In Proceedings of New Heritage: Beyond Verisimilitude - Conference on Cultural Heritage and New Media, Hong Kong, pp. 265-283.

THE COMPONENTS OF ENGAGEMENT IN VIRTUAL HERITAGE ENVIRONMENTS

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Abstract. Virtual Reality (VR), as popularized through films and the media at large, has been greatly preceded by its reputation of spectacular promises. VR has had the ability to engender fascination far beyond its commercial prospects and practical limitations, even before it had the opportunity to undergo, as every new technology, a process of maturation. In reality, it is for a variety of practical limitations, including high cost, development complexity, high maintenance, and thus restricted ability to serve the needs of a commercially produced mass entertainment industry that VR has not taken off as the promised technological platform of work, education, and leisure in the beginning of the 21st century. Nevertheless, the development of virtual worlds has not subsided; on the contrary it is involving more and more the crossing of disciplinary boundaries, particularly in the case of heritage environments experienced by the broad public. In this paper we will examine the components that attract visitors to virtual cultural experiences and explore how these may affect the educational, scholarly or recreational goals set out by their designers.

1. Virtual Heritage: A Cross-fertilization of Disciplines

The intersection of Virtual Reality (VR) and cultural heritage, also coined as Virtual Heritage (VH), is an example of a "cross-fertilization" of disciplines. Virtual heritage involves a number of functions to facilitate the synthesis, conservation, reproduction, representation, digital reprocessing, and display

of cultural evidence with the use of advanced VR imaging technologies (Roussou 2002). The representation of landscapes, objects, or sites of the past and the overall process of visualization of archaeological data with the use of VR technology forms a sub-domain known as Virtual Archaeology (Barcelo 2000), while extended forms of VR which blend the virtual with the real, such as Mixed Reality (MR) and Augmented Reality (AR), have found ideal application areas in archaeology and heritage. These applications are frequently identified with the reconstruction of ancient sites in the form of 3D models.

Virtual heritage, as it forms into a distinctive domain, provides the opportunity to increase the impact of VR and expand it. Because the context within which virtual heritage is situated is inherently interdisciplinary and intercultural, while the content and material it works with can fulfill the requirements of a society of mass image consumption, in other words it can be colorful, impressive, spectacular, and deal with "great things" (Niccolucci 2002), virtual heritage productions may be ideal in responding to a need for a fashionable synergy between scientific enquiry, technology, art, and everyday life, and, consequently, influence more serious cultural demand (Niccolucci 2002). Indeed, VH productions are in a position to pave the way for a widespread acceptance of the technology and, provided they are designed carefully, serve as indisputable means to disseminate knowledge and raise public awareness.

Pioneering examples of virtual reality applications in heritage serve as a showcase for best practice when it comes to embedding technological advancement within a practical outcome. However, as public presentation and exhibition opportunities broaden and as the field attracts an even greater mixture of disciplines –from technologists, archaeologists and cultural heritage specialists to interaction designers, artists, psychologists, entertainment and marketing specialists- the challenges presented in the creation of virtual heritage productions coalesce in enabling a rich mixture of representation (to accurately visualize or visually "reconstruct" the data), experience (to present and enhance the virtual environment with elements that incorporate knowledge providing and spectacle), and interaction (to provide the ability to gain insights by actively engaging in and even modifying the experience). Most virtual heritage projects would ideally strive to include all three of these characteristics in their implementations, yet few examples exist where successful blending of the three is achieved.

The reasons for which VH productions have not yet exploited their promised potential can be many, both practical and conceptual. As far as archaeological research is concerned, even basic computer-based tools have not achieved the penetration one would expect. Even though archaeologists

have to cope with huge amounts of data, traditional pre-computer tools still play a major (if not exclusive) role in supporting inquiry and analysis (Niccolucci 1999). Furthermore, archaeologists and similar field scholars do not easily recognize the validity of sources other than the primary sources they work with (i.e. the artifacts or associated written texts recovered from the period they study) and regard technological innovations suspiciously, as exhibits of high cost and questionable content. In terms of presenting the results of their research, the dominant carrier of information is the written form –textual culture provides the cognitive infrastructure of the discipline of history, while visual information is subordinate to the "real" and "serious" information conveyed through written prose (Staley 2003).

In this sense, the visual representation of the past using digital means is accused of lacking accuracy, as a result of the abstractions and dramatic assumptions that a visual representation of multivariate information must adopt in order to adhere to the visual culture of our times. The design of a virtual "experience" further complicates matters due to the difficulty entailed in its production and the particularities of the medium, while the addition of immersive and interaction features can challenge the border that divides an educational experience of the past from an entertainment endeavor.

In this paper we will engage in an exploration of the dialogical relationship between representation, experience design, and interaction, which we consider to be the three main components of virtual heritage environments. We will draw examples from the research, education, and entertainment fields where such projects are developed and presented. At the same time, we hope to raise new fundamental questions, practical and conceptual, concerning the issues involved in using state-of-the-art interactive virtual environments for cultural heritage and archaeology, for learning, historic research, and recreation.

2. Representation

One of the most fascinating dimensions of virtual heritage is its preoccupation with representation; with the complications that the representation of historical sites and artifacts entails but also with the perspectives that it opens up to the study and dissemination of knowledge concerning the past. This preoccupation with representation is connected both to the historical evolution of the VR medium but also to the practice of representation, which is endemic to archaeology as a discipline. Since the goal of archaeology as a discipline is first to understand the past and then to preserve it by studying it and delivering this acquired knowledge to future generations (Sidiropoulos and Sideris 2002), the representation of the past

through visualization of its landscapes, sites, and artifacts forms an important vehicle for conveying information and meeting these objectives.

ACCURACY AND PHOTOREALISM

Representation in the case of a cultural artifact, site or event refers to the creation of visual matter (or language or a story) that truthfully corresponds to the real world object, site or situation. This precision is a quality that archaeologists and scholars strive to achieve in heritage representation and that the general public comes to expect from museums as cultural authorities. On the other hand, technologists dealing with the virtual representation of heritage content are, naturally, less concerned with accuracy of the content itself and more involved with the form of the visualized content. This causes diffusion in the distinction between accuracy of representation and photorealistic depiction -if it looks realistic it must be more accurate. As Naimark points out, the degree of perceived realness is usually correlated with
quality of content (Naimark 1990).

No other discipline relates realness, or sensory realness, or photorealism to representation more than the field of Computer Graphics (CG). Since its emergence as a distinct discipline, CG has concentrated on its representational power of making images that are indistinguishable from reality. As a natural extension to computer graphics, virtual reality has based its developmental existence on this premise of visually -and perceptually- immersing its viewers in an ultimate simulation of the real world where representation is so faithful that it can not be distinguished from reality. It is thus of no surprise that the area of virtual heritage, as an amalgam of archaeology and VR imaging technologies, has primarily focused on generating digital reconstructions of historical or archaeological artifacts and sites with enough fidelity to be truly accurate representations of their real-world counterparts.

Figure 1. Photorealistic rendering of heritage sites: here the virtual reconstruction of Place Garibaldi in Nice, France using modelling-from-images techniques. The CREATE project (http://www.cs.ucl.ac.uk/create).

Achieving this immersive ideal in the visual representation of sites is identified with a fixation with the perfection of simulated photorealism (Darley 2000). In virtual heritage representation, architectural walkthroughs and picture-perfect simulations of objects have defined a practice where photorealism is considered as perhaps the most important measure of a successful representation. As Gillings puts it, virtual archaeology is identified with the "relentless questing for the elusive grail of photorealism and ever more faithful simulation" (Gillings 2000). This is also evidenced by the rapid advancement of techniques with obvious applications in virtual heritage, such as 3D scanning (Callieri et al. 2004), the plethora of research

projects that attempt to capture real-world properties such as shading, lighting, textures, and reflections and apply these to synthetic worlds that represent the past, and the "reproduction" of spaces using real-world panoramic photographs[1] (Kenderdine 2004) or modeling-from-images techniques with spectacular photographic-quality results (see Figure 1).

A review of the history of old media such as film, and even older mechanical media, such as the panoramic and stereoscopic devices of the eighteenth century (Kenderdine 2004), indicates that the ideal of photorealistic representation is certainly not a new concept. One can even argue that photorealistic representation, as an ideal, is similar to the quest of early impressionists' who sought visual realism by extraordinary stylistic means. The impressionists observed nature closely, with a scientific interest in visual phenomena. It is not difficult to draw parallels with the field of computer graphics, which, as noted, has long been defined as a quest to achieve photorealism (Durand 2002) in the same way that the impressionists sought to impress reality on a canvas.

As the mastery and "language" of painting evolved, however, the representation of reality became "distorted" to communicate an inner vision. The post-impressionists sought to transform nature on canvas rather than imitate it. Similarly, as the tools and techniques in computer graphics evolve, the development of different imaging techniques that transform the impression and perception of reality evolves as well. An evolution from craftsmanship to the maturation of an artistic language has been taking place throughout the history of media and is now also leading to the liberation of the creative potential within three dimensional digital representations (Roussou and Drettakis 2003). Gwilt notes that digitally referenced images encompass a conflict between realistic representation, on the one hand, and artistic expression and abstraction on the other, concluding that perhaps the arrival of ubiquitous digital technologies and postmodern concepts have "released the need for digital image makers to reference the real" (Gwilt 2004).

Hence, as the field matures and the VR medium itself starts to develop a "language", more experimental and expressive explorations take place and alternatives to previous ideals are considered. There is a greater realization that, in many cases, what may interest users is not so much about achieving realistic representation as it is about abstracting away from reality and creating believable and convincing environments, regardless if the imagery emulates the physical properties of the real world or not. This relates to the

[1] Real Virtual - Representing Architectural Time and Space. (2005). Last accessed January 10, 2006, from http://www.mcah.columbia.edu/ha/

Wonderland, Ivan Sutherland's vision of the ultimate display, where the believability of the virtual world is not necessarily linked to perfect visual realism (Sutherland 1965). In computer graphics, the newly defined field of Non-Photorealistic Rendering (NPR) reflects this evolution to a different impression in the representation of space, where the idea is to convey a sense of an image as an "artistic impression" rather than a reflection of a future reality (Gooch and Gooch 2001). The choice between using photorealistic or non-photorealistic rendering may be just a matter of stylistic preference or, more importantly, it may reflect a decision that depends on the context. In specific contexts one does not wish to make a firm commitment, an artistic depiction may be appropriate; in other cases, the need for realism may be more appropriate (Roussou and Drettakis 2003).

THE PARADOX OF AUTHENTICITY

Accuracy or the exact conformity to truth, in the representation of heritage information is in many ways related to authenticity, the quality of being genuine, of established authority, or not corrupted from the original. In cultural heritage simulations both these attributes have been considered important, meaning that the simulations must reflect as truly as possible the familiar-to-the-user object or surrounding environment (Roussou 2002). Situating the user in an authentic environment presupposes the creation of a high-quality simulation that is as close to the real-world context as possible.

Paradoxically, the virtual rather than simply being a mimetic mirror of reality, redefines it. Walter Benjamin, one of the first to argue that technology has raised issues of authenticity, noted that reproduction is no longer just imitation or a mere translation of data into images or worlds that mimic reality but goes beyond it. According to Benjamin, the presence of the original is the prerequisite to the concept of authenticity (Benjamin 1978). The reproduction refers the viewer to the original; thanks to its virtual replicas, the aura of the authentic is amplified, while the fake may appear more authentic. The original becomes more familiar and so our emotions and ideas in relation to it our strengthened or weakened as we share them with the world (Bonami 2005). Moreover, if we accept that history is a subjective construct, then which (whose) authenticity should we choose to recreate? In this sense it is not the authentic, but the authentication that needs to be interrogated (Diller and Scofidio, in (Bonami 2005)) and the concept of authenticity in synthetic environments is questioned altogether.

SUBJECTIVENESS AND MULTIPLE INTERPRETATIONS

Archaeology is a discipline based on interpretation and hypotheses. Archaeologists work with more than one possible interpretation of the same set of data and construct theories around the data that they can collect and synthesize. According to Huizinga, historical knowledge is essentially aesthetic, intuitive, and subjective (Huizinga 1971). Virtual archaeology involves recreating a concrete or an abstract entity, captures its quantitative and qualitative parameters, allows the study of its structure and behaviour, incorporates the higher degree of interpretation, and still leaves space for a subjective way of "seeing" it (Sidiropoulos and Sideris 2002).

Due to this subjectivity, the purpose for which a virtual heritage reconstruction is made is important and a distinction must be made between VR worlds intended for use by archaeologists and environments created as a means to bring the past alive and educate about it. A single model may not be sufficient to serve both the needs of scholars and non-experts (Levy 2001). Virtual environments developed for research purposes can help illustrate, detect, and resolve archaeological controversies, in other words to assist the process of interpretation of a site or case by specialists (Frischer et al. 2000). In such a case, the final digital environment contains virtually no assumptions, or it forms the final stage of a process where several varying assumptions have been subsequently tried and failed (Sidiropoulos and Sideris 2002). On the other hand, heritage simulations made to facilitate visualisation of the past for educational purposes incorporate the interpretations made by the specialists in order to provide the general public with a consistent and comprehensible virtual representation (Sidiropoulos and Sideris 2002). We believe that purpose must remain the primary criterion that guides the development of a virtual heritage environment and that it is not possible to make the past available to wide audiences in an understandable form while, at the same time, visualize accurately the multitude of information required by experts for the study of a complex situation.

3. Constructing experience: storytelling, multimodality, human presence

As themed exhibitions proliferate and cultural institutions become more involved with immersive and interactive technologies, their conception of creating "experiences" is greeted with less suspicion by their communities and welcomed by their visitors. Nevertheless, museums still rely on the aura of their collections to create experience, letting visitors conjure their own meaning via their exploration of exhibition spaces. On a parallel level, the

most common mode for VR experiences in one of architectural or world exploration (Hertz 2005) where visually stimulating representation dominates. However, as the practitioners of theme-based entertainment have shown, designing experience is more about creating a psychological space. In this respect, the field of entertainment, with its spectacular success in creating the kind of narrative-based multisensorial experiences that fire audience's imaginations, can inform the designers of digital heritage experiences.

INTEREST, EMPATHY, AND IMAGINATION VIA STORYTELLING

Schell defines a successful entertainment experience as such when the right combination of a visitor's levels of interest (the desire and will which enables us to focus attention), empathy (the ability to put one's self in the place of another), and imagination (the ability to fantasize alternate realities), is triggered and maintained throughout the experience (Schell 2003). Storytelling is undoubtedly the best vehicle to trigger these abilities in the visitor experiencing a virtual environment of cultural content.

Cultural institutions create narrative experiences through the collection, informed selection, and meaningful display of artefacts, and the use of explanatory visual and narrative motifs in their exhibits and in the spaces between exhibits. Whereas in the entertainment world the lines between fact and fiction become irrelevant, in the cultural heritage domain the stories expected and inferred through the exhibits form part of an interpretative process that provides cohesion for the exhibited content. This interpretative process is at the core of the cultural institution's credibility as the ultimate keeper of knowledge, a crucial context that museums wish to preserve while providing memorable experiences that can, ideally, suspend disbelief.

Suspending disbelief is one of the key aspects of narrative engagement and perhaps the most central goal of an immersive virtual environment. Recent virtual archaeology productions, such as "Mummy: The Inside Story" by the British Museum, have adopted many of the tricks used by the theme park industry to engage the audience into the cultural narrative. In this particular example, the central story of Nesperennub, the mummy of an Egyptian priest that was never unwrapped, began to unfold in the form of a pre-show before visitors entered the main virtual reality experience (Figure 2).

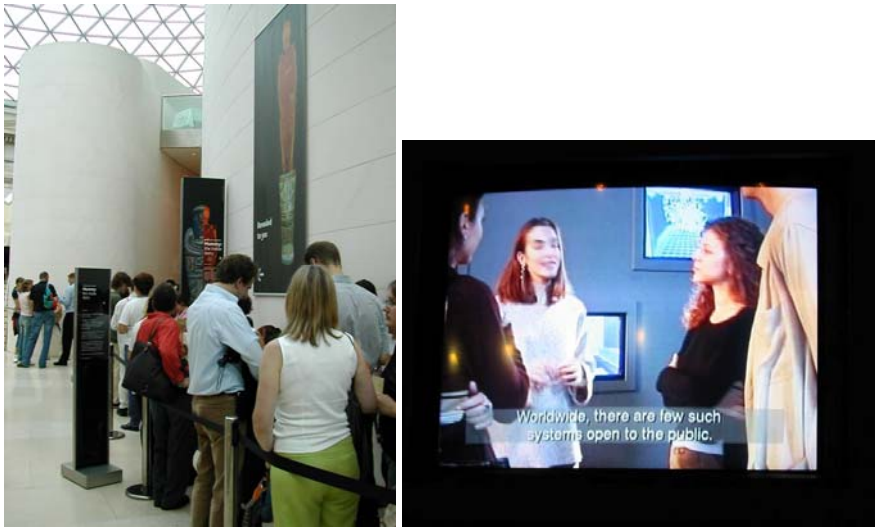

Figure 2. Preparing the visitor for the experience is an integral part of the "story": (left) visitors queuing to enter the pre-show at the British Museum's "Mummy: The Inside Story" exhibition; (right) the visitor information video at the entrance of the Foundation of the Hellenic World's VR exhibits informs visitors while, at the same time, raising expectations.

CHARACTERS AND THE PRESENCE OF LIFE

An important element in the unfolding of every narrative and the enhancement of a virtual experience is the development of characters, preferably in a human or other life-like form. However, at the same time, visualizing characters that are of aesthetical quality, historical accuracy, and conceptually soundness is one of the most difficult topics for archaeologists and designers alike. Thus it is not surprising that the majority of virtual heritage projects only deal with the reconstruction of the architecture, resulting, in the words of Margaret Morse, in a kind of "Nature Morte" (Morse 1996)[2].

On the contrary, Hollywood film reconstructions of ancient cities are usually there to support the characters, thus de-emphasizing the reconstruction. Similarly, interactive entertainment has explored representing the visitor as a character in the experience (Hercules or Aladdin at DisneyQuest), thus emphasizing the issue of personalisation.

[2] Morse uses this term to refer to the ambiguous relationship between the virtual and the real.

Virtual environments, on the other hand, have been limited in the ways characters are depicted, and usually follow an anthropomorphic model. However, many research efforts exist “to build synthetic characters that are not only believable but also as remarkable and unforgettable, as humans are”[3].

TRIGGERING MULTIPLE SENSES

Peter Greenaway’s idea of an "expanded metacinema", whilst referring to cinema, transfers well to the ideal of the virtual experience designers should be striving for. Greenaway suggests to integrate all manner of sophisticated cultural languages into a three-dimensional form with "stimulus for all five senses where the viewer is not passively seated, can create his or her own time-frame of attention and can (as good as) touch the objects he is viewing and certainly have a more physical / virtual relationship with them" (Pascoe 1997).

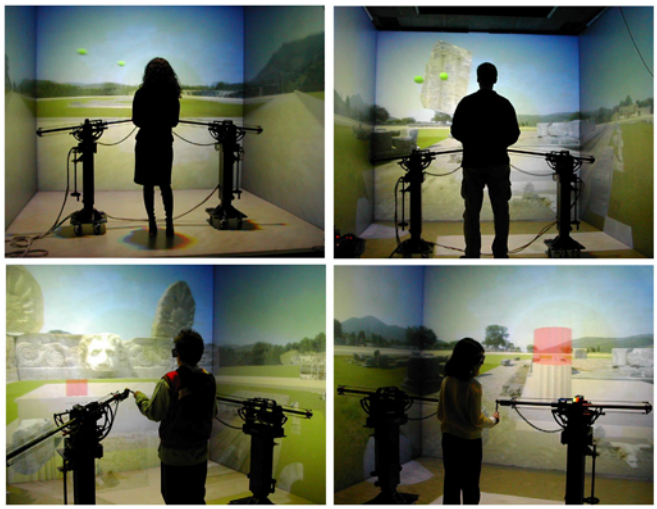

Figure 3. Museum visitors use a haptic interface, built by PERCRO, to reconstruct, piece-by-piece, a section of the Doric temple of Ancient Messene in Greece as part of the CREATE project (http://www.cs.ucl.ac.uk/create).

Visitors to today's virtual heritage environments may not expect the productions to have reached the level of sensorial richness illustrated by Greenaway's vision or Heilig’s Sensorama (Heilig 1992), but when it comes

[3] Vision statement of http://gaips.inesc.pt/gaips/en/vis.html

to experience it is not only what appeals to the eyes but also to all other senses. McLuhan many years ago predicted that we are moving out of the age of the visual into the age of the aural and tactile (McLuhan 1964).

Preliminary studies with 15 adult and children museum visitors that used a high-end haptic interface for reconstructing an ancient temple indicated that the sense of touch, despite the rather intrusive robotic gear required to acquire it in the virtual environment, added a tangible element to their experience and was perceived to enhance their understanding of the material attributes, weight, and volume of the architectural members (see Figure 3). Further research is required to study precisely how the lack or existence of tangibility affects our relation to virtual space and whether the virtual replica can substitute the real thing in all aspects of its physicality.

4. Interaction: First-person Control or Guided Tour?

Interactivity has emerged as a catch-all term, ascribed to digital media as its most defining component. So far, interactivity in VH environments has been identified with spatial navigation, the dominant form of experience being the guided tour. The passive aspect of watching a screen is replaced by a less passive act of traveling into a world in the same way as a camera pans through the space of a film set. Tzortzaki argues that this genre of experiencing a virtual world creates a space of kinesthetic illusion, which is both visual-spatial (the tradition of reconstruction) and textual-spatial (the guided tour), as facilitated by a human or surrogate tour guide (Tzortzaki 2001).

The seduction of navigating through the virtual space has been strong enough to maintain this model of interaction (Carlsson 1995). Furthermore, the difficulty, both on a technical and a conceptual design level, of incorporating other forms of interaction has prevented designers from exploring more exciting and innovative models of communication with the virtual world. Interactivity is largely restricted and difficult to apply in a public space, especially when the practical difficulties of visitor throughput and other complications must be overcome or when more than one users must share the same screen (Robinett 1994).

Figure 4. A robot character called “Spike” guides children through the construction of a virtual playground by enacting a pre-recorded sequence of actions. The Virtual Playground project (http://www.cs.ucl.ac.uk/staff/M.Roussou/research/).

If true interactivity is what takes place in the human brain which carries the unique ability of finding a nearly infinite range of responses to any situation, as well as the ability to imagine completely new, unanticipated possibilities, then applying this to any digital environment seems next to impossible and is certainly dependant on the achievements of artificial intelligence. In other words, meaningful interactivity implies something more than the binary state of a light switch; it involves having multiple opportunities to decide upon in a continuous seduction of choices; it also resides in the user's ability to change the environment (Ryan 2001). The difficulty of incorporating interactivity in VR productions explains why in the most successful examples of highly interactive virtual environments targeted to the public, the creators have engaged in a sophisticated engineering of the illusion of interaction (Roussou 2004). The choices that the user makes and the attempts to modify the world or cause a response are directed by a set of predefined options that are predetermined by the creator. In the location-based entertainment world, examples that demonstrate mastery of what Schell refers to as “indirect control” (Schell 2003) include the DisneyQuest virtual reality attractions of Aladdin and Hercules, and the more recent adventure of the Pirates of the Caribbean (Schell and Shochet 2001). In all these cases, visitors assume the roles of central characters in the story and, for the duration of their experience, believe they control the progress of the story, which is rapidly building to a climax, when in fact every aspect of the experience has been carefully and intelligently planned in advance.

Interactivity is not only promoted widely in entertainment venues in order to attract and motivate visitors but also in the informal education world, where an exhibition or learning environment is considered more effective if it is interactive. An ongoing study with children in a

constructivist interactive virtual environment, examining the effect of interactivity on conceptual learning, has so far provided an unexpected result, which may well be considered in the design of VH environments: the guided experimental condition, where a virtual agent performed all actions in constructing a playground in VR, showed to be more effective in encouraging deeper reflection of the underlying conceptual learning problems than the interactive experimental condition, where children perform the activity themselves, having full decisional and kinesthetic control over the environment (Figure 4). In this case, it is believed that Kolb's experiential learning cycle[4] is in effect what is triggered when the learner or museum visitor observes rather than directly participates in an interactive experience, indicating that the combination of contructivist techniques and guided exploration may be the recipe for an effective virtual experience (Roussou and Slater 2005).

HUMAN MEDIATION OR AGENCY

As VR technologies become available to the public in an increasing number of informal education venues and attractions worldwide, interaction designers struggle with the problems of providing meaningful interactive experiences. Very few, if any, reasonable solutions have been found. Adding a human guide is a solution that some museums and attractions have chosen to circumvent an, up to now, difficult issue. In the few places where immersive projection-based VR installations and productions are experienced by the general public on a daily basis, namely the Ars Electronica Center in Austria and the Foundation of the Hellenic World in Greece, a human guide (called info-trainer in the first case and museum educator in the latter) is employed to act as mediator for every visitor group (Alexaki 2006). However, in cases where the installations are of a larger scale, the use of a human acting as a tour guide, especially with passive walkthroughs, does not guarantee interaction between the audience and the given content. In fact there is rarely any meaningful interaction between the audience and the "presenter" in the case of a VR theater show, apart from the audience responding to questions prompted by the human actor.

Virtual tour guides, on the other hand, despite adding novelty and a sense of playfulness to the presentation, have a limited capacity for interactivity.

[4] Kolb argues that learning by experience is essentially a cycle that begins with concrete experience, goes on to observation and reflection, then to abstract conceptualization and finally to active experimentation in new situations (Kolb, David A. 1984. *Experiential Learning: Experience as the Source of Learning and Development.* Englewood Cliffs, N.J.: Prentice-Hall, Inc.)

Programming them requires extensive knowledge on the part of the programmer in order to make them do anything much more sophisticated than choice-driven interaction.

5. Conclusion

Despite their complexity, virtual heritage environments are inherently fascinating and possess essential properties to have a positive effect on supporting research and educating the broad public. Heritage institutions such as museums and cultural centres are in a better position to lead the design of the necessary VR productions, ensure the appropriate implementation that will meet their needs, make use of the advanced systems required for VH simulations, define their potential benefit, and evaluate the effects for different audiences. Best practice for advancing the field, we believe, lies in the convergence of presentation (and representation), experience design, and interaction, particularly if we, as practitioners and scholars, are willing to dispose of our old ideas and challenge our preconceptions concerning the use of these elements in our productions.

Specifically, in the case of representation, the answer to the question of whether we must create accurate and authentically situated representations or subjective yet convincing environments depends on our target audience and purpose. The challenge for designers of virtual heritage simulations lies in the way the relationship between realism of form and quality of content is handled; i.e., if photorealism is deployed or if an alternative visual language is discovered to convey a world of the past, facilitate researchers to preserve information and test different hypotheses, and enrich a wider audience's understanding and appreciation.

In the case of experience design, experience can "become a formula", where characters and life forms tie into story structures that trigger more than just our visual sense, to produce chemistry that successfully fires the visitor's imagination. The best virtual heritage worlds, similarly to the best museums, must "seek to promote different modes and levels of 'interpretation' by subtle juxtapositions of 'experience'" (Serota 1996). Additionally, the underlying principles of human-virtual system interaction design practiced and applied by the entertainment industry can also serve as models in the design of interactive virtual heritage experiences. Nevertheless, the medium has its own "language" and we should be exploiting its own expressive powers rather than merely depending on the language that has been shaped by earlier media (Murray 1997).

In the case of interaction, a key challenge is to incorporate interactivity that is meaningful, whether we are dealing with individuals or groups. In

both cases, it is upon the institution to decide if a human (educator, guide, content expert) will assume a mediating role between visitor and virtual environment or if other, possibly less costly, more practical or more novel digital surrogates suffice to add value to the experience. In any case, if novel interfaces are deployed, these must be naturally incorporated, transparent, flexible, and responsive to the needs of contemporary visitors.

Acknowledgements

The author wishes to thank all colleagues, past and present, that have contributed their creative talent and technological expertise to the development of virtual heritage environments mentioned as examples throughout this paper.

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