The Future of Virtual Museums: On-Line, Immersive, 3D Environments.

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Introduction

The face of virtual on-line museums is entering another period of change. While the emphasis has been on expanding access to museums via the use of interactive web-based presentation, the next generation of virtual on-line museums will seek to create immersive environments that place the museum patron in a representation of the museum, not just viewing information about the collection. The use of state-of-the-art real-time rendering software on low-cost personal computers and next generation console game systems that support Internet access will allow students and instructors to have a 'lean-forward' seamless educational museum experience. (Jones 2002)

This paper overviews current approaches to virtual museums used today and then discuss the future of 3D immersive virtual on-line museum environments.

Virtual Museums Today

Virtual museums today are principally offered using the World Wide Web and HTML technology through a personal computer-based web browser such as Netscape or Internet Explorer over the Internet. The degree of technology and information presentation varies greatly. It can range from simple hyper-linked text with graphics to more advanced use of multi-media clips, animations, audio, and interfaces requiring the user to have high-speed Internet access via cable modem or DSL. The approaches are similar in that museums and virtual libraries are seeking ways to expand access of their collections to a wider audience that cannot otherwise travel to the museum during the short interval of showings.

One example of a basic site that also includes QuickTime Virtual Reality (QTVR) segments to enrich the presentation of the materials is the Virtual Tour of the National Museum of the American Indian Exhibitions Creation's Journey and All Roads are Good (2002). This Virtual Tour was the result of collaboration between the Smithsonian Institution's National Museum of the American Indian (NMAI), the Four Directions project, and the US Department of Interior Bureau of Indian Affairs. The National Museum of the American Indian is an education and research institution that consists of three physical facilities: the George Gustav Heye Center in New York City, the Museum on the Mall in Washington D.C., and the Cultural Resources Center in Suitland, Maryland. The NMAI identified a "fourth virtual museum which exists outside the walls of the three physical museum buildings, serving those who would benefit from the knowledge and experiences the museum can offer, but are unable visit the New York City or Washington, D. C. museums". (NMAI, 2002) The project is an excellent example of the type of outreach being done by museums.

The project was different in that students from Indian schools participated actively in the creation of the content and added their own first hand knowledge of the artifacts. A QTVR studio was set up at the museum and students recorded virtual objects of items they had selected from the exhibition catalogs, recorded virtual panoramic spaces in the exhibition halls, and researched their artifacts for their accompanying essays in the museum's resource center library. Figure 1 is an image from the NMAI virtual tour web page. A visitor to the site clicks on different areas of the tour (bottom left of the figure) and is then presented with a panoramic 360-degree picture of the location on the map (top left). If the visitor selects an artifact, a QTVR of the selected content (the right side) is displayed along with information on the object that was researched and written by the students. Full information regarding the project can be found on the web site http://www.conexus.si.edu/VRTour/.

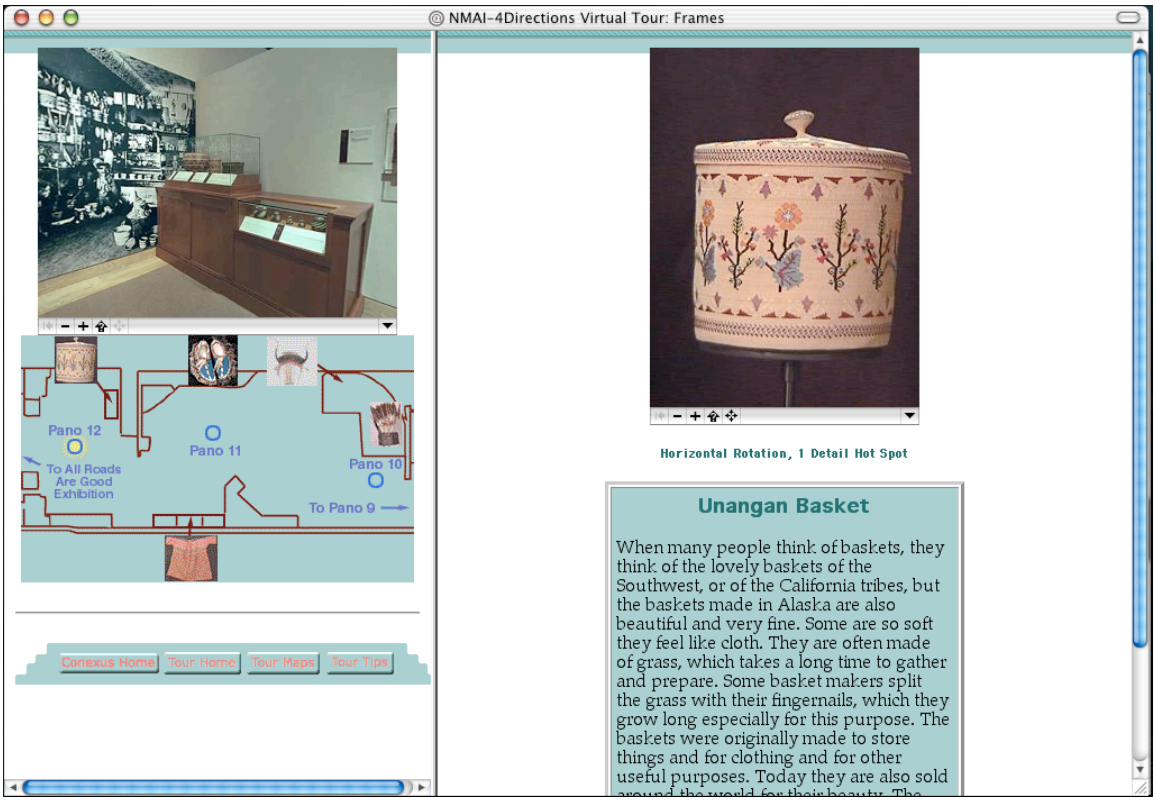

Figure 1: Virtual Tour of the National Museum of the American Indian

The NMAI site is a good example of a medium level web-based virtual museum. The site requires moderate bandwidth due to the large size of the QTVR images that might be encountered and downloaded. A basic web browser that is common today supports the basic interface without the need for additional software or plug-ins. The site provides the content in a clear and concise way and the use of the 360-degree panoramas for each area provides some immersion into the space for the visitor.

An example of a more sophisticated web site that uses advanced web browser plug-ins to create a more advanced multi-media interface is the Virtual Smithsonian. The Virtual Smithsonian highlights over 360 artifacts from the 14 Smithsonian museums along with a virtual tour of the Castle (Virtual Smithsonian, 2000). The on-line web-based exhibits are high-resolution images, video and audio clips, and artifacts that rotate in 3D (QTVR) and morph into other artifacts. One of their goals is to show what might be possible when the next generation of Internet (faster throughput) becomes a reality. The site provides for both low (modem) and high-speed (broadband) connected Internet visitors. The downside to this advanced multimedia presentation is that the on-line visitor is required to have a fairly high-speed Internet connection to fully appreciate the presentation, which the majority of homes in the US do not have access to. As will be discussed later in this paper, Internet access barriers will continue to be an issue in the future. The site is a good example of the potential for presenting a diverse collection of materials to people that might never have the chance to visit the actual museums. It is also a good example of the use of graphic motifs that place the visitor within a context during their information navigation. Figure 2 is an image from the web site. The opening graphic seeks to place the visitor in an entry area.

Figure 2: The Virtual Smithsonian

Both of these sites show a good cross section of current technology being used to present virtual museums on the Internet today. The focus has been on providing information to those equipped with the now ubiquitous Internet web browser. The next section will seek to explore a possible solution of providing high-quality on-line low-bandwidth experiences in a more natural and widely available manner taking into account not everyone will have broadband or Internet2 connections for many years.

The Future of Virtual Museums

We believe that the future of on-line virtual museums will be on-line immersive 3D rendered environments that place the museum patron in the actual space of a current or past exhibit. The created realities methodology takes current commercial approaches to provide contextually accurate software-derived 3D environments. This interface creates a true immersive environment that places the patron in the museum space while providing necessary access to information on the presented collection. With the addition of collaborative tools such as chat, audio, overheads, and whiteboard interfaces on-line presentations can range from real-time tours and discussions to pre-programed self guided tours. The use of state-of-the-art real-time rendering on consumer personal computers and game consoles can allow students and instructors to have a 'lean-forward' seamless museum experience.

Instead of accessing a two-dimensional Web site that may feature three-dimensional objects or QTVR, imagine a system that would allow visitors to experience a truly immersive 3D experience. Their experience would feel as if they were actually visiting the museum in person. A visitor to a new virtual museum could walk into a replica of the museum building and then select how halls might be configured based on previous exhibits. With a more advanced system, the museum patron could perform a meta-search on the collection(s) and have a virtual space tailored to their visit. Add to that the ability that other patrons or museum employees can be on-line and in the virtual space at the same time to interact or discuss topics or artifacts. We can take this experience one step further by programming an artificial intelligence to take visitors on a tour of the exhibit. Unlike an audiotape tour, the amount of information the visitor might wish to review or access could be custom-tailored depending on their interest level.

Figure 3 – Example of simple museum using Created Realities software.
In this example, visitors can select portraits and learn more about the scientists.

Technology

This is not science fiction. The technology to implement the above vision is available today and can be deployed for use on most personal computers. It is possible to deliver this because of two factors - lower cost of better performing personal computers and better access to the Internet. In the last two years, the price/performance plateau has been reached on a personal computer that supports the required technology that the average consumer purchases. In 2001, personal computers with the required 3D video graphics cards were shipped in over 70% of all new personal computers sold (NT and Windows). Both of these trends will continue and will make the technology for presenting a virtual museum in this manner even more compelling.

However, personal computers are not the only method for presenting virtual museums. By the end of 2002, low-cost gaming consoles will support Internet capabilities. These game consoles, like Sony's PlayStation2 or Microsoft's X-box, are designed to render high quality 3D graphic environments and with the addition of Internet access will make it possible to deliver virtual museum tours on systems that cost a fraction of a personal computer. Personal computers are the largest providers of web-based virtual museums. However, with the introduction of new game consoles with

Internet capability, a shift will begin to occur such that game consoles will be the primary means of accessing on-line virtual environments and not personal computers. By using created realities technology, virtual museums can be supported on both platforms.

Many of the latest web-enhanced presentations are geared toward users and institutions that can access the newer and higher bandwidth Internet connection. The Virtual Smithsonian (2000) is a good example of such a museum space that is aimed at these newer high-speed connections. It is estimated there will be 20 million broadband customers in the United States by 2004 (RHK, 2001). The importance of this information is that a majority of citizens in the United States will have problems gaining access to these new higher speed Internet connections in the future. As computer technology and networking become increasingly important to economic and social success, many people in inner cities and isolated rural areas are failing to acquire the new technology as rapidly as their more affluent neighbors. This is commonly referred to as the Digital Divide (Benton Foundation, 2001). The benefit of creating the virtual museum in a 3D rendered environment is that it is highly bandwidth efficient. Since the museum is rendered and not retransmitted the initial bandwidth is minimum supporting those without access to faster Internet connection, but can grow to accommodate higher-bandwidth and more multi-media objects as access to faster Internet occurs over time. Users can view environments in real-time using a 28.8k modem connection to the Internet. This is possible because a rendered textured geometry of an object is much smaller than a high-resolution photo or QTVR. Thus, fast performance over thin-client Internet connection is ensured by small file sizes and incremental rendering that only renders active visible areas on the visitor's screen.

One of the primary obstacles of generating realistic 3D virtual museums has been in the area of digital assets collection and management. QTVR is a good example of one digital assets collection system that went from being expensive and difficult to one that over the last several years has become easy, low-cost and very common. This is primarily due to the fact that computers have become more powerful and digital cameras have dropped in cost. While QTVR is good for presenting 3D objects in 2D space as on the Web, to collect information for 3D rendered environment, we need slightly more sophisticated technology than a digital camera taking still images and stitching them together. The problem of capturing 3D information for presentation has been overcome. Several scanning systems

are now available which allow the generation of 3D rendered and textured objects that to directly placed into a virtual museum. One such company is 3Q.com. Their system uses one or more Qlonerator (digital camera systems which merge views to produce a single 3-D surface and texture) to scan an object, regardless of the size and coverage of the object. Up to twelve Qlonerator can be connected depending on the coverage of the object. The Qlonerator system can be configured based upon coverage needs, or whether it is full head, face or body, and logistical requirements, whether it needs to be portable or not. While the technology is expensive, those processes are only expected to drop as the technology becomes more widely adopted. Figure 4 shows an example from the 3dmd web page (2002) showing a rendered solid colored object and then one with the texture of the face placed over it generated using 3Q technology. The texture once placed on the geometry looks life-like.

Figure 4 – 3Q object scanning example (3dmd, 2002).
Left: solid wire frame. Right: captured image texture.
When combined you have one object that combines
both the 3d shape and texture of the scanned person or object.

One last hurdle for this new approach to virtual museums is that environments must be as easy to develop as web pages. The Created Realities Environment is very simple to support and build content in. Using low cost 3D modeling tools like TrueSpace that computer hobbyist, web developers, and other creative professionals can use, 3D experiences, environments, and materials can easily be developed and placed on-line. The example virtual museum shown above was created in an afternoon and placed on-line. As the technology develops, more advanced tools will emerge allowing more advanced environments to be created in less time.

The Benefits

Now that we have discussed the vision and the technology, we will conclude the paper by discussing some of the benefits for education, historical continuity, dual-development paths, and the potential of meta-data searching.

Education

The development and maintenance of a virtual museum is an ideal way to provide a student-centered constructivist learning environments. It allows students to make choices about what they want to study and provides meaningful topics that incorporate academics and culture while providing a way to get families and the community involved in their education. (Nah Tah Wahsh, 2002) There are many examples on the Web today that demonstrate this powerful mixture of on-line technology and student learning. Virtual museums can be used to collaborate between classrooms, grade levels and even schools, since the Created Realities system is designed to support collaborative learning interactions. It could be possible to generate virtual museums using cultural artifacts or items and allow visiting students from other parts of the world to compare and contrast aspects of their research, heritage, or culture depending on the setting of the museum. Thematic examples could include traditional foods, plants, songs, dances, and family, while at the same time empowering the student to be the creator of the information and curator for other students.

Many school age children today have grown up playing 3D immersive games on various computer systems. In recent years the term “Nintendo generation” has been used. This technology approach is a result of those early systems and is a next step in taking it beyond entertainment into something much more significant in its potential impact on learning.

Children will have little problem in imagining and creating environments to present information regarding subjects and for other children to explore and interact with.

Since the environment is kept on-line and stored in a database, it is very easy to link information together for future use. One example might be a student who creates a report in grade school who could then continue their work through high school, becoming knowledge builders rather than mere consumers.

Historical Continuity

After talking to museum curators, one of the more powerful reasons for creating on-line virtual museums is the ability to capture a snap shot of the work accomplished and allow visitors to continue to visit the presented exhibit for some time in the future. The work of organizing, displaying, explaining artifacts in a meaningful way is not lost when the exhibit is closed and replaced by the next one. Many times we have heard from museum patrons about their disappointment on a missing an exhibit.

By recreating an exhibit in a virtual museum, the effort of creating the original in-person one is never lost. It even has the ability to be on-going in the future as changes or new information is discovered or understood. Once a virtual museum space has been developed that accurately reflects existing museum building space, it is simple for later exhibits to inhabit this space without having to recreate the basic space each time. A virtual museum curator would simple copy the building space and then place or rearrange objects in the newly copied building space. This would allow easy transfer of existing information from new exhibits directly into the virtual system without a large amount of work each time.

Dual-development paths

With the ability to change virtual environments to reflect changes in actual museum space, it would be very easy to create dual-development paths in both areas. The virtual museum curator could follow the creation of a new exhibit and create the virtual environment as aspects of the new exhibit are completed. Development of the on-line space would not have to be a separate project, but integrated into the building of the in-person one. This approach could save time and money for the museum.

Creating Environment using Meta Data Searches

One powerful benefit could be the ability to link stored virtual 3D objects and its linked information and make it searchable via Meta Data searching techniques. Imagine the ability to perform a search and have a virtual space generated that contained the relevant information returned from the search in text, audio, photos, and 3D images. One example would be that a user accesses the system, performs a search using Leonardo da Vinci, and has the system generate a virtual museum that would contain the various text, art, and models from da Vinci. The user could tour the collected and presented information or simply perform another search.

Conclusion

The next generation of on-line virtual museums using 3D technology is now possible and affordable. This paper has discussed the benefits of the new technology and concept approach for both the participant and the museum. 3D created reality is the next logical step in museum presentation beyond web-based Internet technology. We see 3D created realities to be in a similar position as the World Wide Web was in the early 90's. Like the web in the early 90's, computers power and Internet access will only continue to increase and thus provide even more impetus to the use of immersive realistic environments for museum presentation.

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