Simulating History in Virtual Worlds

Nicola Lercari

1 Virtual Worlds for History

Historical virtual worlds (HVWs) are 3D3C worlds (Sivan, 2008) that visualize the past and its relics or simulate specific socio-cultural dynamics and historical events. Virtual space, immediacy, and real-time simulation are characteristics that make 3D3C worlds unusual tools for historiography. One may wonder whether virtual worlds can be used in historical research, in the first place.

To address this problem, let's consider the general meaning of history through a quote by Edward H. Carr. This author defines History as "an unending dialogue between the present and the past" (Carr, 1961). Pondering this statement, it seems to me that the gap between history and virtual worlds diminishes, instead of growing. In fact, is there anything more relevant to the study of history than a HVW, meaning a potentially unlimited place of discussion where the relation between past and present can be represented in its own context and negotiated endlessly?

Indeed, historians, archivists, experts of material culture and heritage can use virtual worlds to negotiate information on the past and its memory with the protagonists of specific historical dynamics, along with their descendants and local communities. The value of historical 3D3C worlds is not limited to the public usage of history and the involvement of the masses in the interpretation of the past. Historical practitioners can use HVWs to re-enact the past and further advance their historiographical research on specific events and eras.

The notion that actions and conscious choices of the protagonists of history can be re-enacted is first introduced by Robin G. Collingwood in 1946. This author examines the process of historical explanation and describes the historian's necessity to mentally re-enact past experiences and actions (Collingwood, 1946). Hence,

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Collingwood pinpoints that re-enactment allows historians to criticize different interpretations of history and produce new knowledge on the past.

This chapter aims to reframe historical re-enactment in the digital era. HVWs can thus be used by historians to analyze the motivations and causes that led individuals to perform specific actions in the past. This is possible because the most important consequence of Collingwood's perspective is to have demonstrated that thoughts stand outside time and therefore past behaviors and choices can be understood by re-enacting the events the protagonists of history took part in (D'Oro, 2000).

2   Simulating History in Virtual Worlds

A 30-year long tradition of virtual reconstruction of built heritage can help us understand the conventions and consequences of historical simulation in 3D3C worlds. Since the first attempt to graphically reconstruct historical buildings in a computer—more precisely the virtual reconstruction of a Roman bath complex in England developed in 1983 (Woodward, 1991)—the simulation of the past and its relics has come a long way.

In the early 1990s museums around the world started employing computer-based simulations—defined "virtual rooms"—intending to engage their visitors with realistic representation of the past (Frisher, Niccolucci, Ryan, & Barceló, 2002). These digital visualizations did not possess strong scientific value since historians and archaeologists were not involved in the design and validation of the simulation.

The early virtual environments for archaeological investigation described by Maurizio Forte and Alberto Siliotti pledged to be scientifically accurate (Forte & Siliotti, 1997), but missed the opportunity to actively involve their users in the process of interpretation of the past and definition of social memory.

The practice of simulating the past went through a major shift in the early 2000s. Coleen Morgan argues that this change has been determined by the abandonment of immersive representations of the past based on expensive and unwieldy virtual reality devices. The early virtual environments for history were successfully replaced by more conceptual reconstructions "where users can directly interact with the environment and with others to build online social systems" (Morgan, 2009, p. 473). It is exactly in this context that the practice of using 3D3C worlds to simulate history first commenced.

Sequeira and Morgado pinpoint that the new modalities of virtual reconstruction in HVWs allow historical and archaeological practitioners to take the lead in the simulation process becoming the creators of the simulated scenarios (Sequiera & Morgado, 2013, p. 2).

The user-generated approach of 3D3C worlds enables the general public of the internet to participate in the co-creation of cultural meanings and share social memories. Critics to this approach may come from those opposed to a collaborative interpretation of the past and from those who fear that the open dimension of HWVs

could undermine the validation of the historical content and, therefore, compromise the accuracy of the simulation.

Conversely, I argue that involving a higher number of individuals—defined by different classes, races, ethnicities, and gender—in the simulation and interpretation of the past allows scholars to expand their viewpoint on history and thus enhance their analytical capability. My point is that if a multitude of HVWs users participate in the negotiation of historical meaning, a larger critical mass provides beneficial comments and critiques to the hypothesis proposed in the virtual environment by historians. This condition helps the designers to enhance the hermeneutical value of the historical simulation in virtual worlds.

One may find similarities between the multi-perspective historical simulation of HVWs and the multi-vocal approach for the interpretation of the past proposed by I. Hodder (1997, 2000) and recently revised by Berggren et al. (2015). The analogy between these two approaches derives from a common interest to multiply the ways our past can be collectively interpreted through the negotiation of knowledge and historical meaning among a plurality of stakeholders.

3 The Principles of Historical Virtual Worlds

The problematic of historical re-enactment and simulation in HVWs needs to be addressed through the discussion of the fundamentals of these new platforms for historical research. A HVW based on the principles exposed in this section of the chapter conveys scientific representations of the past while refuting potential critics of lack of accuracy and scarce validation.

Recognized Standards: historical simulation in 3D3C worlds must comply with internationally recognized standards for the digital representation of the past—such as the *London Charter* (Beacham, Denard, & Niccolucci, 2006) or the *Seville Charter* (Denard, 2012).

Validated Methodologies: the recreation of built heritage in HVWs must employ previously validated methodologies for the reconstruction of buildings and landscapes, for instance a source-based virtual reconstruction relying on comparative analysis of historical sources (Lercari, 2010a).

Replicable Practices of Data Gathering and Processing: the information conveyed in HVWs needs to be gathered and processed using practices for data collection and dissemination specifically customized for a tridimensional representation of the past (Forte, Dell'Unto, Issavi, Onsurez, & Lercari, 2012). For the sake of accuracy, the employed practices need also to be easily replicable by others.

Transparency of Data: HVWs need to clarify the provenance of the displayed historical data as well as to provide statistics or visual clues on the level of uncertainty and ambiguity of the reconstructed scenario.

Historical Circuit Reliability: historians, archaeologists, or other experts of the past involved in the design of HVWs need to make sure that simulating history in 3D3C worlds depends on *historical circuit reliability*. This condition occurs when users of HVWs can visualize accurate and validated historical content while accessing metadata on its interpretation and reconstruction, directly within the virtual environment.

Representation of Multiple Viewpoints: in order to enhance the analytical capability of the simulation and its inclusiveness, HVWs need to convey different viewpoints on history—in terms of class, race, ethnicity, and gender.

Embodiment in Historic Characters: embodiment in avatars influence users' expectations and motivation in simulating history in HVWs (Bonini, 2008). Thus HVWs need to foster cognitive involvement and comprehension of historical information through avatars designed and costumed based on careful study.

Place Making: the design of HVWs poses the question of what defines a place and how to really achieve "placeness" in 3D3C worlds (Champion & Bharat, 2007). Virtual reconstruction of historical places thus requires an in-depth understanding of the ephemeral qualities of the simulated scenarios including the unique and dynamic nature of the environment. Hence, HVWs design needs to involve techniques of place making able to actively capture the culture and physiological experience of the simulated place and not only its tangible properties.

4   State of the Art in Historical Virtual Worlds

The value of historical 3D3C worlds derives from the capability of scientifically-accurate HVWs and historical re-enactment to help scholars understand how ancient civilizations developed their thoughts, actions, and cultures.

My analysis of the usage of 3D3C worlds for historical research relies on the assumption that the conscious choices of virtual worlds' users define a system of conceptual possibilities that informs us about the way people think and behave in real life. Thus, I argue that the data collected in historical virtual worlds can help historians and archaeologists develop new analysis and interpretations of the past and its relics. This condition only occurs when the virtual scenario is based on validated historical data and scientific virtual reconstruction.

This section strives to support my thesis through the discussion of seven case studies—selected among a vast number of projects and initiatives available online—that represent the state of the art of historical virtual worlds as of 2014.

The HVWs described in the following pages address historical simulation in a novel way. The goal is to define alternative methodologies of interpretation of the past based on new principles and techniques that rely on the new forms of perception and cognition available in the cyberspace.

Fig. 1 Garisenda and Asinelli towers in thirteenth-century Bologna in Second Life

This analysis takes into consideration platforms developed from the second half of the 2000s through 2014 as academic initiatives or collaborations between museums and virtual worlds' specialists (Fig. 1).

The common denominators among the presented case studies is a strong emphasis on the simulation of scientifically accurate historical data along with the relevance of the social component in the interpretation of the past or the collaborative reception of cultural content by the general public as it is best exemplified by the public history research project Nu.M.E. 2010 (Lercari, 2010b).

4.1 Remixing Çatalhöyük

PRODUCER: Open Knowledge and the Public Interest research group (OKAPI)—University of California, Berkeley
AUTHORS: Ruth Tringham, Michael Ashley, Coleen Morgan
ORIGINAL RELEASE: 2007
DESCRIPTION: Archaeological virtual world that engages users in interactive experiences of a Neolithic town and promotes participatory pedagogy
HISTORICAL CONTEXT: Neolithic town of Çatalhöyük, Central Anatolia, current Turkey
TECHNOLOGY: Second Life, 3D Modeling, avatars, LSL scripting, multimedia
DATA ACQUISITION/POST PROCESSING: archaeological excavation
WEB: http://okapi.wordpress.com/projects/okapi-island-in-second-life/

Remixing Çatalhöyük is a cyber-archaeology initiative developed by the Open Knowledge and the Public Interest research group at the University of California, Berkeley in Second Life. The primary aim is to digitally recreate in a HVW the Neolithic site of Çatalhöyük—located in Central Anatolia, Turkey—where a group of archaeologists from UC Berkeley were invited by director Ian Hodder to experiment with new multivocal ways to investigate and represent the past. Çatalhöyük, is one of

the first urban centers in the world (7100 BC–5600 BC) to present evidence of spectacular mural art works, artifacts, and mud-brick architecture. These features provide us with precious information on how life was 9000 years ago and make this proto-city a UNESCO World Heritage site as well as a fundamental milestone in the comprehension of the origins of agriculture and the first human settlements. The project visualized in Second Life a large amount of information collected onsite creating a *virtual settlement* open to alternative interpretations of Çatalhöyük history and architecture (Fig. 2). At the same time this virtual world was used as a platform for training undergraduate students and as a virtual gathering venue for discussing new digital ways to communicate the past. With this in mind, *Remixing Çatalhöyük* aimed to become a digital platform of discussion, collaboration and sharing of cultural information able to involve archaeological practitioners, students, and the general public in an open discussion on the origin of our civilization. Like many other historical virtual worlds in Second Life, *Remixing Çatalhöyük* faced overwhelming maintenance costs and was discontinued in 2012.

4.2 The Forbidden City: Beyond Space and Time

PRODUCER: IBM and the Palace Museum of Beijing
AUTHORS: Wu Zhen, Michael Bacon
ORIGINAL RELEASE: 2008
DESCRIPTION: Historical virtual world validated by historians whose simulation was enhanced by pedagogical videos, synchronous communication, and high interactivity between users and with autonomous non-player characters
HISTORICAL CONTEXT: The Forbidden City during Ming and Qing dynasty, Beijing, China

(continued)

Fig. 2 Neolithic buildings in Remixing Çatalhöyük

TECHNOLOGY: Custom avatar-based game engine developed by IBM, 3D modeling, render to texture, artificial intelligence to manage NPCs
DATA ACQUISITION/POST PROCESSING: historical sources, site survey, photographs
WEB: No longer available

The Forbidden City—Beyond Space and Time is a virtual reconstruction initiative developed by IBM with the support of the Chinese government and the Palace Museum in Beijing. The main goal of this project is to create awareness of Chinese culture and history through a very realistic simulation of the Forbidden City in a HVW. The art and architecture of this stunning monumental complex have been symbols of the power and majesty of the Chinese emperors and their courts for five centuries. This historic virtual world—freely accessible online between 2008 and 2012—spanned an area of about a square kilometer including splendid monuments and buildings constructed by the Qing and Ming dynasties. Between 2006 and 2008 experts of Chinese heritage from the Palace Museum provided scientific guidance to a team of IBM 3D artists and programmers in the recreation of a very realistic environment able to portray the harmony and architectural balance of the Forbidden City. The game engine employed in *Beyond space and Time* has been developed by IBM with the goal to enhance online interaction between users and collective exploration of the historic scenario. Autonomous Non-player Characters (NPCs) provided information on the buildings and life of the Forbidden City while leading guided tours of the environment (Fig. 3). Users could collectively experience the ritual and daily life at the Qing court through interactive activities and game-like experiences enhanced by high quality 3D animation videos. This HVW was discontinued in 2013.

4.3   Theatron[3]

PRODUCER: King's Visualization Lab—King's College London
AUTHORS: Mark Childs, Richard Beacham
ORIGINAL RELEASE: 2009
DESCRIPTION: Historical virtual world that simulates a number of key historic theaters that belong to different cultures and eras
HISTORICAL CONTEXT: Multiple
TECHNOLOGY: Second Life, 3D modeling, avatars, render-to-texture, LSL scripting, motion tracking and gesture analysis
DATA ACQUISITION AND POST PROCESSING: comparative analysis of archaeological data and historical sources
WEB: http://cms.cch.kcl.ac.uk/theatron

In 2002 the THEATRON project was started by King's Visualisation Lab at King's College London with the support of Eduserv. Initially THEATRON investigated and virtually reconstructed 19 theatre buildings belonging to different eras

Fig. 3 Avatars interaction in beyond space and time

as milestones in the development of European theatre design (Fig. 4). At an early stage, THEATRON relied solely on a stand-alone interactive application able to render simplified versions of the virtual theaters and presented in-context pre-rendered images and animations of the related high quality models along with metadata and images about them. In 2009 *Theatron*[3] was launched to transform the initial virtual reconstructions of THEATRON into a vast historical virtual world within Second Life. The aim of *Theatron*[3] is to provide highly innovative, interactive teaching and learning resources that allow students from five higher education institutions to collaborate and learn within the HVW. This historical 3D3C world has the merit to have fostered the study of historical simulation as a tool for interpreting and visualizing the past. In addition, *Theatron*[3] verified that Second Life is not the most suitable platform to simulate theater performance that already exist in reality world, but that it has a lot of potential as a medium able to explore new forms of performative arts (Childs, 2009). Particularly relevant is the usage of advanced LSL scripts to make the scenarios interactive as well as to enable the creation of avatar-based theater performances in the HVW.

4.4 Nu.M.E. 2010

PRODUCER: University of Bologna
AUTHORS: Nicola Lercari, Francesca Bocchi, Antonella Guidazzoli
ORIGINAL RELEASE: 2010
DESCRIPTION: Historical virtual world validated by historians that simulates urban space and daily life in the Late Middle Age
HISTORICAL CONTEXT: Thirteenth-century Bologna, current Italy

Fig. 4 The Theater of Epidaurus in Second Life

TECHNOLOGY: Second Life, 3D Modeling, avatar design, LSL scripting, cloud computing and in-world web browsing
DATA ACQUISITION/POST PROCESSING: comparative analysis of historical sources
WEB: http://www.cineca.it/en/progetti/new-electronic-museum-city-four-dimensions-virtual-bologna

Nu.M.E. (New Electronic Museum) is a multidisciplinary research initiative developed at the University of Bologna and Cineca Supercomputing Center in Italy. *Nu.M.E.* started in the late 1990s with the goal to experiment new methodologies in the field of urban history and cultural visualization. In 2010 a new version of *Nu.M.E.*—known as *Nu.M.E. 2010*—was developed in Second Life, more precisely in a SIM owned by the University of California Merced, called *Heritage Island*. The aim of *Nu.M.E. 2010* is to define new methods for the dissemination of historical information on the late Medieval Bologna and to reinterpret the urban space of this early city through storytelling, embodied interaction, and geographical cloud computing (Lercari, Toffalori, Spigarolo, & Onsurez,2011). Covering an area of about half a square kilometer, this virtual world simulates several buildings and monuments in downtown Bologna (Fig. 5). It also portrays the cloth market held in Porta Ravegnana square at the hearth of the city and allows users to re-enact a daily life scene in thirteenth century. Between 2010 and 2012 the users of *Nu.M.E. 2010* collaborated in the HVW to redefine and reinterpret the historical meanings embedded in the simulation using re-enactment, in-world internet browsing, and cloud computing platforms for mapping geographical and historical content. Like many other historical virtual worlds in Second Life, *Nu.M.E. 2010* faced overwhelming maintenance costs and was discontinued in 2012.

Fig. 5 Cloth market in thirteenth-century Piazza di Porta Ravegnana, Bologna in Second Life

4.5   Teramo: A City Virtually Dressed

PRODUCER: University of California, Merced—Teramo Archaeological Museum—Cineca
AUTHORS: Maurizio Forte, Nicola Lercari, Fabrizio Galeazzi, Davide Borra
ORIGINAL RELEASE: 2010
DESCRIPTION: Archaeological virtual world that simulates monumental complexes and private houses of the Roman city of Interamnia
HISTORICAL CONTEXT: First century BC—second century AD Interamnia, current Teramo, Italy
TECHNOLOGY: 3D Modeling, OpenSimulator, multimedia
DATA ACQUISITION/POST PROCESSING: Comparative analysis of archaeological data and historical sources
WEB: http://www.3dmetaversity.org/site/default.asp?lingua=1

Teramo—A city virtually dressed (TaCVD) was created in 2009 as a joint research initiative involving the University of California Merced, the City of Teramo and the Institute of Technologies Applied to Cultural Heritage at CNR, Rome. The aim of this project is to virtually reconstruct in the open source platform OpenSimulator the archaeological context of the Roman city of Interamnia—the current Teramo, in central Italy—on the basis of the key archaeological areas of its urban network. Despite the importance of Interamnia from an archaeological point of view, the fragmentation of the sites—mostly hidden or decontextualized—and the difficulties to communicate them a in broader sense, made it difficult for archaeological and museum practitioners to conduct an adequate cultural communication of the city's heritage. TaCVD was created to find solution to this issue and to test new uses of public archaeology in the open virtual world *3DMetaversity* hosted at Cineca supercomputing center. Between 2010 and 2011 TaCVD became the first historical virtual worlds in OpenSimulator to promote an open approach to the simulation of the past (Forte, Lercari, Galeazzi, & Borra, 2010). TaCVD

Fig. 6 The Roman Theater of Interamnia in OpenSimulator

featured key ancient Roman monuments of Interamnia, more precisely the Roman Theater and the Lions' Domus (Fig. 6). In addition, the creation of a virtual library, known as *Virtuoteca*, provided users with an in-world meta-space for gathering and exchanging archaeological information on the simulated sites.

4.6 Virtual Middletown Living Museum

PRODUCER: Ball State University—Institute for Digital Intermedia Arts (IDIA)
AUTHORS: John Fillwalk and IDIA staff
ORIGINAL RELEASE: Pilot available in 2011—currently under development
DESCRIPTION: Historical virtual world that simulates twentieth-century Ball Brothers Glass Manufacturing Co. fostering virtual re-enactment of contemporary history
HISTORICAL CONTEXT: 1920s–1930s Muncie, in the state of Indiana, United States
TECHNOLOGY: Blue Mars, 3D modeling, advanced lighting based on graphics shaders, NPCs animation, advanced scripting, spatialized sound
DATA ACQUISITION/POST PROCESSING: Comparative analysis of historical photographs and sources
WEB: http://cms.bsu.edu/about/administrativeoffices/hybriddesigntech/researchanddesign/contractedservices/virtualworlds

The *Virtual Middletown Living Museum* is a pilot project currently developed by the Institute for Digital Intermedia Arts (IDIA) in collaboration with the Center for Middletown Studies and University Libraries at Ball State University. The project aims to simulate the socio-historical scenarios at the core of the 1929 and 1937 *Middletown Studies* authored by Robert S. Lynd and Helen M. Lynd as a series of sociological case studies that focus on cultural norms and social change in 1920s–1930s America. This historical virtual world simulates an archetypical industrial context from the town of Muncie in Indiana—the Ball Glass Factory as it was in 1920s—engaging users in a highly realistic immersive experience based on historical re-enactment and interactive activities (Fig. 7). *Virtual Middletown Living Museum* enhances the learning process typically available in open-air museums (e.g. Colonial Williamsburg) providing historical information, metadata, and

Fig. 7 Virtual Middletown living Museum in Blue Mars

historical photographs directly within the HVW. The Ball Glass Factory setting serves as a prototype for a larger virtual world, currently under development, that will reconstruct the whole cultural landscape of Middletown as well as will simulate elements of private and religious daily life representing Muncie's dwellings and churches.

4.7 Venice Virtual World

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| PRODUCER: Duke University—Wired! Lab |
| AUTHORS: Nicola Lercari, Kristin Lanzoni, Virtual Form and Space 2013–14 course students, Wired Lab fellows |
| ORIGINAL RELEASE: Pilot available in 2014—currently under development |
| DESCRIPTION: Historical virtual world that simulates the island of Santa Lucia in Venice before Napoleonic occupation and the advent of train completely transformed its urban landscape |
| HISTORICAL CONTEXT: 1740s Venice, current Italy |
| TECHNOLOGY: OpenSimulator, 3D modeling, advanced lighting based on graphics shaders, LSL scripting, ESRI ARC GIS, Bundysoft L3DT, Bayliwick, Omeka and Neatline for management and display of historical sources |
| DATA ACQUISITION/POST PROCESSING: Comparative analysis of historical sources |
| WEB: http://www.dukewired.org/projects/venice-virtual-world/ |

Venice Virtual World (VVW) is an educational project developed with the contributions of postdoctoral scholars, undergraduate, and graduate students at Duke University. The project aims to engage students by combining the study of art history with visual and new media studies. VVW recreates the life of Venice, its buildings, bridges, boats, gardens, and inhabitants in a 3D3C world that simulates the Island of Santa Lucia as it was in 1740s (Fig. 8). The focus of the historical
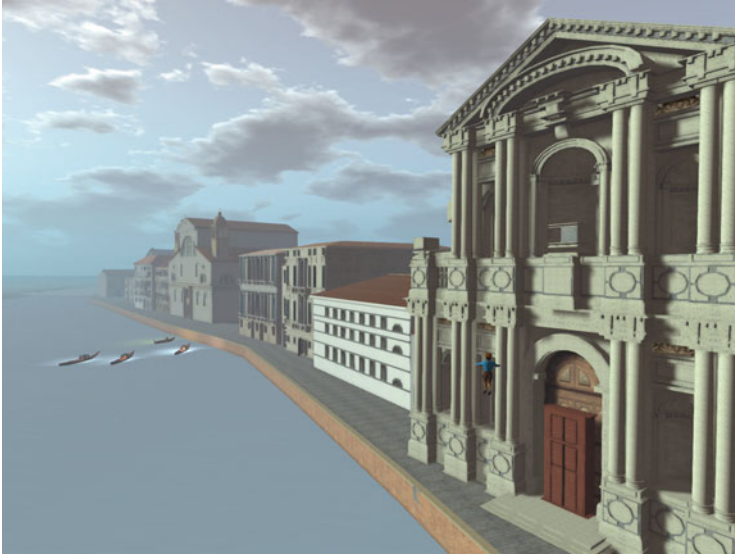
Fig. 8 View of buildings and churches in Venice Virtual World

simulation is on the now completely transformed zone of the city around the train station. Using a geographic information system (ESRI ARC GIS) and digital terrain tools (Bundysoft L3DT and Bayliwick), historic maps of Santa Lucia were transformed in a scientific, 1:1 scale reconstruction of the island. Students reconstructed the urban landscape using drawings, building plans, views of monuments and interiors. Avatars—designed and costumed based on careful study— interact within this virtual world and guide users to explore the reconstructed urban space. VVW users can access primary and secondary historical sources through small interactive kiosks that connect to an online content management system (Omeka). The pedagogical approach of VVW results in immersive, active engagement with the experience of what it would have been like to inhabit a particular space at a key historical moment.

5 Conclusions

This chapter focused on the analysis of the cultural role of historical 3D3C worlds as well as on the discussion of the effects of historical simulation on the general public and local communities. Drawing upon the theories and facts discussed in the previous pages, one infers that the power of historical simulation and virtual reconstruction derives from the capability of HVWs to attract people inside the simulated historical context. HVWs involve users in a synesthetic process of creation of historical meaning in which both tangible and intangible elements of the past can be discussed, shared, and understood (Lercari, 2010a, p. 130).

This chapter strived to demonstrate that the power of HVWs is to expand the historians' capability to study the past by enabling new types of re-enactment and interpretation that involve minds and bodies. For instance, users of HWVs can re-enact past experiences embodying themselves in avatars that represent historical characters. Through their new electronic bodies users can retrace the conscious choices of individuals that made history or that simply lived in a specific era.

Maurice Merleau-Ponty assigns a fundamental role to our body arguing that the cognition and interpretation of the world where we live occur through our sensori-motor system (Merlot-Ponty, 1945). In addition, Francisco Varela, Evan Thompson, and Eleanor Rosh emphasize the importance of *embodied mind*, *situated cognition* and *enaction* in the interpretation of complex data (Varela, Thompson, & Rosh, 1993).

In my perspective, the comprehension of historical content in HVWs is thus deeper than in other types of historical simulations. This occurs because HWVs users—embodied in historical characters—experience the simulated scenario through the virtual bodies of their avatars while collectively re-enact the past and negotiate historical meaning between one another.

The power of simulating history in 3D3C worlds is expanded by new peculiar typologies of *causation*, *emotional involvement*, *spatiality*, and *temporality* that cannot be found in any other media. These unique features allow historical practitioners to represent continuities and discontinuities of history in a tridimensional virtual environment based on scientific data.

Drawing upon Michel Foucault theories on the production of knowledge in historical disciplines (Foucault, 1969), I argue that historical simulations strongly affect the ways our society understands its history or the modalities in which local communities develop their own social memory.

The approach to historical simulation discussed in this chapter refer to Ian Hodder's theory stating that our representations of the past derive from analytical models that are themselves interpretations of our reality. Thus, different people may have different interpretations of the same past phenomenon or event (Hodder, 1997, 2000).

The *multivocal approach to simulating history* proposed in this chapter stresses the significance of visualization and re-enactment of history in 3D3C worlds both as tools for the interpretation of the past and as resource that enable a collective negotiation of the meaning of cultural heritage. In the proposed perspective, the multiple points of view on history conveyed by HVWs add a multitude of critical voices and viewpoints to the interpretation of the past suggested by historians and archaeologists. As a consequence, the analytical capability of HVWs is enhanced.

In addition, this chapter strived to demonstrate that when HVWs follow validated standards and principles for the simulation of the past (for example the *London Charter in Second Life* or the *Seville Charter*) they acquire universal historical validity and become platforms capable of conveying valid knowledge about our past and heritage. The new forms of *spatiality*, *temporality*, and *causation systems* typical of HVWs assign a new role to the *emotional involvement* of users in their heritage. As noted by Gaynor Bagnall, emotions and memory thus play a fundamental role in the consumption process of cultural heritage (Bagnall, 2003). At the same time, such properties generate new embodied cognitive opportunities

for HVWs users, allowing them to understand the complex meanings embedded in the simulated environment.

Thus, this chapter claims that HVWs users develop a deep comprehension of simulated historical contexts through their avatars. The embodied cognition processes available in HVWs allow users of 3D3C worlds to become protagonists of pervasive re-enactment of historical events.

To conclude this discussion on the usage of 3D3C worlds in history, one needs to specify that archaeologists, historical practitioners, and other scholars involved in the study of cultural heritage have the responsibility to identify new truthful ways to represent the past in HVWs, or better the many pasts of which our history is constructed.

Scholars in these fields can thus utilize the new types of space, time, causation systems, and cultural artefacts described in this chapter to re-enact and simulate history in virtual worlds, opening new horizons to the study of the past using 3D3C worlds.

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