Mixed Realities – Virtual Object Lessons

Andreas Kratky

USC School of Cinematic Arts, Interactive Media Division,
900 West 34th Street, SCA 201, Los Angeles, CA 90089-2211
akratky@cinema.usc.edu

Abstract. The question of how to design and implement efficient virtual classroom environments gains a new quality in the light of extensive digital education projects such as the One Laptop Per Child (OLPC) initiative. At the core of this consideration is not only the task of developing content for very different cultural settings but also the necessity to reflect the effects of learning processes that operate exclusively with digitally mediated content. This paper traces the design of the project *Venture to the Interior*, an interactive experience that presents selected objects from the collections of the Museum of Natural History in Berlin and reflects them as building blocks for the Enlightenment-idea of a building of knowledge. The project investigates the role of objects as a knowledge device and the possibilities for a translation of the didactic effects of experiential learning into virtual environments.

Keywords: Virtual Museums, Virtual Reality, Mixed Reality, Virtual Classroom, Distance Learning, Photorealism.

1 Introduction

The recent announcement of a 10 Dollar computer by the Secretary for Higher Education in India as well as the announcement of a new computer series of the One Laptop Per Child initiative of the MIT for 2010 gives the discussion about virtual classrooms a new and strong impulse. These initiatives are designed to make educational resources available to children who do not have a regular access to them. Targeted for mass distribution in developing countries these networked computers will be used in areas with sparse infrastructure where the computer and the content available through this computer will often be the only contact with a wider range of educational resources. While many of the studies about the pedagogy and efficiency of virtual classroom settings have been conducted in areas where the technological platforms are generally available and where also other access channels to knowledge exists, the question of how to design and distribute educational resources for a situation where the codes and a basic familiarity with digital media is not developed poses a new challenge. At the same time this increasing demand for digital learning resources and remote learning is not limited to developing countries. Also in the industrialized countries the need for targeted and customized educational tools grows and a growing number of institutions sees the need to provide information and educational content through digital channels such as the Internet and electronic publications.

J.A. Jacko (Ed.): Human-Computer Interaction, Part III, HCII 2009, LNCS 5612, pp. 440–445, 2009.

The motivations behind the efforts to develop affordable computer technology to extend the availability of knowledge and education to areas where large parts of the society are excluded from the access to appropriate learning facilities bears parallels with earlier historic projects of this kind. The English social reformer James Silk Buckingham published in 1849 his ideas for a reformation of the society towards a more healthy and stable life. As a complement to the transformation of the inner attitudes of people he suggested a number of exterior improvements, among them "ready access to Libraries, Lectures, Galleries of Art, Public Worship, with many objects of architectural beauty, fountains, statues" [1]. Buckingham was instrumental in introducing awareness for the role of culture into the agenda of British reform politics and promoted the establishment of municipal museums and libraries. The attempt for a general cultivation of people through "rational recreation" had the goal to make the society more disciplined, controllable, and efficient and to give people better access to education and future development. These motivations are not unlike those that are the driving force behind the ten Dollar computer in India, which is supposed to improve the skills of millions of students across the country and to build a more efficient and innovative layer of workers and future scientists. The same aim is behind the OLPC initiative, which has the goal to promote children to become an "educated and empowered resource" for countries whose "governments struggle to compete in a rapidly evolving, global information economy" [2].

While the example of English reform politics is situated around the time when the museum acquired its modern form as a public institution the idea did not originate in this time. The German philosopher and mathematician Gottfried Wilhelm Leibniz formulated in 1669/70 the plan for an academy of the sciences and art, the *theatrum naturae et artis*, a plan which he promoted several times to different political leaders in Russia, Austria, France, and Germany. The idea was a combination of archive, museum, theatre and forum, open to all people to come together and admire new inventions and participate in discussions and various kinds of entertainment. A particular role was attributed to the collection of tangible objects that conveyed the matters and results of sciences to the visual and tactile senses and thus provided a basis for the "reform of economy, education, and the arts and crafts" [3].

2 Virtual Objects of Knowledge

All these examples do not only share a very similar motivation, they also have in common that they favor the practical and manifest interaction with objects as a suitable learning approach for a wide range of people who do not share the same educational background. In the historic examples it may be rather obvious that collections of objects of scientific enquiry are chosen as the vehicle to bring these sciences, their procedures and results to a mass of largely uneducated people because this was the state of the art of the sciences at that time. The value of these tangible objects that speak to all senses is also confirmed by recent studies about the value of sensory stimulation for the development of the brain. "The brain uses the outside world to shape itself and to hone such crucial powers as vision, reasoning, and language. Not hard wiring but continual interaction with the external environments is now thought to produce even the most abstract kinds of cognition." [4]

This turn towards the object and its sensual stimulation was not only a form of enlightenment entertainment where "bewitching arrangements of colorful rough stuff […] piqued the curiosity of the public [4], it was part of a general turn towards objectivity as a way to decipher and understand nature and the structure of the world. In his *Critique of Pure Reason* (1781/1787) Immanuel Kant places the human capacity to be affected by objects as a necessary precondition for any valid statements about the world. With the distinction between subjective opinion and objectively valid conviction he offers a paradigm that has influenced most modern philosophical discussion of the objectivity of mind. Operating with the term *communicability* Kant justifies objectivity "on the grounds that if a judgment can be communicated to other rational beings, there is a solid (though not infallible) presumption that they are talking, and talking accurately, about the same object." [5]

How can this immediacy of the encounter with tangible objects that is the characteristic of collections and museums be translated into a digitally mediated context? It seems particularly valuable for the context outlined above, where education has to deal with significant cultural differences, to turn to this tangible immediacy to convey the desired information. Thus it is crucial to find an efficient translation of the real-world object encounter. Several studies have been conducted on the use of Virtual Reality environments for educational purposes favoring the potential for high interactivity and a high degree of realism. Virtual Reality environments provide the possibility for the learner to explore and manipulate three-dimensional spaces that are displayed on a computer. As Michitaka Hirose points out, the most important contribution of this technology is "to visualize various objects that are difficult to understand intuitively" [6]. This evaluation goes along with several other studies finding VR environments capable of making "what is abstract and intangible to become concrete and manipulable" [7].

In combination with smaller, portable and more affordable computer hardware the use of digital VR technology seems to be on the track to move away from the costly and cumbersome hardware that was formerly necessary to implement a convincing experience. Classically VR environments operated with expensive immersive display technologies that were only suitable for a lab environment and due to their focus on an individual-centered perspective inhibiting the communication and interaction with other people and the immediate environment. The aspect of less intrusive devices and more mobility allows to bring some of the social aspects back into the experience that make learning and knowledge exchange effective and pleasurable [8].

These recent developments and applications suggest that VR technology provides possibilities to implement aspects of the immediacy and communicative value that was attributed to the real-world object in the earlier examples. At the same time it becomes conceivable to use VR approaches also for distance learning projects and virtual classrooms in technologically less developed areas thanks to affordable hardware and solid technology.

3 Translation Artifacts

For our project about the Museum of Natural History in Berlin we decided to use a virtual space in which selected objects of the museum are represented. The viewer can explore this space according to the museum geography as well as according to an

alternative geography based on contextual connections. The implementation was done using a 3D game engine suitable for fast and robust development.

We found, though, that the particular quality of the rich and textured objects and the museum space itself were not conveyed in the virtual environment. The tangible reality effect of the encounter with real objects was impossible to achieve with a pure CG approach using computer-generated models of the objects and real-time rendering. The computer graphics are not in the position to transmit the pungent feeling that the object on display actually is a real animal, maybe a sample of a species that used to live on earth and that now is extinct. The particular power of realizations from this reality-encounter and its pedagogic values were not communicable in the VR environment.

Geoffrey C. Bowker points in his book *Memory Practices in the Sciences* to the inherent difference between the two devices, the museum collection and the computer-based collection, as two different memory regimes. We can either be "acting as archives commissioners or conjuring the world into a form that can be represented in a universal Turing machine whose past has been evacuated in order to render its future completely controllable. Integrally associated with each are two symbolic realms: memorializing difference and secular time through classification and hermeneutics, or memorializing sameness and circular time through abstraction and analysis" [9]. Bowker sharpens our understanding of how the encoding of information into a particular memory practice shapes the information that is being encoded and produces distortions and translation artifacts. We perceive the computer-generated images as the idealized result of an abstraction, as the result of a complicated but nevertheless formulaic description rather than as individual real objects of which only this one singular entity exists. Despite the qualities of the VR environment stated above this particular aspect of individuality and historicity of the presented objects was missing.

4 Mixed Reality Environment

In order to preserve the quality of object representations, which we considered very important for our application, the decision was to create a mixed reality environment using a combination of computer-generated space and photography. With a motion control camera we took a series of photographs from all perspectives of the objects in 10-degree steps and texture-mapped these images on planes in the virtual space. We are using a technique similar to Quicktime VR-objects. The effect of realness is enhanced by distributing photographically derived images posed throughout the virtual space in such a way that the images correspond to a particular point of view and line up with the architectural geometry of the virtual museum building. The posing data were gathered with the help of laser distance measuring and inclination measuring using accelerometers attached to the camera.

The use of photographic images allowed us to re-establish at least part of the rich and individual quality of the space and the objects. In holding with Roland Barthes' considerations of photography we use the aspect that a photograph makes "it possible to recover and print directly the luminous rays emitted by a variously lighted object. The photograph is literally an emanation of the referent" [10]. According to Barthes a photograph has the ability to conjure the presence of an object or person – or in our case of an animal – even when it is the image of a corpse: it is the living image of a dead thing.

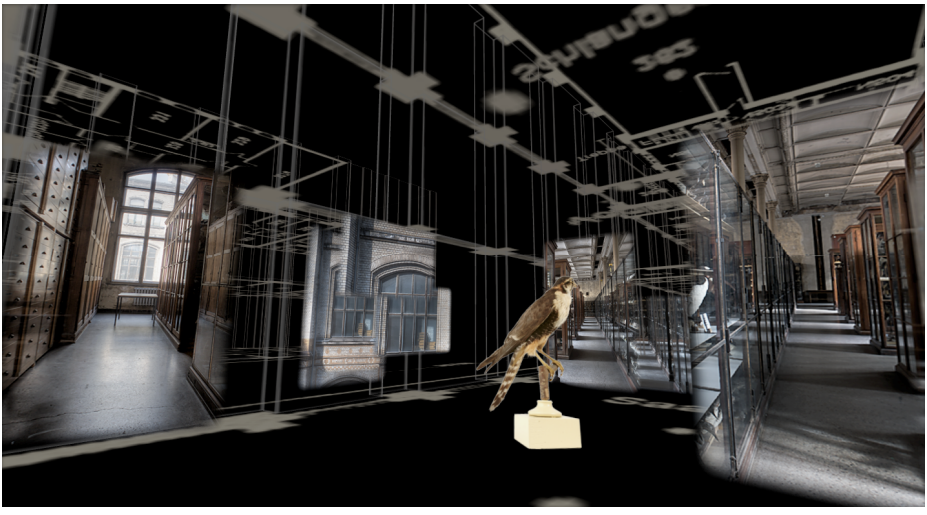

Fig. 1. Screenshot of the space and one object of the mixed reality environment of the *Venture to the Interior* project

The design approach we followed in our project does not aim for photorealism instead we are underlining the fact that each photograph is just one perspective from one particular point of view inside an abstract constructed space. By navigating through the museum space the viewer moves in and out of these vantage points and experiences an impression of a space reminiscent of cubist paintings that combine multiple perspectives into one picture. The same principle applies to the objects which can be seen from all sides as if they were three dimensional objects but it is still clear that each individual perspective is given by one flat image. Our motivation for this design is that we want to heighten the awareness for perspective dependency rather than creating a coherent illusory space and at the same time communicate the historicity and the immediacy of the objects.

5 Conclusion

The project *Venture to the Interior* allowed us to reflect the issues of representing real historic objects in a computer-based simulation environment. The particular setting of the project made it obvious to consider these issues between the two poles of the classic natural history museum as a collection of tangible objects and digital data-collections communicated through electronic networks. Of special interest was the possibility to translate the didactic values that the encounter with real-world objects provides for a learning experience into a digitally mediated environment. We found that a mixed reality approach provides particular advantages to integrate the high degree of interactivity and flexibility of a virtual environment with the reality reference of photographic media. This combination allows to create a learning experience that is engaging and has the advantages of the digital format and easy and widespread distribution through electronic networks while still communicating a feeling of

groundedness in reality. The aspect of immediacy and experiential directness provides great potential for the use in communicative situations spanning vastly different educational levels and cultural backgrounds. Further experiments based on this model have to be developed to further investigate this potential.

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