Title: *Defining Cultural Agents for Virtual Heritage Environments*

For: Presence: Teleoperators and Virtual Environments-Special Issue on "Immersive and Living Virtual Heritage: Agents and Enhanced Environments"

Name: Erik Champion

Institute: Curtin University

Address:

School of Media Culture and Creative Arts

Faculty of Humanities, Curtin University

GPO Box U1987 Perth, Western Australia 6845

AUSTRALIA

Email: erik.champion@curtin.edu.au

Keywords: Cultural agents, virtual heritage, computational archaeology, visualization, virtual environments, immersion.

Abstract

This article describes the primary ways in which intelligent agents have been employed in virtual heritage projects and explains how the special requirements of virtual heritage environments necessitate the development of cultural agents. How do we distinguish between social agents and cultural agents? Can cultural agents meet these specific heritage objectives?

Introduction

As the call to papers for this special issue has noted, "Most heritage applications lacked a sense of immersion in terms of 'livingness', life, behaviour and intelligent agents in the virtual environments, and there has not been any progression in such developments since a decade ago. This criticism of "lifeless" and "sterile" digital environments (and virtual heritage environments in particular) is shared by various scholars (Papagiannakis et al., 2002; Roussou, 2008) but a simple directive to 'populate' a virtual environment with intelligent agents masquerading as walk-on characters will not necessarily communicate cultural significance (Bogdanovych, Rodriguez, Simoff, & Cohen, 2009). And communicating cultural significance is an objective of virtual heritage environments even if it is not a requirement of all virtual environments.

Virtual Heritage Agents

Despite criticism of virtual heritage projects as being sterile and lifeless there are various examples of projects that feature intelligent agents. Perhaps the most common examples are of guides (M. Y. Lim, Aylett, & Jones, 2005; Roussou, 2001) and route-planners (Costantini, Mostarda, Tocchio, & Tsintza, 2008; Papagiannakis & Magnenat-Thalmann, 2007; Song, Elias, Martinovic, Mueller-Wittig, & Chan, 2004). In many other projects intelligent agents are employed to create a sense of inhabitation and enact crowd simulations (Bogdanovych et al., 2009; C.-K. Lim, Cani, Galvane, Pettre, & Zawawi, 2013; Sequeira, Morgado, & Pires, 2014; Sequeira & Morgado, 2013).

There are more sophisticated examples as well, such as Belief-Desire-Intention agents that perform social roles, as in the 'City of Uruk' project (Bogdanovych, Ijaz, & Simoff,

2012). There are story-telling agents (Ibanez, Aylett, & Ruiz-Rodarte, 2003) and virtual augmented characters who re-enact dramatic events (Papagiannakis & Magnenat-Thalmann, 2007). In other examples agents are employed to create a sense of inhabitation and enact crowd simulations (Bogdanovych et al., 2009; C.-K. Lim et al., 2013; Sequeira et al., 2014; Sequeira & Morgado, 2013). In a few examples, such as the 'Roma Nova' project, agents are employed to improve learning about historical simulations (Vourvopoulos, Liarokapis, & Petridis, 2012).

One major distinction between virtual heritage environments and computer games is that the latter typically place more emphasis on challenge and competition than on expressive intelligent agents. There are sophisticated commercial games where agents as NPCs (Non Playing Characters) are used, but these are still few in number. For example, in the commercial game *Elder Scrolls V: Skyrim* (Champion, 2015a), NPCs can complete requests from players, such as carry or find specific objects, and provide limited social feedback of the player's action back to the player.

In most virtual heritage projects intelligent agents are primarily used as guides (Bogdanovych et al., 2009), they lead players to important landmarks, or they are historical guides, (perhaps even reveal past events and situationally appropriate behaviour). This is particularly important for larger environments or where navigation (orientating and wayfinding) is difficult, as intelligent agents can provide a sense of scale and inhabitation. However, these intelligent agents are usually designed for limited forms of conversation and typically help convey social presence rather than cultural presence (the distinction between the two will be made later in the article). While these agents may appear to convey a sense of culture, they typically convey social presence, they are not conveying the significance of the cultural heritage that the virtual environment was designed to convey.

Defining Culture

Culture is a widely used yet vaguely defined term (Bogdanovych, Rodriguez-Aguilar, Simoff, & Cohen, 2010). Fischer (2006, p. 259) wrote "Culture transcends material and behavioural contexts. Cultural solutions are instantiated in material and behavioural terms,

but are based in large part on 'invented' symbolic constructions of the interaction space and its elements." For Fischer, culture is a dynamic system of representations that multi-agent modelling can simulate. He defined culture as "the system of activities and resources that support human social organisation," but he did not detail the social organisation of multi-agents, nor did he elaborate on how they would hold or convey values, beliefs and attachments to material objects and intangible heritage.

While his article focused on extracting a notion of culture as systems of representation that can be algorithmically simulated, it did not address the role of the material in cultural heritage as being inextricably integrated with cultural heritage itself. Yet for philosophers such as Malpas, "…the artwork is not reducible just to the materiality 'stuff' of which it is made and yet the artwork is what it is through its concrete spatio-temporal existence" (Malpas, 2008, p. 16). Here lies a schism between those focused on the development of intelligent agents (such as Fischer) and those focused on how to explain and transmit the cultural significance of heritage sites, values and objects (such as Malpas).

As well as Malpas, other scholars place more emphasis on culture as the manifestation of values and beliefs over time. For Crang (Crang, 1998, p. 103): "Spaces become places as they become 'time-thickened'" Here culture is viewed as more a framework that places the worth of cultural objects and behaviours in a landscape. This is more clearly seen in UNESCO's (UNESCO, 2015a) definition of cultural landscapes, land use "associated in the minds of the communities with powerful beliefs and artistic and traditional customs."

However, cultural heritage is not merely sites, buildings, monuments or landscapes. UNESCO (UNESCO, 2015b) defines intangible heritage as "practices, representations, expressions, knowledge, skills – as well as the instruments, objects, artefacts and cultural spaces associated therewith – that communities, groups and, in some cases, individuals recognize as part of their cultural heritage … [is] transmitted from generation to generation, is constantly recreated by communities and groups in response to their environment, their interaction with nature and their history, and provides them with a sense of identity and continuity." So heritage sites are a complex amalgam of both tangible and intangible content.

Cumulative Culture

An important distinction between culture and society is the cumulative nature of human culture, which separates us from animals (Vale, Flynn, & Kendal, 2012). According to biologists (Claidière, Smith, Kirby, & Fagot, 2014, p. 1) "A wide range of other animals have culture too, but often in a limited form that does not complexify through the gradual accumulation of innovations." So humans *accumulate* culture, they modify cultural knowledge (culture managed by infrastructure or institution) using past knowledge from previous generations. Culture is also an assortment of objects and rituals that frame and express a communally shared idealized future. In these dual functions culture extends beyond society: a social environment can exist where shared understandings are never preserved beyond the life-experiences of the group. Yet the cultural heritage of a real-world society outlives specific individuals. For example, in archaeology we can draw interpretations about past societies in terms of their cultural heritage.

This does not mean that developing a social virtual environment is *necessarily* the same as developing a cultural virtual environment. Imagine meeting people in an airport lounge and socializing with them, one is not likely to be partaking in a shared culture as the social exchanges will not become part of a cultural framework. Likewise, meeting people in a social online world does not require that the social online world is a cultural online world.

While virtual heritage is typically orientated towards UNESCO and ICOMOS definitions and criteria (Addison, 2001, 2008), many papers discussing social agents or cultural agents still conflate culture and society, or culture and art. For example Penny's paper (1997) mentioned "culture" or "culturally" nine times (including in the title "Embodied Cultural Agents: at the intersection of Robotics, Cognitive Science and Interactive Art"). While the cultural was often mentioned in tandem with society ("Petit Mal seeks to raise as issues the social and cultural implications of 'Artificial Life'"), the paper neither defined them nor distinguished between them. Similarly, in presence research articles, culture is also often placed alongside society, or the terms are used interchangeably, but without clear

distinctions or definitions (G. Riva, Castelnuovo, Gaggioli, & Mantovani, 2002; Giuseppe Riva & Mantovani, 2000).

Cultural Presence

Leaving aside the question of whether evaluating virtual reality environments can or will eventually lead to universal presence criteria, the immediate and pressing requirement for virtual heritage projects is to communicate the importance of the heritage content. So I propose that a major object of virtual heritage environments is to convey the unique significance of the simulated culture, which requires an attempt to understand how the original site was experienced and understood by its original inhabitants.

I have previously defined (Champion, 2011, p. 179) cultural presence as "the feeling of being in the presence of a similar or distinctly different cultural belief system." Various digital heritage infrastructures have adopted this or similar definitions (Universitat Pompeu Fabra Barcelona, Undated; v-must: Virtual Museum Transnational Network, 2011). Unfortunately, providing for this experience is no easy exercise (Rizzo & Mignosa, 2013). Recognising semblances of culture independently of living people is possible, because that is what cultural heritage specialists attempt to uncover (Jacobson & Holden, 2007) though theanalysis of signs of inhabitation (Champion, 2011, p. 49), but that does not mean the culture is still extant, only that it can be interpreted via place.

Specific Issues In Modeling Culture

How do we model culture if we are unsure what it is? Real-world culture is often learnt via observation, ritual practice (which take time) or by instruction (Csibra & Gergely, 2009). Agents might appear to provide for learning by observing their actions or being guided by their instruction, but they lack granularity of expression, individuality or rich and expressive responses. Rituals are especially hard to simulate, in virtual environments there is no social judgement that will teach people right from wrong and ensure they keep to cultural protocols when visiting and interacting with these virtual environments (Champion, 2009).

Interactive freedom can compete with scientific authority. Virtual heritage projects typically require the portrayal of and interaction with layers of certainty and authenticity

(Bentkowska-Kafel, Denard, & Baker, 2012; Roussou & Drettakis, 2003) as well as conveying those layers and levels of detail. Although they may feature relatively permanent cultural monuments and landscapes, virtual heritage environments usually attempt to capture changing knowledge (Boado, 2001), from incomplete and often conflicting sources (Affleck & Kvan, 2005; Boado, 2001) with changing technology that cater to different and highly fluid audiences (Schweibenz, 1998). Thanks to the advent of expensive computer-generated movies, the public may expect pre-rendered film quality with real-time interaction so they may be disturbed by gaps in simulated environments left by gaps on historical knowledge (Mosaker, 2001). For the above reasons, virtual heritage environments pose difficult evaluation issues (Economou & Pujol, 2008).

Requirements For Virtual Heritage Content

Our challenge is to develop agents that can pass on information about a past or distant culture without disrupting historic authenticity or player engagement. Our aim should then to be to develop an evaluable proof of concept leading to realized projects that incorporate and integrate historical situations. Technology could be cutting-edge (face tracking, speech to text engines, biofeedback, or game-themed situations), but it should be supporting the simulated content, rather than the content being there to support the investigation of technology.

Contrary to calls for highly sophisticated interactive narrative agents proposed by leading AI experts (Bringsjord, 2001), we do not have to create highly refined narratives as these projects are not totally fictional. Virtual heritage projects don't necessarily have to include 'great art' or highly dramatic Shakespeare-level experiences, a more pressing problem is how to incorporate what is known, with the mechanics required to provide both a sense of agency and thematic meaning (Paolini & Di Blas, 2014; Pujol et al., 2012). Due to their typical classroom or museum settings, participant time may be severely limited so intricate narratives may be counterproductive (Davey, 2005; Kubota & Olstad, 1991; Ma, Liao, Ma, & Frazier, 2012; Serrell, 1997).

There is however another element that can greatly improve both engagement and learning in a virtual heritage environment. We know that multimodality can help provide

multiple narratives and different types of evidence (Paggio & Jongejan, 2005). We can also design narrative fragments that are threaded and buried through an environment, coaxing people to explore, reflect and integrate their personal exploration with what they have uncovered. Clues can be provided to uncover stories or stories can in turn be the clues to help people find certain objects or complete tasks. Story aids are not thus just aids or rewards for exploration. They can also help convey the fragility of specific sites, their situated cultural significance and the underlying universality of their content.

Secondly, plot-driven characters (with limited agency) that set the scene might prove useful, for completely emergent narrative is not always required and is sometimes an obstacle to the aims of virtual heritage (Ioannidis et al., 2013). Characters can do more than simply advance a plot; they can also convey a specific theme to an audience. Social roles specify historical significance and local situated challenges; they provide motivation to explore and understand the simulated environment (Paolini & Di Blas, 2014).

Thirdly, conversational agents can provide site-specific or activity-specific information more conveniently than through game-interaction and may help lessen the risk players will leave the virtual environment to read background material. Human-like agents can provide a sense of inhabitation and human scale; they attract attention and are easy to mimic. They can help draw attention to important events or landmarks, direct or reveal mannerisms and social behaviours, can highlight specific places spots and times, are useful affordances for competition or can act as external memory devices and tools for players. They are typically used in games to create competition, but they can also be employed to evoke empathy, to develop leadership skills (by following and commenting on the decisions of the player) or deployed as aids to help the player.

A particular type of agent is of special interest here, for conveying situated cultural behaviours and values, conveying cultural change, or transmitting elements that create cultural change. There may be an important distinction to be made here between AI's notion of intelligent agents and this particular type of agent. Agents for virtual heritage environments are thus not necessarily logical or even reasonable, (by our standards, they

might not even understand us. So the specialised aims of various strands of AI research may be less important and relevant here: the central concern is to convey the cultural significance of the simulated heritage site, object or event.

Cultural Agents

I suggest that where simulated heritage sites require a sense of inhabited place, engaging narrative-related elements, or embodiment, the field of virtual heritage should develop and test the following concept of cultural agents, who help provide a sense of cultural presence. A cultural agent recognises, adds to or transmits physically embedded and embodied aspects of culture. Either the cultural agents interpret cultural cues, or interaction with them by the human visitor/player leads to a situated interpretation of cultural cues and wider cultural frameworks. These cues could be contested or contradictory or even fragmented, but they are required to convey a situated understanding of resources, monuments, environmental events and behaviours in a way that both engages and educates participants.

Cultural agents are not merely conversational agents for they should be able to:

1. Automatically select correct cultural behaviours given specific events or situations.
2. Recognise in/correct cultural behaviours given specific events, locations or situations.
3. Transmit cultural knowledge.
4. Modify, create, or command artefacts that become cultural knowledge.

To fulfil the above features as criteria, cultural agents are culturally constrained. They are not just socially constrained; they are space and time or role-dependent. They can understand and point out right from wrong in terms of culturally specific behaviour and they understand the history and possibly also the future trajectory of specific cultural movements. We could distinguish at least three types of cultural agents:

1. Constrained in terms of cultural beliefs, cultural demarcation (time, space, events).
2. Apparently aware of the transgenerational value of material objects and intangible heritage.

3. Apparently aware of the transgenerational value of culture but also actively attempting to preserve or understand and appreciate it.

Example Design Scenarios

These design scenarios are to demonstrate how intelligent agents could be employed to convey cultural significance. Cultural agents could be deployed to help human visitors recognize and identify, transmit and modify or create cultural objects, events and behaviours.

The first design scenario involves observation and extrapolation: identifying historical agents or socially situated agents (Champion, 2015a, 2015b). Imagine a masked ball, where all the agents are in disguise. They all play characters, but some are actually authors in disguise and their books are located throughout the building. The style of dialogue of each agent could relate to the style of the books or inscriptions nearby. The human players may be required to identify cultural styles, or individual authors in order to advance through the environment. Is this social rather than cultural? It can be cultural, if the situation requires the human player to understand the importance that particular occasions, settings and artefacts, trigger particular agent behaviour.

The second scenario involves both observing and imitating culturally constrained agents, something I have called a reverse Turing test, but the idea is not new (Champion, 2011). I mention it here as it has specific significance for agent design in virtual heritage, even though it would require elaborate spatial awareness, hero expressivity and possibly natural language processing. The aim is to convey cultural knowledge through an impostor-style game where the player has to adopt, steal or change (via a spell) their appearance and attempt to infiltrate a local community through effectively imitating certain professions, races or individuals. The player must disguise himself or herself as an NPC or take over an NPC's role in society and see how long they last before being discovered. Unfortunately, most contemporary games and virtual environments do not clearly and consistently distinguish between NPCs in terms of race, locality, profession or voice and it would require more spatial awareness to allow for a rich role-playing experience.

One may also ask if the agents are actually only social agents, but situations could be 'staged' in such a way that their behaviours and detection techniques are triggered, affected and modified by culturally specific events and settings. A similar scenario is played out in the Spyparty game (http://www.spyparty.com). Unfortunately that game is still in beta, playable but not yet complete.

A third scenario suggested here is providing cultural learning by directing or otherwise persuading cultural agents to perform certain actions that affect and modify historical events. Cultural artefacts could also be collected and used to train agents. By opening in-world books to specific pages, certain events or other forms of knowledge could be communicated to the NPCs. Some existing moddable games (such as *Elder Scrolls V: Skyrim*) have more NPC options, including the ability to collect followers. One great benefit of incorporating training of NPCs by players is that an external person can judge how effectively a player has learnt the content by how accurately they convey information in the training of NPCs (learning by teaching).

Agents could be persuaded according to the correct timing and information provided by the human player. Like the second scenario this puts more responsibility on the human player to observe, experiment and act according to local customs and beliefs. For a very complicated simulation, perhaps the detection of appropriate, correct or logically reasonable decisions in history require human experts, or perhaps agents can incorporate some form of distributed historical consciousness that allows them to predict the historical likelihood or cultural authenticity of human player decisions.

In all these three scenarios, the human player becomes an active participant, a social actor that is culturally constrained and to some extent socially judged by the cultural agents. As the human participant becomes focused on achieving the appropriate task and as some form of narrative or gameplay depends on the responses of the cultural agents, these scenarios differ from environments where the human player merely observes the behaviours of artificial characters (intelligent agents). And this may also mean the agents' apparent authenticity and ability to engage the human players is easier to achieve.

Summary

Virtual heritage environments have special needs that create more criteria than those required by mainstream digital environments and too many agent-virtual heritage projects have not communicated the significance and value of the heritage content) due to their focus on perfecting the technology. In their attempt to create more engagement, virtual environment researchers and designers have conflated social presence with cultural presence (Champion, 2005, 2011; Flynn, 2007). A solution is to develop agents who help interpret cultural cues and transmit to the human participant a sense of situated cultural presence and an awareness through place-specific and time-specific interaction of the cultural *local* significance of the simulated sites, artefacts and events. Such agents would be cultural agents, not merely social agents, as they would convey accummulated and place-specific cultural knowledge that would outlast or extend beyond their own individual 'lives'.

References

Addison, A. C. (2001). *Virtual Heritage: Technology in the Service of Culture.* Paper presented at the Proceedings of the 2001 Conference on Virtual Reality, Archeology, and Cultural Heritage, Athens, Greece.

Addison, A. C. (2008). The Vanishing Virtual: Safeguarding Heritage's Endangered Digital Record. In Y. Kalay, T. Kvan, & J. Affleck (Eds.), *New heritage: New media and cultural heritage* (pp. 27-39). Oxford: Routledge.

Affleck, J., & Kvan, T. (2005). *Reinterpreting Virtual Heritage.* Paper presented at the Tenth Conference on Computer-Aided Architectural Design Research in Asia, New Delhi.

Bentkowska-Kafel, A., Denard, H., & Baker, D. (2012). *Paradata and transparency in virtual heritage*. Farnham, Surrey, United Kingdom: Ashgate Publishing, Ltd.

Boado, F. C. (2001). Problems, functions and conditions of archaeological knowledge. *Journal of Social Archaeology, 1*(1), 126-146.

Bogdanovych, A., Ijaz, K., & Simoff, S. (2012). *The City of Uruk: Teaching Ancient History in a Virtual World.* Paper presented at the *Intelligent Virtual Agents Conference*, Santa Cruz.

Bogdanovych, A., Rodriguez, J. A., Simoff, S., & Cohen, A. (2009, September). *Virtual Agents and 3D Virtual Worlds for Preserving and Simulating Cultures.* Paper presented at the *Intelligent Virtual Agents, 11th International Conference, IVA 2011*, Reykjavik Iceland.

Bogdanovych, A., Rodriguez-Aguilar, J. A., Simoff, S., & Cohen, A. (2010). Authentic interactive reenactment of cultural heritage with 3D virtual worlds and artificial intelligence. *Applied Artificial Intelligence, 24*(6), 617-647.

Bringsjord, S. (2001). Is it possible to build dramatically compelling interactive digital entertainment (in the form, eg, of computer games). *The international journal of computer game research, 1*(1).

Champion, E. (2005). Cultural presence. In S. Dasgupta (Ed.), *Encyclopedia of virtual communities and technologies* (pp. 95-101). Hershey, P.A.: Idea Group.

Champion, E. (2009). Roles and worlds in the hybrid RPG game of Oblivion. *The International Journal of Role-Playing*(1), Online. Retrieved from http://ijrp.subcultures.nl/?page_id=208

Champion, E. (2011). *Playing With The Past*. London: Springer.

Champion, E. (2015a). *Ludic Literature: Evaluating Skyrim for Humanities Modding*. Paper presented at the Digital Humanities Congress 2014. Studies in the Digital Humanities, Sheffield. http://www.hrionline.ac.uk/openbook/chapter/dhc2014-champion

Champion, E. (2015b). *Roleplaying and Rituals For Heritage-Orientated Games*. Paper presented at the DiGRA Digital Games Research conference, Lüneburg Germany. http://projects.digital-cultures.net/digra2015/

Claidière, N., Smith, K., Kirby, S., & Fagot, J. (2014). Cultural evolution of systematically structured behaviour in a non-human primate. *Proceedings of the Royal Society of*

London B: Biological Sciences, 281(1797), 1-9. Retrieved from http://rspb.royalsocietypublishing.org/

Costantini, S., Mostarda, L., Tocchio, A., & Tsintza, P. (2008). DALICA: Agent-based ambient intelligence for cultural-heritage scenarios. *Intelligent Systems, IEEE, 23*(2), 34-41.

Crang, M. (1998). *Cultural Geography*. London and New York: Routledge.

Csibra, G., & Gergely, G. (2009). Natural pedagogy. *Trends in cognitive sciences, 13*(4), 148-153.

Davey, G. (2005). What is museum fatigue. *Visitor Studies Today, 8*(3), 17-21.

Economou, M., & Pujol, L. (2008). Educational tool or expensive toy? Evaluating VR evaluation and its relevance for virtual heritage. In Y. Kalay, T. Kvan, & J. Affleck (Eds.), *New heritage: New media and cultural heritage* (pp. 242-260). London, UK: Routledge.

Fischer, M. D. (2006, 26-28 October). *Cultural Agents: a Community of Minds.* Paper presented at the Engineering Societies in the Agents World VI: 6th International Workshop, ESAW 2005, Kusadasi, Turkey.

Flynn, B. M. (2007). *Digital Knowledge as Archaeological Spatial Praxis*. Paper presented at the 13th International Conference on Virtual Systems and Multimedia (VSMM 2007), Brisbane Australia.

Ibanez, J., Aylett, R., & Ruiz-Rodarte, R. (2003). Storytelling in virtual environments from a virtual guide perspective. *Virtual Reality, 7*(1), 30-42.

Ioannidis, Y., El Raheb, K., Toli, E., Katifori, A., Boile, M., & Mazura, M. (2013). *One object many stories: Introducing ICT in museums and collections through digital storytelling.* Paper presented at the Digital Heritage 2013 Conference, Marseille, France.

Jacobson, J., & Holden, L. (2007). Virtual Heritage. *Techné: Research in Philosophy and Technology, 10*(3), 55-61.

Kubota, C. A., & Olstad, R. G. (1991). Effects of novelty- reducing preparation on exploratory behavior and cognitive learning in a science museum setting. *Journal of research in Science Teaching, 28*(3), 225-234.

Lim, C.-K., Cani, M.-P., Galvane, Q., Pettre, J., & Zawawi, T. A. (2013). *Simulation of past life: Controlling agent behaviors from the interactions between ethnic groups.* Paper presented at the *Digital Heritage International Congress 2013*, Marseille France.

Lim, M. Y., Aylett, R., & Jones, C. M. (2005). Affective guide with attitude. In J. Tan, T. Tan, & R. Picard (Eds.), *First International Conference, ACII 2005, Beijing, China, October 22-24, 2005. Proceedings* (pp. 772-779). Berlin, Heidelberg: Springer.

Ma, J., Liao, I., Ma, K.-L., & Frazier, J. (2012). Living liquid: Design and evaluation of an exploratory visualization tool for museum visitors. *Visualization and Computer Graphics, IEEE Transactions on, 18*(12), 2799-2808.

Malpas, J. (2008). Cultural heritage in the age of new media. In Y. Kalay, T. Kvan, & J. Affleck (Eds.), *New heritage: New media and cultural heritage* (pp. 13-26). Oxford United Kingdom: Routledge.

Mosaker, L. (2001). Visualising historical knowledge using virtual reality technology. *Digital Creativity, 12*(1), 15-25.

Paggio, P., & Jongejan, B. (2005). Multimodal Communication in Virtual Environments. In O. Stock & M. Zancanaro (Eds.), *Multimodal Intelligent Information Presentation* (Vol. 27, pp. 27-45): Springer Netherlands.

Paolini, P., & Di Blas, N. (2014). Storytelling for Cultural Heritage. In A. Contin, P. Paolo, & R. Salerno (Eds.), *Innovative Technologies in Urban Mapping* (pp. 33-45): Springer.

Papagiannakis, G., & Magnenat-Thalmann, N. (2007). Mobile augmented heritage: Enabling human life in ancient pompeii. *International Journal of Architectural Computing, 5*(2), 396-415. Retrieved from http://multi-science.metapress.com/index/UR401GV233354054.pdf

Papagiannakis, G., Ponder, M., Molet, T., Kshirsagar, S., Cordier, F., Magnenat-Thalmann, N., & Thalmann, D. (2002). *LIFEPLUS: Revival of life in ancient Pompeii.* Paper presented at the VSMM 2002 (8th International Conference on Virtual Systems and Multimedia), Gyeongju, Korea.

Penny, S. (1997). *Embodied cultural agents: at the intersection of robotics, cognitive science, and interactive art.* Paper presented at the AAAI Socially Intelligent Agents Symposium.

Pujol, L., Roussou, M., Poulou, S., Balet, O., Vayanou, M., & Ioannidis, Y. (2012). *Personalizing interactive digital storytelling in archaeological museums: the CHESS project.* Paper presented at the 40th Annual Conference of Computer Applications and Quantitative Methods in Archaeology. Amsterdam University Press.

Riva, G., Castelnuovo, G., Gaggioli, A., & Mantovani, F. (2002). *Towards a cultural approach to presence.* Paper presented at the Proceedings of the Fifth Annual International Workshop PRESENCE, Porto Portugal.

Riva, G., & Mantovani, G. (2000). The need for a socio-cultural perspective in the implementation of virtual environments. *Virtual Reality, 5*(1), 32-38.

Rizzo, I., & Mignosa, A. (2013). *Handbook on the Economics of Cultural Heritage*: Edward Elgar Publishing.

Roussou, M. (2001, 27-28 September). *The Interplay between Form, Story, and History: The Use of Narrative in Cultural and Educational Virtual Reality.* Paper presented at the Virtual Storytelling Using Virtual Reality Technologies for Storytelling, Avignon, France.

Roussou, M. (2008). *The components of engagement in virtual heritage environments.* Paper presented at the New Heritage: New Media and Cultural Heritage Conference, Hong Kong.

Roussou, M., & Drettakis, G. (2003). *Photorealism and non-photorealism in virtual heritage representation.* Paper presented at the First Eurographics Workshop on Graphics and Cultural Heritage (2003).

Schweibenz, W. (1998). *The "Virtual Museum": New Perspectives For Museums to Present Objects and Information Using the Internet as a Knowledge Base and Communication System.* Paper presented at the Internationalen Symposiums für Informationswissenschaft (ISI 1998), Aguascalientes, Mexico.

Sequeira, L. M., Morgado, L., & Pires, E. (2014). Simplifying Crowd Automation in the Virtual Laboratory of Archaeology. *Procedia Technology, 13*, 56-65.

Sequeira, L. M., & Morgado, L. C. (2013). Virtual archaeology in second life and opensimulator. *Journal For Virtual Worlds Research, 6*(1).

Serrell, B. (1997). Paying Attention: The Duration and Allocation of Visitors' Time in Museum Exhibitions. *Curator: The Museum Journal, 40*(2), 108-125. doi:10.1111/j.2151-6952.1997.tb01292.x

Song, M., Elias, T., Martinovic, I., Mueller-Wittig, W., & Chan, T. K.-Y. (2004). *Digital heritage application as an edutainment tool.* Paper presented at the *2004 ACM SIGGRAPH international conference on Virtual Reality continuum and its applications in industry*, Singapore.

UNESCO. (2015a). Cultural Landscapes. Retrieved from http://whc.unesco.org/en/culturallandscape/

UNESCO. (2015b). Text of the Convention for the Safeguarding of the Intangible Cultural Heritage. Retrieved from http://www.unesco.org/culture/ich/index.php?lg=en&pg=00006

Universitat Pompeu Fabra Barcelona. (Undated). {LEAP] LEarning of Archaeology through Presence. Retrieved from http://www.upf.edu/leap/project/summary.html

v-must: Virtual Museum Transnational Network. (2011, 2011). Cultural Presence. *v-must-Virtual Museum Transnational Network.* Retrieved from http://v-must.net/virtual-museums/glossary/cultural-presence

Vale, G., Flynn, E., & Kendal, R. (2012). Cumulative culture and future thinking: Is mental time travel a prerequisite to cumulative cultural evolution? *Learning and Motivation, 43*(4), 220-230.

Vourvopoulos, A., Liarokapis, F., & Petridis, P. (2012). *Brain-controlled serious games for cultural heritage*. Paper presented at the 18th International Conference on Virtual Systems and Multimedia (VSMM) Milan, Italy.