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VIRTUAL MUSEUM TOUR

An Interactive Qualifying Project Report

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by

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ABSTRACT

According to the U.K. Disability Discrimination Act of 1995, museums must provide inclusive access to their facilities and exhibits. Many small, low-income museums, however, cannot modify their premises to provide disabled access, and can satisfy the law by providing a virtual tour. This IQP team, working in London at the Centre for Accessible Environments, visited a variety of museums, conducted research to determine what comprises the museum "experience," and investigated the technologies most suitable to implement that experience into a virtual tour. Finally, the team created a web–based template that will guide small museums in their efforts to provide virtual tours for disabled visitors.

EXECUTIVE SUMMARY

The goal of the Virtual Museum Tour project was to create a template that would guide and facilitate the process of creating a virtual tour, aimed specifically to meet the needs of museums or other historic sites. The primary motivation behind the project was the United Kingdom Disability Discrimination Act (DDA), the third phase of which went into effect in October 2004. The Act requires all small businesses and public buildings to provide inclusive access to their facilities, making them accessible to disabled people. If physical modification, such as installing ramps or elevators is not possible, the DDA states that the use of auxiliary aids, such as virtual tours, to provide access is an acceptable alternative.

Museums and other historic sites are often in a position where physical modification of their facilities is not possible. This may be due to a number of reasons, such as when such modifications would affect the historic nature of the site, when the museums have a lack of finances, or when modification is simply a physical impossibility. A virtual tour, already in use by a number of historic sites, is an effective and viable solution to the problems faced by such sites, as it is acceptable by the DDA, and does not require physical modification to the site.

When creating a virtual tour optimally suited for a particular museum, there are two key issues that need to be addressed. The first is defining the experience of the museum, so that the virtual tour can be designed to include key aspects of the experience, and the second is the issue of the technology used to replicate these aspects in the tour.

To determine what constitutes the museum "experience", we conducted several case studies. We visited museums that offer virtual tours, comparing the subjective, actual experience to the virtual experience. To further expand our understanding of museum needs, we also visited a number of museums that may need to provide virtual access, or that host unique exhibits. To obtain a representative definition of a museum

experience, we ensured that our case studies spanned a broad range of museums, varying in size and the nature of the provided experience. We visited very small museums with equally small funding such as the Twickenham Museum all the way up to the very large, very well funded Tate Galleries. In between fell such places as the London Transport Museum, Shakespeare's Birthplace, Anne Hathaway's Cottage, and the Handel House. Additionally, we conducted several interviews with museum staff to get a broad range of opinions and insights on the issue of virtual reality tours of museums. Overall, the task was quite challenging, as the concept was highly subjective, and thus a large number of individual variations had to be taken into account.

Once the "museum experience" was identified to an acceptable generalisation, we investigated the technologies for recreating the experience in virtual form. The technologies were assessed based on how well a digitised object could be presented, what kind of objects could be presented, and what costs would be encountered. The possible types of objects that we identified during our research on the museum experience span a very broad range, including paintings, sculptures, interactive displays and aural exhibits, among many others, such as the Raw Materials Unilever Series, an audio exhibit also known as the 'You May Want to Hear' exhibition, in the main hall of the Tate Modern. Detail and level of immersion were the main factors used to assess how well these objects were presented in digital form by the various technologies. As the form of presentation can range from a simple photo to a complex, interactive, three-dimensional model, an evaluation of the level of immersion was necessary to define how fully the virtual model represents the physical object. We used this information together with our findings on the museum experience to subjectively rate each technology. The costs associated with each technology were also investigated in detail, as they are perhaps the biggest concern for most museums when considering a virtual tour.

The final product of our work is in the form of an interactive web-based tool, hosted online by the Centre for Accessible Environments (CAE) in London, the hosting

agency of our project. This tool allows museums to specify details about their financial limitations and the particular experiences provided by their site. Once these details are entered into the template, the museum representative will receive an overview of the choices available to them for creating a virtual tour. Detailed and illustrated descriptions of the choices are given, as well as guidelines for creating the actual tour. The template thus facilitates the creation of a virtual tour that is optimally suited to a particular museum, and allows museums to be fully aware of the tour requirements, the costs, and the final appearance that their virtual tour is likely to take.

While the goal of our project was not to actually create a single virtual tour, we have attempted to identify the stages of the process that are the most costly and problematic, and suggest automated solutions that would facilitate the tour creation process even further. Mock-ups of tours using various technologies were created to help us do this, offering crucial insight into the details of the process, and providing informative illustrations for the template.

Throughout the course of the project, the needs of both disabled people and the museums were kept in mind, so that the best possible experience will be provided to disabled visitors at minimal cost to the museum. A broad range of disabilities was also considered in our research, ensuring that the template allows the creation of tours that provide truly inclusive access. This project thus contributes to society by helping historic sites comply with legal requirements, increasing motivation to do so by making the process less estranging and difficult, and allowing disabled people to experience sites that would have been inaccessible to them otherwise.

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AUTHORSHIP

All members of the group contributed equally to the project.

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1. INTRODUCTION

According to part III of the UK's Disability Discrimination Act of 1995, people with disabilities are entitled to all goods, services and facilities that are provided to the public. On October 1, 2004 the third and final phase of this act went into effect, in which "service providers may have to make other 'reasonable adjustments' in relation to the physical features of their premises to overcome physical barriers to access"(DDA 1995). With this law coming into place, there are a number of small museums and historical sites that cannot be physically modified to comply with this standard, as it would interfere with the integrity of the structure, or be too costly. Such museums need another method to provide inclusive access to their exhibitions, so that disabled visitors can receive the museum experience, while the museum can satisfy the requirements of the Disability Discrimination Act.

A virtual representation of the on-site facilities is likely to offer an optimal compromise between cost, on-site modifications, and provided experience. This virtual system would focus on allowing disabled people virtual access to parts of the site they otherwise would be unable to view. Additionally, it could be expanded to encompass the entire site, and thus provide an alternative method of access for all visitors, if desired by the museum.

Since there are numerous small museums in the situation of needing to comply with the DDA, our task was to create a template of virtual tours that could be adapted to as many of these establishments as possible. We needed to ensure that the template would be easy to use, update, and maintain. Technology played a key role, as various methods for providing virtual access needed to be evaluated. The results of the research would then allow us to create a template, which could be used by museums to select the tour that is best suited to their needs and resources.

The major components of the work were both research on the various experiences that the historic sites may wish to provide to their visitors, and research on the technological knowledge and costs involved in providing various methods of virtual representation. Optimally, we sought a robust and versatile template, which provides a means of determining available solutions tailored to the specific experience and financial restrictions of a given site. We intended the template to guide museum personnel in acquiring digital representations of museum exhibits and integrating them in a virtual environment. We also wanted the template to be as user-friendly as possible, and to offer an easy means of updating the information.

The final template is web-based, hosted on the Centre for Accessible Environment's website. A museum representative using the template is asked to provide details about the physical experience of the museum, such as the type and number of exhibits, as well as additional details, such as available financial resources. Based on the input, the template then suggests a virtual tour that is best suited for the particular museum experience, providing extensive information on how to digitise various exhibit types and create the actual tour. The user can then browse through alternatives to each of the template's suggestion, tailoring the tour more precisely to the museum's needs and financial capabilities. This interactive process helps the user explore all the possibilities easily, informs the user on which factors are important in creating a virtual tour, and allows the user to gain a clear understanding of the process.

2. BACKGROUND INFORMATION ON VIRTUAL TOUR RESEARCH

2.1. Law

We must define who a disabled person is in terms of the UK Disability Discrimination Act, or DDA, of 1995. According to the text of the act, "a person has a disability for the purposes of this Act if he has a physical or mental impairment which has a substantial and long-term adverse effect on his ability to carry out normal day-to-day activities" (DDA 1995, I-1). Our project goal is to help provide access for all people who fall under this description. The organisations that will be providing the access are small museums, as outlined in the act – "access to and use of any place which members of the public are permitted to enter; facilities for entertainment, recreation or refreshment" (DDA 1995, III-19). The bulk of our work resides in how to familiarise these museums with the means of providing virtual access to disabled visitors. This access must be in accordance with the DDA, specifically,

> "Where a physical feature (for example, one arising from the design or construction of a building or the approach or access to premises) makes it impossible or unreasonably difficult for disabled persons to make use of such a service, it is the duty of the provider of that service to take such steps as it is reasonable, in all the circumstances of the case, for him to have to take in order to - (d) provide a reasonable alternative method of making the service in question available to disabled persons." (DDA 1995, III-21)

An example taken from the DDA itself is very similar to what we wish to accomplish:

> "Where an auxiliary aid or service (for example, the provision of information on audio tape or of a sign language interpreter) would- (a) enable disabled persons to make use of a service which a provider of services provides, or is prepared to provide, to members of the public, or (b) facilitate the use by disabled persons of such a service, it is the duty of the provider of that service to take such steps as it is reasonable, in all the circumstances of the case, for him to have to take in order to provide that auxiliary aid or service."(DDA 1995, III-21)

Also provided is an important limitation on how this alternative access can be accomplished:

> "Nothing in this section requires a provider of services to take any steps which would fundamentally alter the nature of the service in question or the nature of his trade, profession or business. Nothing in this section requires a provider of services to take any steps which would cause him to incur expenditure exceeding the prescribed maximum." (DDA 1995, III-21)

It is clear that changes need to be made, but the physical modification of the building for access is not necessary, and that other "virtual" means will satisfy the law.

2.2. Past Implementations and New Ideas

In the last several decades, legislation has been introduced worldwide to aid in providing inclusive access for all people. From shopping malls and schools to historic homes, attempts at providing access to disabled people have been made in order to lower the limitations that people would face due to their possible physical impairments. Great strides have been taken in the past ten years in terms of finding ways for buildings that previously seemed impossible to modify, such as historic homes or poorly financed small museums, to provide as much of their inherent experience as possible to visitors who previously could not access the premises. Some of the most significant and extensive laws that have been passed to address the issue of inclusive access are the Disability Discrimination Act of 1995 in the United Kingdom and the Americans with Disabilities Act of 1990 in the United States. Both the regulation and the guidance of these acts lean heavily toward physical modification of the site, such as the installation of ramps, elevators, easy-to-use door handles (Making Historic Properties Accessible, 3), or even constructing new buildings so as not to harm the original historic structure in any way (Access to the Historic Environment). While such modifications would be viable for a well-funded site, a small property or location with little funding is likely to find it difficult to create much in the way of a physical change to its site.

Fortunately, the laws leave open the possibility of providing virtual access to areas otherwise inaccessible to disabled visitors. Much like a store's website allows

customers to view and compare products without having to visit the physical store building, a virtual tour allows visitors to view and experience much of what they would experience at a historic location, without having to go to the site physically. This avoids the need for any modification of the site proper, while providing access to disabled people. The costs of a virtual tour are much less than that of structural alteration (Human-Computer Interaction), the cost of which ranges from £70 per meter for a single ramp without steps to £30,000 for a passenger lift (BCIS Access Audit Price Guide, 49-103). In addition, virtual implementations do not degrade the overall experience for all visitors by changing the site, something which can be a problem when the changes for increased accessibility are not well hidden (Making Historic Properties Accessible, 4).

In the past, virtual tours have been implemented not so much as a replacement for visiting and taking an actual tour, but rather as a sort of tease, or advertisement to entice potential patrons into visiting. Art museums construct websites featuring low to medium resolution photos of a sample of their collection, but not enough to replace an actual visit to the gallery. They might also have several on-site kiosks to provide more information about a certain exhibit via a computer simulation, but again, these have usually been designed to complement the already displayed items, not to provide an alternate method of viewing them. Some historic buildings have made videos of a walking tour through their site, but due to lack of interactivity, this may not be acceptable as a substitute of a tour. The step required to go from a tour-augmentation device to a tour-proxy is a leap of applied technology. Not new technology, but merely new uses of current technology. There are several museums using "bleeding-edge" technology to provide virtual access to their experience. One example of this is the Museum of Modern Art in New York City, which not only digitised a large portion of its collection for viewing on their website (http://www.moma.org) while their building was being reconstructed, but also created several internet-only exhibits. These exhibits later became available on-site when the museum was reopened.

2.3. Implementation Technology

While sites may be able to achieve compliance with the laws to some extent by using physical modifications and workarounds, there will nonetheless be a significant number of sites that are unable to employ these techniques. As suggested by the initial Centre for Accessible Environments proposal for our project, a computer-based solution is likely to be the optimal choice for such sites, and may also be a viable and affordable alternative for sites lacking in resources to implement a physical solution.

At the core of a computer-based implementation lies the issue of converting the site experience into a digital form, with an extensive and robust selection of available technology to choose from (Proceedings of 12th ICIAP, 166-170). However, an underlying issue of defining the museum experience remains, regardless of the technology. While, for the purpose of our research, we will assume that the experience is visual, and perhaps also aural, it should not be forgotten that there may be tactile or even olfactory elements to the experience, not to mention an undefined sense of the immersion into the "atmosphere" of the site. Since current technology cannot cover such a scope of experiences, any virtual implementation should strive to provide the highest level of immersion possible to compensate for those shortcomings.

Advancements in providing virtual access to a physical environment have centred on remotely accessible implementations, usually intended for access via the Internet. Implementations with static images and limited interactivity have been available since the early days of Internet development (Proceedings of 18th ICIAP, 43-47). However, they provide only limited immersion. The development of the Virtual Reality Modelling Language (VRML) was the first step in establishing an industry standard, providing an immersive experience that is compatible with a wide range of existing technology, including high-end 3D development software, popular World Wide Web user agents (browsers) and virtual reality hardware, such as 3D glasses (Cultural Heritage

Presentation in Virtual Environment, 1-4). Consequent developments resulted in the X3D specification, which is an eXtensible Mark-up Language (XML) based successor to VRML. While development of the standard is not complete, working specifications, numerous open-source implementations and conversion tools are available. The versatility of the standard is its main advantage, with the scope of its potential applications covering a wide range of solutions of varying cost. Most implementations with immersion and interactivity beyond the scope of X3D are much more costly, as they require high-end software and higher development skills to implement (Proceedings of Theory and Practice of Computer Graphics, 94-101), and thus may not be viable solutions for museums with limited financial resources. However, technologies that are less immersive than X3D are available at a disproportionately lower resource and development effort requirement (Second IEEE Workshop on Internet Applications, 20-22) and thus still remain viable as solutions.

A major issue that remains uncovered by the available research, however, is the cost of conversion of the museum experience into digital form. With the equipment, such as cameras and scanners, as well as development costs arising from digital image editing and environment construction, requiring significant expenditure, the choice of technology for tour presentation may often be trivial in comparison. A large part of academic research on the topic assumes that professional image manipulation can be done at trivial cost, which is far from the case for museums without on-site IT departments (Fifth Mexican International Conference in Computer Science, 134-136). We needed to obtain information on the range of available digitisation techniques, including the type of experiences or exhibits to which they are applicable. Most importantly, these needed to be supplemented with the associated costs, compiled in the context of the needs of a museum wishing to create a virtual tour. The definition of this range, in combination with a thorough analysis of the technologies for presenting the digitised objects in a virtual environment, was a fundamental objective in achieving the goal of our project.

2.4. Social Implications

Since one of the principal goals of almost any museum is to educate its visitors, we can examine how effective virtual solutions have been for other educational purposes, to assess how well a virtual tour would fulfil that task for a museum. Distance learning is one of the areas that often make extensive use of virtual educational tools, and there are a variety of sources that praise distance learning as a viable method of learning. One such source claims that "Online learning gives you the flexibility to meet your education goals at your convenience—anyplace, anytime! All you need is access to a computer and the Internet, and you're ready to take advantage of the many online programs and courses" (Virtual Education). The author goes on to say that distance learning programs "use the power of modern information technologies to dramatically increase access to global educational resources throughout the world" (Virtual Education). These statements suggest that a virtual tour, if made remotely accessible, may carry an even broader range of benefits than expected.

One of the very few foreseeable downsides of a virtual-tour implementation is the opportunity cost, in that by constructing and maintaining a virtual tour, a certain amount of their budget will have to be allocated away from other programs. However, it is possible for some museums that create a virtual tour to offset their costs by charging admission to the tour, just as they would for their corporeal facilities. The matter of what percentage of the full admission price to charge or whether to charge admission at all would be left to the museums, depending on their perceptions of the virtual tour and their current admissions policies. The social impact of a virtual tour thus has the potential to be entirely positive.

3. METHODOLOGY

The primary goal of our project was to identify methods for providing virtual access to museums by creating a template that could be used by museums to choose the methods that would best suit their individual needs. To achieve this goal, out first task was to identify the available methods for creating a digital representation of the museum experience. This required analysing the abstract notion of a "museum experience" in order to identify concrete components that would lend themselves to conversion into digital form. We took numerous components into consideration, including exhibits, architectural structures, and panoramic views, and assessed their contribution to the overall experience. These assessments were important in determining to what extent the full museum experience could be provided by a virtual implementation. This qualitative information was combined with quantitative data on the associated costs and difficulties to form the basis of our template.

Our second task was to review the available technologies for implementing the virtual tour, and to evaluate them based on factors such as ease of development, available documentation, and cost. We supplemented this information with the data we obtained previously on specific experience components, noting which components are supported by each available technology. Doing so also helped us assess the development costs more accurately. While this process resulted in a set of mainly quantitative data on the available choices, qualitative assessments of the technologies were also included, encompassing aspects such as level of immersion and aesthetics. This information was then compiled into a computer database, so that it could be accessed by a computer-based template. Given the details about the museum experience and financial limitations, the template would then use the database to identify the most immersive virtual tour that the museum could afford. The template also provided a concise overview of the choices available to a museum, so that the museum staff could then make an informed decision on which tour suits them the best.

3.1. Defining the "Experience"

3.1.1. Data collection

We derived the information needed to define the "experience" of visiting a museum from an extensive list of exhibits and other individual components that we felt were important in our visits. A broad list was preferred, as having a wide range allowed us to identify rare or unusual components that were not immediately apparent in the speculative stages. The coverage of as broad a span of museums as possible was also essential, as it greatly eased the identification of experience components that are most commonly encountered. Our qualitative assessment of the extent of a component's contribution to the experience was also essential.

Interviews with museum representatives were one of the fundamental methods of obtaining this information, since such representatives are thoroughly aware of the aspects of the experience that is provided by their museum. The information they provided was concise, complete, and often included extensive useful qualitative information on the significance of the individual experience components, as well as further insight on the definition of a museum experience. Along with speaking to the staff that runs each museum site, we toured each site, examining what possible difference we perceived between the virtual experience and the physical one. In several interviews, we discussed our perceptions of the two tours with member of the staff and noted any discrepancies we had between staff and user. Of the museums we visited, including the London Transport Museum, the Shakespeare Birthplace and Anne Hathaway's Cottage, the Tate Galleries, and the Twickenham Museum, each written about separately in Appendix C. Interviews and visits were essential to our objective, as the "experience" is a subjective concept that may vary significantly among individuals. The visits answered those concerns by allowing a wide range of perspectives to be considered in the research.

3.1.2. Data analysis

We analysed the list of exhibits we obtained from the various visits to find generalisations of the exhibit types, such as a painting, fresco, or sculpture. Since the purpose of the analysis was to identify methods of the conversion of these exhibits to digital form, the distinguishing features we used to define an exhibit type correspond to the limitations of the format used for digital representation. Some of these features include whether the exhibit is 2 or 3 dimensional, whether it is very large, whether it is presented on a planar or a more complex surface, whether navigation through the exhibit is required, whether the exhibit is interactive, and what kind of actions are applicable when interacting with the exhibit. We identified even further distinguishing features as we encountered less conventional exhibits in our research.

A notable validity threat that we identified is the potential discrepancy between what is viewed as the museum "experience" by the museum administration and the museum visitors. To address this, we supplemented the interviews with museum representatives by touring the museum on our own as patrons, ensuring that the "experience" definition encompasses the views of both groups.

From this analysis, we were able to research the methods that could be used to digitise an exhibit of each type. We categorised the methods primarily based on cost, however we also considered factors such as versatility, ease of development. To aid the process, we assigned each exhibit type a record of which general virtual museum tour technologies they were applicable to. We also investigated whether their any combinations of technologies would cause additional costs or difficulties.

3.2. Implementation Technology

3.2.1. Data collection

In addition to information on methods of representing exhibits in digital form, we needed to identify the technologies currently available to present those exhibits as a virtual tour. We also needed a qualitative evaluation of the technologies based on factors such as level of immersion and aesthetics, which allowed us to compare the technologies subjectively and to estimate the "value" offered by an implementation in exchange for the expenditure. While research on topics such as technology specifications and price estimates from companies offering solutions based on the technology formed the basis of the required information, it provided an incomplete overview of the implementation process. Using case studies of specific implementations, including descriptions of the development process, outlining the additional costs and difficulties encountered, we attained a significantly more complete evaluation of a specific technology. Technical research was one of the only applicable methods of gathering a basic specification set for each technology, including the exhibit types supported, system requirements, and extent of available documentation.

While the technical research and case studies were the only available methods for gathering a complete set of the required quantitative information, case studies offered significant advantages over the technological research in obtaining the majority of such information. These advantages include a more complete set of cost data, lower bias, invaluable information on the development process, and a more illustrative and relevant presentation of the technology.

3.2.2. Data analysis

The analysis of the data was a relatively simple process. Records for each technology were created, with quantitative information such as the costs, both of development and maintenance, the exhibit types supported, and the difficulty of

implementation being recorded. We processed a qualitative assessment of the records based on the information to an extent by assessing the applicable exhibit types, and thus estimated the versatility and expandability of the implementation methods. This led to a number of scenarios, including a set of technologies with distinctly a high or low subjective rating, and with distinctly higher and lower development costs associated with them respectively. We then placed such technologies in discrete high or low-end sections of the range of choices. A number of technologies have proved to be subjectively similar, with variations among the specific factors of assessment, where one technology exceeds in one aspect, while an alternative exceeds in another.

The advantages and disadvantages of each technology were then summarised and recorded, in order to facilitate the choosing process for the individual museums. In the case of a technology being identified as subjectively worse in all aspects than another technology with lower costs, the more expensive technology was disregarded. Since cost was the most well-defined and basic factor involved in the decision process for a virtual tour implementation, the data collected allowed a specific definition of the range of technologies available for a museum, as defined by the museum's available financial resources. Subjective qualitative assessment of the technologies encompassed by the range then would allow a museum to make the optimal choice that is most applicable to their experience and provides the highest subjective benefits.

There were however some problems with the use of documentation produced by service-providers, which may be written with intent to promote a certain technology, or lack relevant details on using the technology to implement a virtual tour. Using case studies has remedied such threats, as the technology is reviewed in a functional form that is relevant to the project and offers information from a neutral point of view.

4. RESULTS AND ANALYSIS

Our research involved three topics: seeing what types of exhibits would need to be digitised, comparing virtual museum experiences to physical ones, and researching matters such as costs, benefits, and features. As outlined in our Methodology chapter, we visited a variety of museums, small museums with limited budgets to large, well-funded ones, in order to get a broad range of the type of exhibits that might be digitised. Specific write-ups about each museum visit can be found in Appendix C, which outlines what we accomplished on each visit and why each visited site was unique. Overall we visited 10 museums ranging from the two-room Twickenham Museum, to the Victoria and Albert Museum, which contains more than four million exhibits across four floors, ten acres, and 145 galleries. Seven were located in London, and three in rural England. We also spoke with representatives of several companies that create professional virtual tours in order to obtain information about the cost and process of their productions.

4.1 Experience

Altogether, the museum visits showed us that many of our original suspicions were correct about the method of exhibiting items. It is possible for a large art gallery to care only about the paintings on the wall and not the display space, but a historic home would be equally, if not more, concerned about the area in the room around the painting and way in which the painting is hung.

There is also a level of detail that each museum needs to decide upon. The Handel House, for example, contains, in one room, a functional harpsichord, which, if it were to be represented virtually, would require special consideration by the creators of the virtual tour. As the harpsichord is a three-dimensional object, they could make a rotatable 3D model of it. As it has detail work etched into it in places, they could take close up photographs of it. Finally, as it is a musical instrument, they could digitally record someone playing a song on it.

4.1.1 External Structure

In many of the museums, the structure that houses the exhibits can be very important. Sometimes, the external structure of the museum is a highly important part of the visiting experience. For example, The Tate Modern is housed in the large, former Bankside Power Station building, with an impressive smokestack that can be seen as a landmark from the river Thames. Since it is an iconic structure of the coastline, its digitisation would have to be able to represent this somehow. The pictures taken from different angles and with other surrounding buildings, such as the Millennium Bridge and St. Paul's Cathedral, would increase the level of the experience and bring the virtual tour closer to reality.

4.1.2 Internal Décor

Another important aspect of the museum experience is the internal décor, That is, the way the exhibits are arranged, the cases that items are housed in, the carpet, the paint on the wall, and the lighting. Our team saw this aspect very clearly at several sites, especially the HMS Belfast, Ann Hathaway's Cottage, and the Victoria and Albert Museum. A major part of Ann Hathaway's Cottage is that it is re-decorated in the style of the time period, the 16th century. The Victoria and Albert on the other hand, is meticulously decorated in the style of a 19th century royal a palace with large hallways and ceilings, marble staircases, and large chandeliers. Capturing all of these details is a key part in representing the museum experience. Perhaps not more so than the individual items that would be highlighted as the collection of the museum, but the way in which the items are arranged is crucial to their interpretation at these locations. This would need to be digitised by the museums if they desired to create an accurate version of their museum's experience.

4.1.3 Presentation of Exhibits

All of these preceding issues would need to be present in the plans of any museum or historic place to create a digital, virtual rendition of themselves. Any exhibit could have a unique way of looking at it and it would be up to the staff of each location to decide how they would preserve these unique aspects of the item. To provide only a single interpretation of each exhibit would be a cheapening of the virtual experience, not providing the full museum experience to anyone who uses the virtual tour alone.

4.1.4 Unique Exhibits

At some museums, for example, the London Transport Museum or the Royal Navy Submarine Museum, the whole of their collection could be classified as "unique". At these locations, the exhibits themselves are to be crawled through and around. Viewing still images of a submarine used in WWII would not nearly capture the experience of making one's way through the narrow passages that make up the interior of the boat. The same goes for the old trains and busses that can be boarded at the Transport Museum. Some form of multimedia video experience would need to be created to attempt to capture the acquired experience that a visitor would receive.

4.2 Technical and Digitisation Issues

4.2.1 Providing An Equivalent Experience

One key topic we discussed with many museum representatives was whether they thought virtual tours would be able to provide the same museum experience as a physical visit. Most were in agreement that they could come close, but could not fully replace the visit. There are virtual tours that do come very close, such as the one at Shakespeare's Birthplace, in Stratford-upon-Avon. Though the second floor of the building is inaccessible to any visitor with a mobility impairment, the first floor is fully accessible. As such, the virtual tour is housed in the foyer of the entrance floor. The hardware for displaying the tour is housed in a hide-away cabinet that well imitates the surrounding

room's décor so as to not detract from the experience of other visitors and to make the device seem more like part of the house rather than an outside item. This is important, considering that the entire house is decorated in period items, which historians and curators went to great lengths to try and preserve the illusion of actually visiting the 16th century. The virtual tour then provides a look at the 2nd floor, which is not accessible to disabled visitors, in order to bring the entire experience to anyone who would want it. This virtual tour method is the most immersive, but also the most expensive. It recreates the entire presentation space in a three dimensional manner while also providing detailed information and close-up views of the individual items on display. The virtual tour at Shakespeare's cottage is also meant to be used within in the space it represents, that is, the virtual tour hardware and interface is housed inside the very physical structure that is it meant to represent virtually, thus adding to its immersive nature. A virtual tour like this provides much more of an experience than any web-based virtual tour that is accessed remotely, since the user is somewhat in the space of the museum.

4.2.2 Range of Available Technologies

Another important fact we found is that there exist a wide variety of technologies that can be used in virtual tours. Most museum representatives, however, are not aware of these technologies, as they do not work in a technical field. Our template brings these technologies to the forefront of the virtual tour creation, and explains them in a simple to understand manner.

4.2.3 Lack of Certain Technologies

Another issue that has yet to be touched upon is the lack of technology used to digitise particular senses. Though certain smells, such as cigar smoke, can be recreated to set a mood in a physical exhibition, the methods of replication require a large set-up and only afford for certain smells. The smell of an old house or boat or painting adds to the gained experience, and as of this writing, there exist no viable commercial products for digitising and sharing this sense accurately, especially to a remote user. Perhaps one day

the technology will exist to capture the whole of human senses, transmit them digitally, and then accurately recreate them for a user to experience.

4.2.4 Copyright Issues

One major issue that came up in dealing with the digitisation of a museum is copyright infringement. A large emphasis on copyright issues was found in our interviews with Jemima Rellie, the Digital Programmes Director at the Tate galleries; Felicity Premru, Interpretation and Education Assistant at the Transport Museum; and Andrew Mallison at Handel House. Although they have many items displayed in their respective galleries, not every item belongs to them. Many are on loan from other museums or private galleries and part of their agreement with these owners is to limit the number of reproductions allowed. These museums have established rules pertaining to the photography of these items in their galleries. At the Handel House, they even have a policy on taking notes based upon their displayed items. To digitise these items and display them would be in breach of their agreement and would lead to legal problems. These items would require extra paperwork, as well as time and money to simply get approval for digitisation.

Previous attempts at digitisation of museum materials have been limited to very low-resolution images, such as the previous WPI IQP at the Dickens House, or museums have been forced to include watermarks in their digital images. Both these methods vastly lower the amount of immersion and quality of a virtual tour.

4.2.5 User Age Issues

One important note that we found was from the curator at the Twickenham museum. The Twickenham museum is a very small museum based on the town history of Twickenham. The curator mentioned that the majority of people that visit are elderly. These people are most likely to have some form of disability or impairment, and thus are more likely to benefit from the use of a virtual tour. The problem is that they are, unfortunately, the least willing to use computer interfaces. Young people growing up in

this age of technology are more adept to using computers, but are less likely to have any type of disabilities. The important note is that the older people that could make the most use of the virtual tour find it more difficult to grasp the concept of interpreting objects on the screen as representations of real, physical objects. Younger, and likely more physically able, people are more adapted to technology, and would be able to use the virtual tour to its full potential, although they might not need the virtual tour. Although the weight of this factor will reduce over time, it is an important to note because we are using this technology now to aid these disabled people. Our template now takes into account that the virtual tours it recommends are very simple to use.

4.2.6 Cost

A general consensus found among museum executives is that virtual tours are expensive. While this may be true in the cases of fully immersive virtual tours such as Shakespeare's birthplace, less immersive html-based tours could be created at a much less substantial cost. The members of staff who voiced this opinion about high cost also said that they have yet to get any real estimates. Our template is of much use to these people, who would then be able to see the options they have for creating a virtual tour and the projected costs that go along with them.

4.2.7 Template

Figure 1.

As seen in the above figure (Figure 1), the template is a self-explanatory tool designed to be used by museum staff. As it is to be housed online, it meets all web-accessibility standards, so that all users will be able to make use of it, no matter if they require special browsing tool due to a disability.

In the first section of question, the user is asked to describe their museums collection, in terms of the type of objects. Illustrations of examples and a textual description help the user determine what type of object an item in their collection would be.

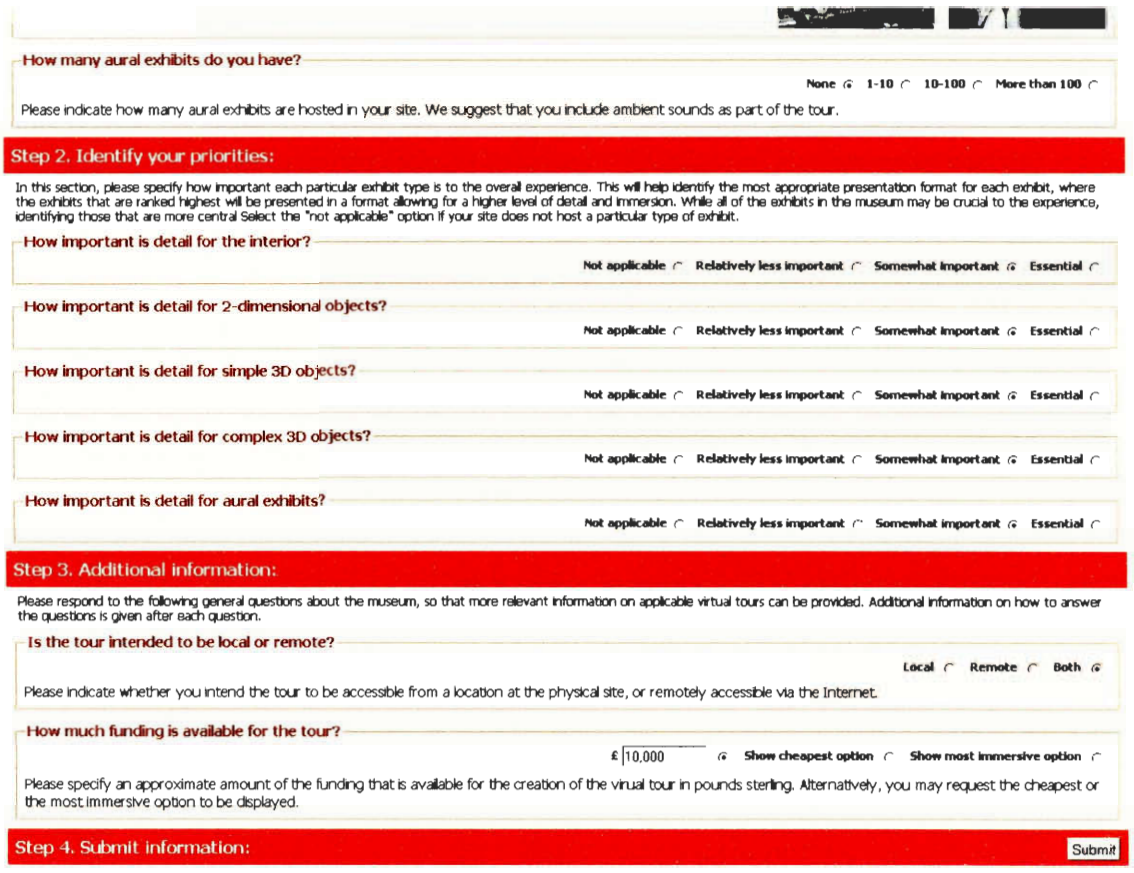

Figure 2.

As seen in Figure 2, the template then asks the user further questions. These questions include the priorities of the museum's virtual tour and two further questions regarding the hosting of the tour and the planned budget. Again, these questions are explained with a paragraph as to why they are important and what they apply to.

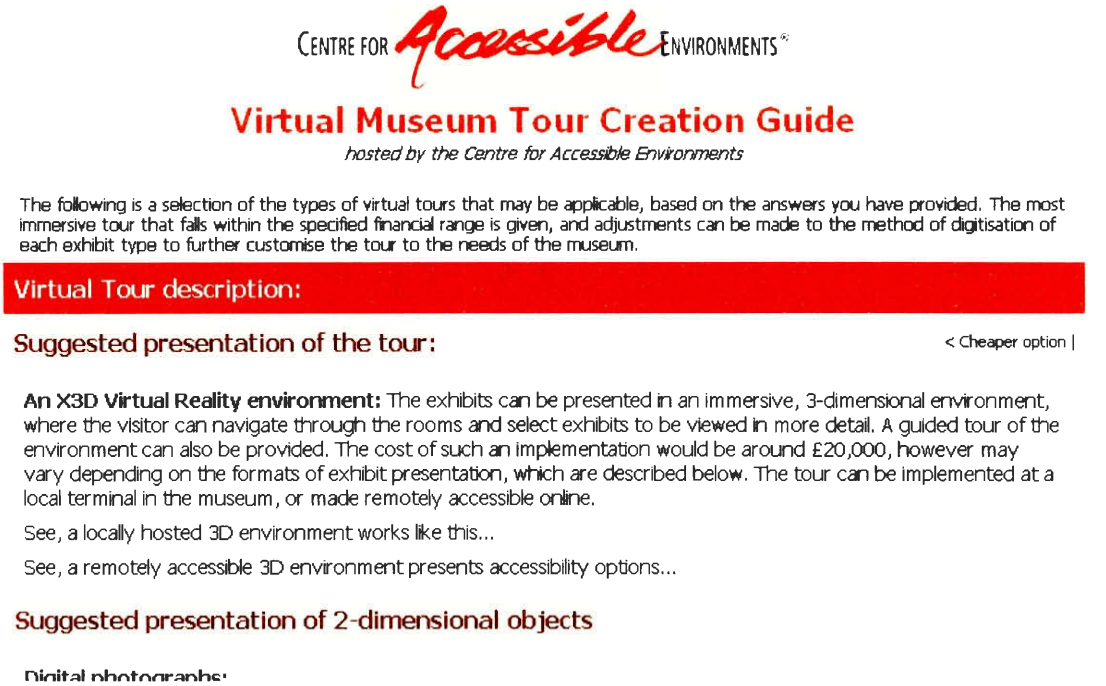

Figure 3.

Figure 3 shows an example of the results page that is displayed after the template user fills in their answers to the questions and clicks the "Submit" button. It contains information about the recommended tour method and ways of presenting each exhibit. At the top of the page, there are links providing options of either a more or less expensive solution, in case the museum feels that the suggested method is not appropriate for their needs.

5. CONCLUSIONS AND RECOMMENDATIONS

Our research focused on three issues: finding out what types of exhibits would need to be digitised, comparing virtual museums experiences to physical ones, and determining costs, benefits, and features of virtual tours. As outlined in our Methodology chapter, we visited a varied assortment of museums to get a broad range of the type of exhibits a museum would be faced with in digitising its collection. The range varied from small, inadequately funded museums such as the Twickenham Museum to large highly funded ones, such as the Victoria and Albert. We also spoke with representatives of several companies that create professional virtual tours in order to obtain information about the cost and process of their productions.

Altogether, the museum visits and interviews resulted in the team's consensus about what could be considered part of the museum "experience". There is first a level of detail that each museum needs to decide upon, as important as the exhibits themselves are, matters such as the architecture and external structure of the building, the interior décor, the carpets and paint, the lighting, and the cases and arrangements of the exhibits also should be considered in the creation of the virtual tours.

The point of view is also important as well. Any exhibit could be observed from various angles and distances. It would be up to the staff at each location to decide whether to choose one perspective for digitalisation, or to try to preserve these unique perspectives. There are available technologies, such as QuickTime VR that can account for these factors.

Another key topic, which we spoke with many museum representatives about, was whether they thought virtual tours would be able to provide the same museum experience as a physical visit. Most people were in agreement that they could come close, but could not fully replace the visit. An example of a tour that came very close was the

immersive 3-D walkthrough tour that can be found at Ann Hathaway's Cottage. In this tour, the virtual visitor walks around an environment very similar to that of a video game that completely replicated the inner space of the physical house.

Another important fact that we found, is that there is a wide variety of technologies that can be used in virtual tours. Most museum representatives, however, are not aware of these technologies, as they do not work in a technical field. Our template brings these technologies to the forefront of the virtual tour creation, and explains them in a simple to understand manner. A general consensus found among museum executives is that virtual tours are expensive. While this may be true in the cases of fully immersive virtual tours such as Shakespeare's birthplace, less immersive HTML-based tours could be created at a substantially lower cost. Our template may be quite helpful to these people, who would then be able to see the options they have for creating a virtual tour and the projected costs that go along with them.

This template will be hosted on the website of the Centre for Accessible Environments (CAE), our hosting agency and an important information provider for inclusive access. The template features several questions posed to the staff member of a museum that wishes to create a virtual tour and is not sure of what kind of tour would be best to suite the needs of the museum. These questions range from what amount of funding would be available for the tour to what kind of exhibits and items the museum would want to emphasize or feature. After submitting their answers to the questions, the user is then presented with the three most appropriate solutions. These solutions are ranked based upon the criteria provided by the user's answers. Each solution includes a small summary, along with illustrations so the user can make an informed decision on which tour best suites the museum.

There are also several links directing users to the Royal National Institute of the Blind in order to reiterate the fact that if the tour is web-based, museums should keep the

needs of blind users in mind. Though it is outside the scope of our project, we understand that visually impaired users may want to access web-based virtual tours. There are several groups working towards making the web more easily accessible to the blind person; the leader of this is the RNIB. Their work focuses mainly upon making sure that websites conform to a set of practices that make their content more easily translated from being presented visually to a higher-contrast, more easily read version, or even an audio rendition. The RNIB emphasizes that websites be created more flexibly so that specially designed browsers will be able to present them in a form accessible to people with visual disabilities. If a museum were to create a fully immersive tour on par with the one implemented at the Shakespeare houses, and wanted to make the tour usable for blind people they would have to make sure that they have an audio rendition of the tour, or a method for translating the highly visual experience of a virtual tour into one that can be experienced without perfectly functional eyes. Perhaps a separate IQP could investigate methods of making websites accessible to the visually impaired, especially websites that rely heavily on visual navigation.

It would also be in the best interest of a museum that has an on-site virtual tour to make sure they use a computer terminal that is easy to use, no matter what kind of disabilities the user may have. The CAE's book, Access to ATMs, though originally intended for a different purpose, would be very useful in the design of a computer kiosk intended for use by disabled visitors. In addition, the museum would want to use the proper signage to point out that they have special facilities set up for inclusive access.

After our template is put into use, another IQP could be assigned one or two years from now as an update of our project. Over time, the available technologies, and prices will change. This next team would research these areas once more, making sure all of the information is accurate and up-to-date. Since the template will be in use, the next team could also make updates based on user feedback that will have been collected. If the template is well maintained and kept up-to-date, this project has the possibility to benefit

many small museums and historic sites as well as to encourage inclusive access for all people to all locations.

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APPENDIX A – Host Information

The Centre for Accessible Environments works as an information provider and a forum for collaboration between properties owners and the users of those properties as to how the properties can be best made or modified to allow for the best access to everyone. They operate and are registered as a charity organisation, meaning they accrue no profits and are supported largely by donations. As a group, they do no lobbying or campaigning, but supply information on usability of environments for the disabled and elderly. Their mission is not only to provide as much inclusive access as possible, but to also make it cost effective and aesthetically pleasing for facilities to do so. Many of their services are free of charge, including site-specific consulting, design modification, enquiries into accessibility design and compliance with disability legislation. Their clients are often the disabled people and their representatives as well as the advisors to, and owners of, facilities in need of modification along with the construction workers who would be making the modifications. They have years of published guides for technical designs, interpretations of building codes, and a quarterly publication, *Access by Design.*

This IQP fits exactly into the CAE's expertise as they have years of experience with finding creative compromises for providing access to facilities that have very limited options for modification. The Centre works closely with the Disabilities Rights Commission, a government lobby, the British Standards Institution, and, most creatively, ITAAL (Is There An Accessible Loo).

APPENDIX B – The Interactive Qualifying Project

I. What is an IQP?

At WPI, there are three major projects that every student is required to complete for their degree, the Humanities and Arts Sufficiency, the MQP or Major Qualifying Project and the IQP, the Interactive Qualifying Project. The IQP is a team-based project based in the social sciences that examines the impact of science and technology on society. The objective of the IQP is clearly defined in the Undergraduate Catalogue – "to enable WPI graduates to understand, as citizens and as professionals, how their careers will affect the larger society of which they are part." The goal of the IQP is to use technology to help benefit society as well as to give large-scale project experience to the students participating.

II. How Does Our Project Qualify as an IQP?

Our project qualifies as an IQP because it makes use of technology, in order to make a significant impact on society. Our project directly benefits a specific part of society, disabled people, by using technology to provide virtual access to them. This project benefits not only disabled people, but also small low-income, often non-profit museums that cannot afford to hire professionals to create virtual tours. By completing this project, we will also be assisting these museums in conforming to new laws, thus keeping them a thriving part of society.

The IQP is also comprised of 13 divisions. Our project falls without question under division 48, Humanistic Studies of Technology. This is because our project deals directly with using technology, the Internet, to directly benefit people. Clearly, this is a project that qualifies as an IQP. This project will make use of all the skills we have learned thus far at WPI, those skills which in the future, we will use in our careers. By completing this project, we will have a newfound sense of how our skills have affected society, which is the stated objective of the IQP.

APPENDIX C – Museum and Interview Reports

C.1. Handel House *(visited on 02 FEB 2005)*

The Handel House is a small museum, dedicated to the life of the classical composer Frederick Handel. They are a well-funded museum. They charge 5 pounds for entry, and have numerous benefactors. The building is physically handicapped accessible, with a lift discreetly installed in the back of the building. They currently do not have any type of virtual tour, or any plans to implement one. They feel that they provide enough physical access, that a virtual tour is un-necessary. They are however interested in a virtual tour not for access, but to attract more patrons. While this is one of the advantages of a virtual tour, it is not the primary goal of our project.

The visit, did, however, point out an interesting exhibit. In one of the rooms in the house, the museum has a playable harpsichord. Though constructed recently, the item is of exceptional beauty and presents an example of an exhibit that would require several methods of digitisation. In order to capture the size and shape of the harpsichord, as it is a three-dimensional object, a rendered 3D model could be made. In order to show the high level of detail engraved into several surfaces of it, high-resolution digital photographs could be taken. Finally, as it is a working musical instrument, an audio sample of the harpsichord being played could be recorded. All three digitisation would need to be presented in a virtual tour in order to present an accurate rendition of the experience of physically visiting the museum.

C.2. London Transport Museum and the Science Museum *(visited on 27 JAN 2005 and 05 FEB 2005 respectively)*

At both the London Transport Museum and the Science Museum, there are many computer touch-screen terminals, so many, they are almost omnipresent. Though they are not designed for the function of providing a virtual tour for disabled people, their existence and implementation marks the possibility and willingness of museums to provide the tools needed for virtual tours.

The terminals at the London Transport Museum were adjacent to nearly every exhibit, though sometimes a single terminal was shared amongst several items. At the terminals, a visitor could call up quite a great deal of stored information, much of which was presented via some form of multimedia. As many of their exhibits are train cars and busses, which allow climbing into, inclusive access is not entirely possible in the physical way. Using their already existing computer terminals, the museum could implement a virtual reality tour of the inaccessible portions of their exhibits, akin to what was don't at the Shakespeare Birthplace and Anne Hathaway's cottage. All they would need to do is create the tour and modify their software to display it; they already have all the hardware needed to create an implementation, if they were so inclined.

At the Science Museum, there are, littered about, handy terminals for guiding visits through the very large facility. These terminals were programmed as to their locations in the building and when asked, via a touch screen graphical interface would provide directions to getting to another exhibit or service in the building. A light summary of each exhibit was available and could be accessed through several different methods, including a graphical map and an alphabetical index. Again, this museum's terminals are not set up primarily for providing access to disabled patrons, and do not truly need to be, since the physical site is quite accessible on its own, but the option exists and could be easily be put into practice.

C.3. Tate Modern *(visited on 18 JAN 2005)*

The Tate Modern, a large gallery of contemporary art, is part of the Tate Gallery group, which also includes Tate Britain in London and two other sites in Britain. The gallery's physical facilities are quite large, and are accessible to physically disabled people. Nonetheless, the gallery has a virtual tour available to the general public on its website, designed primarily as a promotion tool.

The visit to Tate Modern was conducted with the primary intention of comparing the virtual tour of the museum to the physical experience of the actual site. This would allow us to be better able to subjectively assess a virtual tour, based on factors such as how well the actual experience is conveyed, and whether there were any significant drawbacks to a virtual visit experience. Additionally, the size of the gallery and the contemporary nature of the art it presents, led us to believe that it is likely to display numerous exhibits unique in their form, medium, and presentation. Seeing such exhibits would contribute significantly to our goal of identifying the possible types of exhibits that may be encountered at a historic site. We were also told that the museum is planning to implement a system, which provides information about exhibits on handheld computers in British Sign Language (BSL), which would serve as an informative example of how inclusive access to information can be provided by digital means.

Due to the gallery's size, the visit took us almost an entire day, and was overall very impressive. Unfortunately, the BSL system was not in place yet, and we were told that it would be available later in the spring. However, the variety in the medium, form, and size of the exhibits made the visit quite informative for our purposes. The building housing the exhibits was quite large, with free exhibitions on two of the floors, both of which we visited. Each floor was divided into three sections, with all rooms within a section displaying exhibits with a similar theme, rather than being organised by author or time period. Most of the exhibits were quite unconventional in their form of presentation, including interactive file cabinets, animated optical illusions, sculptures over 10 metres

high, rooms with projected video on all the walls, groups of sculptures in a specific arrangement, and aural exhibits with multiple sound sources, among many others.

The virtual tour was implemented using Flash technology, and was accessible through the Tate Modern website. The tour provided a representation of the physical architecture of the museum, where floors and rooms within the floors can be selected to view the artwork displayed in the room. Small digital images of the artwork could be viewed, along with extensive accompanying textual information. However, due to copyright issues, only a portion of the artwork was available for viewing for the website.

Exhibit types of concern:

Exhibits that rely on optical illusion – mostly change appearance with perspective change, thus may be satisfied with video recording. An assessment on the types of optical effects that can be reproduced in a virtual environment may also be helpful. This also applies to exhibits that rely on the change of lighting (through change of perspective or otherwise) to present themselves.

Interaction – a prominent feature among exhibits, especially contemporary art. Interaction may be as simple as pushing a button, but models that are more complex may also be encountered, an example of this at Tate being the Thames Dig file cabinet, where visitors can open numerous drawers to examine their contents.

Exhibits designed to be viewed in a specific environment – some exhibits may have been designed for a specific form of presentation, including a specific room size, colour of walls, sound source arrangement within the room, and specific lighting. The effect of light on exposing brush stroke patterns through highlighting the painting texture may also be significant for paintings.

Additional points of concern:

The feeling of seeing the original artwork – while a famous painting may have been seen countless times, there is an undefined appeal of seeing the original work. Compare with the appeal of an original celebrity autograph, in contrast to a copy that may look exactly the same.

Exhibit size – One of the most notable disadvantages of digital representations of artwork is the lack of an impression of the size of the work. Using familiarly sized objects, such as chairs in the virtual environment, or a coin in a photograph is crucial.

Mirrors – some exhibits may rely on the use of mirrors, and the observer seeing his/her own reflection. The use of realistic avatars (digital representations of the observer) may be necessary to allow such exhibits to be experienced fully.

Exhibits vs. Environment – the Tate Modern virtual tour, where a representation of the building structure is available, presents exhibits separately from the environment, with no indication given as to how they are arranged within a room and the ambient qualities of the room. This raises the question of whether a historic site wants to place emphasis on presenting itself or its exhibits in a virtual tour.

C.4. The Twickenham Museum *(visited on 01 FEB 2005)*

The Twickenham Museum is a small museum in the town of Twickenham in the Greater London region. It is volunteer-run, and aims to raise awareness of the rich history of the area by housing an archive of records and exhibits related to the history of the town and its people. It is currently not fully accessible to disabled people, mainly due to lack of funding, although a very informative website with an extensive picture gallery of objects in the museum is available.

The primary intentions behind our visit to the museum was to better understand the needs of small museums that have difficulty providing inclusive access, and may thus wish to provide virtual access to their facilities. We also hoped that the visit would contribute to our understanding of a museum experience, and provide further insight on unique exhibit types.

The museum is very small, only having two floors, with one room on each floor. A large part of the exhibits is on glass covered tabletop displays, and consists mainly of items recovered from the bottom of the Thames River. The most notable exhibits, however, are various aged scuba diving apparatuses, which visitors can touch and even put on. The museum in general has a unique hands-on approach to presenting their exhibits, and curators manually bring down exhibits for visitors who cannot access the second floor, who can then touch and examine them. The curators were quite friendly to us, giving us informative insight on the intentions of the museum and their views on virtual tours. Interestingly, even through various aspects of the interior have previously had historical significance; the interior has been refurbished and repainted to have a contemporary appearance.

The aforementioned scuba diving apparatus, where extensive physical interaction with a complex object is the primary component of the experience, would be extremely difficult, if not impossible, to replicate in a virtual environment. Such exhibits may

therefore require physical access to them, with no viable alternatives provided by current technology.

An interesting point brought up by the curators, was the fact that they have found that older people find it more difficult to grasp the concept of interpreting objects on the screen as representations of real objects than younger people. Thus, elderly visitors, who often find it difficult to walk up steep staircases, may not find a virtual reality tour to be a completely viable alternative.

The curators also noted that raising awareness on the history of the region was the primary purpose of the museum, and a publicly available virtual tour of their site would contribute to their general agenda quite effectively. They indicated that such a tour would be welcome even if it drew away visitors from the physical site, although they were confident that it would not have such an effect.

C.5. Shakespeare Birthplace Trust *(visited on 21 JAN 2005)*

We caught a bus to Birmingham around 7am and took a train from there to Stratford. We first went to Shakespeare's Birthplace. The first thing we did was take a look at the already implemented virtual tour. It was installed very nicely in a wood cabinet that folded out to the perfect viewpoint of a person in a wheelchair. The virtual tour is usually reserved for this use only and not for regular visitors since having a computer running inside the period furnishings is a bit jarring. The tour was completely 3D based, where the user touches the touch screen to move or 'walk' through the house. You have the option of taking an automatic guided tour, or exploring on your own, much like at the actual museum. There were clickable hot-links on various objects, allowing you to go a little more in depth, such as opening and closing drawers and curtains that are roped off to the public. The tour was not however accessible to people with all disabilities, only to those with mobility impairments. We then took the tour of the house ourselves, and overall the virtual tour was very accurate to walking through the house. We attempted to speak to the museum curator, Ann Donnelly, but she was too busy to speak to us. We then walked across town to Ann Hathaway's Cottage. There was another implemented Virtual Tour that is very similar to the Shakespeare's Birthplace but, with added audio, and a larger screen. The tour was created by the same organization, the Virtual Experience Company. It was very well done as well. We spoke to the curator at Ann Hathaway's Cottage, but he did not know any details about the virtual tour, he recommended us emailing the Shakespeare Trust curator Ann Donnelly. We later obtained much information from Ms Donnelly through email.

C.6. Interview with Jemima Rellie *(conducted on 25 JAN 2005)*

The Tate Galleries have already created a graphical interface for accessing their collection via their website. Each gallery has a slightly different version of this interface, as each is modelled after the floor plan of the building that houses their collection. They are not quite fully immersive virtual reality tours of their buildings, but provide a convenient way to alternatively access their collection, without visiting the physical site itself.

In planning visits to compare an actual visit to the gallery to the experience of using only their online collection, we get in contact with the Tate Gallery's Head of Digital Programmes, Jemima Rellie. After touring the galleries and comparing them to their virtual counterparts, we were able to sit down for an interview with Ms. Rellie. She was very happy to speak with us and provide us with any answers she could about our research, as she obviously knew much in the way of digital versions of museum collections.

We discussed the purpose of making virtual tours, difficulties in creating virtual tours, and possible feelings museums and their staff might have about virtual tours and their creation.

Virtual tours, according to Ms. Rellie, have three basic purposes: 1) to prepare for a visit, 2) to extend a visit, and 3) to replace a visit. The current Tate tours, which are referred to as "Explore Tate (insert specific gallery name here)" truly only function towards the first two purpose at the moment, as they have yet to find an easily accessible method of bottling up their entire experience in a digital form and because their physical locations are very accessible to users with disabilities. The first two purposes, though, are not to be underestimated. As a preparation of a visit, a user could see which rooms particular pieces are in and plan a route to see specific works without wasting much time.

The user could also print out textual information that is on the website but not able to be displayed in the caption card on the physical wall of the gallery do to size issues and learn more during his or her visit than otherwise possible. The "extension" purpose is similar, in that the user would be able to access more textual information via the website than available on the wall of the gallery, although after the visit instead of before. Both of these purposes are also of much use to schools in the organisation of field trips.

In the creation of their tours, the Tate was lucky enough to be funded by government grants and created by in-house developers along with help from BT, otherwise Ms. Rellie estimates that an out-of-house private creation would have cost, at minimum, £20 thousand. Their hosting is taken care of off-site, again by BT, which, as a telecom company, is more than capable of handling the load. They chose to program their interface in Macromedia Flash due to their programmers being proficient in that environment, along with a desire to avoid any possible bandwidth issues and forcing users to download an obscure plug-in for their Internet browser. They were also lucky that almost all of the content used in the virtual interface had already been created such as multiple language captions and photographs of many of the exhibits, so the only difficult work was in making the interface to tie all the content together.

Each time that a gallery host a special occasion, they have their own website set up and any virtual experience is on a per diem basis for each exhibition.

Ms. Rellie did not believe that a loss of profit would affect a museums choice of whether to present itself and its collection in a virtual venue; instead, it would be the integrity of the exhibition that would be the concern. The Tate offers many of their exhibitions that require a pay-admission for free on their website. They would consider setting up a possible charge for access one day, depending on the specifics of their sponsorship and if there existed a market for buying the content.

The main issue that Ms. Rellie felt were present in creating virtual tours are the cost and copyright issues. The cost was not a big issue for the Tate with its generous sponsorship, but when digitising and sharing content from the Tate Modern, they ran into more trouble with copyrights than with the other galleries. Art less than seventy years old is harder to clear the copyrights to, thus making modern art more difficult to display. From there, main issues with creation were the usability of the interface and systems integration of the databases of content with the graphical interface. The Tate is working on dialog between their users and staff, using comment boxes, a bulletin board, and a "Write your own caption" program. The bulletin board is mostly artistic commentary about the pieces in the collection, but occasionally has comments on the usability of the system. There is a Tate employee who regularly checks this board, at least twice a day, to log comments and, in effect, liase between the users and the creators.

We also discussed the different methods of digitising a particular item. The current virtual Tate galleries are almost entirely based upon two-dimensional photographs, so we asked if there was any work in creating three-dimensional rendering of sculptures and such. Ms. Rellie responded that making 3D models costs thousands of pounds, but they hope to do more 3D work once the price comes down and they can take higher resolution imagery of their collection, which will come with copyright issues and internet download speed improvements.