technology	http://www.cam.net.uk/home/steam/	22	Y	Y	Y	Y	Y	Y				
23	Centre for the History of Delence Electronics	http://chide.bournemouth.ac.uk/	23	Y	Y	Y	Y	Y	Y				
24	Chertsey Museum	http://www.surreyemc.gov.uk/chermsus/intro.htm	24	Y	Y	Y	Y	Y	Y				
25	Christ Church Picture Gallery	http://www.chch.ox.ac.uk/gallery/	25	Y	Y	Y	Y	Y	Y				
26	Cole Museum of Zoology	http://www.cs.reading.ac.uk/museum/cole/	26	Y	Y	Y	Y	Y	Y				
27	The Cowper and Newton Museum	http://www.olio.demon.co.uk/cnnthome.html	27	Y	Y	Y	Y	Y	Y				
28	Cotswolds Motor Museum	http://www.digital-brilliance.com/org/bour_coc/booklet/exhib.htm	28	Y	Y	Y	Y	Y	Y				
29	Cotswold Woolen Weavers	http://dspace.dial.pipex.com/town/plaza/hk67/	29	Y	Y	Y	Y	Y	Y				
30	Crabble Corn Mill	http://www.invmcd.demon.co.uk/mill/index.html	30	Y	Y	Y	Y	Y	Y				
31	Dickens House Museum	http://www.rmpc.co.uk/orgs/dickens/	31	Y	Y	Y	Y	Y	Y				
32	Edinburgh Uni. Collection of Musical Instruments	http://www.music.ed.ac.uk/euchml/	32	Y	Y	Y	Y	Y	Y				
33	Eigin Museum	http://www.virtual-pc.com/museum/eigin/	33	Y	Y	Y	Y	Y	Y				
34	Eureka!	http://ourworld.compuserve.com/homepages/Eureka_Museum/	34	Y	Y	Y	Y	Y	Y				
35	Exploratory Science Centre	http://www.exploratory.org.uk/	35	Y	Y	Y	Y	Y	Y				
36	Fairford and District Museum	http://www.rmpc.co.uk/eduweb/sites/davet/taclm.html	36	Y	Y	Y	Y	Y	Y				
37	Finchcocks Living Museum of Music	http://www.mistral.co.uk/hammerwood/finch.htm	37	Y	Y	Y	Y	Y	Y				
38	Fizwilliam Museum	http://www.cam.ac.uk/CambArea/Fiz.html	38	Y	Y	Y	Y	Y	Y				
39	Foxton Canal Museum	http://ipresent.wildnet.co.uk/foxton.htm	39	Y	Y	Y	Y	Y	Y				
40	Gallery of Modern Art	http://www.glasgow.gov.uk/cityva/gma/	40	Y	Y	Y	Y	Y	Y				
41	Garlogie Mill Power House Museum	http://www.weblink.co.uk/leisure/garlogie.html	41	Y	Y	Y	Y	Y	Y				
42	Globe Theatre	(ERRORS)	42										
43	Green's Mill	http://www.innolts.co.uk/greensmill/	43	Y	Y	Y	Y	Y	Y				

Museum Name	Site Address	Text	Images	Animated GIF's	Image Maps	URL Links	E-Mail	Frames	Forms	Visitor Counter	Site Search	Audio Clips	Video Clips
44 Hadrian's Wall	http://www.demon.co.uk/hadrial/	Y	Y				Y		Y				
45 Hancock Museum	http://www.ncl.ac.uk/~nhancock/	Y	Y				Y		Y				
46 Harveys Wine Museum	http://www.harveysbc.com/hwm/main.htm	Y	Y				Y		Y				
47 Haslemere Educational Museum	http://ourworld.compuserve.com/homepages/Richard_Hawkes/	Y	Y	Y			Y						
48 Horsforth Village Museum of Local History	http://www.brad.ac.uk/~pnceeth/horsmuse/horsmuse.html	Y	Y				Y		Y				
49 Hunterian Museum and Art Gallery	http://www.gla.ac.uk/Museum/	Y	Y				Y		Y		Y	Y	Y
50 Imperial War Museum	http://chide.bournemouth.ac.uk/information.office/imperial.war.museum.	Y	Y				Y		Y				
51 International Helicopter Museums	http://dspace.dial.pipex.com/town/terrace/aaa76/	Y	Y				Y		Y				
52 Ironbridge Gorge Museum	http://www.ironbridge.org.uk/	Y	Y				Y						
53 The Jewish Museum	http://www.ort.org/community/jewmusm/home.htm	Y	Y				Y						
54 Jorvik Viking Centre	http://www.heritagedevelopment.co.uk/	Y	Y				Y		Y			Y	
55 Kew Bridge Steam Museum	http://www.cre.canon.co.uk/~davidr/kbsm/	Y	Y				Y						
56 Kilmarth House Museum	(ERRORS ????)	Y	Y										
57 Kingston Museum	http://www.kingston.ac.uk/muy/text7.htm	Y	Y				Y						
58 Leeds University Gallery	http://www.leeds.ac.uk/library/gal/intro.html	Y	Y				Y						
59 Letchworth Museum	http://www.mjm.co.uk/museum.html	Y	Y				Y		Y				
60 The London Dungeon	(ERRORS ????)	Y	Y										
61 London Canal Museum	http://www.charitynet.org/~LCanalMus/	Y	Y				Y						
62 London Transport Museum	http://www.londontransport.co.uk/lmusem/index.html	Y	Y	Y			Y		Y		Y		
63 Lothbury Gallery	http://www.netwestgroup.com/exhibit.html	Y	Y				Y						
64 Lunt Roman Fort	http://www.discover.co.uk/~lunt/	Y	Y				Y						
65 Madame Tussauds	http://www.illumina.co.uk/illumina/interac/uss.html	Y	Y				Y						
66 Manchester City Art Galleries	http://www.u-net.com/sea/mcag/cag.html	Y	Y				Y						
67 Manchester Jewish Museum	http://www.aam.org.uk/venues/jewish.html	Y	Y				Y						
68 The Manchester Museum	http://www.mcc.ac.uk/Museum/	Y	Y				Y				Y		
69 Marischal Museum	http://www.abdn.ac.uk/~ant010/	Y	Y				Y						
70 Mary Rose Maritime Museum	http://www.manyrose.org/	Y	Y				Y						
71 Midland Air Museum	http://www.discover.co.uk/~mam/	Y	Y				Y			Y			
72 Museum of Antiquities	http://www.ncl.ac.uk/~nantig/	Y	Y				Y						
73 Museum of Archaeology and Anthropology	http://www.cam.ac.uk/CambArea/Museums/AAM/	Y	Y				Y						
74 Museum of British Road Transport	http://www.discover.co.uk/~motor/	Y	Y				Y		Y				
75 Museum of Classical Archaeology	http://www.classics.cam.ac.uk/ark.html	Y	Y				Y		Y				
76 Museum of Costume	http://www.openworld.co.uk/britain/pages/MMMUS12QHa.html	Y	Y				Y		Y		Y		
77 Museum of English Rural Life	http://www.cs.reading.ac.uk/museum/mert/	Y	Y	Y			Y						
78 Museum of Garden History	http://www.compuink.co.uk/~museumgh/	Y	Y				Y		Y				
79 Museum of Science and Industry	http://www.edes.co.uk/mussc/index.htm	Y	Y				Y		Y				
80 Museum of the History of Science	http://www.mhs.ox.ac.uk/	Y	Y				Y		Y				
81 Museum of Lincolnshire Life	http://www.personal.u-net.com/~lincsc/ml.html	Y	Y				Y		Y				
82 Museum of the Moving Image	(ERRORS ????)	Y	Y										
83 Museum of Scotland	http://www.museum.scotland.net/	Y	Y	Y			Y		Y				
84 Museums of The Royal College of Surgeons	http://www.rcseng.ac.uk/facility/museums.htm	Y	Y				Y		Y		Y		
85 National Army Museum	http://www.falite.com/nam/	Y	Y				Y		Y				
86 National Coal Mining Museum for England	http://www.clanwis.com/coatmine/	Y	Y	Y			Y		Y				
87 National Gallery	http://www.gallery-guide.com/gg/museum/national/	Y	Y				Y		Y		Y		
88 National Maritime Museum	http://www.nmm.ac.uk/	Y	Y				Y		Y				
89 National Motor Museum	http://www.tl.net/features/nmm/	Y	Y				Y		Y				
90 National Museum of Childhood	http://www.vam.ac.uk/vbgm/	Y	Y				Y						
91 National Museum of Photography, Film & Television	http://www.nmsi.ac.uk/nmpft/	Y	Y				Y		Y		Y		

Museum Name	Site Address	Text	Images	Animated GIF's	Image Maps	URL Links	E-Mail	Frames	Forms	Visitor Counter	Site Search	Audio Clips	Video Clips
92 National Museums & Galleries of Wales	http://www.cardiff.ac.uk/nmgw/	Y	Y			Y			Y				
93 National Museums of Scotland	http://www.nms.ac.uk/	Y	Y			Y			Y		Y		
94 National Portrait Gallery	http://www.npg.org.uk/	Y	Y										
95 National Railway Museum	http://www.nrmi.ac.uk/nrm/	Y	Y			Y							
96 Natural History Museum	http://www.nhm.ac.uk/	Y	Y	Y		Y			Y		Y		
97 Newlyn Pilchard Works	http://www.x-soft.co.uk/fish.html	Y	Y			Y							
98 Nothe Fort and Museum of Coast Defence	http://www.weymouth.gov.uk/nothe.htm	Y	Y			Y							
99 Open Museum	http://www.world.compuserve.com/homepages/Nat_Edwards/	Y	Y			Y							
100 Oxford University Museum of Natural History	http://www.ashmol.ox.ac.uk/oum/	Y	Y			Y							
101 Past Impressions On-line Museum	http://www.enf.port.ac.uk/~phillips/PASTIMPR.HTML	Y	Y			Y							
102 Pitt Rivers Museum	http://unitis.ox.ac.uk/departments/prm/	Y	Y			Y							
103 Portsmouth Bus Museum	http://dSPACE.dial.pipex.com/town/terrace/abe28/busmuseum1.htm	Y	Y			Y			Y				
104 Pump House People's History Museum	http://www.aam.org.uk/venues/pump.html	Y	Y			Y							
105 The Queen's Gallery (at Buckingham Palace)	http://www.royal.gov.uk/collect/exhib.htm	Y	Y			Y							
106 Reading Museum	http://www.reading.gov.uk/museum/index.htm	Y	Y	Y		Y							
107 River and Rowing Museum	http://www.comlab.ox.ac.uk/archive/other/museums/rowing.html	Y	Y			Y							
108 Rochdale Pioneers Memorial Museum	(ERRORS ???)	Y	Y										
109 Roman Baths Museum	(ERRORS ???)												
110 Royal Armouries Museum	http://www.leeds.gov.uk/tourinfo/attract/museums/armour.html	Y	Y			Y							
111 Royal Botanic Gardens	http://www.rbgkew.org.uk/	Y	Y			Y			Y		Y		
112 The Royal Collection	http://www.royal.gov.uk/collect/index.htm	Y	Y			Y			Y				
113 Ryhope Engines Museum	http://www.g3wte.demon.co.uk/	Y	Y			Y							
114 Science and Industry Museum	http://birlingtonham.gov.uk/html/tourist_info/science.html	Y	Y			Y				Y			
115 Science Museum (London)	http://www.nmsi.ac.uk/	Y	Y	Y		Y			Y		Y		
116 Sedgwick Museum of Geology	http://www.esc.cam.ac.uk/SedgwickMuseum/museumindex.html	Y	Y			Y			Y		Y		
117 Shelton Museum	http://www.ncl.ac.uk/~nclassic/pages/museum.html	Y	Y			Y							
118 Shelland Museum	http://www.shelland-news.co.uk/gallery/museum.html	Y	Y			Y							
119 Sir John Soane's Museum	http://www.demon.co.uk/heritage/soanes/	Y	Y			Y							
120 Stoke-on-Trent City Museum	http://www.keele.ac.uk/koss/sikmg/home.htm	Y	Y			Y				Y			
121 Swaledale Folk Museum	http://www.yorkshirenet.co.uk/sinfo/swfolk/	Y	Y			Y				Y			
122 Tate Gallery	http://www.gallery-guide.com/gg/museum/late/	Y	Y			Y							
123 The Teddy Bear Museum	http://www.demon.co.uk/quinsolve/soaleddy.htm	Y	Y			Y					Y		
124 Theatre Museum	http://www.vam.ac.uk/thm/	Y	Y			Y							
125 Tolnes Motor Museum	http://www.devon-cc.gov.uk/tourism/pages/attracts/tolmotor.html	Y	Y			Y							
126 Ure Museum of Greek Archaeology	http://www.cs.reading.ac.uk/museum/ure/	Y	Y			Y				Y			
127 Victoria and Albert Museum	http://www.vam.ac.uk/	Y	Y			Y							
128 Virtual Museum of Computing	http://www.comlab.ox.ac.uk/archive/other/museums/computing.html	Y	Y			Y							Y
129 The Wallace Collection	http://www.demon.co.uk/heritage/wallace/	Y	Y	Y		Y				Y			
130 Wellcome Museum	http://www.swan.ac.uk/classics/mushp.htm	Y	Y			Y							
131 Wellington Museum	http://www.vam.ac.uk/gpsley/	Y	Y			Y							
132 Wheel Martyn China Clay Museum	(ERRORS)	Y	Y										
133 Whitworth Art Gallery	http://www.man.ac.uk/wag/	Y	Y			Y							
134 Wolverhampton Art Gallery	http://www.scil.wlv.ac.uk/university/sites/gallery/guide.html	Y	Y			Y							
135 The Wordsworth Museum	http://www.dovecott.demon.co.uk/	Y	Y			Y				Y			
136 The York Dungeon	http://www.yorkshirenet.co.uk/yorkdungeon/	Y	Y			Y							

USA Heritage Attraction

WWW Site Survey

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1.0 Introduction

The purpose of the USA heritage attraction WWW site survey was to make a qualitative assessment of the most advanced WWW sites. The USA was chosen in preference to other countries because it is at the forefront of computing technology, there were a large number and variety of heritage attractions with WWW sites, there are more people connected to the Internet and developments are a lot more advanced.

The Virtual Library Museum Page for Museums in the United States of America (<http://www.cs.reading.ac.uk/vlmp/usa.html>) was used as a sampling frame. It was decided that attempting to visit all the 393 listed sites was unrealistic especially with the well known slow downloading of sites from the USA to the UK, therefore it was decided to use the Virtual Library's 46 nominated "Top Sites" as the sampling frame.

Each heritage attraction WWW site was visited and evaluated against a number of key points detailed below. For each site there is a brief review of any exemplary features or elements and a mark given out of 5 as way of ranking the sites. For a heritage attraction WWW site to get a mark of (5/5) it must excel in each of the evaluation criteria. The criteria for evaluating the heritage attraction WWW sites were as follows:

- The design, structure and layout of the site
- The quality of graphics and graphic design
- Accessibility of museum exhibits, galleries and collections
- The level and type of visitor interaction
- The appropriate application of WWW technologies
- The provision of educational resources
- Overall impression

2.0 WWW Site Survey & Reviews

It was assumed that each of the “Top Sites” surveyed would include basic admission information, details of forthcoming exhibitions, contact details and links to other related WWW sites. Therefore these details will be omitted from the site reviews below unless they were of particular significance.

- **American Museum of Natural History, New York City (3/5)**

This site was well designed, making good use of Animated GIF's, frames and a pseudo 3D image map of the museum to facilitate an excellent interactive tour. This was coupled with high quality images of artefacts and comprehensive, clearly structured information about exhibits. The site also included a 21 question quiz, when all the multiple choice questions had been answered, feedback was given on each with an explanatory paragraph. The educational section of the site is currently under construction.

- **Archer M. Huntington Art Gallery (2/5)**

A basic site with text descriptions of exhibits supplemented by high quality photographs of the galleries. The education section described the programmes offered by the museum and contact details for the staff with educational responsibility within the museum.

- **Art Museum Network (4/5)**

This is the official WWW site for the largest art museums in North America, it was very well designed with excellent graphics, animations and rollovers of buttons and hotspots. Both standard and Macromedia Flash enhanced versions were provided. The site made use of the television as a metaphor, with each channel relating to a different area of the WWW site, for example;

- 1: Museum of The Week,

- 2: Press & Media

- 3: Kids

- 4: Teachers

...and so on

- **Bishop Museum, Honolulu, Hawaii (2/5)**

This is the WWW site of a rather unconventional a museum, but apart from that this is not a particularly outstanding site. However it does have one interesting feature not found on many other WWW sites, the ability to send electronic postcards to your friends from Hawaii. The visitor enters their message followed by the their own e-mail address and the e-mail address of their friend. The friend with then receive an email telling that they have a postcard at the Museum's site together with a unique identifier so that they can collect their postcard and so that no one else can read it. This is an effective way of publicising the museum to other potential visitors.

- **Boston and New England Museums (1/5)**

A professionally designed site with links to museums in Boston and New England, sorted by category. This site is a part of Boston.Com an on-line directory for the area.

- **China the Beautiful, Guttenberg, NJ (1/5)**

This site has an amateurish feel about it with brash colours, poor design and below average quality of graphics. However the site does support both English and Chinese browsers and enables the visitor to read poems, view calligraphy, download and listen to Chinese music, songs and poems and view Chinese works of art.

- **Cleveland Museum of Art, Ohio (3/5)**

A beautifully designed site with excellent graphics, informative text and high quality images of exhibits. Some of the photographs of artefact from the museums collections have a stamp/logo on the image to act as a crude digital watermark. A comprehensive map of all three floors of the museum are used an image map which links to text descriptions of each area of the gallery. However more images of the artefacts in each area would have given a better impression of what could be expected on an actual visit to the museum. The "Highlights Tour" was not so much a tour of the most important things to see, rather it was an illustrated list of the most prestigious artefact in each collection. An extensive gift shop was also included with the items divided into several categories relating to the museums galleries. It was not possible to purchase the items via the WWW site with secure transfer of funds, however a fax sheet that could be printed out was provided.

- **Colonial Williamsburg, Virginia (4/5)**

A simple yet very effectively designed site with outstanding images, making good use of the almanac metaphor and historic time line to link peoples, places and events together. Resources for teachers and students included classroom tested lesson plans and details of electronic field trips. The electronic field trips have three components: a teacher's guide, a one-hour live interactive television program, and special Internet activities. Several weeks before the televised portion of the field trip, teachers receive a guide, complete with historical background material, suggested lesson plans and facsimiles of original documents. The teacher's guides aids educators in preparing their classes for the live, interactive television program, which is offered twice on the date of broadcast to accommodate students in all time zones.

- **Cornell Museum of Glass (2/5)**

A basic site containing a description and high quality images of glass artefacts, a glossary of glassmaking terms and details of courses in glass making run by the museum.

- **Dallas Museum of Art, Texas (1/5)**

Another basic WWW site with general text and images of galleries & collections. Additional details of the education resource centre at the museum were also provided.

- **Diego Rivera Web Museum (2/5)**

This WWW site had an unremarkable design and layout but was lifted above the majority of similar site by impressive graphics and the innovative use of a Virtual Gallery Tour. The tour was developed in VRML and allowed the user to navigate around the virtual gallery, clicking on a painting would bring up an additional screen with a higher quality image and caption. The site was available in both English and Spanish, with a comprehensive gallery of paintings and murals with brief captions.

- **Field Museum of Natural History, Chicago (4/5)**

A nicely designed site with attractive graphics and some effective animated GIF's. Also to be found on the site were MPEG movies of Dinosaurs, audio material to listen to and a quiz to try. The majority to the site was devoted to the "Life Over Time" exhibit. This included two useful tours, one before and one during the time of the dinosaurs. The tours made effective use of dinosaurs foot prints as the navigation interface, with the tours being composed of good graphics, diagrams, movies, animations and sounds to download or view along the way. However at times the tours did become a bit disorientating. It was possibly branch off from the main tour, get lost and it was not clear how to return to the main tour. Teachers notes and activity sheets to print out, including crossword puzzles, colouring sheets and flip books depicting the motion of animals were also provided as was a comprehensive bibliography.

- **Franklin Institute Virtual Science Museum, Philadelphia (3/5)**

The design of this site lead to a cluttered feeling even with the good graphics and animations. There were movies to download and several exhibitions with images or variable quality. Several On-line exhibits were also available, probably the best was "The Heart: An Online Exploration", an informative and very detailed tour with the user free to choose from multiple routes and concentrate on the areas that interested them most. At each stage there was a quiz to test what the visitor had learned from that section, and all the time there was the atmospheric sound of the heart beating in the background.

- **Getty Art History Information Program, California (1/5)**

A generally well designed site that makes good use of graphics, however the poor implementation of frames in some sections makes navigation rather confusing and gives an unprofessional impression.

- **High Museum of Art, Atlanta, Georgia (1/5)**

The straight forward site design was clear and simple, combined with themed graphics created an atmosphere. The overall content of the site was good, but rather sparse and

it was not possible to view any of the works of art. The site really amounted to little more than an expanded digital leaflet, all be it well executed.

- **Berkeley, University of California**

Error, This site could not be accessed.

- **Illinois State Museum (4/5)**

A nicely laid out site that is well designed with good graphics. The site featured six on-line exhibits including the best and most recent, "At Home in the Heartland" which exists in both physical and virtual forms. This was a comprehensive on-line exhibit that at times seemed more like a reference book, similar to Encarta. The exhibit enables the visitor to view objects and people and follow developments over time, plus explore rooms furnished in the period style using a QTVR panorama. The navigation provides freedom for the visitor to select his or her own route through the exhibit but you never feel you are lost. Teacher resources comprised lesson plans for 3 three different age groups of pupils, these included exhibit themes, questions for discussion and activities, one set for each of the six areas of the exhibition.

- **International Museum of the Horse, Kentucky (2/5)**

A typical site design with well designed graphics including an interesting animated GIF depicting the motion of a horse. This site was not so much a museum bur a all inclusive history of the horse over time with seemingly limitless information that was both informative and well structured.

- **Internet Arts Museum for Free (3/5)**

An unusual site with excellent graphic design that was broadly divided into the three areas of Sound, Vision and Words. The site facilitated the viewing of photographs, pictures and digital images, and reading of stories. A unique feature of this site was the ability to download and listen to full length CD quality music and songs. Each track from the CD was MPEG compressed with file sizes of 2-10Mb, requiring a download time of approximately 10-60 minutes depending upon the individual track.

- **Kennedy Space Centre NASA (3/5)**

A very poorly designed site which was little more than a long list of links to other sites internal departments and details of current and future NASA missions. The most interesting link from this site was to Mars Pathfinder site hosted by SGI. This cutting edge site included a VRML and QTVR panoramas of the surface of Mars and models of the Mars Lander and Rover. The site also provided the opportunity for visitor to try their hand at driving the Mars Rover across the surface of the planet using another VRML model. Other interesting features of this site included live audio and video feeds from NASA Select TV that did not require a plug-in and plans that could be printed out for a cut out and stick together of the Mars Lander for children to build.

- **Library of Congress, Washington DC (2/5)**

This was not a typical museum, however the WWW site had good graphics and site design, despite being primarily text based with only the occasional image included.

- **Los Angeles Museums inc. Natural History Museum (3/5)**

Both the listing of Los Angeles museums and the Natural History Museum have an old fashioned and dated look. However the information provided regarding the physical and on-line exhibits were in-depth resembling a reference work in terms of coverage rather than a museum exhibit, with each exhibit having several routes through which the visitor could navigate. It was also interesting to see sponsorship starting to appear on museum WWW sites, for example the exhibition "Cats! Wild to Mild" was sponsored by Friskies PetCare Company with the support of Jaguar Cars of North America.

- **Metropolitan Museum of Art, New York City (3/5)**

This museum site has clear and tastefully designed graphics, although the layout on some sections leaves something to be desired. The Glory of Byzantium, and excellent on-line exhibit was also provided, with several ways to explore the works of art by investigating a theme or viewing the works of art along a visual timeline. A comprehensive gift shop and museum membership service was also provided with on-line purchase using with encrypted secure transfer of information.

- **Michael C. Carlos Museum, Atlanta, Georgia (4/5)**

The site features very well designed graphics and extensive collections all available over the WWW. There is also a link to “Odyssey Online”, this is a children’s version of the museum, again this was well design with excellent graphics, informative animations, well structured bit size chunks of information plus video clips. The background music made the site feel very lively. The audio features were also used to let children hear the correct pronunciation of foreign words and place names. Throughout the exhibition there were lots of educational games for the children to play that reinforced the concepts they had just read overall an excellent site.

- **Minneapolis Institute of Arts, Minnesota (4/5)**

Textural information dominated the design of this WWW site, with the exception of good image maps of the museums layout and for finding exhibit or gallery information. However there was only limited information and images available for each of the museums galleries. Interestingly the site also contained details, descriptions and screen shots relating to a series of multimedia gallery interactives to be found in the museum. The museums also used the WWW site to publicise their CD-ROM which included an on-line QTVR demonstration. Education was also a key consideration, with the provision of curriculum materials, including teachers background information and an on-line preview of the World Mythology in Art slide set. This contained a set of highly interactive, cross referenced slides with over 24 high quality images and 60 minutes of downloadable stories.

- **Museum of Jurassic Technology (2/5)**

An atmospheric and tastefully designed site with good graphics and a simple site structure. However the information provided amounted to little more than an overview of each gallery with the limited photographs of the actual exhibits.

- **Museum of Modern Art, (MoMA), New York (2/5)**

A well structured site with a professionally designed feel. However the clear photographs were only supplemented by minimal detail about each of the galleries and artefacts in within it.

- **Museum of Palaeontology, Berkeley (1/5)**

An interesting and useful site with a logical information structure and a good on-line exhibition. This included high quality photographs but overall was rather let down by the poor quality graphics that have been produced for diagrams and buttons.

- **National Air and Space Museum, Washington, DC (3/5)**

A site with very good graphics and clear photographs. However navigation was occasionally not user friendly, for example there was not always a link to the museum map screen from each gallery. The site included MPEG movies which can be download and separate feedback forms for each of the museums galleries.

- **National Gallery of Art, Washington, DC (3/5)**

A tastefully designed site featuring stylish layout and comprehensive collection information supplemented with high quality images. A particularly innovative approach was taken to the displaying of a painting by John Singleton Copley entitled Watson and the Shark. This included a gallery guide available in 5 languages (Adobe Acrobat format), but more unique was the use of Animated GIF's to show elements of the painting similar to a flip book. This helped to take the static painting and turn it into a story, bringing the painting to life and highlighting details that might otherwise have been overlooked.

- **National Museum of Women in the Arts, Washington, DC (4/5)**

This site was well designed and structured, although the table of contents was rather unmanageable as it scrolled for several pages. A comprehensive tour of exhibitions with photographs of many works of art and profiles the artists. The unique feature of this museum WWW site was the ability to take a video tour of the museum with Founder Wilhelmina Cole Holladay. Visitors were present with the option of either download the entire tour which would take an estimated 45 minutes or to view any of the 21 video clips individual, which took 1-5minutes each to download. This was an excellent feature, the downloads were reasonable quick and the quality of the video images and production was excellent.

- **Nelson-Atkins Museum of Art, Kansas City, MO (1/5)**

This site has a nice graphic feel to it with some good images and a straightforward structure. An overview of museums exhibitions are illustrated with photographs of several works of art in each gallery.

- **New York City Museums**

Error, This site could not be accessed.

- **Peabody Museum of Natural History, New Haven, CT (2/5)**

A not a particularly well designed site, with some poor graphics, particularly for headers, section titles and buttons. The most interesting feature of this site was the use of murals as a navigation metaphor for the galleries. Clicking on the appropriate animal or feature of the image map would take you to that artefact in the gallery. Overall there was far too much text based information only occasionally interspersed with small images.

- **Photo Perspectives**

Error, This site could not be accessed.

- **Rice University Art Gallery, Houston, TX (1/5)**

A basic site with images of work by students of the Rice University with minimal explanation or captions. Several versions of each piece of work were available in different resolutions to cater for different connection speeds.

- **San Diego Museums (0/5)**

Another basic site with links to three museums in the San Diego Area.

- **San Francisco Bay Area Museums (1/5)**

This page provided a very comprehensive listing of museums in the San Francisco Bay area, as part of the KPIX Television and Radio site.

- **San Francisco Exploratorium, San Francisco, CA (5/5)**

A very well designed site with some excellent graphics, although perhaps sometimes there were a few too many options on screen at one time. The site revolved around a backbone with the following sections;

- The *Science Information Infrastructure (SII)* included interviews with NASA scientists (RealAudio)
- A set of 18 *Interactive Exhibits* covering a range of subjects, these made use of standard HTML, Images QTVR and Shockwave
- The *Science Explorer* (Exploratorium at Home) incorporated a series of 8 experiments for children to try out at home, with clear instructions and excellent graphic illustrations
- The *Teachers Section* was developed by teachers for teachers, and showed how to build classroom and home versions of over 40 Exploratorium exhibits, and included a multitude of resources and links for teachers
- An *On-line Journal* was also available, featuring QT Movies and experiments to try at home or in the classroom
- The *Cow's Eye Dissection*, one of the most popular activities at the museum was also featured on the WWW site and included an illustrated step by step guide and a small interactive program that could be download to teach children about the different parts of the eye.

- **San Jose Art Museum, California (2/5)**

This site used the entrance hall and receptions metaphor for navigation of museum, and microchip on a circuit board for the navigation of courses and student work. However it was not always clear what clicking on a certain link would do, these sections would benefit from better labelling. Also to be found on the site was an electronic journal which used 3D text created in VRML as the interface for navigation, unfortunately this was very slow and quite difficult to use, but an interesting attempt at a new WWW site interface.

- **Sixth Floor Museum (0/5)**

A poor site with just two pictures on the first page. A digital brochure with long pages of scrolling text, and details of collections limited to a couple of sentences each and no images.

- **Smithsonian Institution, Washington DC (5/5)**

This WWW site featured good graphics, with both graphically rich and text only versions available. The main page included a very comprehensive and effective navigation structure, however the aesthetics require attention. The Smithsonian has not provided one tour for all visitor to its WWW site, but 14 of what it terms “Pre-Packaged Tours”. Each of these tours can be based on particular perspectives or areas of interest. For example there are tours especially for children or focussing on Botany, Mammals or Dinosaurs. However these are not the virtual tours of the museum, but provided specialised itineraries for when visiting the physical museum. In addition to the expected information on galleries with photographs of artefacts the museum has developed a VRML version of the Smithsonian's Travelling Exhibit. As you navigate around the virtual exhibit clicking on the virtual objects brings up more information and a photograph about each. An excellent education section was also available, this features lesson plans, with procedures and worksheets to printout in Adobe Acrobat format for 3 topics (Art to Zoo Library, Ocean Planet Kit and Art Kit), the Ocean Planet being by far the most developed and refined. The highlights of the other museums linked to from the main page are as follows;

- **National Design Museum:** excellent graphic design and site structure with lots of high quality graphics
- **National Air & Space Museum:** see previously
- **National Zoo:** featured an audio tour around the zoo, making use of audio wands as used in the zoo as a metaphor. The site also included educational games including word searches and crosswords. An excellent video cinema (supports AVI and VIV formats) with both streaming (plug-in required) and downloadable movies were available as were images from an Internet camera that updates the display every minute.

- **St. Louis Science Centre, Missouri (3/5)**

A well structured site with good graphics in a cartoon style, especially for the buttons. The images used as page headers were again very well executed, maintaining the same size and form on every screen, but changing the texture applied to them depending which area of the museum you were currently in. However away from the core of the site the other pages did not maintain this high level of presentation. Excellent image maps of the museums floor plans with multiple levels of detail were used to create the effect of zooming in a specific areas of the gallery. A streamed video (MPEG) and self-guided tours of the museum were both provided for visitors. Also provided was an On-line gallery with pre-visit educational treasure hunts and over 300 pages of text, drawings, photographs, animations (15 Quicktime), videos (3 Quicktime & 3 MPEG). This was supplemented by a large amount of background information and theory to back up the exhibits in the Galleries.

- **Tech Museum of Innovation, San Jose, California (3/5)**

This site was well designed and featured exceptional graphics, especially for the button bars and some Animated GIF's. The majority of the site was devoted to the HYPER-TECH On-Line Exhibits. These contained clear information in small bit sized pieces tailored towards children. However this section although good could have been improved even further if greater interaction or on-line experiments were included. In one section an interview with an astronaut was streamed over the WWW using RealAudio. Each month a section called "TECH 10" is updated with links to 10 recommended sites. In order to persuade visitors to visit all 10 sites a crossword puzzle has been developed, with the answers to the clues being hidden on the linked sites. If you can correctly complete the crossword then you can have your name put up on the WWW site next month. Also located on the site was a detailed statistical breakdown of those users who had visited the site, from per hour to per year.

- **The Computer Museum, Boston, Massachusetts (5/5)**

This site features exemplary graphical design with the interface being themed and tailored for each of the four targeted groups. As you enter the site you have the ability to personalise your visit based upon your age or interest (Select one: Kid, Student, Adult or Educator). Which ever option is chosen the general section headings and overall structure of the site remain the same but the content will have a different

focus. This was identified as a very effective feature. As on the Bishop Museum's WWW site the visitor had the ability to send electronic postcards to their friends or family. Each of the galleries and exhibitions contained clear and concise information illustrated by lots of photographs. As visitors enter the site they have the option of entering your name and home country, then as you move around the museum the name of other visitors who have recently visited the same gallery will appear at the top of the screen. This means that you can click on their name and send them messages, this is a good way for visitors from all over the world to communicate with each other, especially as museum visits are primarily social experiences. Found at the top of every screen is a suggestion of another page or part of the museum visitors may like to visit. The children's "Game Court" featured two interactive games, Robots and Networks. The Robots game was an interactive Shockwave application that has to be downloaded and installed and does not run in a Web Browser. Whereas the Networks game in an interactive JAVA applet and requires 2-4 players to work together over the WWW to play. The Robot game is a very good application, with the child being given the task of designing a robot with a specific task. They must then make selections for each of the six elements of the robot's design (Sensing, Movement, Power, Manipulation, Intelligence and Looks). Once the child has completed their design it is assessed and feedback given. Unfortunately the graphic design of the application is rather crude and some animation or audio feedback and perhaps seeing what the finished robot would look would be an improvement. For teachers there are educational packets, classroom activities and museum activity circuit sheets. There is also an excellent Web-Store with a wide range of fully illustrated products, a well designed shopping mechanism and the ability to order items and have them delivered anywhere in the world with purchases possible over the internet using secure encrypted transfer of details.

- **Virginia Museums, a listing (1/5)**

A simple yet nicely designed site that acts as a directory of museums in Virginia.

3.0 Summary

In this section those museums whose WWW sites features exemplary graphic design and layout, made innovative use of WWW technologies or effective use of the WWW for education will be summarised. The innovative ideas and concepts developed by

museums in the survey will be discussed and a comparison made between the WWW sites of museums in the UK and USA.

3.1 High Quality Images and Good Graphic Design

The majority of USA Museum WWW sites surveyed displayed a reasonable level of graphic design and layout. However the following sites were considered to be exemplary:

- American Museum of Natural History
- Art Museum Network
- Cleveland Museum of Art
- Colonial Williamsburg
- Field Museum of Natural History
- High Museum of Art
- Internet Arts Museum for free (IAMfree)
- Metropolitan Museum of Art
- Michael C. Carlos Museum
- National Air and Space Museum
- National Gallery of Art
- San Francisco Exploratorium
- Smithsonian Institution
- The Computer Museum

3.2 Innovative Use of WWW Technologies

The WWW technologies available to museums developing a WWW site are continually advancing, the following sites made effective or innovative use of these technologies:

- Diego Rivera Web Museum – VRML Gallery
- Internet Arts Museum for free – MPEG Encoded CD Tracks to download
- International Museum of the Horse – Animated GIF (Animal Motion)
- Kennedy Space Centre - Mars Pathfinder VRML Models & Activities
- Michael C. Carlos Museum – Animated GIF (Animal Motion)
- National Gallery of Art – Animated GIF (Watson and the Shark)
- National Museum of Women in the Arts – Video Tour
- Smithsonian Institution – VRML Gallery Tour
 - National Zoological Park - Streamed Video Cinema and Internet Camera
- San Francisco Exploratorium – Interactive Exhibits (Shockwave & QTVR)
- St. Louis Science Centre – Video Tour (MPEG) & Zoom-In Image Maps
- The Computer Museum – Robots (Shockwave) & Networks (JAVA)
- Tech Museum of Innovation - Interview with an Astronaut (RealAudio)

3.3 Effective Education Over The WWW

One of the key functions of all museums is to educate their visitors, with the advancement of the WWW it is now possible to make resources available on-line and even interactive activities. The following museums have made particularly effective use of the WWW for educational purposes:

- Colonial Williamsburg – Electronic Field Trip
- Illinois State Museum – At Home in the Heartland Online
- Michael C. Carlos Museum – Odyssey Online
- San Francisco Exploratorium – Learning Studio, Science Information Infrastructure (SII), On-Line Exhibits, Science Explorer & Cow's Eye Dissection
- Smithsonian Institution – Ocean Planet
- The Computer Museum – Possible to focus the site for children & Game Court

3.4 Original Ideas

Many of the heritage attractions that were visited as part of this survey demonstrated original ideas and concepts for ways in which information may be delivered to the visitor and innovative ways of engaging them in the museum experience. The following sections briefly describe the most innovative of these original ideas;

3.4.1 Use of Metaphors

Metaphors were used by several heritage attractions as a method of making information available to visitors or assisting them to navigate the WWW site. Typically the visitor will already be familiar with the concept behind the metaphor and this can help to put them at ease and overcome the uncertainties of which button to click that some non computer literate people face when navigating the site. The San Jose Art Museum used the metaphor of an entrance hall and reception desk as a way to navigate the site and access information. The Tech Museum of Innovation used the metaphor of a bar, to serve up information on different objects. At the National Zoological Park, part of the Smithsonian Institution visitors can take an audio tour of the zoo using solid state audio equipment, this approach was also used as a metaphor for the tour of the Zoological Parks WWW site.

3.4.2 Education Outreach Programs

Of all the heritage attractions surveyed the Colonial Williamsburg museum stood out as being unique in its education and schools program. In particular the electronic field trips that it organises. The electronic field trips have three components: a teacher's guide, a one-hour, live, interactive television program, and special Internet activities. Several weeks before the televised portion of the field trip, teachers receive a guide, complete with historical background material, suggested lesson plans and facsimiles of original documents. These teacher's guides allow educators to prepare their classes for the live, interactive television program, which is offered twice on the date of broadcast to accommodate students in all time zones. This approach allows schools that would not otherwise be able to visit the museum due to their physical location to participate in the activities.

3.4.3 Personalised Tours and Visits

One problem facing designers of museum WWW sites is who the target audience should be. If they focus on one particular group they run the risk of alienating the other groups and you can rarely please everyone all of the time. An innovative and extremely effective solution to this dilemma was implemented by The Computer Museum, Boston. When a visitor first enters the site they can select from one of four profiles (Kid, Student, Adult or Educator), the overall structure of the site will remain the same, but the graphics and content of the site will then be personalised to the chosen profile. A WWW site development of this kind requires large amounts of additional work, time, expertise, money and storage space. Realistically this type of WWW site is only feasible for larger museums, but when implemented correctly as in this case can significantly enhance the visitor's experience.

The Smithsonian Institution had a similar concept but it was executed in a different way. Rather than personalising the site visitors could take a "Pre-packaged" tour of the museum and its exhibits. Similarly the visitors could choose a profile and additionally in this case an area of specialist interest, be it Botany, Mammals or Dinosaurs. The visitor would then be presented with a page of links to exhibits that may be of interest to them. This can then be used as a guide when visiting the physical or as a starting point for exploring the museums WWW sites.

3.4.4 Exhibit & Gallery Sponsorship

Sponsorship of galleries or exhibits on museum WWW sites is starting to appear. The most appropriate example was Friskies PetCare Company and Jaguar Cars of North America's sponsorship of the "Cats! Wild to Mild" exhibit at the LA County Natural History Museum. The sponsorship amounted to little more than a banner stating that this exhibit had been sponsored by the two companies and providing links to their respective WWW sites. This may be an effective way for museums to fund the development of improved WWW sites and facilities, but may detract from the museum experience if sponsorship becomes too widespread.

3.4.5 Electronic Postcards

A novel feature found on both the Bishop Museum and The Computer Museums WWW sites was the facility to send electronic postcards to your friends and family.

The procedure is as follows;

For the sender

- Select a design or photograph for your postcard
- Write your message
- Address and send your postcard (e-mail address of friend or family)

For the recipient

- Receive an e-mail saying that you have a postcard waiting for you at the museum WWW site and a unique identifier that you need to read it
- Access the museums WWW site and go to the read postcards section
- Enter your unique identifier
- Read your postcard

As the example above demonstrates this is a rather drawn-out yet fun activity, but more importantly it is an excellent way to promote a museums WWW site, especially as the recipient must access the WWW site in order to read their postcard. However implementing functionality of this type requires experienced developers and can place a considerable load on server delivering the WWW site, therefore it is critical to ensure that the museum has access to appropriate hardware and skills before attempting to develop this feature for their WWW site.

3.4.6 Foreign Language Pronunciation

The Egyptian Gallery of the foreign Michael C. Carlos Museum has numerous audio samples that are used so that the visitors can hear the correct pronunciation of the Egyptian words and place names. This is a very interesting feature and as the individual samples are very brief the files sizes are small meaning that they download almost instantly.

3.4.7 Site Search Activities

Visitors to a museums WWW site typically only view a proportion of the whole site, generally admission details and their particular are of interested. However museums

would like visitors to explore the whole of the museums WWW site. At The Tech Museum of Innovation a crossword puzzle was used, with the answers to the clues located throughout the WWW site, this was effective in encouraging visitors to access every section of the site. This was increased further by offering an incentive for successful completion of the crossword, for example at The Tech Museum of Innovation your name will be displayed on the WWW site the following month. A similar concept was in place at the St. Louis Science Centre where the concept of a Treasure Hunt was used to encourage especially children to explore the site.

3.4.8 Visitor Communication & Collaboration

One of the most important things about visiting a museum is that it should be a social experience, where people interact together. However this is very difficult to achieve with a WWW site where the visitors are not in the same physical location, being potentially spread across the world. The Computer Museum, Boston has come up with an ingenious solution on its WWW site. When the visitor first enters the museum they have the opportunity to enter their name as a visitor to the museum. Then as they move around the museum the names of other visitors who have recently visited the same gallery appear at the top of the screen. Clicking on these names allows the user to send the other visitor a message. The site even goes a stage further by requiring that 2-4 visitors work together over the WWW to solve puzzle written as a JAVA applet.

3.5 USA & UK Heritage Attraction WWW Site Comparison

When compared to the WWW sites of museums in the UK those of USA museums generally have a better structure and layout, the sites are much larger and have superior graphic design. American museums are also more media rich and make extensive use of advanced WWW technologies and Plug-In's to make their sites a more interactive and engaging experience. There are also about three times as many USA museum as UK museums listed on the Virtual Library Museum Pages, and overall they appear to have more educational resources available for pupils and teachers.

However this is a biased comparison as the WWW sites of all UK museums listed were surveyed but only the top 46 USA museum WWW sites were surveyed. If

however a random of the 393 listed USA museums with WWW sites had been taken it is anticipated that the results would have been very similar to those from the UK. The WWW sites of some UK museums are comparable to the top USA ones on individual criteria, however the only site that compares favourably with the majority of USA museum WWW sites surveyed is the Natural History Museum in London.

4.0 Conclusions

In summary the WWW sites of museums located in the USA are generally comprehensive, well structured and have excellent graphics. They have moved beyond the electronic leaflet and are making effective use of WWW technologies for visitor interaction and education.

A Comparison of the WWW Sites

Of UK and USA Heritage Attractions

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1.0 Introduction to the WWW and Virtual Museums

According to James Johnson a new media designer at the Natural History Museum:

“The World Wide Web has been heralded as a milestone in the history of communication, as important as the invention of the printing press or the television. But for many, the reality does not match expectations. And first-time users are often disappointed by the experience. They cannot find the information they want and what they can find is no use. However, the Web is a rapidly expanding source of information, including specialist material aimed at museum professionals.”
(Johnson 1997)

In recent years we have witnessed the rapid expansion of the World Wide Web (WWW) and the emergence of the virtual museum. For the purpose of this paper a virtual museum is defined as a set of WWW pages created by physical museums, that are accessed by virtual visitors over the Internet. Virtual museums typically contain “information from opening times to extensive multimedia versions of their exhibits - and everything in-between.” (Standage 1995) Generally a virtual museum will house a collection of electronically digitised artefacts, including texts, photographs, diagrams, video clips and links to other virtual museums and historical resources around the world. (McKenzie 1997)

The number of virtual museums has grown dramatically in recent years, according to Jonathan Bowen, founder of the Virtual Library Museum Pages (VLMP) “currently several museums a day are joining the Internet around the world.” (Bowen 1996), he continues “The numbers are doubling approximately every three months.” (Standage 1995)

However, the majority of information contained within these virtual museums is “taken from existing paper publications, brochures and leaflets aimed at educational groups, groups from overseas, and families and individuals actually visiting the Museum and its facilities.” (Gordon 1985) According to Susan Glasser “It is perfectly logical to start by putting your museum's brochure-type information on a Web site. However, it is under-utilisation of the technology if that is the only information the site provides. Interactivity is the single greatest contribution that Web technology has to offer the museum field and the least exploited.” (Glasser 1997)

Constructing a virtual museum is not sufficient to engage visitors, as explained by Samantha Clutton of the V&A, “It is easy to see why it is called "surfing the net".

Nobody actually reads the information, or wants to. Instead the average viewer skims over the surface of material on offer.” (Clutton 1996)

The development of a virtual museum should be considered a long-term investment in the future of the museum. (Tupholme 1996) The WWW will become of increasing importance to museums, as it is not just computers that can access the Internet but soon everyone can have easy access from their living room just like subscribing to another satellite or cable television channel. “Hence the interest in cheap, easy-to-use boxes which can provide Internet access via a standard television.” (Youlgreave 1997) We are currently seeing the introduction of WebTV which brings the WWW directly into people’s homes and onto their televisions and be as easy to use as a video recorder or satellite decoder. “In coming years, television set-top boxes are expected to become a major portal to the Net – and a whole new variety of digital programs will be offered over it.” (Kirwan 1997)

2.0 Why Construct A Virtual Museum

Museums may take the decision to go on-line with a number of aims in mind, be it for advertising and promotion, marketing, to make admission details available (location, opening times and admission prices), the provision of pre-visit material, to provide access to their collections or to support academic research and educational outreach programs.

The World Wide Web offers museums new ways of communicating beyond the traditional boundaries of the museum gallery and provides an additional channel of communication to potential visitors. (Martin 1996) The communication opportunities of a virtual museum cannot be over-emphasised, as explained by Jonathan Gollow “... as we approach the millennium a World Wide Web site is an integral part of the marketing mix for all organisations. Consumer perception of your organisation can be radically enhanced by a top quality web-site with excellent content and attractive design.” (Gollow 1996) Therefore the aim of publicising the museum may be the principle reason for constructing a virtual museum, however this will not utilise this communications medium to the full. With the interactivity available on the WWW today a virtual museum can be used for so much more, for example conducting tours of

the virtual museum, providing interactive exhibits and building relationships with virtual visitors.” (Tupholme 1996)

A number of advantages for museums contemplating establishing a presence on the WWW have been proposed:

- Increased Visitor Numbers
- Provision of Access to Collections
- Communicating with International Visitors
- Prevention of Damage to Sites and Artefacts
- Cheap Distribution of Information
- The ability to Track Visitor Progress
- Visitor Interaction with Exhibits

However establishing a virtual museum is not-without its associated problems:

- Slow Downloading of Information
- Potential Copyright Infringements
- Development and Maintenance Costs

2.1 Advantages of Virtual Museums

Some museums are fearful of opening a virtual museum because they anticipate that by making their collections available over the WWW the number of visitors coming through the doors of the physical museum will be reduced and subsequently their revenue. However "the history of technology suggests that, far from reducing the number of people through the door, virtual visits will encourage more people to seek out the real thing." (Sudbury 1996) Johathan Bowen agrees, I don't "think it very likely net surfers will regard a virtual museum visit as a substitute for the real thing. 'I think it will increase visits, if anything'." (Standage 1995) This view is also supported by Jim Bennett, keeper at Oxford Museum of the History of Science, who explained that "... the museum's web site had helped in almost doubling visitor numbers in the past financial year." (Carrington 1996) However Jeff Tupholme advises that "A balance must be struck - not providing so much information as to discourage paid visits, but enough to make an application valuable in its own right." (Tupholme 1996)

Many people who wish to visit museums and heritage sites throughout the world or even in the same county are prohibited from doing so because of the expense of travel and time constraints. However "the Internet provides a low-cost and instantaneous means of accessing heritage information over huge distances." (Bowen 1996) This view is echoed by Neil Thomson of the Natural History Museum, "... we would like to offer this material to folk who could never visit the museum for reasons of logistics or finance.", and "... the Web seems to me to be tailor made to fulfil one of the museum's main objectives, which is to make information about the natural world available to as wide an audience as is humanly possible." (Standage 1995)

A problem facing physical museums is trying to provide visitors with access to their collections. For example the "Natural History Museum has 68 million specimens, most of which are not on public display due to constraints of space and conservation requirements." (Mason 1995) The virtual museum also has the advantage that because "it does not occupy real space, it offers opportunities to display reserve collections which cannot be accommodated in the gallery." (Martin 1996)

As communication and transportation links improve the use of the Internet to market a museum to potential visitors from other counties is becoming a reality. According to Jonathan Bowen a museum "with an on-line presence is likely to get more visitors, especially from the USA." (Mason 1995) He continues, "if you go to another country and you know there's a museum there because you have visited its Web site I'd say you'd be substantially more likely to actually go and visit that museum." (Standage 1995)

Another advantage of the virtual museum is that provides access to collections for visitors and researchers from anywhere in the world, therefore the requirement to ship artefacts to different museums for exhibits is reduced thus minimising the changes of artefacts being damages in transit. (Mason 1995) However, Internet access can be even more useful at protecting heritage sites than individual artefacts. Bob Stone of VR Solutions explained that by using VR and the WWW can be used "... as a means of electronically preserving the country's treasures and archaeological sites for future generations, as was the whole rationale behind English Heritage's successful Virtual Stonehenge project." (Stone 1997)

A virtual museum can also communicate with and distribute information to potential visitors throughout the world, without the associated costs with paper based media which would make it prohibitively expensive. (Tupholme 1996)

The demographics of virtual visitors can be captured using basic Web-Counters which count the number of visitors to a virtual museum and Web-Trackers which can monitor every page of the WWW site that the accessed by the visitor. (Winslow 1997) This type of detailed data would be expensive and time consuming to gather in the physical museum, but is almost free within the virtual museum.

One of the most enjoyable features for many visitors to virtual museums is the ability to interact with objects and exhibits, something they can rarely do in the physical museum. In physical museums "artefacts are usually passive. People can see them but they can not 'play' with them. For older generations this is fine since they have been accustomed to see but not touch. For younger generations it is not sufficiently exciting. They want to directly explore different possibilities and see the results." (Tsichritzis and Gibbs 1991) However "With the new software such as Java and Shockwave, the use of video and audio clips, and approaches to virtual reality such as QuickTime VR and VRML, all of which are already in use by science centres and museum, the potential for museums is enormous." (Jackson 1997) for visitors to virtual museums to interact with objects and artefacts.

2.2 Disadvantages of Virtual Museums

Constructing and accessing a virtual museum is not without its problems. Firstly the network connections between computers connected to the Internet do not have sufficient bandwidth to provide users with the speed of service they require. (Mason 1995) This is particular critical for those people connecting from home, "... given the constraints of conventional telephone links to the Internet, leading-edge graphics technology, such as Java and ShockWave, increase site upload time substantially." (Gollow 1996)

A concern expressed by many museums regarding their presence on the WWW is that of infringement of copyright of images and photographs of works of art from their collection. According to Robert Mason, "... it is almost impossible to exercise copyright" on the Internet and "Museum will have to adapt the culture before others do

it for them.” (Mason 1995) It has been suggested that that invisible digital signatures could be embedded into the actual electronic image. (Gordon 1985) However, probably “the simplest method for deterring unauthorised copying of images is to only make them available as low resolution images – good enough for display on World Wide Web pages, for example, but not reproduction in a marketable publication.” (Gordon 1985)

The development and maintenance of a virtual museum is resource intensive, “as a rough guide, the main cost in developing a system is that of time.” (Tupholme 1996) It is important that museums realise constructing a virtual museum is not a one-off activity, to be effective and generate repeat visits it will requires frequent updates and revisions. When it comes to developing the virtual museum “just because it can be done in-house does not mean that it should be, particularly where organisations with a high public profile are concerned. An understanding of the etiquette of the Internet is essential, and specialist skills are required to exploit the available technology.” (Tupholme 1996) This view is echoed by Jonathan Gollow who states that there “is a strong argument for using Internet specialists, rather than trying to design and build a web-site in-house.” (Gollow 1996)

3.0 Main Study

It has been proposed by Samantha Clutton that:

“Museum pages on the net are quite simply boring. There is too much text and pages of long, monotonous lines merge into each other. I would rather go out and buy a book than read it on screen. Have we learnt nothing from the oft-quoted statistic that museum visitors concentrate for an average of three seconds on a display panel? The Internet is no different. If anything the attention span of web users is shorter that that of museum visitors. They have not paid for the experience and they have not had to make the physical effort of leaving the armchair.” (Clutton 1996)

To evaluate if this is actually the case or if virtual museum can compliment their physical counterparts and are making effective use of this new communications medium a survey of virtual museums was undertaken.

3.1 Research Objectives

The research had three main objectives, firstly to identify the information, resources and features which were provided for virtual visitors and to identify which of the current

WWW technologies were being employed in the creation of virtual museums. Secondly to compare and contrast virtual museums in the United Kingdom with those in the United States. The final objective of the research was to review and evaluate the top virtual museums in the USA.

According to Jonathan Bowen “the Virtual Library Museum Pages (VLMP) provides the world’s foremost global directory of on-line museums available on the Internet.” (Bowen 1996) This view is supported by James Johnson who commented that “The Virtual Library Museum Page is an excellent directory of museums on the Web and is supported by the International Council of Museums. This is the most comprehensive directory of museum web sites available and is regularly maintained.” (Johnson 1997) Listings from the VLMP were used as a sampling frame during the research.

3.2 United Kingdom Virtual Museum Survey

Initially virtual museums located in the United Kingdom were surveyed. The VLMP pages for UK based virtual museums (<http://www.cs.reading.ac.uk/vlmp/uk.html>) was used as a sampling frame. The sample consisted of 136 virtual museums, each was visited and all pages/links within the site were explored. The presence of features, information and different WWW technologies were recorded in a digital record sheet.

The results of the UK Virtual Museum survey are summarised in the tables on this, and on the following page.

Features	Frequency (136)
Location Details	53.7%
Contact Details	83.1%
Admission Details	72.1%
Site/Collection Details	73.5%
View Site/Collection	57.4%
Interactive Exhibits	2.9%
Museum Tour	11%
Schools Program	35.3%
Special Events	47.8%
Museum Shop	23.5%
Q&A Quiz	2.9%
Guest Book, Mailing List Or Questionnaire	12.5%

(Figure 1: Features found in Virtual Museums in the UK)

Technology	Frequency (136)
Text	92.6%
Images	88.2%
Animated GIF's	10.3%
Image Maps	6.6%
URL Links	76.5%
E-Mail	59.6%
Frames	5.9%
Forms	19.9%
Visitor Counter	16.2%
Site Search	15.4%
Audio Clips	1.5%
Video Clips	2.2%
Streamed Audio	0.7%
Streamed Video	0%
QuickTime VR	2.2%
Director/Shockwave Movies	1.5%
VRML	2.9%
JavaScript	1.5%
JAVA	0.7%
Plug-In Required	5.1%

(Figure 2: Technology found in Virtual Museums in the UK)

3.2.1 Summary of the UK Virtual Museum Survey

In general the majority of UK virtual museums were little more than electronic leaflets constructed of text and static images. However a few virtual museums did provide an interactive and educational experience.

The design of virtual museums was highly variable, from very amateur to highly professionally designed. Most sites were adequate but not outstanding, there is definitely the need for improved design for virtual museums as with almost every other type of site on the WWW.

Of the 136 UK virtual museums that it was intended to include in this survey, 10 had errors and could not be accessed. This may be due to a change of URL address, the file

server having gone down or the virtual museum having being removed from the Internet.

A selection of virtual museums provided alternative versions of their WWW sites, generally there was a graphically intensive site often, employing frames and requiring Plug-In's, these sites are designed for the latest browsers and a fast connection to the Internet. Typically the other site is less sophisticated with a lower graphic content, did not require Plug-In's, and was designed for older browsers and a slower connection to the Internet.

In summary most UK virtual museums are still composed of basic text and graphics, with links to related sites, providing basic information about the museum and its collection. These sites often translate to little more than an electronic version of the attraction's leaflet. Even those museums that have employed some of the more advanced Internet technologies have only scratched the surface of what can be achieved. There is still much to be done to improve the presence of UK virtual museums on the World Wide Web.

3.2.2 Summary of Features

Over 70% of the virtual museums surveyed included the basic information provided on their leaflet, contact details (address, telephone, fax and often e-mail), admission details (opening times and prices) and details of the site and/or collection.

Approximately 50% of the virtual museums also provided directions how to find the museum, frequently including a map. Approximately half also provided the facility to view either the site or collection and provided details of special events or future exhibitions.

Information specially targeted at schools (pupils and/or teachers) was provided by approximately 5% of virtual museums.

Almost 30% of the virtual museum also had a section on the museum shop, at the most basic level the presence of a museums shop was mentioned, up to a full visual catalogue of items for sale

A museum tour was provided by only about 15% of virtual museums, these constituted a structured approach and route through the museum, possibly allowing the visitor to choose their own route. A simple list of collections, galleries or exhibits was not sufficient to be counted in this section. Frequently the museum tour progressed room by room with the visitor clicking a next room, previous room or map buttons, the latter displaying a map of the museum or current gallery so that the visitor can jump to a section of interest or join the tour at any point.

Over 15% of virtual museums included a guest book so that visitors could leave comments, a mailing list to which they could subscribe, or a questionnaire that they could fill about the virtual museum. All of these methods are superior to the simple "E-mail your comments..." type and provided an effective way for the virtual museum to receive feedback or to create a database of visitor profiles that could be used for future direct mail or marketing.

Interactive exhibits proved to be very uncommon, being found in less than 5% of the virtual museums surveyed.

A feature that was also present in only a few virtual museums was an on-line Q&A Quiz, where a number of questions were posed, with the answers or information required to answer them contained somewhere within the virtual museum.

3.2.3 Summary of Technology

The basic building block of every WWW site and virtual museum is text and was used by every site surveyed. Almost all of the sites also used images, typically of the museum buildings, galleries or collections. However animated GIF's, image maps and frames were used by less than 10% of virtual museums.

The majority of virtual museums also provided URL Links, primarily these were to four types of WWW site, related museums & research, service providers, WWW Page Developers and WWW sites where Browsers or Plug-In's could be downloaded.

The use of E-Mail was also popular, and often used for a point of contact or for basic feedback on the Museums WWW site, typically "Please E-Mail your Comments to...".

Forms, Visitor Counters and Site Search facilities were present on approximately 15% of virtual museum. The site search is a useful additional method of navigation and provides the visitor with a quick and efficient way to locate resources contained within the WWW site.

Other technologies, Audio and Video, both downloadable clips and streamed, QuickTime VR, Director Movies, VRML, JavaScript, JAVA and where applicable a required plug-in were each included on less than 5% of the virtual museums surveyed.

The types of on-line Competition as used by the Museum of Science & Industry in Manchester and the Museum of Scotland were interesting and a good way to attract visitors to your site, particularly if the competition runs over a period of months and requires several repeat visits to the virtual museum www site.

Only the National Museums & Galleries of Wales made their WWW sites available in multiple languages (English & Welsh). With the importance of revenue from the international tourists it is surprising that more museums, especially the larger internationally renowned ones did not employ this strategy to try and attract potential overseas visitors.

A novel and unexpected use a WWW site was made by Museum of Scotland, which used its WWW site advertise for funding/donations and volunteers to help with the construction of the physical museum, which has not yet been built.

3.3 United States Virtual Museum Survey

Due to the well known problems of downloading sites from the USA to the UK especially in the afternoon as the Americans come on-line, (Mason 1995) it was decided that rather than attempt to conduct a survey of every virtual museum in the USA (393). A random sample should be taken of 10% of USA virtual museums and compared them to those virtual museum in the UK. The VLMP pages for the United States (<http://www.cs.reading.ac.uk/vlmp/usa.html>) was used as a sampling frame, and the identical survey method was used as for the UK survey, trying to identify those information, features and technology present.

The results of the USA virtual museum survey can be found in the tables on this page.

Features	Frequency (39)
Location	82.1%
Contact Details	69.2%
Admission Details	79.5%
Site/Collection Details	92.3%
View Site/Collection	84.6%
Interactive Exhibits	7.7%
Museum Tour	12.8%
Schools Program	59.0%
Special Events	38.5%
Museum Shop	41.0%
Q&A Quiz	2.6%
Guest Book, Mailing List or Questionnaire	12.8%

(Figure 3: Features found in Virtual Museums in the USA)

Technology	Frequency (39)
Text	97.4%
Images	97.4%
Animated GIF's	25.6%
Image Maps	20.5%
URL Links	69.2%
E-Mail	64.1%
Frames	7.7%
Forms	7.7%
Visitor Counter	18.0%
Site Search	20.5%
Audio Clips	0%
Video Clips	2.6%
Streamed Audio	0%
Streamed Video	2.6%
QuickTime VR	5.1%
Director/Shockwave Movies	2.6%
VRML	0%
JavaScript	2.6%
JAVA	2.6%
Plug-In Required	7.7%

(Figure 4: Technology found in Virtual Museums in the USA)

3.3.1 Comparison of USA and UK Virtual Museums

Generally those virtual museums located in the UK and USA were similar (within 10%) both in terms of features and their use of WWW technologies, although those virtual museums located in the USA were generally larger. However there were a few differences between virtual museums in the two continents. Firstly 20% more virtual museums in the USA provided details of the site or collection, 25% more included education programs and 30% more featured location details and the ability to view the collections. In Terms of WWW technology the only significant differences were that the USA virtual museums used 15% more animated GIF's and image maps than those in the UK.

3.4 Review of the Best Virtual Museum in the United States

Having completed a survey of all virtual museums in the UK and a random sample of 10% of the virtual museums in the USA it was decided to focus on the best virtual museums on the Internet. The purpose of the survey was to observe and identify what could be achieved, in terms of state of the art WWW technology, design and historical interpretation.

It was decided to use the VLMP top virtual museums in the USA as nominated by virtual visitors. The USA was chosen in preference to the UK or any other country because, according to Mike Spearman the rest of the world is "... five to ten years behind the US." (Falconer 1996) And because "... of the 'thousands' of museums worldwide listed in the directory more than half are in the US." (Falconer 1996)

In this section those virtual museums which featured exemplary graphic design and layout, made innovative use of WWW technologies or provided useful education resources will be reviewed and summarised. In addition the innovative ideas and concepts developed by some virtual museums identified during the survey will be discussed.

The majority of top USA virtual museums surveyed displayed a reasonable level of graphic design and layout.

However the following sites were considered to be exemplary;

- American Museum of Natural History
- Cleveland Museum of Art
- Colonial Williamsburg
- Internet Arts Museum for free
- Metropolitan Museum of Art
- Michael C. Carlos Museum
- National Gallery of Art
- San Francisco Exploratorium
- The Computer Museum

The WWW technologies available to museums developing site are continually advancing, the following sites made effective or innovative use of the following technologies:

- **VRML Gallery or Models** - Diego Rivera Web Museum, Smithsonian Institution & Kennedy Space Centre
- **Video Tour** - St. Louis Science Centre & National Museum of Women in the Arts
- **Internet Camera** - National Zoological Park
- **Animated GIF** - National Gallery of Art (Watson and the Shark)
- **Interactive Exhibits** - San Francisco Exploratorium & The Computer Museum

One of the key functions of all museums is to educate their visitors, with the advancement of the WWW it is now possible to make resources available an on-line and even provide interactive activities. The following museums have made particularly effective use of the WWW for educational purposes;

- **Colonial Williamsburg** – Electronic Field Trip
- **Illinois State Museum** – At Home in the Heartland Online
- **Michael C. Carlos Museum** – Odyssey Online
- **San Francisco Exploratorium** – Learning Studio, On-line Exhibits & Science Explorer
- **Smithsonian Institution** – Ocean Planet

3.4.1 Original Concepts and Ideas

Many of the virtual museums that were visited as part of this survey demonstrated original concepts for ways in which information could be delivered to the visitor and

innovative ideas to engaging them in the museum experience. The following sections briefly describe the best of these original concepts and ideas;

Metaphors were used by several museums as a method of making information available to visitors or enabling them to navigate the WWW site. Typically the visitor will already be familiar with the concept behind the metaphor and this can help to put them at ease and overcome the uncertainties of which button to click that some non computer literate people face when navigating the site. For example the San Jose Art Museum used the metaphor of an entrance hall and reception desk as a way to navigate the site and access information.

Of all the museums surveyed the Colonial Williamsburg museum stood out as being unique in its education and schools program. In particular the electronic field trips that it organises. The electronic field trips have three components: a teacher's guide, a one-hour, live, interactive television program, and special Internet activities. Several weeks before the televised portion of the field trip, teachers receive a guide, complete with historical background material, suggested lesson plans and facsimiles of original documents. These teacher's guides allow educators to prepare their classes for the live, interactive television program, which is offered twice on the date of broadcast to accommodate students in all time zones. This approach allows schools that would not otherwise be able to visit the museum due to their physical location to participate in the activities.

A problem facing designers of museum virtual is deciding who the target audience should be. If they focus on one particular group they run the risk of alienating other groups and you can rarely please everyone all of the time. An innovative and extremely effective solution to this dilemma was implemented by The Computer Museum, Boston. When first entering the virtual museum you can select from one of four profiles (Kid, Student, Adult or Educator), the overall structure of the site remains almost constant, however the graphics and content of the site will then be personalised to the chosen profile. A WWW site development of this kind requires large amounts of additional work, time, expertise, money and file space to create. Realistically, this type of virtual museum is only feasible for larger museums, and when implemented correctly as in this case can significantly enhance the visitor's experience.

Sponsorship of galleries or exhibits within virtual museums is beginning to appear. The most appropriate example was Friskies PetCare Company and Jaguar Cars of North America's sponsorship of the "Cats! Wild to Mild" exhibit at the LA County Natural History Museum. The sponsorship amounted to little more than a banner stating that this exhibit had been sponsored by the two companies and providing links to their respective WWW sites. This may be an effective way for museums to generate additional revenue, but may detract from the museum experience if sponsorship becomes too widespread.

In the Egyptian Gallery of the Michael C. Carlos Museum numerous audio samples are used so that the visitors can hear the correct pronunciation of the Egyptian words and place names. This is a very interesting and useful feature and as the individual samples are very brief the file sizes are small meaning that they download almost instantly.

Visitors to a virtual museum typically only view a small proportion of the museum, generally limiting themselves to admission details and their particular area of interest. However some museums would like visitors to explore the whole of their virtual museum. At The Tech Museum of Innovation a crossword puzzle has been developed, with the answers to the clues located throughout the virtual museum, this was effective in encouraging visitors to access every section of the site. This was increased further by offering an incentive for successful completion of the crossword, for example your name will be displayed at the virtual museum the following month. A similar concept was in place at the St. Louis Science Centre where a Treasure Hunt was used to encourage especially children to explore the virtual museum more fully.

One of the most important things about visiting a museum is that it should be a social experience, where people interact together. However, this can be difficult to achieve for a virtual museum where the visitors are not in the same physical location, frequently being spread across the world. The Computer Museum in Boston has come up with an ingenious solution. When the visitor first enters the museum they have the opportunity to enter their name as a visitor to the museum. Then as they move around the museum the names of other visitors who have recently visited the same gallery appear at the top of the screen. Clicking on these names allows the user to send the other visitor a

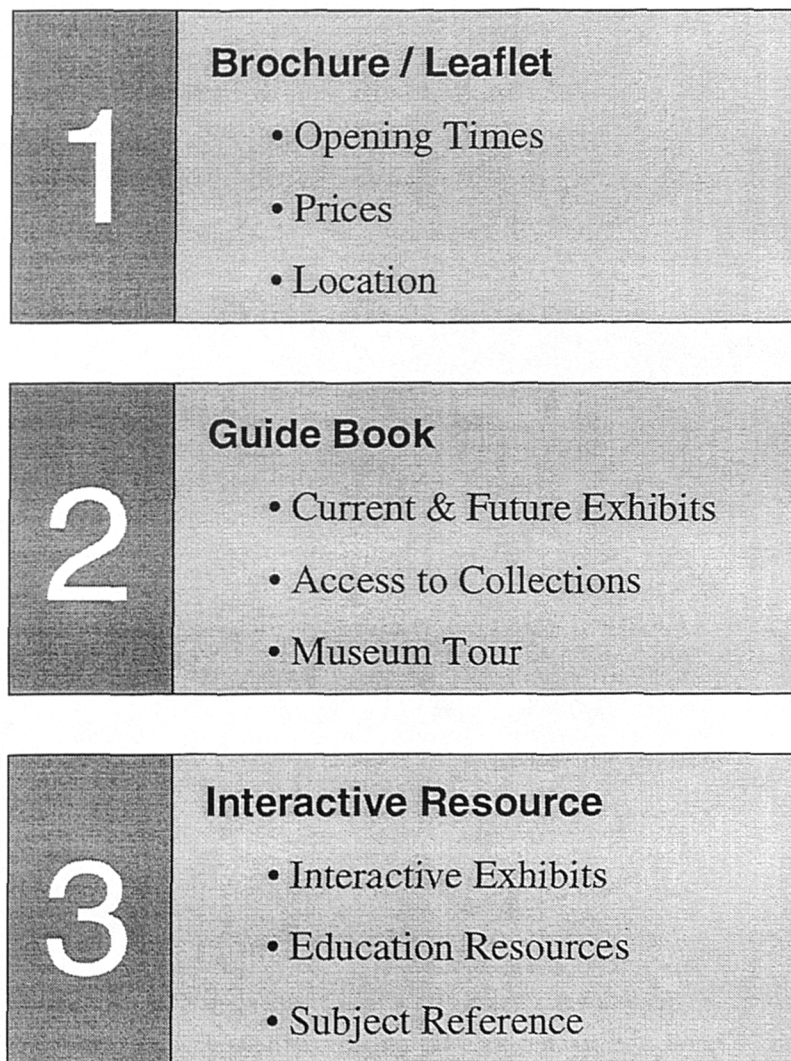
message. The site even goes a stage further by requiring that 2-4 visitors work together over the WWW to solve puzzle written as a JAVA applet.

3.4.2 Summary of Best Virtual Museums

In summary the best virtual museums located in the USA are generally comprehensive, well structured and feature excellent graphics. They have moved beyond the electronic leaflet and are making effective use of WWW technologies for visitor interaction and education. In many cases they have developed original concepts and ideas for the use of metaphors, educational resources, personalisation of the virtual museum for different visitors, sponsorship, multimedia interactives and visitor interaction.

4.0 Heritage Attraction WWW Site Classification

Based upon the findings of the WWW site surveys a classification of WWW sites has been constructed with the following three categories:



(Figure 5 : Heritage Attraction WWW Site Classification)

5.0 Conclusion

The many virtual museums located in the UK and USA have made a promising start, however there is still much to do to improve the presence of museums on the WWW, especially as user expectations increase and the audience expands in the months ahead.

When compared to virtual museums in the UK those in the USA generally have a better structure and layout, are much larger, have superior graphic design and overall they appear to have more educational resources available for pupils and teachers.

The best virtual museums in the USA are media rich and make extensive use of advanced WWW technologies to make them a more interactive and engaging experience. These virtual museums should act as a bench mark by to which other museums from around the world should aspire.

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Appendix B

MEDIA CONTENT LIST

Museum of Science and Industry in Manchester Fibres, Fabrics and Fashions Gallery

Title Screen

- Fibres, Fabrics and Fashions Gallery Logo (msin_logo.gif)
- Museum of Science and Industry in Manchester Logo (fff_logo.gif)

Menu Bar

- Map Icon (Map/Compass/Sign Post)
- Cotton Icon
- Cotton Bale & Lap Icon
- Sliver in Can Icon
- Bobbin & Spindle Icon
- Shuttle Icon
- Help Icon (?)
- Fabric Background

Room 0: Cotton Field to the Mill

Background:

- Cotton/Cotton Bush
- Plantation Pickers
- Ship
- Train
- Barge
- Textile Mill (r00room.jpg)
- Overview Text (r00text.txt)

Hotspot 1: (Cotton)

- Cotton Image (r01cotton.gif)
- Map of where cotton is grown (r01map.gif)
- Cotton Text (r01text.txt)
- Audio SFX

Hotspot 2: (Cotton Plantations & Picking)

- Plantation Images (Over Time) (r02plant1.gif ...)
- Video of Cotton Picking (r02video.avi)
- Picking Text (r02text.txt)
- Audio SFX

Hotspot 3: (Shipping)

- Image of Ship/Docks/Loading (r03ship.gif)
- Map of Routes (r03map.gif)
- Shipping Text (r03text.txt)
- Audio SFX

Hotspot 4: (Transport)

- Image of Train (r04train.gif)
- Image of Barge (r04barge.gif)
- Map or routes (r04map.gif)
- Transport Text (r04text.txt)
- Audio SFX

Hotspot 5: (Textile Mills)

- Image of Textile Mill (r05mill.gif)
- Image of Mill Owner (r05owner.gif)
- Map of Mills (r05map.gif)
- Mill Text (r05text.txt)
- Audio SFX

Room 1: Blowing Room**Background:**

- Mill Room including:
- Hopper Feeder
- Scutcher
- Cotton Bale
- Laps
- Men
- Power Belts (r10room.jpg)
- Blowing Room Text (r10text.txt)

Hotspot 1: (Hopper Feeder)

- Hopper Feeder Image (Whole Machine) (r11hf1.gif)
- Hopper Feeder Image (Close Up) (r11hf2.gif)
- Hopper Feeder Video (r11video.avi)
- Hopper Feeder Animation (r11anim.avi)
- Hopper Feeder Text (r11text.txt)
- Audio SFX

Hotspot 2: (Scutcher)

- Scutcher Image (Whole Machine) (r12sc1.gif)
- Scutcher Image (Close Up) (r12sc2.gif)
- Scutcher Video (r12video.avi)
- Scutcher Animation (r12anim.avi)
- Scutcher Text (r12text.txt)
- Audio SFX

Hotspot 3: (Cotton Bales)

- Cotton Bale Image (r13bale.gif)
- Cotton Bale Text (r13text.txt)

Hotspot 4: (Laps)

- Lap Image (r14lap.gif)
- Lap Text (r14text.txt)

Hotspot 5: (Men)

- Men Image 1 (r15men1.gif)
- Men Image 2 (r15men2.gif)
- Men Text (r15text.txt)
- Audio SFX

Hotspot 6: (Water Power)

- Water Wheel Image (r16waterw.gif)
- Power Shafts Image (r16power.gif)
- Water Power Text (r16text.txt)
- Audio SFX

Room 2: Carding Room**Background:**

- Carding Engine Image
- Drawing Frame Image
- Speed Frame Image
- Slivers in Cans (Red, Yellow & White)
- Women
- Power Belts (r20room.jpg)
- Carding Room Text (r20text.txt)

Hotspot 1: (Carding Engine)

- Carding Engine Image (Whole Machine) (r21ce1.gif)
- Carding Engine Image (Close Up) (r21ce2.gif)
- Carding Engine Animation (r21anim.avi)
- Carding Engine Video (r21video.avi)
- Carding Engine Text (r21text.txt)
- Audio SFX

Hotspot 2: (Drawing Frame)

- Drawing Frame Image (Whole Machine) (r22df1.gif)
- Drawing Frame Image (Close Up) (r22df2.gif)
- Drawing Frame Animation (r22anim.avi)
- Drawing Frame Video (r22video.avi)
- Drawing Frame Text (r22text.txt)
- Audio SFX

Hotspot 3: (Speed Frame)

- Speed Frame Image (Whole Machine) (r23sf1.gif)
- Speed Frame Image (Close Up) (r23sf2.gif)
- Speed Frame Animation (r23anim.avi)
- Speed Frame Video (r23video.avi)
- Speed Frame Text (r23text.txt)
- Audio SFX

Hotspot 4: (Slivers)

- Sliver Image (Close Up) (r24sliver.gif)
- Sliver Cans Image (Red, Yellow & White) (r24cans.gif)
- Sliver Text (r24text.txt)

Hotspot 5: (Women)

- Women Image 1 (r25women1.gif)
- Women Image 2 (r25women2.gif)
- Women Text (r25text.txt)

Hotspot 6: (Steam Power)

- Steam Engine Image (r26steam.gif)
- Power Shafts Image (r26power.gif)
- Water Power Text (r26text.txt)
- Audio SFX

Hotspot 7: Bobbins

- Bobbins Image (r27bobbin.gif)
- Bobbins Text (r27text.txt)

Room 3: Spinning Room**Background:**

- Pair of Spinning Mules
- Bobbins
- Spindles
- Men (Mule Spinner)
- Children (Piecers) (r30room.jpg)
- Spinning Room Text (r30text.txt)

Hotspot 1: Spinning Mule

- Spinning Mule Image (Whole Machine) (r31sm1.gif)
- Spinning Mule Image (Close Up) (r21sm2.gif)
- Spinning Mule Animation (r21anim.avi)
- Spinning Mule Video (r21video.avi)
- Spinning Mule Text (r31text.txt)
- Audio SFX

Hotspot 3: Spindles

- Spindles Image (r33spindles.gif)
- Spindles Text (r33text.txt)

Hotspot 4: Men

- Men Image 1 (r34men1.gif)
- Men Image 2 (r34men2.gif)
- Men Text (r34text.txt)
- Audio SFX

Hotspot 5: Children

- Children Image 1 (r35child1.gif)
- Children Image 2 (r35child2.gif)
- Children Text (r35text.txt)
- Audio SFX

Room 4: Weaving Shed**Background:**

- Lancashire Loom
- Ribbon Loom
- Shuttle
- Men, Women & Children
- Goods for Export (r40room.jpg)
- Weaving Shed Text (r40text.txt)

Hotspot 1: Lancashire Loom

- Lancashire Loom Image (While Machine) (r41loom1.gif)
- Lancashire Loom Image (Close Up) (r41loom2.gif)
- Lancashire Loom Animation (r41anim.avi)
- Lancashire Loom Video (r41video.avi)
- Lancashire Loom Text (r41text.txt)
- Audio SFX

Hotspot 2: Ribbon Loom

- Ribbon Loom Image (Close Up on Cards) (r4cards.gif)
- Ribbon Loom Image (Close Up on Ribbons) (r42ribbons.gif)
- Ribbon Loom Animation (r42anim.avi)
- Ribbon Loom Video (r42video.avi)
- Ribbon Loom Text (r42text.txt)
- Audio SFX

Hotspot 3: Shuttle

- Shuttle Images (r43shuttles.gif)
- Shuttle Text (r43text.txt)

Hotspot 4: Men, Women & Children

- Men Image (r44men.gif)
- Women Image (r44women.gif)
- Children Image (r45child.gif)
- Men, Women & Children Text (r44text.txt)

Hotspot 5: Goods for Export

- Finished Goods Image 1 (r45fgoods.gif)
- Map of destinations (r45map.gif)
- Finished Goods Text (r45text.txt)

Appendix C

Visitor Survey Questions

Pre-Visit Questions

I am from the University of Salford studying a postgraduate degree. I am doing research on the part of the gallery that has the original textile machines. Would you be prepared to help me out with my research today? This will involve me asking you a few questions, you will then be free to look around the gallery, then I would like to ask you a couple more questions before you leave the gallery.

1). Male / Female 2). Age group A / B / C / D / E / F / G / H / I / J / K

3). Have you visited a textile mill or textile gallery at a museum before? YES / NO

3i). (If YES) Can you tell me which ones?

- | | | |
|---|---|---------------------------------------|
| <input type="checkbox"/> Quarry Bank Mill | <input type="checkbox"/> Macclesfield Silk Museum | <input type="checkbox"/> Liverpool |
| <input type="checkbox"/> Science Museum | <input type="checkbox"/> Costume Museum | <input type="checkbox"/> Huddersfield |
| <input type="checkbox"/> Helmshaw | <input type="checkbox"/> Halifax | <input type="checkbox"/> Bradford |
| <input type="checkbox"/> Other | | |

4). Have you visited the Fibres, Fabrics and Fashions gallery here before? YES / NO

5). Is there anything in particular you are hoping to get out of your visit to this gallery?

- | | | |
|---|---|---|
| <input type="checkbox"/> Nothing specific | <input type="checkbox"/> General Overview | <input type="checkbox"/> Textile Machines |
| <input type="checkbox"/> Other | | |

The next few questions are to help me understand what you know about the cotton process. It does not matter if you do not know the answers.

6). Can you tell me the name of this textile machine and what it does?

- | | | | | |
|----------------------------------|---|--------------------------------|-----------------------------------|----------------------------------|
| <input type="checkbox"/> No | <input type="checkbox"/> Spinning Jenny | <input type="checkbox"/> Loom | <input type="checkbox"/> Printing | <input type="checkbox"/> Cutting |
| <input type="checkbox"/> Weaving | <input type="checkbox"/> Spinning | <input type="checkbox"/> Other | | |

7). Can you tell me the stages which cotton goes through from plant to finished fabric?

- | | | | |
|----------------------------------|-------------------------------------|------------------------------------|-----------------------------------|
| <input type="checkbox"/> No | <input type="checkbox"/> Harvesting | <input type="checkbox"/> Unpacking | <input type="checkbox"/> Cleaning |
| <input type="checkbox"/> Carding | <input type="checkbox"/> Spinning | <input type="checkbox"/> Dying | <input type="checkbox"/> Weaving |
| <input type="checkbox"/> Other | | | |

Thank you very much for your help, please look around the gallery and I will ask you some more questions when you have finished.

Post-Visit Questions (All Visitors)

If you have finished looking around this area of the gallery then I would like to ask you a few more questions.

1). Did the textile gallery meet your expectations? YES / NO / No Expectations

1i). (If YES) Can you tell me in what way it met your exceptions?

- Had what I was looking for Informative
 Other

1iii). (If NO) Can you tell me why the textile gallery did not meet your exceptions?

- Didn't have what I was looking for Other

2). Can you tell me what you liked best about your visit to this textile gallery?

- Printing area Textile Machines Atmosphere Process
 Videos Education Focus Models None
 Other

3). Can you tell me what you liked least about your visit to this textile gallery?

- Shoe area No working machines
 Design Interactives not working
 Children/Artist Work Nothing for very young children
 None Other

4). Can you tell me the name of this textile machine and what it does?

- No Spinning Jenny Loom Printing
 Cutting Weaving Spinning Other

5). Can you tell me the stages which cotton goes through from plant to finished fabric?

- No Harvesting Unpacking Cleaning
 Carding Spinning Dying Weaving
 Other

Post-Visit Questions (For Computer Group Only)

6). Did you like using the computer? YES / NO

7). Did you find it easy to use? YES / NO

7i). (If YES) What made it easy to use?

- Good Instructions Clear Interface/Buttons
 Pen & Touchscreen Other

7ii). (If NO) Why was it difficult to use?

- Poor Instructions Other

8). Did the computer help you to explore the textile machinery and the cotton process more than you would have done normally? YES / NO

9). Do you think that you have learnt more about the textile machinery and the cotton process by using the computer than you would have done normally? YES / NO

10). What did you like about the portable computer?

- New Technology Visual Screen Design Good Display
 Video Clips/Animations Information Easy to use
 Audio Other

11). What did you not like about the portable computer?

- None Distract from exhibits Other

For all visitors

That completes my questions. Thank you very much for your help with my research. I hope you enjoy the rest of your visit to the museum.

A 16-20yrs

B 21-25yrs

C 26-30yrs

D 31-35yrs

E 36-40yrs

F 41-45yrs

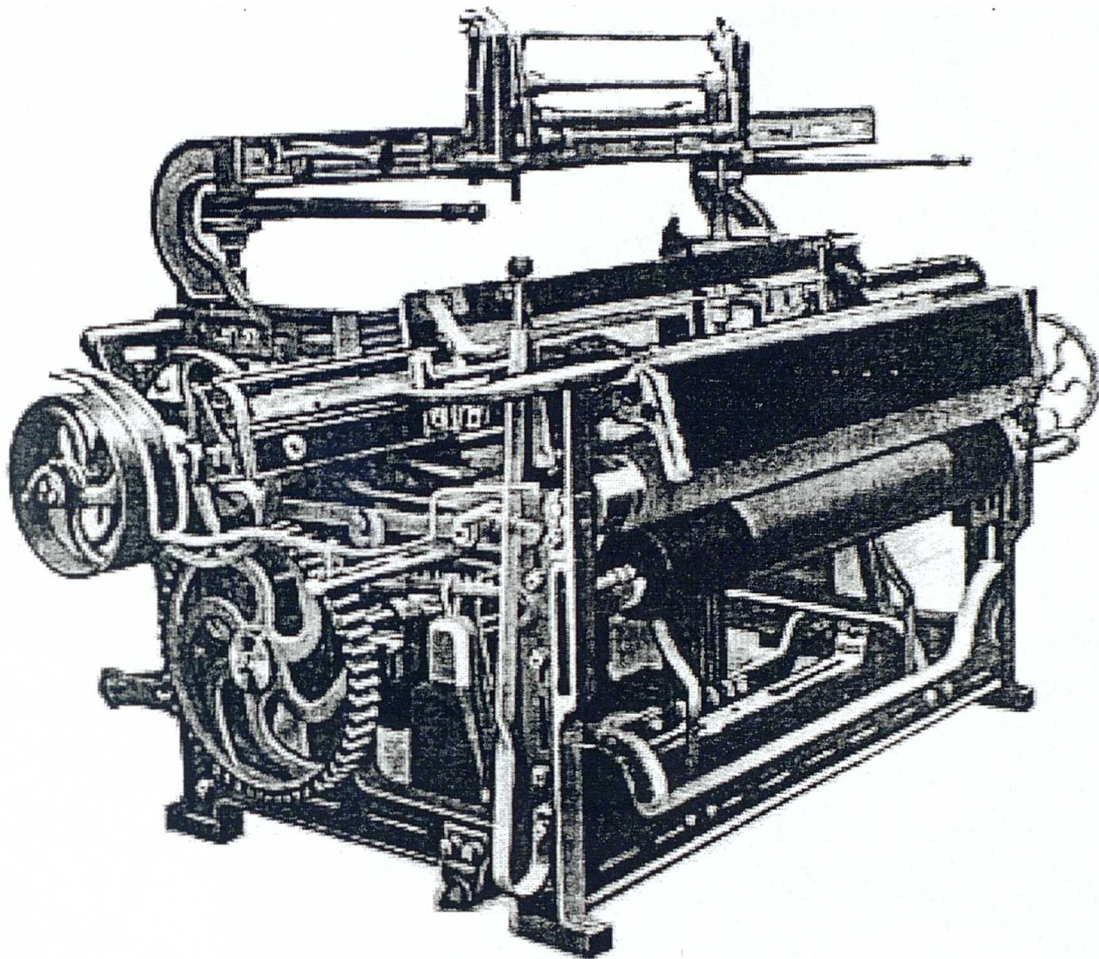
G 46-50yrs

H 51-55yrs

I 56-60yrs

J 61-65yrs

K 66+yrs



Appendix D

Spreadsheet A

**Control Group
Questionnaires**

Questionnaire - Control Group																						
Week	Day	Visitor	Sex	Age	Visit Mus.	OBM	Helmshaw	Macdesfield	Other	Visit FFF	Nothing Specific	General Overview	Textile Machines	Textile Industry	No	Loom	Weaving	Other	No	Harvesting	Unpacking	Washing/Cleaning
1	1	1	f	1	n					n	1				1	1			1			
1	1	2	m	h	n					n	1				1	1			1			
1	1	3	m	d	n					n	1				1	1			1			
1	1	4	m	c	n					n	1				1	1			1			
1	1	5	m	c	y					n	1				1	1			1			
1	2	6	m	k	n					n	1				1	1			1			
1	2	7	m	k	y					n	1				1	1			1			
1	2	8	f	k	n					n	1				1	1			1			
1	2	9	m	k	y					n	1				1	1			1			
1	2	10	f	b	n					n	1				1	1			1			
1	3	11	m	k	n					y	1				1	1			1			
1	3	12	m	l	n					n	1				1	1			1			
1	3	13	f	d	y					n	1				1	1			1			
1	3	14	m	c	y					n	1				1	1			1			
1	3	15	f	h	y					y	1				1	1			1			
1	4	16	m	k	y			1		n	1				1	1			1			
1	4	17	f	g	n					n	1				1	1			1			
1	4	18	m	d	y					y	1				1	1			1			
1	4	19	f	d	y					n	1				1	1			1			
1	4	20	m	h	n					n	1				1	1			1			
1	5	21	f	e	n					n	1				1	1			1			
1	5	22	f	d	n					n	1				1	1			1			
1	5	23	f	l	n					n	1				1	1			1			
1	5	24	m	l	n					n	1				1	1			1			
1	5	25	m	e	n					n	1				1	1			1			
2	1	26	f	a	y					y	1				1	1			1			
2	1	27	m	e	y					n	1				1	1			1			
2	1	28	f	b	n					y	1				1	1			1			
2	1	29	f	g	n					n	1				1	1			1			
2	1	30	m	h	n					y	1				1	1			1			
2	2	31	f	c	n					n	1				1	1			1			
2	2	32	m	h	n					n	1				1	1			1			
2	2	33	f	b	n					y	1				1	1			1			
2	2	34	f	l	y					n	1				1	1			1			
2	2	35	f	h	n					n	1				1	1			1			
2	3	36	f	d	n					n	1				1	1			1			
2	3	37	m	j	n					n	1				1	1			1			
2	3	38	m	e	y					n	1				1	1			1			
2	3	39	m	l	y					n	1				1	1			1			
2	3	40	m	d	n					n	1				1	1			1			
2	4	41	m	l	n					n	1				1	1			1			
2	4	42	f	c	n					n	1				1	1			1			
2	4	43	m	l	n					n	1				1	1			1			
2	4	44	m	d	y					y	1				1	1			1			
2	4	45	m	l	n					n	1				1	1			1			
2	5	46	f	a	n					n	1				1	1			1			
2	5	47	m	b	n					n	1				1	1			1			
2	5	48	m	h	n					n	1				1	1			1			
2	5	49	f	d	n					n	1				1	1			1			
2	5	50	f	b	n					n	1				1	1			1			

Carding	Drawing	Spinning	Winding	Dying	Weaving	No. Correct	Meal Expectations	Had What I Was Looking For	Very Interesting	No Working Machines	Textile Machines	Layout	Process	Outside Areas	Demonstrators	Text Panels & Displays	Lighting
						0 NoExp					1						
						0 NoExp											
						4 NoExp											
						2 NoExp											
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						4 NoExp</											

Spreadsheet B

Computer Group Questionnaires

Questionnaire - Computer																								
Week	Day	Visitor	Sex	Age	Visit Mus.	OBM	Helmshaw	Macclesfield	Wigan Pier	Bradford	Leeds	Halifax	Huddersfield	Science Museum	Newcastle	Yorkshire	Other	Visit FFF	Nothing Specific	General Overview	Textile Machines	Other		
3	1	1	f	n	n													n						
3	1	2	m	n	n													n						
3	1	3	f	c	n													n						
3	1	4	m	c	n													n						
3	1	5	m	g	y				1									n						
3	2	1	m	f	n													n						
3	2	2	f	j	y													y						
3	2	3	m	e	y					1								y						1
3	2	4	f	g	n													y						
3	2	5	f	d	n													y						
3	3	1	f	g	y						1							n						
3	3	2	f	g	y													n						
3	3	3	f	a	n													n						
3	3	4	m	j	y													y						
3	3	5	f	a	n													n						
3	4	1	m	k	n													n						
3	4	2	f	e	y													n						
3	4	3	m	e	y													n						
3	4	4	f	f	y					1								n						1
3	4	5	m	f	y													n						
3	5	1	f	d	y													1	y					1
3	5	2	m	g	y													n						
3	5	3	f	c	n													n						
3	5	4	f	d	y													y						
3	5	5	f	d	y													n						
4	1	1	m	e	n													n						
4	1	2	f	e	n													n						
4	1	3	f	e	y													n						
4	1	4	m	b	n													n						
4	1	5	f	j	n													n						
4	2	1	f	b	n													y						1
4	2	2	m	c	n													n						
4	2	3	m	e	y													1	y					
4	2	4	m	b	y													n						
4	2	5	m	f	y													n						
4	3	1	f	e	n													y						
4	3	2	m	d	n													n						
4	3	3	m	d	y								1					n						
4	3	4	f	e	y									1				y						
4	3	5	m	b	n													n						
4	4	1	f	b	y													n						
4	4	2	m	k	y													n						
4	4	3	m	d	n													y						
4	4	4	m	b	y													n						
4	4	5	f	d	n													n						
4	5	1	m	e	y													n						
4	5	2	m	e	n													n						
4	5	3	m	c	y													n						
4	5	4	f	c	y													n						
4	5	5	m	b	y													y						

No	Loom	Weaving	Other	No	Harvesting	Unpacking	Washing/Cleaning	Carding	Drawing	Spinning	Winding	Dying	Weaving	Printing	No. Correct	Meet Expectations	Had What I Was Looking For	Knew what to expect from p. vii
		1	1				1								1	NoExp		
		1	1	1			1								0	NoExp		
								1						1	2	NoExp		
		1	1	1											0	NoExp		
		1	1	1				1							3	NoExp		
		1	1	1				1							0	NoExp		
		1	1	1				1							4	NoExp		
		1	1	1				1							2	No		
		1	1	1				1							3	NoExp		
		1	1	1				1							0	NoExp		
		1	1	1				1							2	NoExp		
		1	1	1				1							2	NoExp		
		1	1	1				1							3	NoExp		
		1	1	1				1							2	No		
		1	1	1				1							3	No		
		1	1	1				1							3	No		
		1	1	1				1							4	NoExp		
		1	1	1				1							3	Yes		
		1	1	1				1							1	NoExp		1
		1	1	1				1							2	NoExp		
		1	1	1				1							0	NoExp		
		1	1	1				1							0	NoExp		
		1	1	1				1							3	NoExp		
		1	1	1				1							0	NoExp		
		1	1	1				1							0	NoExp		
		1	1	1				1							2	NoExp		
		1	1	1				1							3	NoExp		
		1	1	1				1							1	No		
		1	1	1				1							4	NoExp		
		1	1	1				1							0	Yes		1
		1	1	1				1							0	NoExp		
		1	1	1				1							4	NoExp		
		1	1	1				1							2	NoExp		
		1	1	1				1							3	No		
		1	1	1				1							3	NoExp		
		1	1	1				1							1	NoExp		
		1	1	1				1							8	NoExp		
		1	1	1				1							3	NoExp		
		1	1	1				1							0	NoExp		
		1	1	1				1							0	NoExp		
		1	1	1				1							2	NoExp		
		1	1	1				1							0	NoExp		
		1	1	1				1							1	NoExp		
		1	1	1				1							3	NoExp		
		1	1	1				1							1	Yes		1
		1	1	1				1							1	NoExp		
		1	1	1				1							3	NoExp		
		1	1	1				1							4	NoExp		

Spreadsheet C

**Control Group
Observed Behaviour**

Week	Day	Visitor	Look at Text Panels		Look at Other Exhibits		Look at Map or Guidebook		Touch Exhibits or Cotton		Point at Exhibits		Attend to Baking Mgs		Attend to Children		Walking		Talk to Members of Group		Talk to Other Visitors		Talk to Staff Demonstrator		Leave			
			LTM	LTP	LOE	LTP	LOE	LTP	LGB	TEC	PAE	APB	ATC	WLK	TMG	TOV	TDM	LVE	TOTAL									
1	1	1	0:00:41	0:00:39	0:01:41	0:00:07																						
1	1	2	0:01:09	0:00:33	0:00:33	0:00:21																						
1	1	3	0:02:22	0:01:19	0:01:51	0:00:09																						
1	1	4	0:02:19	0:00:17	0:00:17	0:00:39																						
1	1	5	0:02:31	0:00:41	0:03:44	0:00:14																						
1	2	1	0:01:57	0:00:30	0:03:06	0:00:16																						
1	2	2	0:02:22	0:01:55	0:02:12	0:00:16																						
1	2	3	0:01:06	0:01:08	0:01:35	0:00:11																						
1	2	4	0:01:36	0:00:20	0:01:25	0:00:04																						
1	2	5	0:00:58	0:00:53	0:00:14	0:00:53																						
1	3	1	0:09:12	0:01:45	0:05:16	0:00:15																						
1	3	2	0:06:13	0:00:24	0:00:28	0:00:04																						
1	3	3	0:01:25	0:02:25	0:01:22	0:00:04																						
1	3	4	0:01:09	0:00:06	0:01:30	0:00:28																						
1	3	5	0:01:18	0:01:18	0:01:18	0:00:13																						
1	4	1	0:02:37	0:02:35	0:04:04	0:00:13																						
1	4	2	0:00:26	0:00:55	0:00:19	0:00:15																						
1	4	3	0:01:47	0:00:19	0:01:04	0:00:15																						
1	4	4	0:00:40	0:01:29	0:00:21	0:00:05																						
1	4	5	0:04:03	0:01:04	0:02:23	0:00:05																						
1	5	1	0:02:39	0:01:54	0:03:02	0:00:17																						
1	5	2	0:03:33	0:01:01	0:03:21	0:01:15																						
1	5	3	0:02:11	0:00:48	0:00:12	0:00:12																						
1	5	4	0:03:06	0:00:19	0:05:39	0:00:57																						
1	5	5	0:01:54	0:01:29	0:01:18	0:01:03																						
2	1	1	0:00:26	0:00:30	0:00:08	0:00:08																						
2	1	2	0:03:03	0:01:45	0:01:36	0:00:32																						
2	1	3	0:05:05	0:02:14	0:03:01	0:00:40																						
2	1	4	0:00:24	0:00:48	0:00:05	0:00:05																						
2	1	5	0:07:11	0:03:14	0:04:15	0:00:05																						
2	2	1	0:01:27	0:00:36	0:02:55	0:00:19																						
2	2	2	0:01:28	0:00:27	0:01:34	0:00:19																						
2	2	3	0:01:52	0:00:55	0:01:26	0:00:11																						
2	2	4	0:04:01	0:02:58	0:02:06	0:00:11																						
2	2	5	0:02:19	0:00:22	0:01:48	0:00:18																						
2	3	1	0:01:11	0:00:58	0:04:22	0:00:18																						
2	3	2	0:01:34	0:00:58	0:01:37	0:00:18																						
2	3	3	0:00:26	0:00:48	0:01:15	0:00:19																						
2	3	4	0:00:59	0:00:10	0:00:20	0:00:11																						
2	3	5	0:01:26	0:00:44	0:02:56	0:00:11																						
2	4	1	0:01:12	0:00:04	0:00:43	0:00:07																						
2	4	2	0:00:14	0:00:22	0:00:58	0:00:17																						
2	4	3	0:02:33	0:00:31	0:01:47	0:00:07																						
2	4	4	0:02:15	0:00:18	0:00:19	0:00:07																						
2	4	5	0:01:00	0:00:27	0:00:37	0:00:11																						
2	5	1	0:00:30	0:00:49	0:02:47	0:00:31																						
2	5	2	0:02:07	0:00:34	0:02:47	0:00:17																						
2	5	3	0:01:17	0:02:08	0:00:17	0:00:07																						
2	5	4	0:00:54	0:01:08	0:00:15	0:00:15																						
2	5	5	0:01:07	0:01:12	0:02:18	0:00:18																						
TOTAL		Visitor	1:43:57	0:52:06	1:29:33	0:10:39	0:00:13	0:00:13	0:01:39	0:02:37	0:02:04	0:00:20	0:06:33	0:20:31	0:00:24	0:23:15	5:22:56											
		Average (MEAN)	0:02:05	0:01:09	0:01:47	0:00:13	0:00:00	0:00:00	0:00:13	0:00:03	0:00:02	0:00:00	0:00:08	0:00:25	0:00:00	0:00:30	0:06:28											
		Standard Deviation	0:01:46	0:00:45	0:01:24	0:00:01	0:00:01	0:00:01	0:00:19	0:00:08	0:00:46	0:00:04	0:00:12	0:00:42	0:00:00	0:04:40	0:05:30											

Spreadsheet D

Computer Group Observed Behaviour

Week	Day	Visitor	Look at Textiles	Look at Other Exhibits	Look at Text Panels	Touch Exhibits or Cotton	Point at Exhibits	Attended to Backgrounds	Waiting	Talk to Member of Group	Look at Computer	Show Computer to Other Visitors	Leave Observation Area	Extra Time In Gallery	TOTAL (inc. EXTRA)
			LTM	LOE	LTP	TEC	PAE	APB	WLK	TMG	CUL	CSV	LVE	EXT	
3	1	1	0:00:38	0:01:27	0:00:53	0:00:13			0:00:13	0:00:41	0:05:38	0:00:27		0:03:00	0:09:57
3	1	2	0:01:33	0:00:09	0:03:18	0:00:04			0:00:04	0:00:20	0:05:13	0:00:05		0:06:00	0:10:57
3	1	3	0:01:32	0:00:14	0:01:25				0:00:11	0:00:23	0:13:01		0:01:53	0:02:00	0:11:02
3	1	4	0:02:45	0:00:14	0:01:47				0:00:11	0:00:23	0:13:01		0:01:53	0:02:00	0:20:14
3	1	5	0:00:43	0:00:24	0:01:02				0:00:11	0:00:23	0:06:56		0:01:53	0:02:00	0:09:05
3	2	1	0:02:32	0:01:15	0:00:05				0:00:11	0:00:37	0:06:56		0:01:53	0:02:00	0:11:05
3	2	2	0:03:25	0:00:36	0:01:30				0:00:11	0:00:37	0:06:56		0:01:53	0:02:00	0:12:14
3	2	3	0:03:24	0:00:10	0:01:14	0:00:03			0:00:11	0:00:49	0:10:05	0:00:16	0:00:13	0:07:00	0:19:14
3	2	4	0:03:28	0:01:29	0:01:20				0:00:11	0:00:49	0:06:20	0:00:28	0:00:13	0:10:00	0:17:28
3	2	5	0:02:03	0:00:37	0:02:47				0:00:11	0:00:05	0:08:51	0:00:47	0:00:13	0:04:00	0:12:39
3	3	1	0:05:00	0:00:28	0:02:25				0:00:11	0:00:05	0:08:51	0:00:47	0:00:13	0:04:00	0:27:23
3	3	2	0:00:43	0:00:33	0:01:00	0:00:24			0:00:11	0:00:14	0:02:41	0:00:34	0:00:23	0:04:00	0:14:30
3	3	3	0:01:15	0:00:49	0:01:08	0:00:07			0:00:11	0:00:19	0:05:04		0:00:23	0:04:00	0:25:18
3	3	4	0:01:30	0:00:32	0:03:50				0:00:11	0:00:15	0:15:08		0:00:23	0:04:00	0:07:32
3	3	5	0:00:59	0:00:35	0:00:53				0:00:11	0:00:15	0:05:40		0:00:23	0:04:00	0:08:42
3	4	1	0:03:20	0:00:32	0:00:59				0:00:11	0:00:15	0:05:40		0:00:23	0:04:00	0:21:11
3	4	2	0:01:18	0:00:44	0:01:05	0:00:05			0:00:11	0:00:17	0:07:31	0:01:33	0:00:23	0:03:00	0:08:22
3	4	3	0:03:30	0:00:37	0:02:57	0:00:13			0:00:03	0:00:07	0:05:40		0:00:23	0:04:00	0:12:32
3	4	4	0:04:32	0:00:15	0:00:55	0:00:18			0:00:03	0:00:07	0:05:40		0:00:23	0:04:00	0:12:33
3	4	5	0:01:01	0:01:40	0:00:55				0:00:03	0:00:06	0:05:21		0:00:23	0:04:00	0:17:51
3	5	1	0:01:25	0:00:06	0:01:22				0:00:03	0:00:06	0:05:21		0:00:23	0:04:00	0:11:50
3	5	2	0:02:20	0:01:07	0:00:45	0:00:29			0:00:03	0:00:06	0:05:21		0:00:23	0:04:00	0:09:46
3	5	3	0:01:13	0:00:22	0:01:38				0:00:03	0:00:06	0:05:21		0:00:23	0:04:00	0:19:23
3	5	4	0:01:15	0:00:05	0:01:32				0:00:03	0:00:06	0:05:21		0:00:23	0:04:00	0:22:21
3	5	5	0:00:58	0:00:08	0:01:35				0:00:03	0:00:06	0:05:21		0:00:23	0:04:00	0:06:59
4	1	1	0:00:57	0:00:07	0:00:48				0:00:03	0:00:12	0:05:54		0:00:23	0:04:00	0:09:27
4	1	2	0:01:12	0:00:10	0:01:30				0:00:03	0:00:12	0:05:54		0:00:23	0:04:00	0:08:34
4	1	3	0:00:46	0:00:19	0:00:47				0:00:03	0:00:12	0:05:54		0:00:23	0:04:00	0:08:02
4	1	4	0:01:56	0:00:36	0:01:25				0:00:03	0:00:12	0:05:54		0:00:23	0:04:00	0:11:28
4	1	5	0:01:08	0:01:05	0:02:14				0:00:03	0:00:12	0:05:54		0:00:23	0:04:00	0:07:10
4	2	1	0:01:16	0:00:32	0:00:06				0:00:03	0:00:12	0:05:54		0:00:23	0:04:00	0:09:35
4	2	2	0:02:18	0:00:15	0:01:25				0:00:03	0:00:12	0:05:54		0:00:23	0:04:00	0:08:51
4	2	3	0:01:53	0:00:12	0:01:11				0:00:03	0:00:12	0:05:54		0:00:23	0:04:00	0:12:00
4	2	4	0:02:49	0:00:08	0:01:33				0:00:03	0:00:12	0:05:54		0:00:23	0:04:00	0:09:42
4	2	5	0:00:28	0:00:03	0:01:19				0:00:03	0:00:12	0:05:54		0:00:23	0:04:00	0:09:27
4	3	1	0:01:32	0:00:10	0:00:50				0:00:03	0:00:12	0:05:54		0:00:23	0:04:00	0:11:39
4	3	2	0:02:32	0:00:10	0:00:31				0:00:03	0:00:12	0:05:54		0:00:23	0:04:00	0:09:13
4	3	3	0:01:17	0:00:34	0:00:22				0:00:03	0:00:12	0:05:54		0:00:23	0:04:00	0:06:35
4	3	4	0:01:25	0:00:04	0:00:23				0:00:03	0:00:12	0:05:54		0:00:23	0:04:00	0:13:17
4	3	5	0:01:08	0:00:04	0:02:21				0:00:03	0:00:12	0:05:54		0:00:23	0:04:00	0:11:27
4	4	1	0:00:38	0:00:06	0:00:47				0:00:03	0:00:12	0:05:54		0:00:23	0:04:00	0:10:24
4	4	2	0:02:28	0:01:21	0:01:44				0:00:03	0:00:12	0:05:54		0:00:23	0:04:00	0:04:20
4	4	3	0:02:19	0:00:15	0:01:17				0:00:03	0:00:12	0:05:54		0:00:23	0:04:00	0:20:22
4	4	4	0:00:45	0:02:01	0:01:42				0:00:03	0:00:12	0:05:54		0:00:23	0:04:00	0:18:12
4	4	5	0:03:23	0:01:11	0:00:22				0:00:03	0:00:12	0:05:54		0:00:23	0:04:00	0:14:25
4	5	1	0:01:16	0:00:08	0:01:36				0:00:03	0:00:12	0:05:54		0:00:23	0:04:00	0:14:25
4	5	2	0:01:03	0:00:04	0:00:16				0:00:03	0:00:12	0:05:54		0:00:23	0:04:00	0:15:19
4	5	3	0:01:46	0:00:34	0:00:47				0:00:03	0:00:12	0:05:54		0:00:23	0:04:00	0:16:14
4	5	4	0:03:53	0:00:49	0:02:39				0:00:03	0:00:12	0:05:54		0:00:23	0:04:00	0:07:17
4	5	5	0:01:32	0:00:06	0:00:31				0:00:03	0:00:12	0:05:54		0:00:23	0:04:00	0:18:17
Week Day	Visitor	LTM	LOE	LTP	TEC	PAE	APB	WLK	TMG	CUL	CSV	LVE	EXT	TOTAL	TOTAL
	TOTAL	1:34:02	0:25:57	1:06:46	0:02:20	0:00:03	0:00:17	0:01:14	0:10:19	6:13:21	0:03:47	0:51:54	2:34:00	10:30:00	13:04:00
	Average (MEAN)	0:01:53	0:00:31	0:01:20	0:00:03	0:00:00	0:00:00	0:00:01	0:00:12	0:07:28	0:00:05	0:01:02	0:03:05	TOTAL	TOTAL
	Standard Deviation	0:01:05	0:00:28	0:00:48	0:00:09	0:00:00	0:00:00	0:00:07	0:00:20	0:03:39	0:00:20	0:04:02	0:06:45	0:12:36	0:15:41

Spreadsheet E

Computer Group Interaction Logs

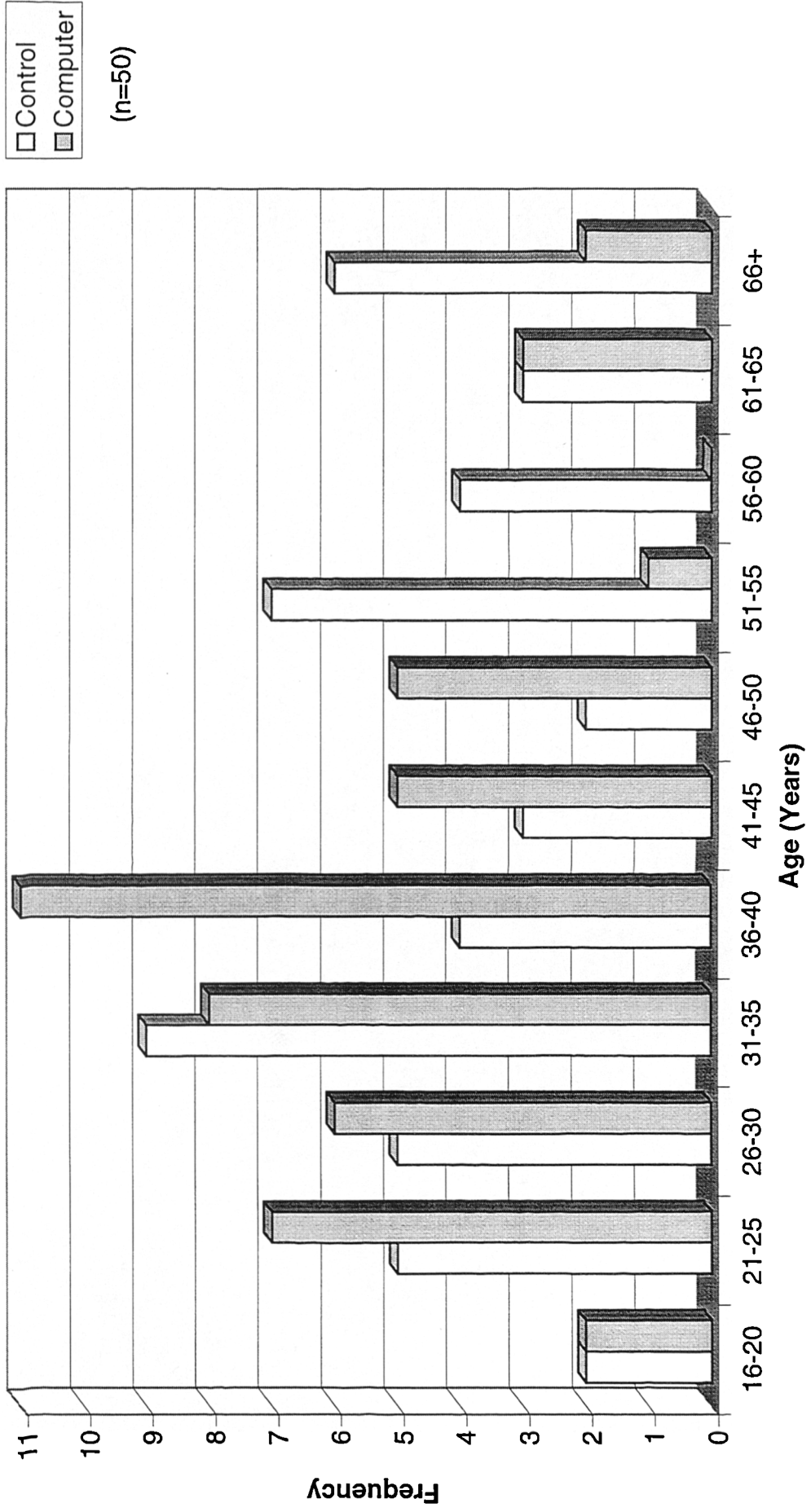
DataLogging - Computer Group																								
Week	Day	Visitor	INST	HELP	R000	R0A0	R0B0	R0C0	R0D0	R100	R1A0	R1B0	R1C0	R1D0	R1E0	R1F0	R200	R2A0	R2B0	R2C0	R2D0	R2E0	R2F0	
3	1	1	03:08		0.0057	0.0013	0.0046	0.0019	0.0008	0.0013	0.0046	0.0019	0.0008	0.0013	0.0046	0.0019	0.0013	0.0114	0.0017					
3	1	2	01:59		0.0055	0.0104	0.0135	0.0023	0.0011	0.0104	0.0135	0.0023	0.0011	0.0104	0.0135	0.0023	0.0011	0.0014	0.0014	0.0014	0.0014	0.0014	0.0014	0.0014
3	1	3	03:37		0.0048	0.0046	0.0030	0.0007	0.0009	0.0046	0.0030	0.0007	0.0009	0.0046	0.0030	0.0007	0.0009	0.0015	0.0014	0.0028	0.0010	0.0048	0.0048	
3	1	4	01:42		0.0044	0.0044	0.0025	0.0006	0.0008	0.0044	0.0025	0.0006	0.0008	0.0044	0.0025	0.0006	0.0008	0.0039	0.0033	0.0026	0.0010	0.0048	0.0048	
3	1	5	02:10	0.0042	0.0030	0.0045	0.0012	0.0013		0.0030	0.0045	0.0012	0.0013	0.0030	0.0045	0.0012	0.0013	0.0012	0.0027	0.0009				
3	2	1	02:13		0.0028	0.0050	0.0011	0.0007	0.0014	0.0028	0.0050	0.0011	0.0007	0.0014	0.0028	0.0050	0.0011	0.0007	0.0014	0.0014	0.0014	0.0014	0.0014	0.0014
3	2	2	03:42		0.0054	0.0054	0.0014		0.0014	0.0054	0.0014		0.0014	0.0054	0.0014		0.0014	0.0040	0.0039	0.0014	0.0014	0.0014	0.0014	0.0014
3	2	3	01:42		0.0043	0.0043	0.0014		0.0014	0.0043	0.0014		0.0014	0.0043	0.0014		0.0014	0.0040	0.0039	0.0014	0.0014	0.0014	0.0014	0.0014
3	2	4	02:40		0.0048	0.0048	0.0011	0.0007	0.0014	0.0048	0.0011	0.0007	0.0014	0.0048	0.0011	0.0007	0.0014	0.0011	0.0014	0.0014	0.0014	0.0014	0.0014	0.0014
3	2	5	01:44		0.0053	0.0050	0.0011	0.0007	0.0014	0.0053	0.0011	0.0007	0.0014	0.0053	0.0011	0.0007	0.0014	0.0011	0.0014	0.0014	0.0014	0.0014	0.0014	0.0014
3	3	1	01:50	0.0053	0.0050	0.0011	0.0007	0.0014	0.0013	0.0050	0.0011	0.0007	0.0013	0.0050	0.0011	0.0007	0.0013	0.0011	0.0014	0.0014	0.0014	0.0014	0.0014	0.0014
3	3	2	01:17		0.0031	0.0031	0.0011	0.0007	0.0014	0.0031	0.0011	0.0007	0.0014	0.0031	0.0011	0.0007	0.0014	0.0011	0.0014	0.0014	0.0014	0.0014	0.0014	0.0014
3	3	3	01:48		0.0007	0.0007	0.0011	0.0007	0.0014	0.0007	0.0011	0.0007	0.0014	0.0007	0.0011	0.0007	0.0014	0.0011	0.0014	0.0014	0.0014	0.0014	0.0014	0.0014
3	3	4	01:49	0.0112	0.0048	0.0048	0.0011	0.0007	0.0014	0.0048	0.0011	0.0007	0.0014	0.0048	0.0011	0.0007	0.0014	0.0011	0.0014	0.0014	0.0014	0.0014	0.0014	0.0014
3	3	5	01:31		0.0038	0.0038	0.0011	0.0007	0.0014	0.0038	0.0011	0.0007	0.0014	0.0038	0.0011	0.0007	0.0014	0.0011	0.0014	0.0014	0.0014	0.0014	0.0014	0.0014
3	4	1	02:07		0.0024	0.0024	0.0018	0.0018	0.0013	0.0024	0.0018	0.0018	0.0013	0.0024	0.0018	0.0018	0.0013	0.0013	0.0013	0.0013	0.0013	0.0013	0.0013	0.0013
3	4	2	01:44		0.0034	0.0034	0.0018	0.0018	0.0013	0.0034	0.0018	0.0018	0.0013	0.0034	0.0018	0.0018	0.0013	0.0013	0.0013	0.0013	0.0013	0.0013	0.0013	0.0013
3	4	3	03:03		0.0026	0.0026	0.0013	0.0013	0.0009	0.0026	0.0013	0.0013	0.0009	0.0026	0.0013	0.0013	0.0009	0.0009	0.0009	0.0009	0.0009	0.0009	0.0009	0.0009
3	4	4	01:37		0.0103	0.0103	0.0033	0.0026	0.0009	0.0103	0.0033	0.0026	0.0009	0.0103	0.0033	0.0026	0.0009	0.0009	0.0009	0.0009	0.0009	0.0009	0.0009	0.0009
3	4	5	01:54		0.0103	0.0103	0.0033	0.0026	0.0009	0.0103	0.0033	0.0026	0.0009	0.0103	0.0033	0.0026	0.0009	0.0009	0.0009	0.0009	0.0009	0.0009	0.0009	0.0009
3	5	1	02:17		0.0028	0.0028	0.0014	0.0014	0.0009	0.0028	0.0014	0.0014	0.0009	0.0028	0.0014	0.0014	0.0009	0.0009	0.0009	0.0009	0.0009	0.0009	0.0009	0.0009
3	5	2	02:33		0.0032	0.0032	0.0018	0.0018	0.0012	0.0032	0.0018	0.0018	0.0012	0.0032	0.0018	0.0018	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012
3	5	3	01:41		0.0038	0.0038	0.0015	0.0015	0.0012	0.0038	0.0015	0.0015	0.0012	0.0038	0.0015	0.0015	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012
3	5	4	01:51		0.0048	0.0048	0.0015	0.0015	0.0012	0.0048	0.0015	0.0015	0.0012	0.0048	0.0015	0.0015	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012
3	5	5	03:28		0.0014	0.0014	0.0011	0.0011	0.0009	0.0014	0.0011	0.0011	0.0009	0.0014	0.0011	0.0011	0.0009	0.0009	0.0009	0.0009	0.0009	0.0009	0.0009	0.0009
4	1	1	02:00		0.0020	0.0020	0.0014	0.0014	0.0009	0.0020	0.0014	0.0014	0.0009	0.0020	0.0014	0.0014	0.0009	0.0009	0.0009	0.0009	0.0009	0.0009	0.0009	0.0009
4	1	2	01:41		0.0056	0.0056	0.0021	0.0021	0.0012	0.0056	0.0021	0.0021	0.0012	0.0056	0.0021	0.0021	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012
4	1	3	01:48		0.0107	0.0107	0.0041	0.0041	0.0024	0.0107	0.0041	0.0041	0.0024	0.0107	0.0041	0.0041	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024
4	1	4	02:33		0.0049	0.0049	0.0025	0.0025	0.0014	0.0049	0.0025	0.0025	0.0014	0.0049	0.0025	0.0025	0.0014	0.0014	0.0014	0.0014	0.0014	0.0014	0.0014	0.0014
4	1	5	02:29		0.0032	0.0032	0.0017	0.0017	0.0011	0.0032	0.0017	0.0017	0.0011	0.0032	0.0017	0.0017	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011
4	2	1	02:17		0.0048	0.0048	0.0029	0.0029	0.0016	0.0048	0.0029	0.0029	0.0016	0.0048	0.0029	0.0029	0.0016	0.0016	0.0016	0.0016	0.0016	0.0016	0.0016	0.0016
4	2	2	01:58		0.0028	0.0028	0.0018	0.0018	0.0012	0.0028	0.0018	0.0018	0.0012	0.0028	0.0018	0.0018	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012
4	2	3	02:10	0.0035	0.0035	0.0028	0.0028	0.0016	0.0016	0.0035	0.0028	0.0028	0.0016	0.0035	0.0028	0.0028	0.0016	0.0016	0.0016	0.0016	0.0016	0.0016	0.0016	0.0016
4	2	4	01:44		0.0025	0.0025	0.0016	0.0016	0.0011	0.0025	0.0016	0.0016	0.0011	0.0025	0.0016	0.0016	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011
4	2	5	01:45		0.0036	0.0036	0.0025	0.0025	0.0014	0.0036	0.0025	0.0025	0.0014	0.0036	0.0025	0.0025	0.0014	0.0014	0.0014	0.0014	0.0014	0.0014	0.0014	0.0014
4	3	1	02:00		0.0238	0.0238	0.0090	0.0090	0.0043	0.0238	0.0090	0.0090	0.0043	0.0238	0.0090	0.0090	0.0043	0.0043	0.0043	0.0043	0.0043	0.0043	0.0043	0.0043
4	3	2	01:40	0.0044	0.0044	0.0038	0.0038	0.0022	0.0022	0.0044	0.0038	0.0038	0.0022	0.0044	0.0038	0.0038	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022
4	3	3	01:42		0.0050	0.0050	0.0026	0.0026	0.0018	0.0050	0.0026	0.0026	0.0018	0.0050	0.0026	0.0026	0.0018	0.0018	0.0018	0.0018	0.0018	0.0018	0.0018	0.0018
4	3	4	01:51		0.0121	0.0121	0.0048	0.0048	0.0026	0.0121	0.0048	0.0048	0.0026	0.0121	0.0048	0.0048	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026
4	3	5	01:52		0.0025	0.0025	0.0016	0.0016	0.0011	0.0025	0.0016	0.0016	0.0011	0.0025	0.0016	0.0016	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011
4	4	1	01:24		0.0034	0.0034	0.0025	0.0025	0.0014	0.0034	0.0025	0.0025	0.0014	0.0034	0.0025	0.0025	0.0014	0.0014	0.0014	0.0014	0.0014	0.0014	0.0014	0.0014
4	4	2	01:58		0.0050	0.0050	0.0025	0.0025	0.0014	0.0050	0.0025	0.0025	0.0014	0.0050	0.0025	0.0025	0.0014	0.0014	0.0014	0.0014	0.0014	0.0014	0.0014	0.0014
4	4	3	01:41		0.0023	0.0023	0.0013	0.0013	0.0009	0.0023	0.0013	0.0013	0.0009	0.0023	0.0013	0.0013	0.0009	0.0009	0.0009	0.0009	0.0009	0.0009	0.0009	0.0009
4	4	4	01:43		0.0118	0.0118	0.0048	0.0048	0.0021	0.0118	0.0048	0.0048	0.0021	0.0118	0.0048	0.0048	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021
4	4	5	01:39		0.0113	0.0113	0.0048	0.0048	0.0021	0.0113	0.0048	0.0048	0.0021	0.0113	0.0048	0.0048	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021
4	5	1	01:39	0.0127	0.0127	0.0098	0.0098	0.0052	0.0052	0.0127	0.0098	0.0098	0.0052	0.0127	0.0098	0.0098	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052
4	5	2	02:00		0.0066	0.0066	0.0048	0.0048	0.0024	0.0066	0.0048	0.0048	0.0024	0.0066	0.0048	0.0048	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024
4	5	3	01:38		0.0014	0.0014	0.0009	0.0009	0.0006	0.0014	0.0009	0.0												

R2C1	R2C2	R2D0	R2E0	R2F0	R2G0	R3A0	R3A1	R3A2	R3B0	R3C0	R3D0	R4A0	R4A1	R4A2	R4B0	R4B1	R4B2	R4C0	R4D0	R4E0	MAP	TOTAL	Week	Day	Visitor	
																							0.10.30	3	1	1
																							0.09:43	3	1	2
																							0.15:25	3	1	3
																							0.19:06	3	1	4
																							0.09:02	3	1	5
																							0.12:54	3	2	1
																							0.16:11	3	2	2
																							0.13:25	3	2	3
																							0.26:02	3	2	4
																							0.15:53	3	2	5
																							0.25:00	3	3	1
																							0.09:23	3	3	2
																							0.08:27	3	3	3
																							0.21:03	3	3	4
																							0.08:12	3	3	5
																							0.12:35	3	4	1
																							0.11:55	3	4	2
																							0.17:17	3	4	3
																							0.09:46	3	4	4
																							0.08:57	3	4	5
																							0.18:19	3	5	1
																							0.11:31	3	5	2
																							0.07:00	3	5	3
																							0.09:30	3	5	4
																							0.05:09	3	5	5
																							0.08:01	4	1	1
																							0.11:41	4	1	2
																							0.06:28	4	1	3
																							0.18:15	4	1	4
																							0.09:00	4	1	5
																							0.07:14	4	2	1
																							0.11:07	4	2	2
																							0.10:05	4	2	3
																							0.09:37	4	2	4
																							0.11:33	4	2	5
																							0.08:35	4	3	1
																							0.06:28	4	3	2
																							0.12:36	4	3	3
																							0.11:54	4	3	4
																							0.10:09	4	3	5
																							0.04:29	4	4	1
																							0.18:11	4	4	2
																							0.17:44	4	4	3
																							0.00:00	4	4	4
																							0.15:10	4	4	5
																							0.16:19	4	5	1
																							0.07:04	4	5	2
																							0.08:45	4	5	3
																							0.19:38	4	5	4
																							0.13:52	4	5	5
																							0.06:56	5	1	1
																							0.13:38	5	1	2
																							0.00:58	5	1	3

Graph A

Demographic Profile of Visitors

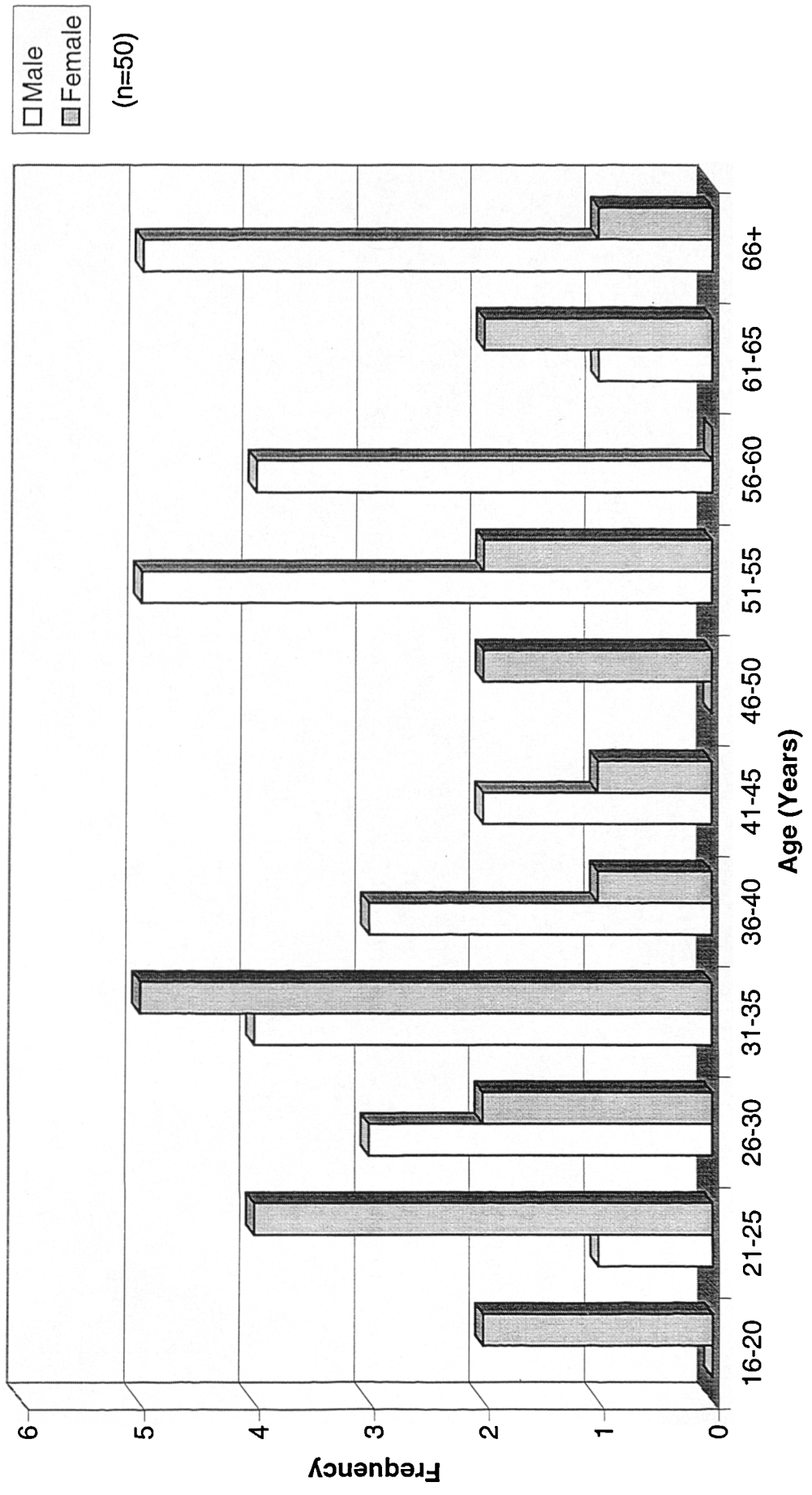
Age Demographics of Visitors from the Control and Computer Group



Graph B

Demographics of Control Group

Gender & Age Demographic of Visitors from the Control Group



Graph C

Demographics of Computer Group

Gender & Age Demographic of Visitors from the Computer Group



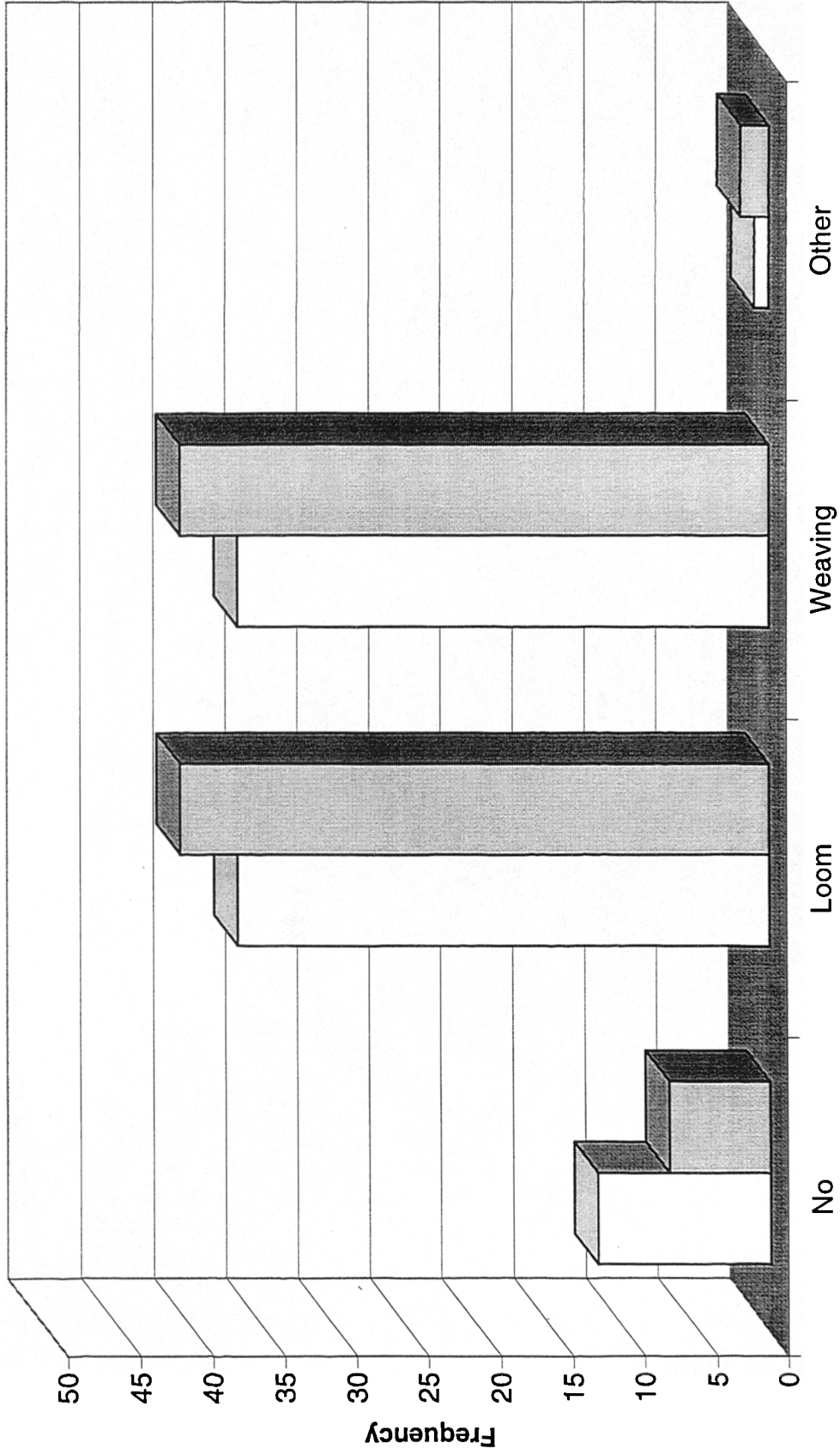
Graph D

**Recognition of Textile Machine &
Process for Control Group**

Recognition of Textile Machine & Process from a Photograph (Control Group)

□ Before
■ After

(n=50)

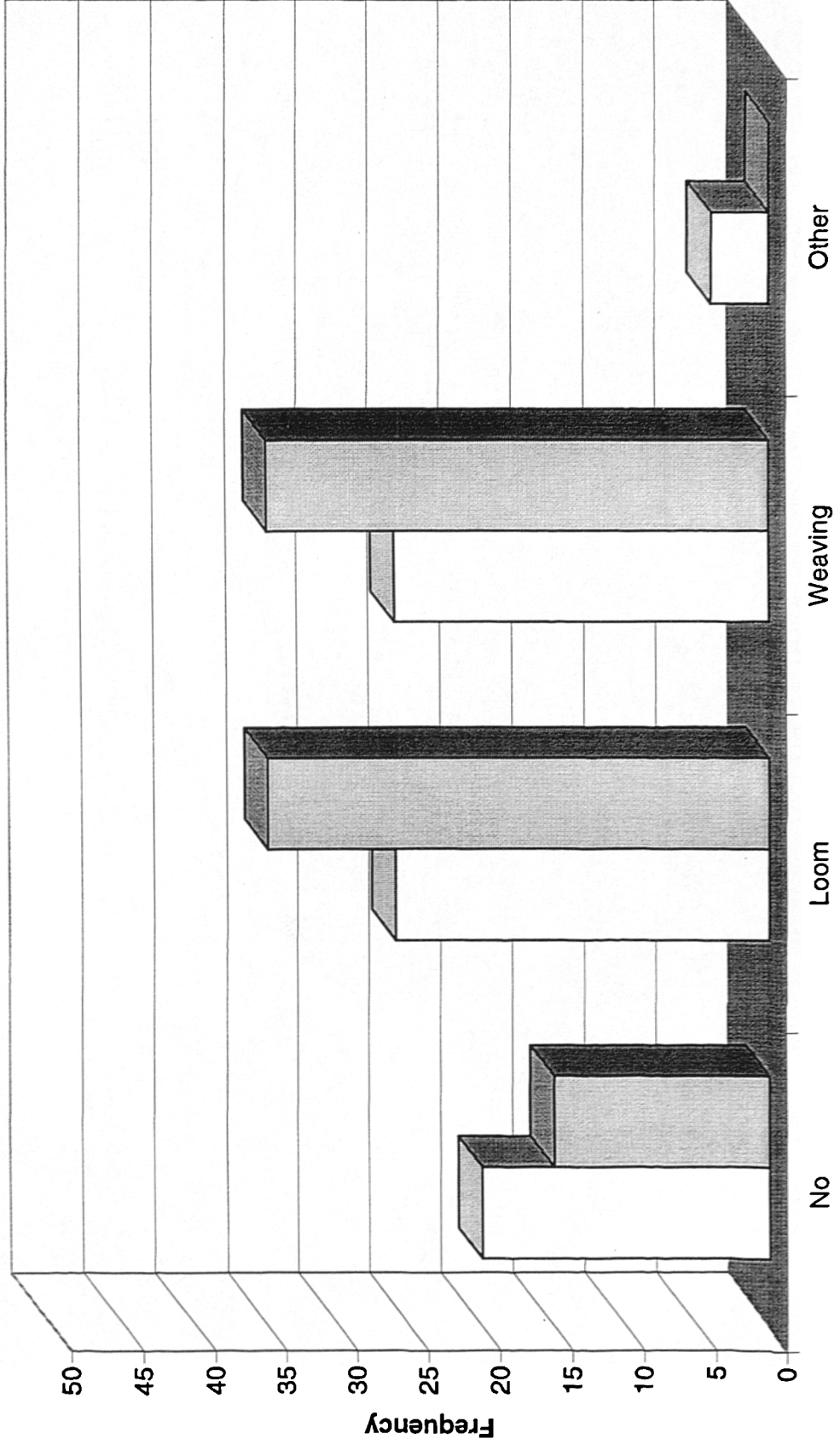


Graph E

**Recognition of Textile Machine &
Process for Computer Group**

Recognition of Textile Machine & Process from a Photograph (Computer Group)

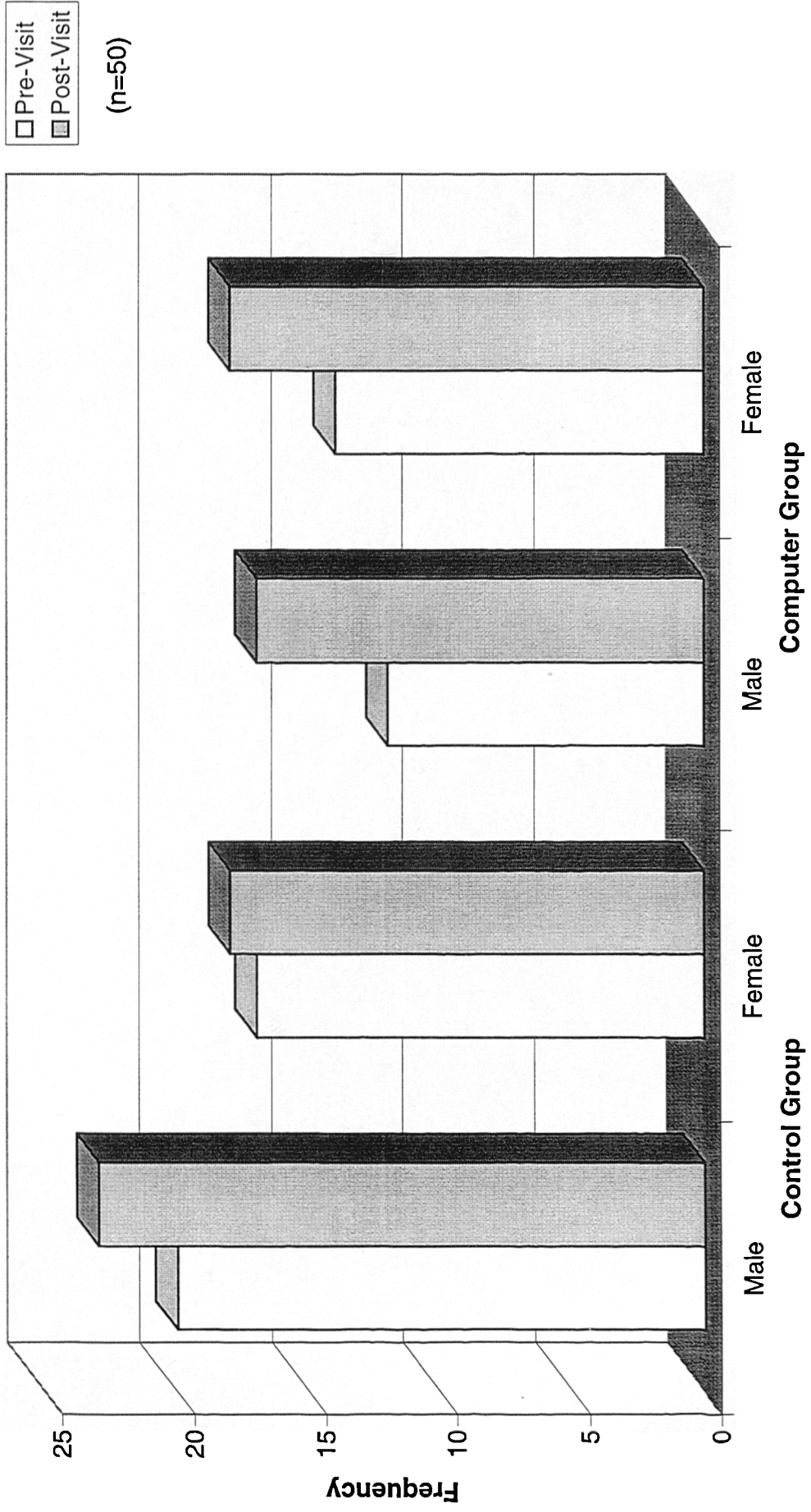
□ Before
■ After
(n=50)



Graph F

**Recognition of Textile Machine &
Process Vs Gender**

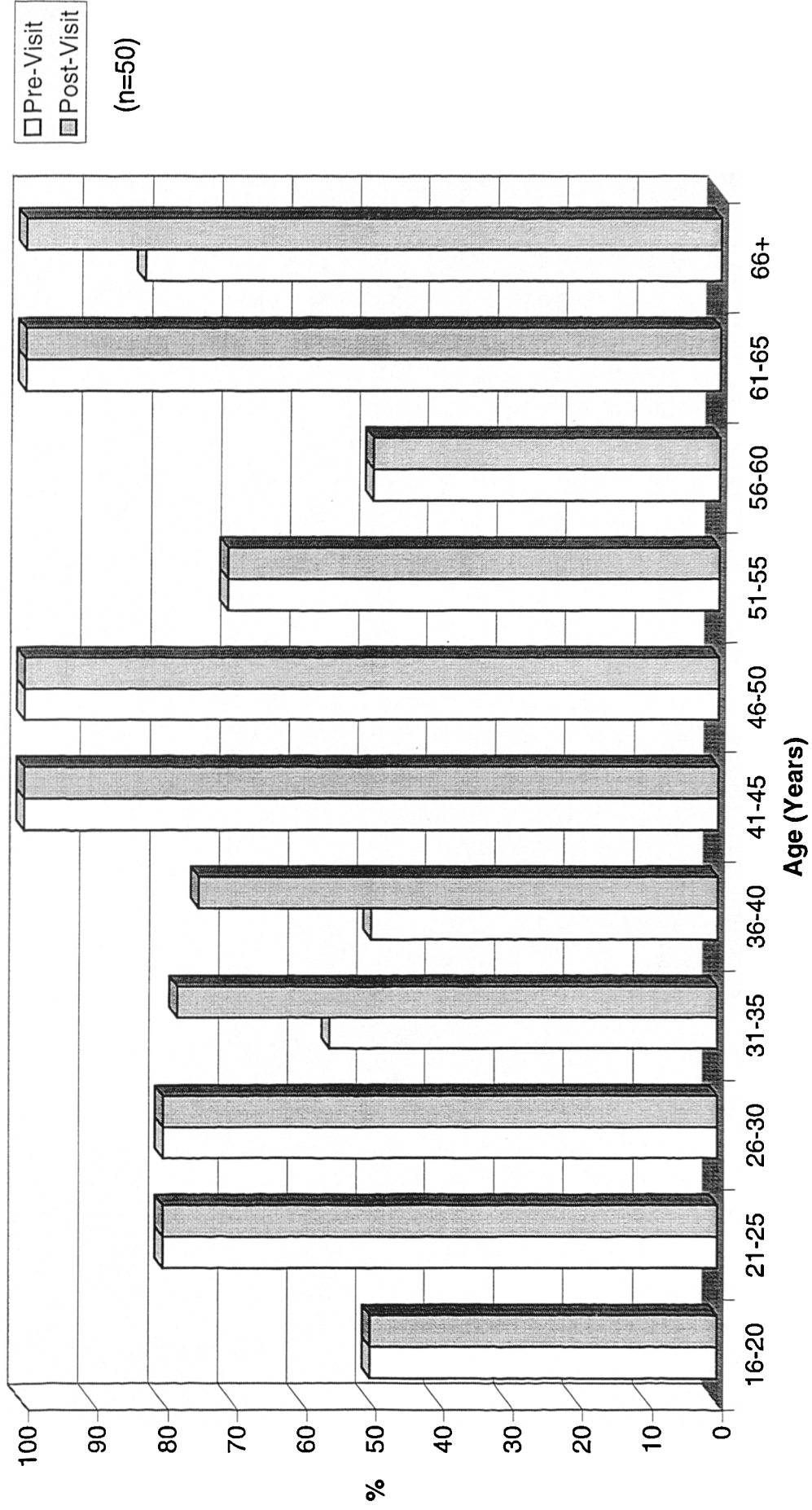
Recognition of Textile Machine and Process from a Photograph Vs Gender



Graph G

**Recognition of Textile Machine &
Process Vs Age for Control Group**

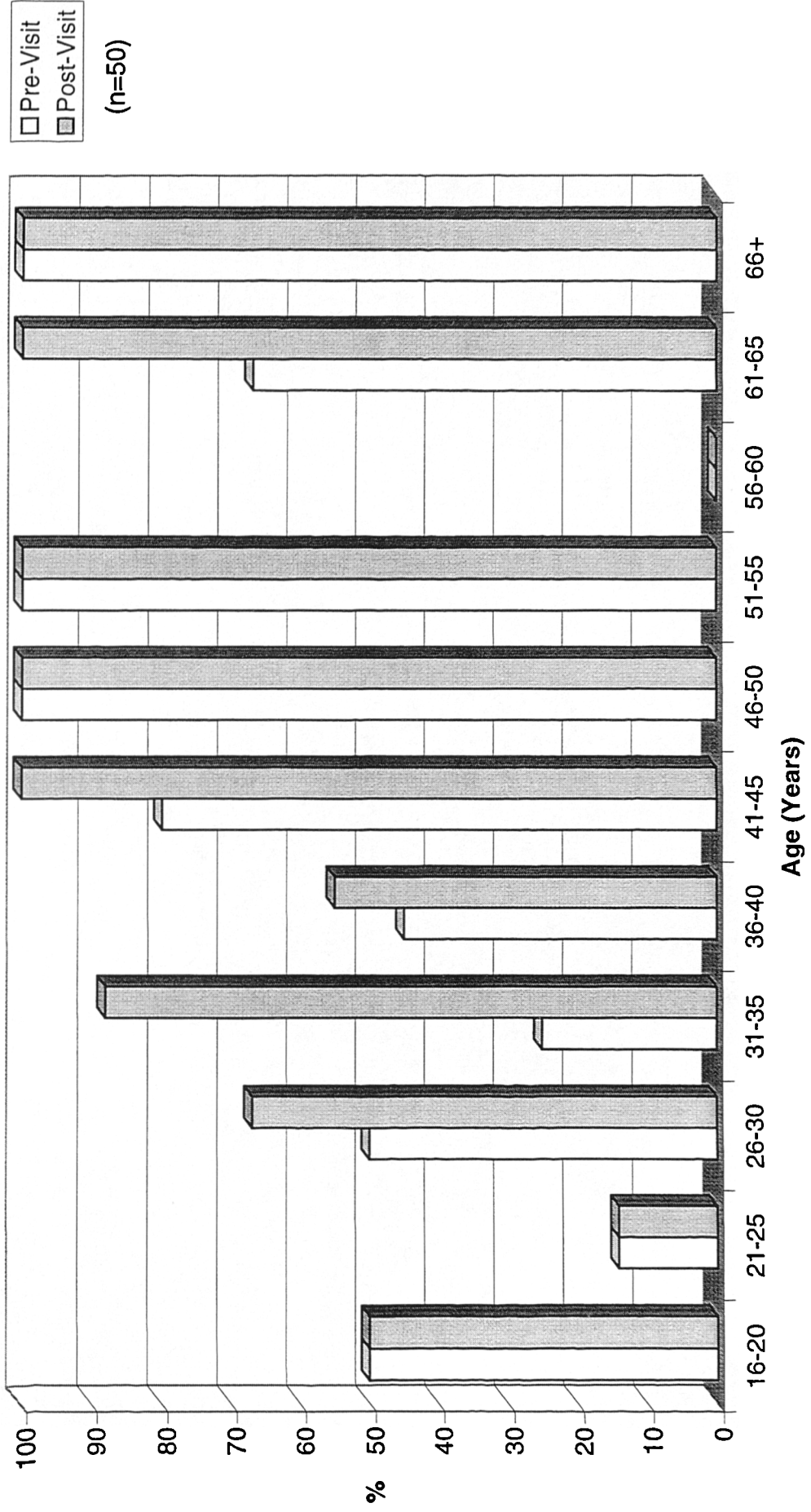
Percentage of Control Group who correctly Recognised the Textile Machine & Process



Graph H

**Recognition of Textile Machines &
Process Vs Age for Computer Group**

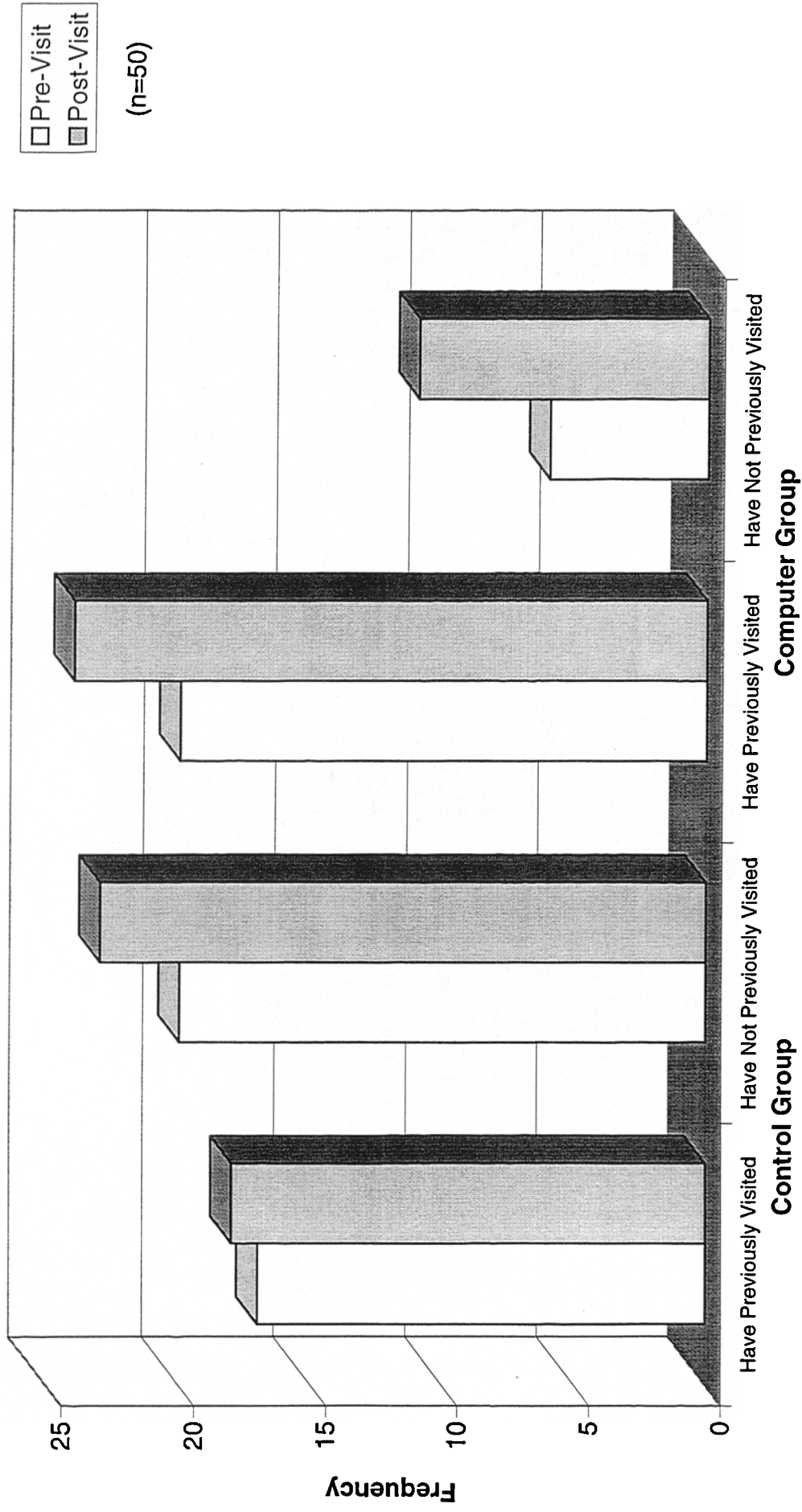
Percentage of Computer Group who correctly Recognised the Textile Machine & Process



Graph I

**Recognition of Textile Machines &
Process Vs Prior Visitation**

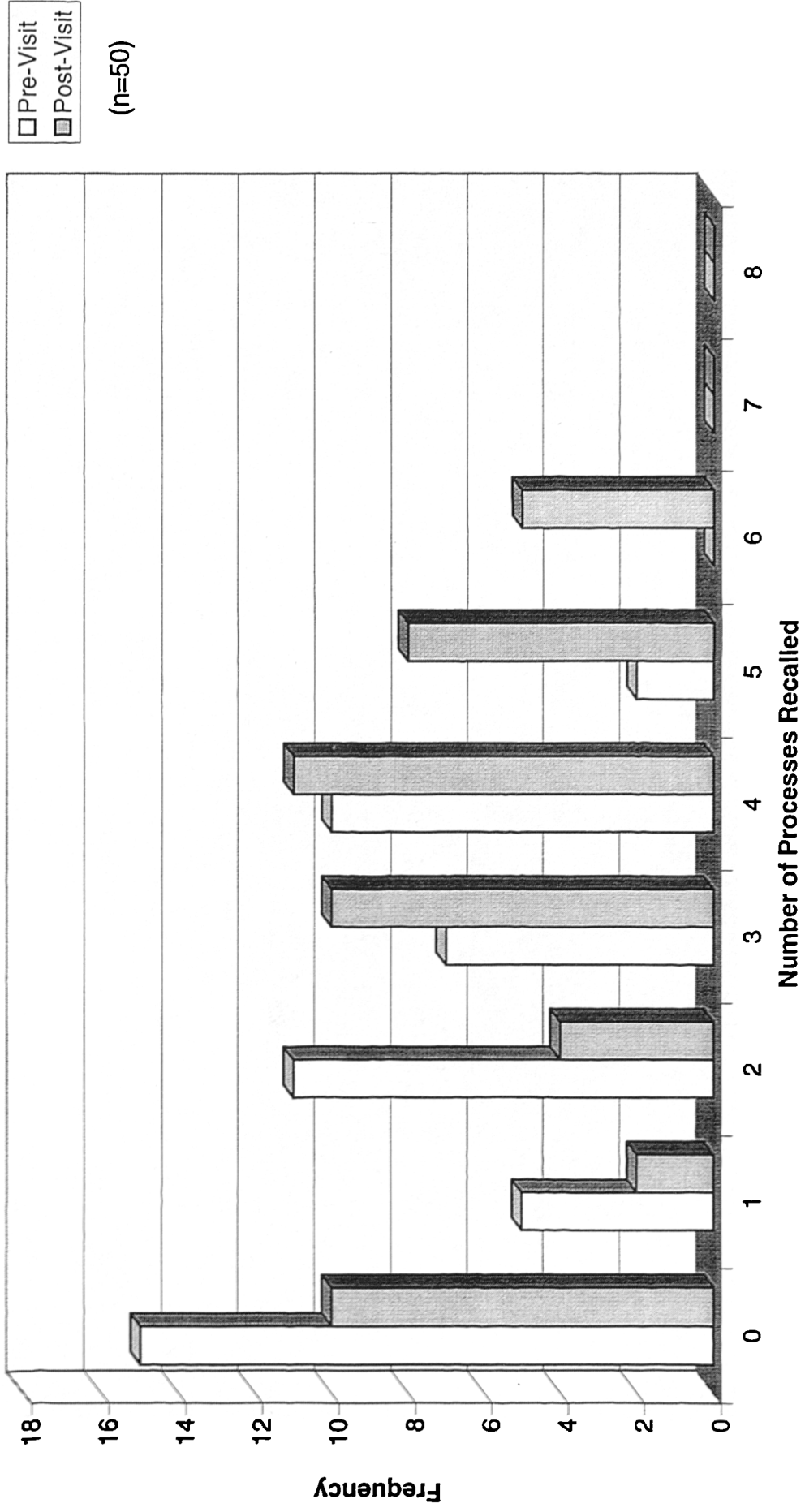
Reconition of Textile Machine & Process Vs Prior Visitation



Graph J

Recall of Processes for Control Group

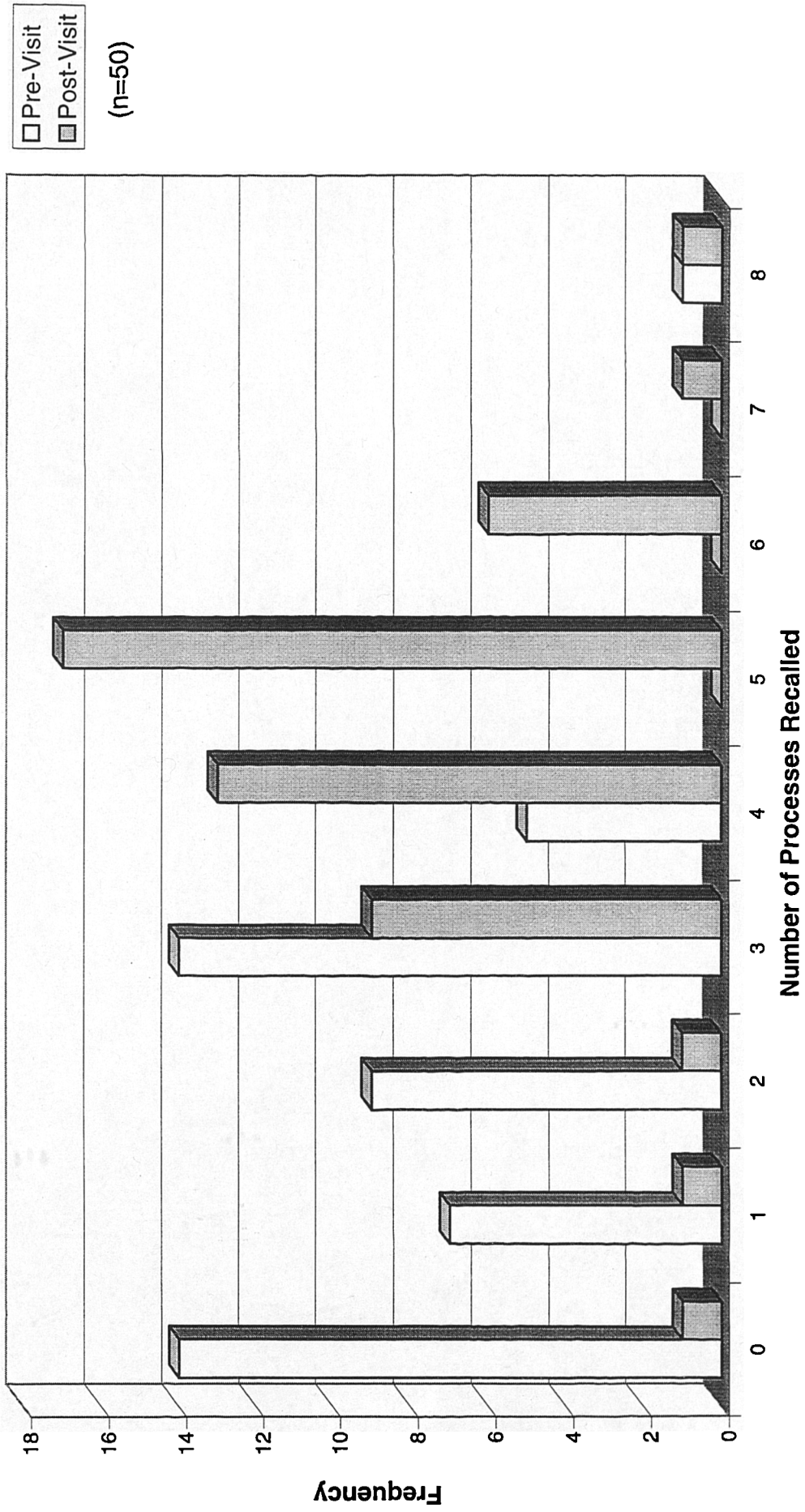
Recall of Processes - Control Group



Graph K

**Recall of Processes for
Computer Group**

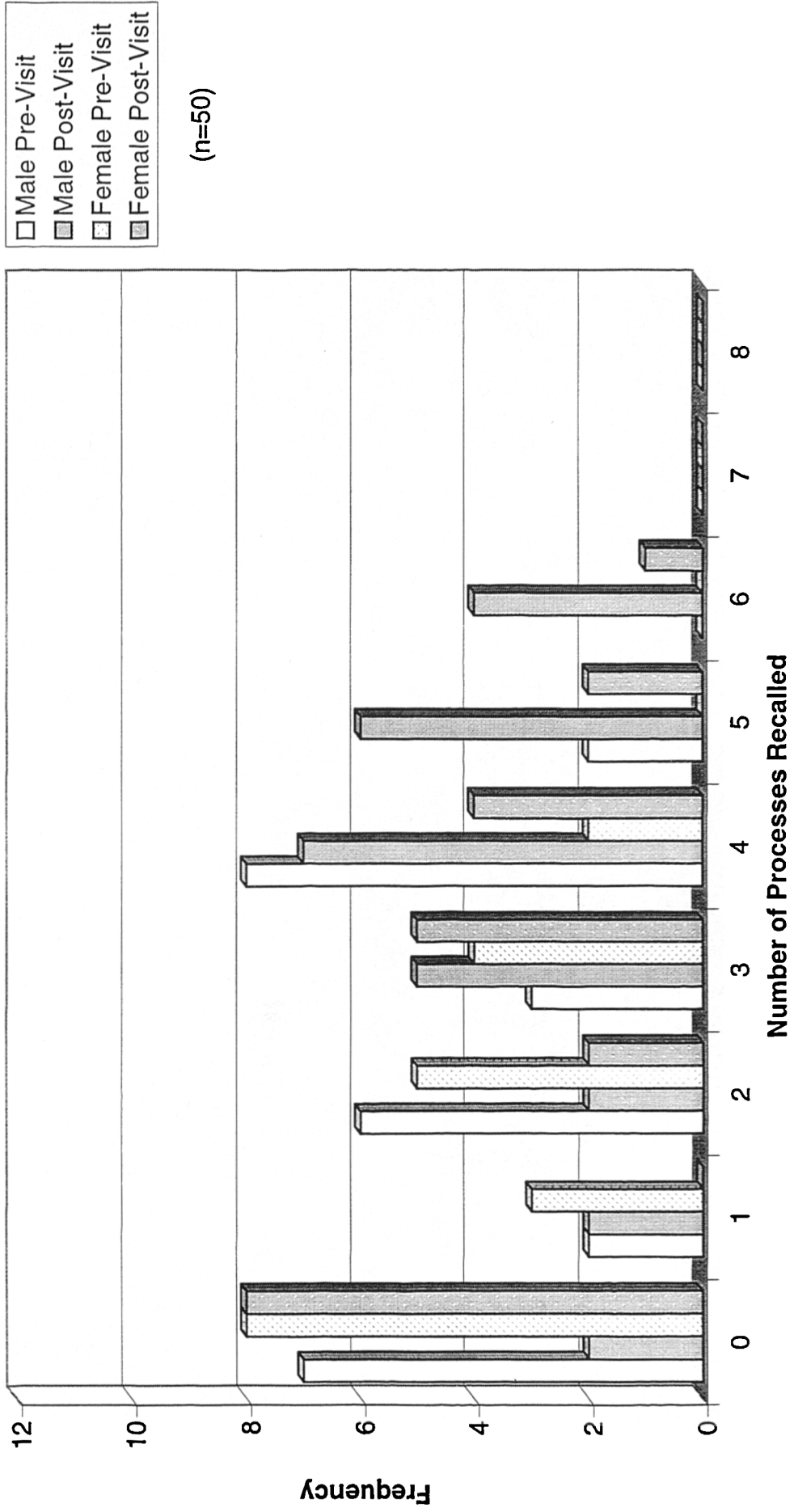
Recall of Processes - Computer Group



Graph L

Recall of Processes Vs Gender for Control Group

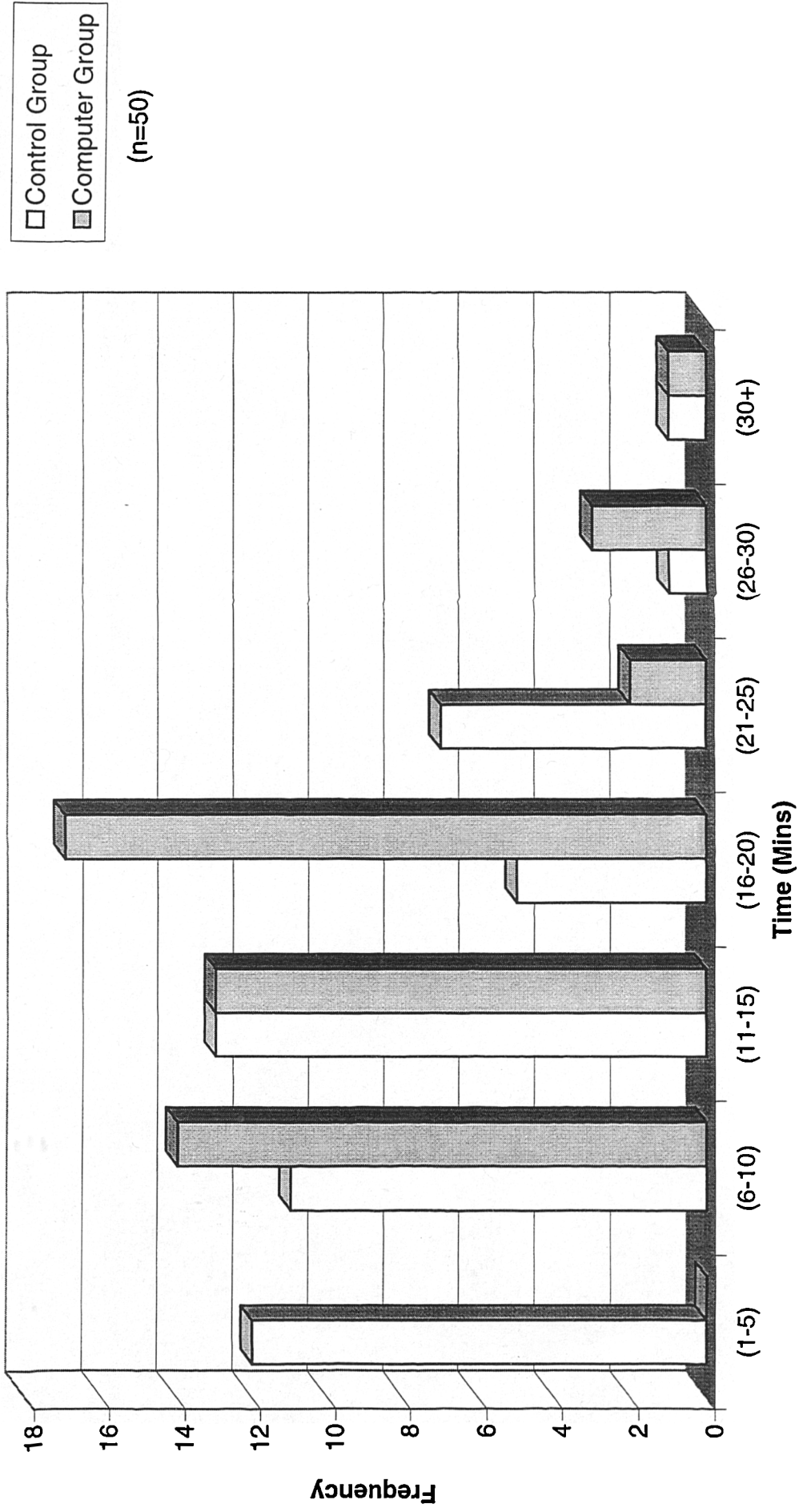
Recall of Processes Vs Gender - Control Group



Graph M

Recall of Processes Vs Gender for Computer Group

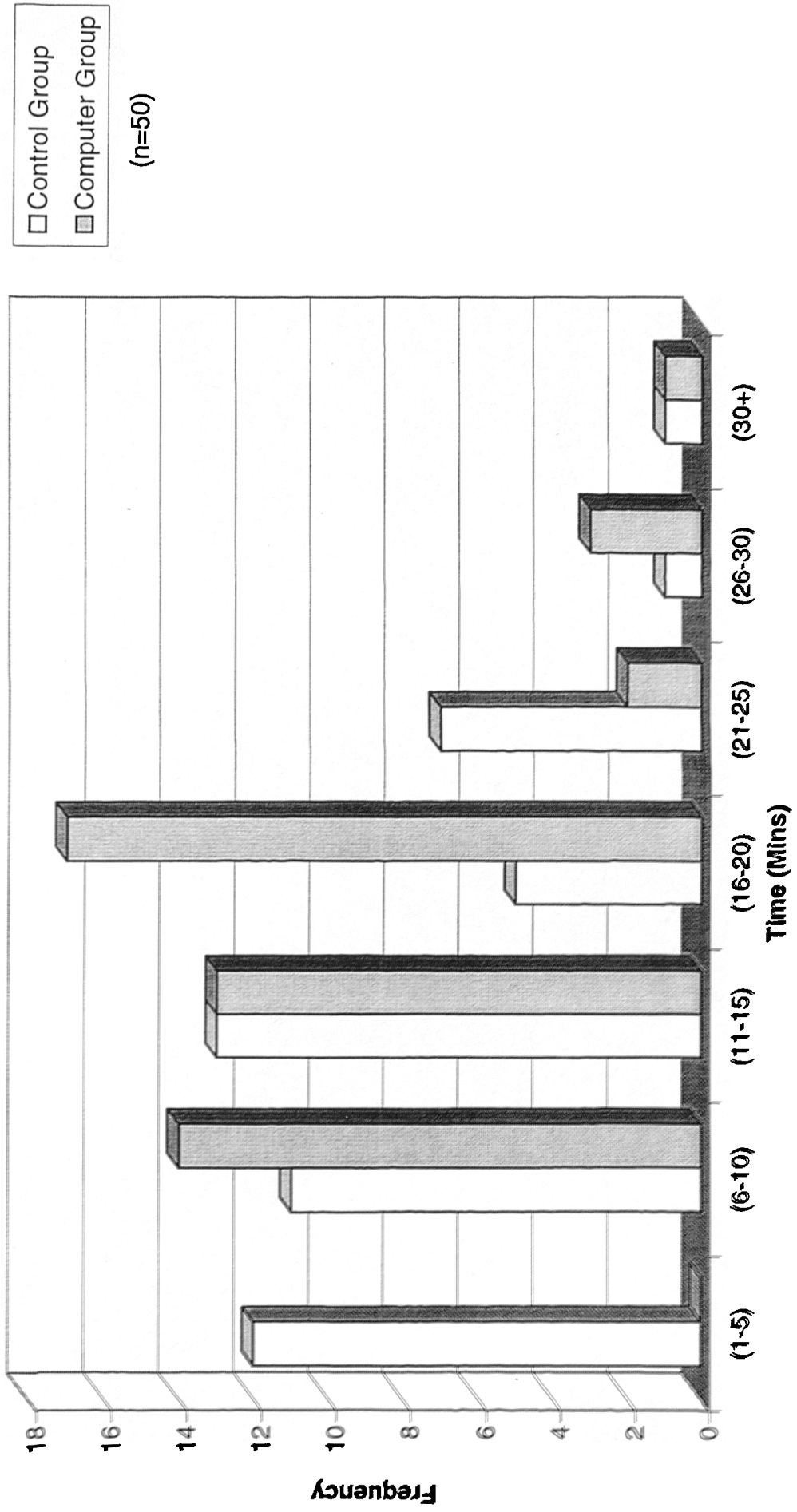
Total Time Spent in the Gallery



Graph N

Observed Total Time in Gallery

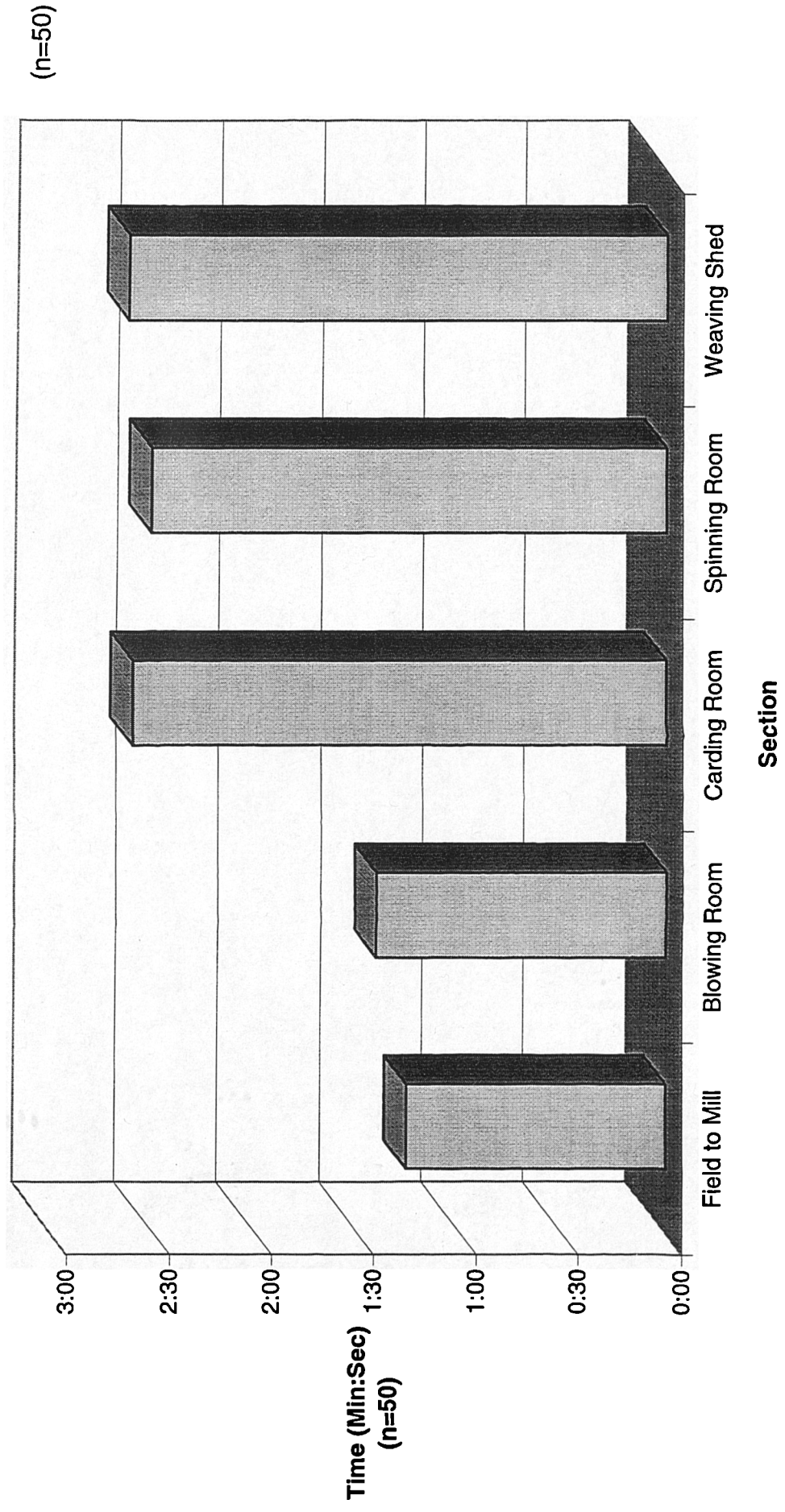
Total Time Spent in the Gallery



Graph O

**Duration of Access
to each Section**

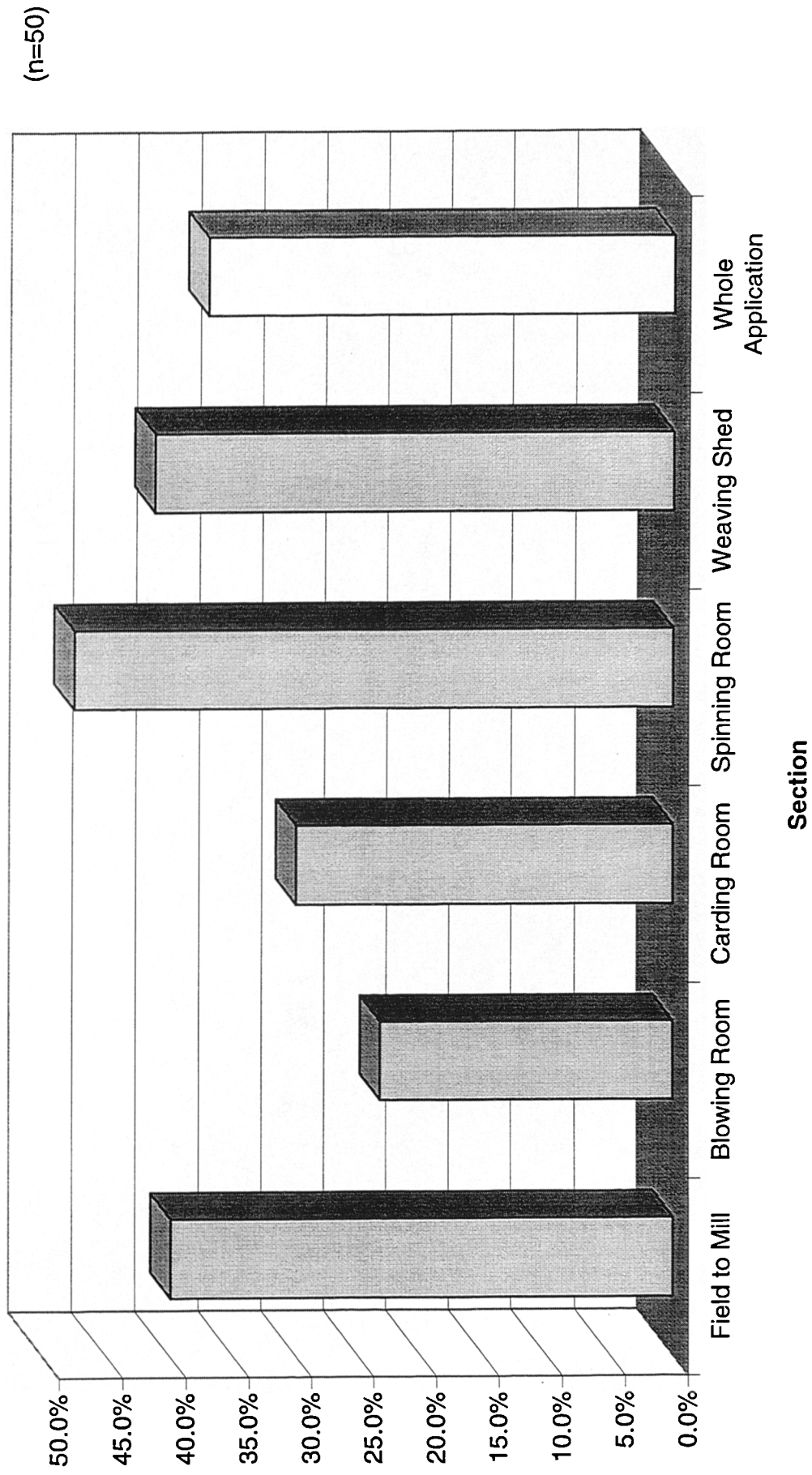
Duration of Access to Each Main Section



Graph P

**Percentage of each
Section Accessed**

Percentage of Each Section Accesses



Appendix E

**Portable Computers & Interactive Multimedia :
A New Paradigm for Interpreting Museum Collections**

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Abstract

This paper describes a GEMISIS doctoral research project nearing completion at the University of Salford, U.K. and offers some preliminary findings. The aim of the project was to design an interactive multimedia application, for a portable computer in a museum setting, to assess the application as an aid to interpretation and to examine its impact on the visitor's understanding and enjoyment of the museum experience. It will discuss the introduction of portable computers into museum galleries, briefly describe the design and development process of the interactive multimedia application, review the methodology employed and provide a summary of preliminary findings.

Keywords

Portable computer, interactive multimedia, Museum of Science and Industry in Manchester, interpretation, visitor study, front-end evaluation, formative evaluation, summative evaluation.

Introduction

The research discussed in this paper has been funded by the GEMISIS 2000 project, a collaboration between the University of Salford, Cable and Wireless Communications, the City of Salford, the City of Manchester and the Manchester Training and Enterprise Council. The objectives of GEMISIS 2000 are to promote economic regeneration, to forge links between the public and private sectors, to improve the quality of life for the community and to provide test-bed sites for multimedia initiatives.

The central aim of this research project, now in its final stages, was to examine the potential applications of new technologies for heritage attractions and museums. Initial exploratory research in the U.K. had revealed that the use of interactive multimedia in museums was variable in terms of quality and sophistication. Although there is a range of different technologies currently being utilised across the U.K. in museums and heritage attractions, (Davies 1995, Francis et al 1992, Lewis 1993, MacDonald 1996) it is mainly in new museums that interactive multimedia has found prominence. Interactive multimedia exhibits are important in the design of new galleries as it is recognised how effectively they communicate to visitors and compliment the more established interpretative formats. (Alsford 1991, Alison and Gwaltney 1991, Valls 1994)

It is also true that museums are beginning to recognise the need to include new technologies. A recent survey found that almost 80% of attractions surveyed were planning to develop new interactive multimedia exhibits in the next two years, with projected budgets up to and in excess of £250,000. (Farnell 1997) These findings were supported by a report into 'The Current and Projected Use of New Media in UK Museums' which found that one quarter of museums in the UK were planning new multimedia installations accounting for up to 50% of their budget. (Visual Arena 1998, Terry 1998)

Recent technological developments such as the Internet and World Wide Web (WWW) are of increasing importance to heritage attractions and museums, (Bowen et al 1996, Campbell and Wells 1996, Clutton 1996, McKenzie 1997) because they provide museums with new channels of communication for both actual and potential visitors, and are an effective way of marketing both destination and the experience. It is evident that much more could be accomplished in terms of applied new technology especially in the interpretation of exhibits.

This paper will review the introduction of a portable computer into a museum gallery, detail the design and development process of a portable interactive multimedia application, review the methodology employed and provide a summary of preliminary findings. For the purposes of this research interactive multimedia is defined as the combination of text, graphics, sound, animation, video and interactivity into a single media. (Bunzel and Morris 1994, Lopuck 1996, Prochak 1990)

Museums, Multimedia and Portable Computers

The introduction of interactive technologies in museums has coincided with the changing role of museums in society. As museums evolve from being custodians of artefacts to interpreters of the past and move away from glass cases towards interactive multi-sensory experiences, museums are no longer a place to visit but a place to participate. (Bearman 1989, Besser 1997, Dodd 1994, Hunter 1996) Interactive multimedia is a promising interpretative medium for heritage attractions and museums that can compliment existing interpretative techniques.

The number of museums with fixed interactive multimedia kiosk installations has increased rapidly in recent years, and it has reached a stage where an interactive multimedia exhibit is a must have for all new galleries. Interactive multimedia exhibits are excellent interpreters, they can communicate large amounts of often complex information in a user friendly and interesting way, whilst empowering visitors to access the information they require at their own pace. (Alison and Gwaltney 1991, Dube 1997, Fahy 1995, Koester 1993) Interactive multimedia exhibits are not a replacement for traditional interpretation methods, but are complimentary, and can assist in placing exhibits and artefacts in their historical and cultural context; and appear to be universally popular with visitors. (Alison and Gwaltney 1991, Koester 1993, Nakano 1995) Multimedia kiosks can provide visitors with an engaging, educational, interactive and media rich experience; the only draw-back is their fixed position.

The museum guidebook was the original portable interpretation medium, enhanced further by audio guides, initially linear cassette tape based units, now random access CD-ROM and digital units. These audio guides can free visitors from having to read text panels, allowing them to concentrate on the exhibits. However even the latest audio guides are limited to providing one channel of information with limited interaction for the museum visitor. (Cooper 1997, Martin et al 1997, Serrell 1998, Whittington 1997)

This research project identified the potential of combining elements from each of these media into a single interpretative application. The portability of the guidebook and audio guide, could be effectively combined with the level of interaction and media richness of CD-ROMs and interactive multimedia kiosks. The result of this fusing of technologies is the portable computer with an interactive multimedia application.

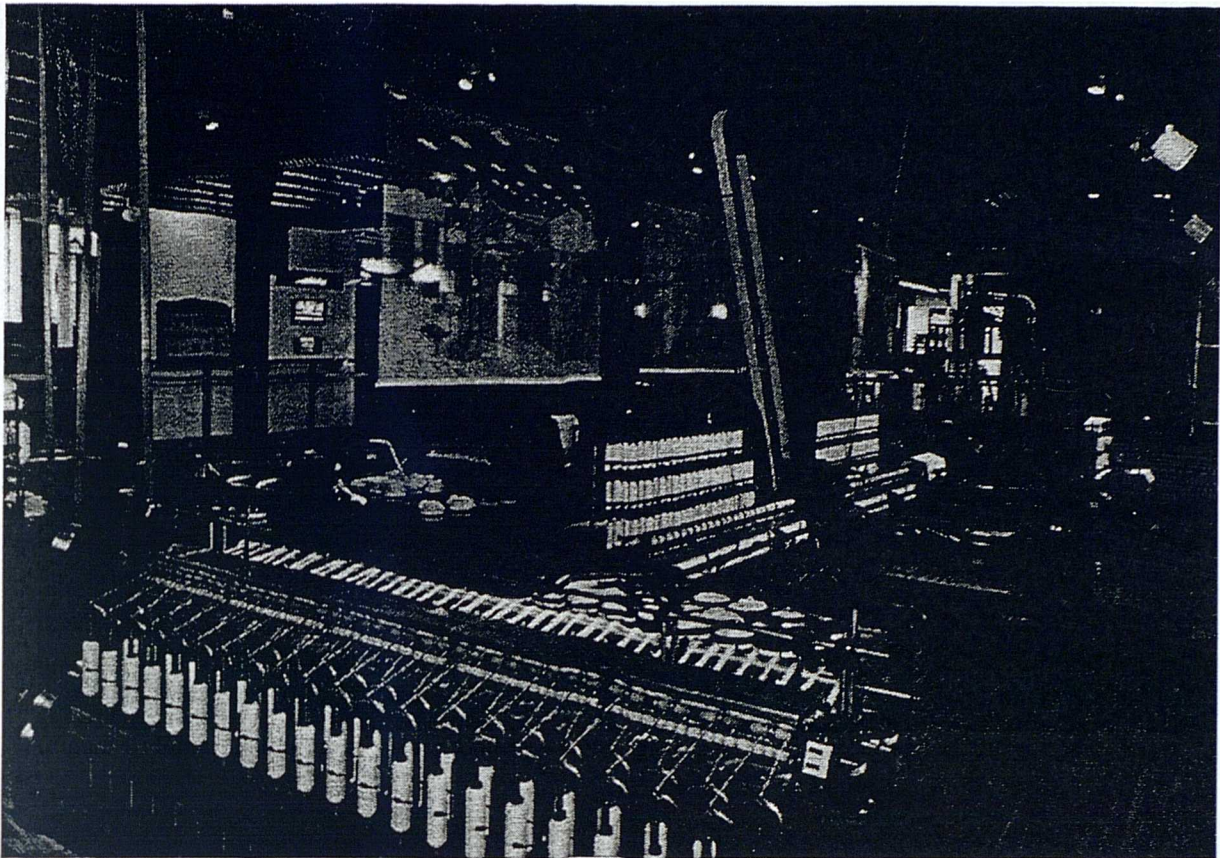
Portable computers and Personal Digital Assistants (PDA's), also referred to as palmtops or electronic organisers are in the early stages of being introduced into museums. (Beishon 1997, Broadbent 1997, Dodds 1995, Not et al 1997, Vodde 1997) These units are being used primarily for visitor navigation and orientation however they may have more sophisticated interpretation applications in the future. For example at the Smithsonian a conventional audio tour has been digitised on to a PDA, in this case an Apple MessagePad. By keying in a number on the touch screen, visitors can access commentary and limited text descriptions of some exhibits. (Vodde 1997) By using infrared transmitters the unit can become location aware and provide information as visitors approach the next exhibit. (Not et al 1997) A touch screen portable computer is under development that will assist visitors in locating a gallery in a museum and specific exhibitions or objects within the gallery with audio instructions via headphones. (Broadbent 1997) Examples such as these although useful are still limited in the interaction between exhibit and interpretation and in enhancing visitor learning.

GEMISIS Research Project

The aim of this research project was to design an interactive multimedia application for a portable computer in a museum setting, to assess the application as an aid to interpretation and to examine its impact on the visitor's understanding and enjoyment of the museum experience. A number of potential hardware platforms were identified and demonstration units obtained. After careful evaluation it was decided that the Fujitsu Point 510 Portable Computer was most suitable, as it featured the Windows 95 operating system, large 10.4" hi-resolution touch screen, reasonably powerful Intel 486DX4/100MHz processor and was relatively affordable at £2000 per unit. Our only misgiving was its weight as it was rather heavy, however it was felt appropriate to continue with this hardware none-the-less. Portable computers are clearly an area of rapid development and no doubt at the completion of this three year research project lighter, smaller and more powerful computers will be available.

The Museum of Science & Industry in Manchester, U.K. was selected to test-bed the project because of a number of factors; it was a local and highly prestigious museum; as a science museum they were interested in the potential of new technology for interpretation; and they were enthusiastic about the project and keen to be involved. Their new Fibres, Fabrics and Fashion Gallery was used as a base for the research. The Fibres, Fabrics and Fashion Gallery is a textile gallery of major importance to the museum. Recently redesigned it contains a number of redundant nineteenth century textile machines, and a range of interpretative areas detailing the harvesting, trading, and exporting of cotton, and other textile processes such as printing and dyeing. There are also a number of hands-on fixed interactive exhibits designed to show the properties of a range of different fabrics. Manchester was a leading centre of importance in the textile trade of the nineteenth

century and at the heart of the industrial revolution. The museum is located in the Castlefield district, which was the hub of rail and water transport links and central to the textile industry.



(Figure 1 : Fibres, Fabrics and Fashion Gallery – Copyright Museum of Science and Industry in Manchester)

This gallery was chosen for a number of reasons; although it was a new gallery little had been added to the interpretation of the large textile machines, which are located in the centre of the gallery. During school holidays and weekends, the textile machines can be seen working at designated times. Therefore for most of the time during weekdays they are inactive and interpretation is limited to a simple text panel with few words and a black and white photograph. The viewing platform is a raised area with the textile machines in the central lower level.

Research Method

The research followed the established methodology of Front-End Analysis, Formative Evaluation and Summative Evaluation. Front-End analysis takes place before an exhibit is developed to identify the current strengths, weaknesses and visitors requirements. Formative Evaluation takes place as the exhibit is being developed, and is used to assess visitors opinions and refine the exhibit whilst under development. Summative Evaluation is used to measure the impact of the exhibit once completed on visitor's experience. (Economou, 1997, Hooper-Greenhill 1996, Miles 1994)

Stage One : Front-End Analysis

Before the design and development of the interactive multimedia application could commence front-end analysis was undertaken to identify the strengths and weaknesses of the gallery and potential areas in which the portable computer could compliment the existing interpretation. Findings were used from a previous major visitor survey commissioned by the museum as an aid to the design process (Fisher 1995), together with opinions and ideas based on discussions with the gallery curator, museum demonstrators, the in-house interactive's designer and personal observations from the researcher and the co-author of this paper. Analysis revealed that visitors preferred to see textile machines working as it was difficult to visualise this process, there was little in the way of interpretation on site and no context for the textile machines, for example the textile mill itself, workers, processes or finished products. Therefore it appeared that visitors left the gallery with little additional knowledge. The absence of any additional interpretative material provided a highly appropriate site for the research project and an ideal situation to test a portable computer.

Stage Two : Interactive Design & Development

A multimedia application was designed and developed for the portable computer which would not only illustrate each of the textile machines working via a touch screen, but also placed them in context. This included the textile mill where they operated, the workers who operated them and the stages associated with the processing of cotton from a raw material into a finished fabric. The computer application used archival images of a textile mill of the period, structuring the application to mirror a working mill with different room sets. The same textile machines that are exhibited in the museum gallery were used in the application.

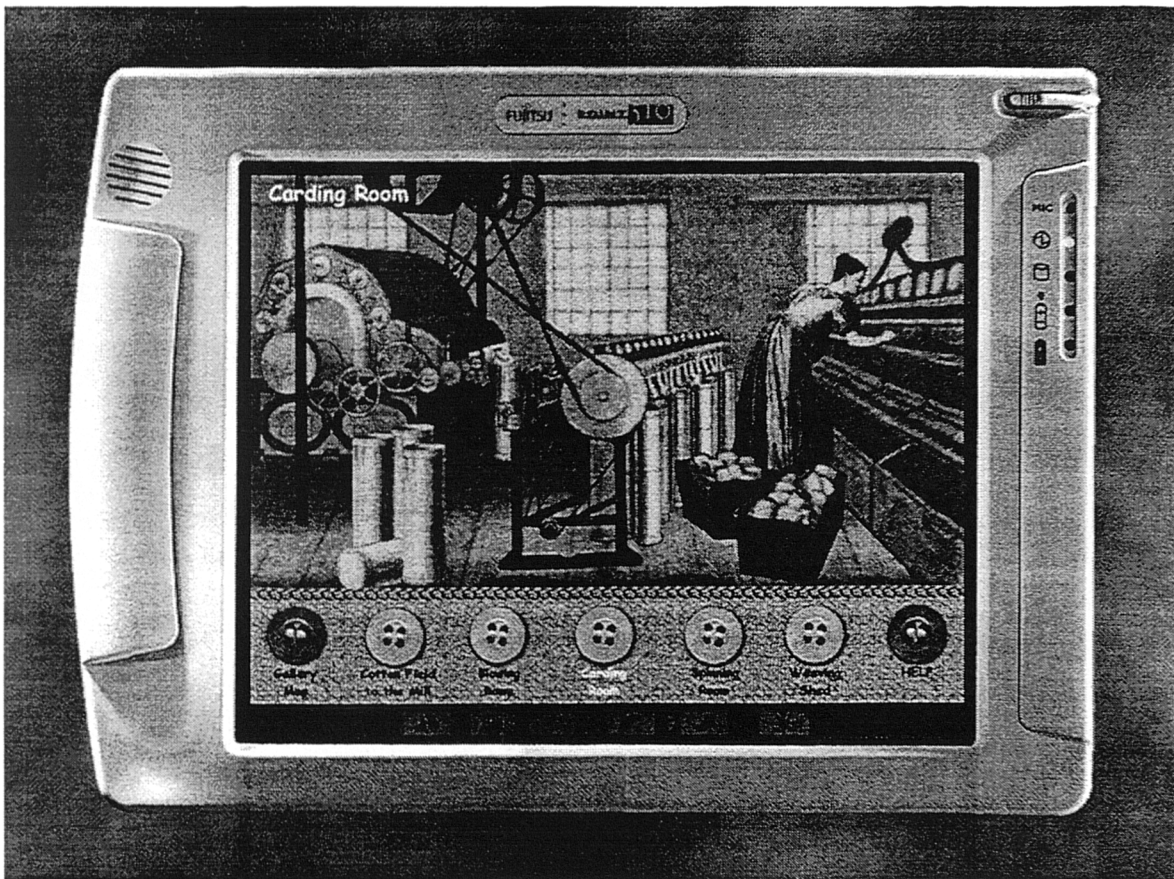
The use of a positioning system to make the computer aware of its location and thus able to provide information based on the visitor's location was considered. However this was not feasible due to technical and budget restraints and an alternative means of visitors navigating the gallery and the application was devised. Existing text panels in the gallery were used as location points and matched the corresponding room names in the interactive multimedia application on the portable computer, thus the structure of the application matched the layout of the textile machines in the gallery and the textile mill.

A map of the gallery was included in the application to provide an additional aid to navigation. Visitors could touch the on screen map where they were standing, thus locating themselves within the gallery and accessing the corresponding section of the application. This was essential if a visitor was unable to locate the text panel in front of them describing that particular room. The application was designed so that as the visitor started using the computer they would have to complete the instructions before they could access the main application. Instructions were available at any time via a help system. An introductory section describing how the cotton was transported from the field to the mill was also included. The structure of the application was documented using a flowchart.

It was vital that the computer application was designed to be easy to use and visually appealing to the museum visitor. It was therefore decided to implement a discovery-based interface; each major section of the

application was represented by an illustration of a room in the textile mill with their appropriate machines, people and objects. Each element on the screen acted as a hot-spot, which when touched linked to supplementary information on the chosen topic.

The main navigation into each room was represented with buttons at the bottom of the screen, one for each of the rooms in the mill. These corresponded with the interpretative text panels in the Fibres, Fabrics and Fashion Gallery. There were two additional buttons, one for the help system and one for the gallery map. To compliment the theme of the textile gallery the multimedia application used a fabric texture as a background. The buttons at the bottom of the screen which were used to access the different mill rooms within the application looked like 'real' buttons, which had been stitched onto the background. The visual design of the application screens was documented using storyboards.



(Figure 2 : An actual screen from the Interactive Multimedia Application)

Once the design had been finalised in the form of a flowchart and storyboards, media acquisition and creation took place before the authoring of the interactive multimedia application. One of the major problems faced in the creation of this application was that some images required were unavailable due to copyright restrictions. Therefore large amount of the media content had to be created from scratch. The final application was

authored using Macromedia Director, with images manipulated using Adobe Photoshop and video edited using Adobe Premier.

Stage Three : Formative Evaluation

With any multimedia software development it is crucial that a prototype is tested by the target audience, to gauge their reaction and incorporate feedback into the final application. (Economou 1997, Raphling 1994) The interactive multimedia application developed for this research project was tested by multimedia developers based at the University of Salford, who were shown the prototype at an early stage, in order to gain feedback from other experienced multimedia designers. During its development, the prototype was also extensively tested with different user groups including general museum visitors and museum staff. Feedback was obtained via informal discussion and observation. A usability test where by visitors in the gallery were asked to use the portable computer for a short time and then asked specific questions was used to clarify user friendliness of the interactive multimedia application and at the same time to establish opinion on the portable computer. Again observation and informal conversation provided feedback. Such testing continued throughout the development stages of the prototype with refinements and adjustments made as appropriate.

In addition the gallery curator, demonstrators and interactive designer also tested the application during the design stages and after completion of final revisions to check that the programme material and context was correct. Not only did this confirm the quality of information but also enabled the in-house curatorial team to gain a clearer understanding of the portable computer's potential as an interpretative tool.

Stage Four : Summative Evaluation

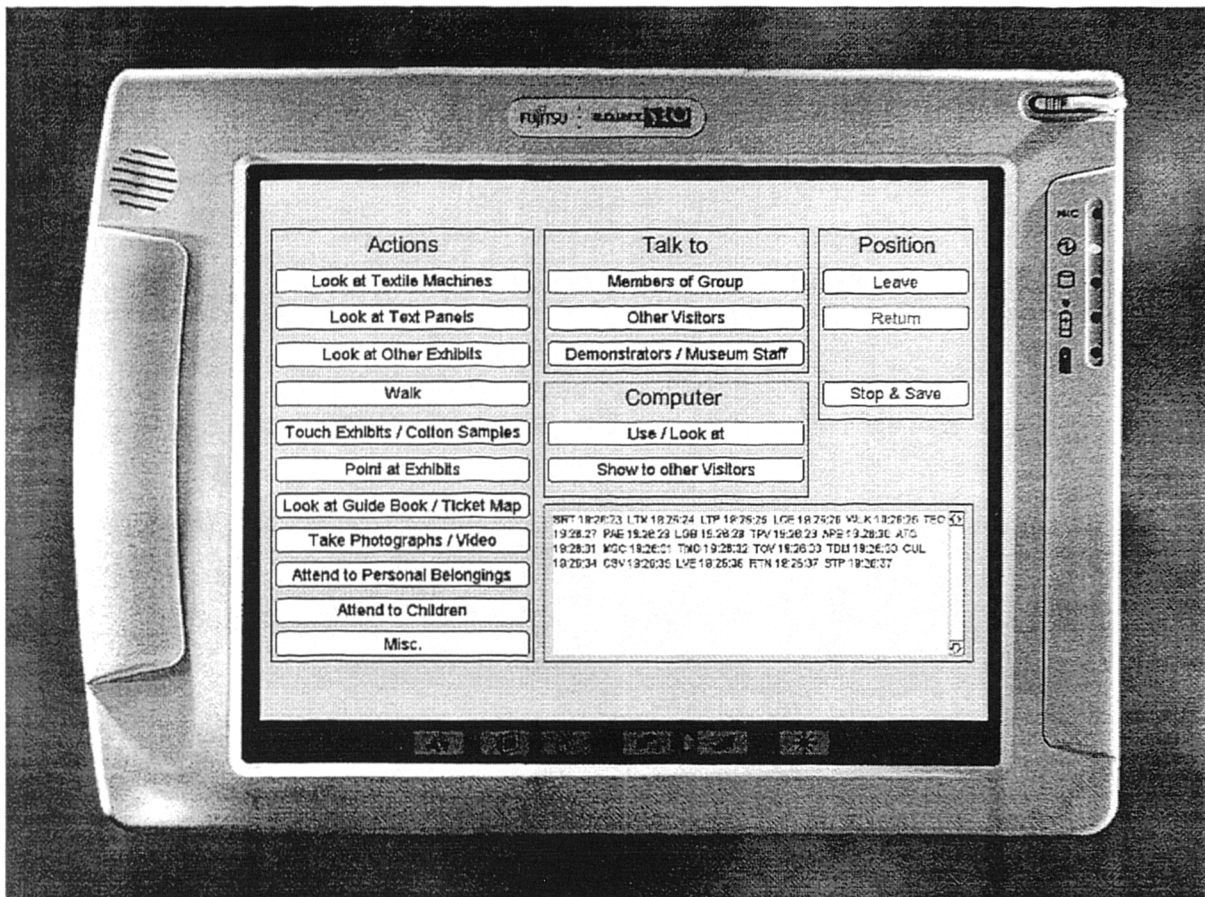
Triangulation of research methods with a range of data collection techniques is often advantageous as each approach can compliment the other and reveal insights that a single method alone would be unable to do. (Allan and Skinner 1991, Veal 1992, Yin 1993) Thus a multi-method approach, combining pre-visit and post-visit questionnaires, structured unobtrusive observation and interaction log recording were used to gather both quantitative and qualitative data.

Questionnaire Survey

In order to assess the impact of the portable computer on the visitor's experience and learning, it was necessary to pre-test the visitor's knowledge and experiences prior to their visit so that changes (if any) could be measured. Visitors were questioned both before and after they visited the study area with a series of open-ended questions. It was perceived that visitors learning could be measured and their opinions on the gallery could be recorded. Visitors were shown a photograph of a textile machine both before and after their visit and asked to identify it and the process it performed. Additionally they were asked to recall processes which took place in the textile mill. Both groups were also asked their opinions of the gallery, including most and least liked elements. Visitors from the computer control group were asked additional questions on their opinion of the computer and the impact, if any, it had had upon their visit and their knowledge of textile machines and processes.

Observation

Visitors were observed unobtrusively as they explored the gallery, because it was important not only to test how using a portable computer effected their learning and experience, but also how it effected their behaviour whilst in the gallery. Typically observations can record the frequency and/or order of behaviours, however for this study it was felt that it was the duration of individual behaviours, which was most important. The researcher therefore used a second portable computer with an application designed to assist the observation. An preliminary observation was undertaken in the gallery to identify the behaviours exhibited by visitors, these behaviours were recorded and used as the basis to construct the observation application.



(Figure 3 : The Observation Application)

The application was designed so that the observer would see a visitor exhibit a particular behaviour and would then touch the appropriate button on the screen, then when a different behaviour is exhibited the observer would touch that button on the screen. The observation program was designed so that it would record each behaviour to the nearest second and would save the file in a format, which could be imported, directly into a spreadsheet for analysis. By reducing the time the observer had to look away from the subject and removing the need to calculate and record the duration of individual behaviours, the accuracy of the data gathered was significantly improved.

Interaction Logs

A problem which arises when trying to evaluate an interactive multimedia application is analysing how the visitor is interacting with the application. This is difficult to achieve without standing next to them for the duration of the observation which was impractical and would clearly affect the visitors behaviour. Therefore an interaction log facility was incorporated into the application, this recorded every section the user accessed and how long they were on each screen to the nearest second. It was hoped this data would be useful for identifying which sections of the application were most popular with visitors and aid understanding of how they used the application. As with the observation application data was saved in a format that could be directly imported into a spreadsheet for analysis.

Research Sample

Two groups were used in the study, a control group of 50 adults who experienced the gallery naturally and a second group of 50 adults who experienced the gallery using the portable computer using the interactive multimedia application. All were selected randomly and asked a series of questions on entry and exit, and observed during their visit in the designated area of the gallery. Due to the fragility and expense of the portable computer it was decided to exclude visitors below the age of 16 years. All organised tour groups and lone parents with young children were also excluded.

The study took place within the raised area of the gallery, which overlooks the display of textile machines situated on a lower level in the central area. The first visitor to enter the raised area was approached and asked if they would be prepared to participate in the research. If they agreed they were asked a series of questions, and left to explore the gallery in their own time. At this point visitors from the computer group were given the portable computer. Visitors were observed during this time and asked another set of questions before they left the gallery. Once the post-visit questionnaire has been completed the next visitor to enter the study area was selected and approached.

With any evaluation project it is important to conduct a pilot study to test the research methodology. To this end a pilot study was undertaken with both visitors from a control group and those using the computer. The pilot study revealed that slight refinements were required for some questions to aid visitor understanding and that revision should also be made to the observation application to improve usability by the researcher. The pilot study was used in addition to develop codified answer categories which simplified the data entry phase significantly and was also useful in practising procedures and timing of the survey.

Summary of Preliminary Findings

This section will summarise the preliminary findings of the research and includes data from each of the research instruments.

Recognition of textile machine and process

Before entering the observation area 74% of visitors from the control group and 52% of visitors from the computer group could correctly identify the textile machine and the process it performed from the photograph shown to them. After their visit 82% of visitors from the control group (8% increase) and 70% of visitors from the computer group (18% increase) could correctly identify the textile machine and the process it performed.

Visitor recall of processes within the textile mill

The average number of processes which could be recalled by visitors from the control group before their visit was 2 rising to 3 after their visit. However for the computer group the average number of processes recalled increased from 2 to 4 after their visit. A significant change was also found in those visitors who were unable to recall a single process. In the control group 15 visitors were unable to name a process pre-visit, this fell to 10 after their visit (10% reduction). However for the computer group, 14 visitors were unable to name a single process pre-visit, this fell to just 1 following their visit (26% reduction). The textile processes most frequently recalled by both the control and computer groups were Spinning, Weaving and Carding.

Visitors Opinions of the Fibres, Fabrics and Fashion Gallery

The favourite element of the gallery for both groups was the textile machines, and the least popular aspect was that the textile machines were not working.

Visitors Opinions of the Portable Computer

When questioned over 90% of visitors from the computer group expressed the opinion that they had enjoyed using the portable computer and that it had been easy to use. The touch screen was identified by 56% of visitors as significantly contributing to ease to use. Other elements mentioned positively regarding ease of use were the flexible and straight forward structure of the application, clear buttons, help system and the location map.

The Videos/Animations were the most liked feature of the multimedia application, being identified by 44% of visitors. Also mentioned positively was the access to information, ease of use, visual screen design and audio narration.

The least liked aspect of the portable computer was that it was too heavy, as identified by 46% of visitors. Few visitors commented that they thought the computer distracted from the

exhibits. However 84% of visitors expressed the opinion that they had explored the textile machines in more detail using the computer, and 92% that they had learnt more using the computer than they would have done otherwise.

Observed Behaviour

Members of the control group spent an average of 12min 45sec in the gallery, however visitors who used the computer spent on average 3min longer in the gallery. Members of the control group spent the majority of their time away from the raised area looking at other exhibits, whereas the computer group spent the largest proportion of their time within the raised area, using the portable computer. Both groups spent approximately the same time looking at the textile machines.

Interaction Logs

Analysis of the interaction logs revealed that on average visitors spent approximately 2min reading the instructions, with 6 visitors later consulting the help section, each for just under 1min. It was also found that 14 visitors accessed the gallery map, each for approximately 1min to assist them in identifying their position with the gallery. Over 80% of visitors accessed the videos/animations of the textile machines, with visitors accessing on average 35% of the entire interactive multimedia application.

Conclusion

The preliminary results of the GEMISIS research project described in this paper indicate that portable computers are popular with visitors, enhance their learning and increase the time spent in the gallery. The project's aim was to design an application and test the viability of a portable computer to enhance interpretation and aid learning in museums. It was not intended to provide a definitive answer or indeed provide the ultimate test model for a sophisticated interpretation application. The research has provided a fascinating insight into a little understood application of new technology and provided new knowledge in the visitor's use of computers in a museum environment. As Screven indicates 'the general impression that learning is taking place at or around computers (and other interactive/manipulative devices) may simply be reflecting their ability to attract and sustain attention not learning.' (Screven 1990) Care must be taken when drawing conclusions.

Typically the findings of this research project have opened up further avenues of exploration, and should become a prime research agenda. If the potential of using portable computers for interpretation is confirmed by additional research then museums will need to carefully consider practical issues, the cost of the computer and software development, the robustness of the computer and the potential risk of damage or theft. These factors may slow the introduction of portable computers, but as equipment becomes more powerful and more affordable this situation may change.

Early indications are that portable computers are a promising and effective interpretative medium for the future of museums. They will provide a professionalism of approach that is both user friendly and at the leading edge of technology and interpretation. As a consequence interpretation will take on a whole new meaning as static exhibits are animated and visitors facilitate their own pace of discovery based learning.

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