

Post-Pandemic Heritage Game Design Tools For An Engaging Experience

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Abstract

Digitisation of heritage and the creation of open digital archive contribute in a large scale dissemination of history and culture. Today, technology allows us not only to easily access information on heritage and view 3D models of buildings or artefacts, but also to experience virtually historic sites or historic object, by representing them accurately, either referring to the recreation of exiting objects or rebuilding models of objects as they may have appeared in the past (Roussou, 2002). Moreover, digital heritage platforms allow visitors to navigate through virtual spaces and access information data, but still provide a low level of interactivity and immersion (Champion, 2008). By providing simple navigation they offer passive interaction and less engagement, while affords to navigate and have inputs to which to respond offer a more active mental interaction. However, what is missing is dynamic involvement of users and an engaging narrative.

Although, digital models today are becoming more and more realistic representations of the physical objects and in general of the environment, they still lack a narrative which describes the intangible elements of cultural heritage, human attitude in this environment and simulates the cultural context. In order to guarantee an effective engagement with learning experience and offer better entertainment to a larger audience, other than conservators, historians and archaeologists, this study will introduce an interactive and immersive approach in heritage 3D platforms based on game design tools.

The paper will explore first the state of the art on virtual heritage worldwide and in particular applications in the case of Albanian heritage, highlighting the level of interactivity and user engagement. Then, interactive tools from video games will be analysed and discussed in view of their incorporation in virtual heritage platforms or serious games to make the dissemination of virtual heritage more interactive and immersive. In this sense, this study will discuss how to develop interactive narrative for historical heritage based on interactivity and narration elements, how to develop an interactive story space and introduce player character as a view point in heritage exploration.

Keywords

game design, heritage exploration, post-pandemic heitage, digitisation, *heritage 3D platforms*

Digitalization of architectural heritage

Digital technologies are becoming more and more important in architectural heritage research and education. Digitisation of heritage and the creation of open digital archive contribute in a large-scale dissemination of history and culture. Architectural heritage as a disseminative human activity is related to the recovery and representation of the physical remains of historical objects and serves to communicate knowledge and transmit ideas and values. It includes three main domains *documentation, representation and dissemination* (Addison, 2000).

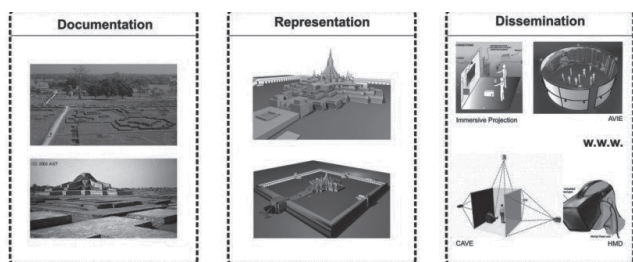


Figure 1. Three main steps of Digital heritage (source: Addison, 2000)

Documentation means data collection regarding the study objects which serve for object 3D representation and as a “deposit” of information for the object.

3D Representation is the 3D model of existing heritage object, or the representation of the supposed object which is no more existent. In this step, research deal mostly with the 3D modelling techniques, texture, polygons and real time rendering.

Dissemination of virtual heritage refers to the way the 3D content is offered to the user based on a purpose of use. VH can be used for excavation, documenting, data analyses and publications, education, display, digital reprocessing, tourism and serious games.

Nowadays, technology allows us not only to easily access information on heritage and view 3D models of buildings or artefacts, but also to experience virtually historic sites or historic object, by representing them accurately, either referring to the recreation of existing objects or rebuilding models of objects as they may have appeared in the past (Roussou, 2002). Herein, UNESCO in 2003 introduced the term ‘Digital heritage’ referring to the recourses “created digitally or converted into digital-form from existing analogue resources”. This means that architectural heritage can be scanned and 3D models can be produced. Architectural heritage recorded digitally has contributed in preserving it but has also significantly increases their accessibility to larger audience (Tonta, 2008). Moreover, digital heritage platforms allow visitors to navigate through virtual spaces and access information data, but still provide a low level of interactivity and immersion (Champion, 2008). Researchers in this field agree that the level of Interactivity in virtual heritage is still very low. (Sanders, 2012, Champion, 2002; Roussou, 2006;) sustain that heritage dissemination should encompass also the cultural and artistic evidences and narratives. Although, digital models today are becoming more and more realistic representation of the physical objects and in general of

the environment, they still lack a narrative which describes the intangible elements of cultural heritage, human attitude in this environment and simulates the cultural context. According to Yang et al. (2006), the lack of human interaction and the limited cultural content in these kinds of representations make them more technical and limit people engagement with heritage.

In order to guarantee an effective engagement with learning experience and offer better entertainment to a larger audience, other than conservators, historians and archaeologists, its essential to introduce an interactive and immersive approach in heritage 3D platforms. 3d reconstruction and data availability is not enough to explore the socio- cultural context as it could be done through the use of narration techniques or the exploration through motion and interaction. Advanced digital technologies and interaction techniques on one side facilitate interaction modes, but still other motivation and entertaining elements are needed.

Historical overview on virtual heritage

Virtual heritage can be considered as a sub-category of digital heritage as it is related with VR technology and a real-time navigation through a computer-generated three-dimensional space. ‘Virtual heritage’ (VH) is a term used to describe works that deals with virtual-reality (VR) and cultural-heritage (Roussou, 2002). The role of virtual reality in this case is not only to reproduce digitally historical content and data, but also to process and display heritage through the use of VR technology. It means that heritage content becomes digital or through the use of computer VR technologies it’s possible to simulate it, if it is lost and deliver it openly to the global audience. VR technologies such as Mixed Reality and Augmented Reality are being used recently to rebuild digitally historical sites, visualise it to the audience by improving user’s experience. Nevertheless, the role of virtual reality is not just to visualize existing or lost objects and other type of historical content, but also to attribute them significance, through the use of interactive media. According to Stone and Ojika, as cited by Champion (2016) virtual heritage is defined as “*the use of computer-based interactive technologies to record, preserve, or create artefacts, sites and factors of historic, artistic, religious, and cultural significance and to deliver the results openly to a global audience in such a way as to provide formative educational experiences through electronic manipulations of time and space.*” For the purpose of this study Virtual Heritage is not just the 3D modelling and animation but refers to a fully immersive 3D virtual space where a user is able to navigate interactively (Champion, 2008; Sanders, 2012). Moreover, Addison (2001) apart from the use of technology to *record, model, visualize* highlighted also its role to *communicate* cultural and natural heritage. Herein, virtual heritage is more complex than just the realistic reconstruction of objects in VR, and information about them, but it includes also the story and context that give meaning to this representation, and offer engagement and entertainment for people. According to Champion (2008) interaction is crucial for virtual heritage to communicate and transmit significance to the user.

Virtual reality was first used in heritage visualisation in 1994, with a brief 'walk-through' 3D reconstruction of Dudley Castle in England. It can be considered as the genesis of virtual tours. Since then, archaeologists start to experiment with virtual reality in research projects demonstrating time by time the power of the new technological systems. In 1995, in the first virtual heritage conference held in England, were presented interactive models of historical objects and hereafter was created VRML programming language (Virtual Reality Markup Language),



Figure 2. The 'walk-through' 3D reconstruction of Dudley Castle in England and an image of Dudley Castle

which allowed highly detailed and fast performing virtual worlds from personal computers. This opens up the possibility of large use of VR in heritage for education. The first interactive models proposed were the ancient sites of Olympia, Epidaurus, and Miletus (Refsland 1998 in Sanders 2012). At the time, these models presented poor graphics and textures and had a low navigation performance which started to be improved in the late 1990s with the development of Alpha world, an online immersive and collaborative virtual environment populated by virtual pedestrian who explore and walk through the 3D space. This has anticipated adventure videogames (such as *Myst* and the sequel *Riven*) with high performance of computer graphics and real-world simulation where players explore the large set of game world and manipulate surrounding objects (Cyan, 1997).

Still during the 1990s, virtual heritage was not fully embraced by archaeologist and compared to video games, this field was left behind. Only few projects (ex. Nemrud Dagi virtual world, Turkey) tried advanced virtual environments with detailed 3d reconstruction models and interactive data linked to object in the virtual world.

During the 2000s, virtual heritage become the primary technology for the dissemination of architectural heritage. Technological achievements such as faster graphic cards and higher hardware performance, high-resolution laser scanners, megapixel photography, GPS, etc. enable large access not only to professionals but also to public for teaching and education use. Moreover, they urge complex and accurate virtual environments (with high-polygon-count), with highly realistic textures and an increased level of interactivity. Nevertheless, when considering real time rendering, visualisation performance was still low.

An interesting project developed during these year's was the interactive 3D model of the battle monument of Octavian at Actium. Through navigation in virtual reality and interaction with object pieces was possible to understand the complex construction methods of this object, which not only was not possible to do in 2d representation, either with the real object, which could be damaged by manual use. Hence, VR in this case was used as a mean to offer new visualisation and interaction modes to relate to the historical objects or constructions. In other projects (ex. the ancient shipwreck found in Cyprus coast) VR was used to put together separate pieces of objects found, and to work on hypothesis of assembly. This model evaluation practice is standard in architecture schools and is used as a mean to check the visual impact of real object or objects that are projected in mind. In architectural heritage they constitute an instrument to test hypotheses about the past. In the historical reconstruction of Athens Acropolis, this practise was used to test the reconstruction and the visual impact of the old Athena Temple upon the classical structure of the Acropolis.

In the last decade, virtual heritage projects are employing advanced communication means such as interaction based on artificial intelligent communication between user or avatar and virtual characters, advanced manipulation of objects in VR, collaboration platforms that link models instantly and give access to users worldwide in real time.

In the VR reconstruction of Assyrian Northwest Palace was introduced interaction between users and virtual characters based on artificial intelligence. Visitors navigate inside the palace and background information's are provided to them depending on the various locations. Moreover, they meet virtual characters and can interact with them. Communication interactivity between them is based dialog stimulated by artificial intelligence. In this regard, research is going further. Interactivity based on the capacity to manipulate objects in 3d space was used in the case of digital reconstruction of historical objects made of separate pieces which needed to be put together (ex. an Egyptian wooden model of ship). This allows object verification, and makes possible various interpretations. In the last decade, digital technology and in particular VR has been

highly evolving allowing not only highly realistic visualisation, but also the possibility to developing interactive narrative of architectural objects or sites (interactive 3D story space). This

Year 1990's	Year 2000 's	Year 2010's
Simple 3d models	Advanced / realistic 3d models	Realistic /Accurate 3d models/
Low polygons	Higher polygons	Very high polygons
	BIM (Building Information Model)	BIM (Building Information Model)
Navigation in VR, limited viewpoints	Better Navigation in VR, Different viewpoints	Advanced Navigation in VR infinite number of viewpoints
Low interactivity	Better interactivity	Higher interactivity
		Simulation
		Manipulation and contribution of VE
		Collaboration
		Artificial intelligence

Figure 3. Virtual heritage characteristics in time (Source: author's)

makes it a highly useful tool to analyse and disseminate data in clear way, to visualise objects in an accurately and in a realistic way and introduce highly engaging environments. So actually, the challenge of interactive virtual environments for cultural heritage and not only, has become the design of virtual “experience”. According to Sanders (2012), there are five main group of users of Virtual heritage: 1. Historians of architecture, archaeology and conservation experts who are interested in understanding the past; 2. Visitors of museums 3. Students and education professionals 4. Researchers 5. Players.

Game elements for engaging virtual heritage environments

People learn about culture from observation, action and conversation (Champion 2006), which in virtual heritage can be translated in visualisation or representation, experience and interaction. According to Roussou (2007), these are the main components of virtual heritage environments and they represent also the principal video game components. That's why, video games as an interactive and dynamic visual media are a relevant tool to incorporate narration and ludic aspects and make the dissemination of virtual heritage more interactive and immersive. Having a different aim and utility compared to games/ video games, these virtual spaces are often known as serious games and serve as learning platforms/applications for research, education, entertainment and marketing. The application of game design elements in architectural heritage such as historic structures, monuments, cities, landscapes can offer a high level of user engagement. Below are listed and discussed the main game elements and their role in an engaging VH.

Representation

The representation of the architectural heritage in virtual reality usually tent to resemble or be faithful to the real world building. Nevertheless, depending on the target groups and purpose, in order to offer a compressible representation, the visualization can be subject of artistic interpretation (ex. in children education, video games). Nowadays technological achievements allow designers to achieve highly realistic representations. Highly engaging environments are influenced especially by the last two components experience design or storytelling and interaction, which contribute in creating an interactive experience in virtual reality. Other elements that make representation

engaging are 3D models seen as information systems, which embody data of different nature (architectonical, material, constructive, economic and environmental) and offer the possibility to access then in real time.

Design Experience through storytelling

An engaging virtual environment is an entertaining space that triggers interest and offers experience to the visitor. Experience is expressed through storytelling or the way the story is narrated. Various scholars (Nitsche and Roudavski 2003) sustain that “narrative” plays an important role in driving the virtual world and consequently in the success of virtual heritage projects. Stories in virtual heritage connect architectural historical objects to human experiences. In virtual heritage, narrative is not just the story you hear or watch walking through the space, but the events and the same spaces you see and discover and the way you are involved to interact with them. The Dissemination of heritage in VR is based on a story driven approach which grounded on collection, selection and display in a meaningful way of objects and information. They can specifically be multimedia elements such as image, sound or video narrative, miseen scene that immerse the user. In video games there are different type of storytelling lines which can serve as a tool to design a narrative based experience of virtual heritage. However, the story does not represent faithfully the historical content, but is an interpretative process. Moreover, it gives an insight on the virtual reality historical content and as a learning tool that engages actively the audience.

Design experience by introducing digital characters

Designers should include digital characters to enhance visitors experience in virtual heritage environment. According to professor and media artists Margaret Morse, virtual heritage without characters populating the story is like a kind of “Natura Morta” (Morse 1996). Virtual space becomes more engaging when user can see and interact with virtual characters, similarly as in real life. Although the focus of architectural virtual heritage is the object and space, the emphasis on the characters populating the space (virtual humans) is important not only to create the historical, social and cultural context and a sense of inhabitation of the space by adding significant value to architecture object but also to increase user motivation and engagement. Characters can help drawing attention and can be useful providing motivation to explore the virtual environment. They can be conversational agents that provide specific information or feedback on particular objects or sites. Moreover, the same user can become an avatar or role-play (Cruz-Neira, 2003) and perform actions inside the virtual space, or became actor/narrator effecting an interpretation of the story. Similarly, as in videogame, avatar can be personalized by choosing gender, body and physical features, style, clothing or character type. In both cases they learn about the environment by experiencing it as they were real citizens.

Design experience by stimulating senses

An engaging virtual environment needs to be multisensory to fully immerse the user into the environment. User for example can have a physical contact with the objects, can touch them

and have a feeling of the materiality. In architecture seeing and touching can help to have a full perception of the objects. Hearing can also help to interact with digital characters or interactive media present in the VR. McLuhan in the '70 predicted that the age of visual is overpasses and we are now into the age of the aural and tactile (McLuhan 1964).

Interaction: from navigation to manipulation and contributive interactivity

Engaging virtual heritage environments are not virtual space that resemble exactly to the real world. The component of interactivity usually offers a new, interpretative point of view that provides an escape from reality. Various authors (Jacobsen and Holden, 2007, Champion 2008) suggest that virtual heritage aim is to convey information and communicate cultural significance of historical objects or sites, and interactivity and simulation are powerful means to achieve this. Interactivity is the ability to interact with objects or characters in a digital or virtual environment. It includes exploration of virtual space through navigation, acting and completing tasks, communication between users or virtual characters, performing quizzes or queries, and real time collaborating.

Interactivity as navigation is visualization-based

Initially, interactivity in VH was limited to spatial exploration, the basic form of interactivity, which consists of walking, flying and examining objects in VR in a different perspective. Exploration depends on the possibilities of navigation, the amount of explorable area, navigation options and the possibility to experience a live experience of the site through augmented reality - mix reality. Interactive navigation interfaces include additional options such as moving the head, focus on point of interest, go ahead or backwards zoom in and out, pan, change viewpoints etc which are not always possible in the real world. Navigation could be either guided (passive) or person control movement (active). In both cases, user has different point of view and the freedom to move, but the environment is not interactive at all, as he cannot modify it.

Interactivity as manipulation and contribution is activity/task based

In video game design, actions and tasks are related to the need to complete or succeed a game goal. In virtual heritage, tasks are used to improve technical and historical knowledge, by involving in first person the user to learn by acting in VR. This can encourage users' interest and consequently his level of engagement. Last decades, advanced interactivity offers to the user the ability to change the environment (Ryan 2001) which include manipulative and contributive interaction (Pares and Pares, 2001). Manipulative interaction resides in the ability of the user to manipulate objects in VE and modify the virtual world, while contributive interaction transforms the environment by adding elements. Both of them are determined by the creator when designing interactive narration of VE and by the freedom of the user to transform the environment.

Interactivity as ludic activity

Ludic activity related to cultural heritage can engage users in

the learning process. Bellotti et al. (2012) suggested quizzes, puzzles, etc to be incorporated in virtual heritage applications as a way to learn similarly to the tests in books. EX. museum games are 'Virtual Egyptian Temple', 'Olympic Pottery Puzzle'

Interactivity as dialog and collaboration

The dissemination of architectural heritage needs to be seen not as a closed scientific activity reserve only to professionals, but as a communication medium that shares information between professionals, public and gathers feedback from them. Collaboration of virtual heritage communities refers to communication and shared experience between multiple users who share the same virtual space. It can be either by sharing materials (images, drawings, photographs, information, etc) , space or to take part in a dialogue with a real /virtual character. Dialog happens through artificial intelligence or pre-programmed character. Pre-programmed character can only respond to limited topics as predicted by narrator. Different authors (Cruz-Neira, 2003; Jacobsen and Holden, 2007), consider dialog and in general communication as an element to use in learning virtual heritage applications in order to involve students to be active members of that society. Similarly, to multiplayer games which allow collaboration of confliction relationship between players, virtual heritage can be a shared space where user is a role-play member and they can collaborate with each other.

Type of virtual heritage. The virtual heritage environments can be divided in two types:

Serious Games for Heritage. Virtual museum or virtual tour – Exploration of virtual herit

ELEMENTS	Sub- Elements	Details
REPRESENTATION	Realism and accuracy	Level of polygons, level of detail, texture
	Representation of the intangible	Cultural, historical, visual, behavioural values
	Visual and Environmental	Visual style
	Sensorial reality	Environmental effects, sound effects, etc.
DESIGN EXPERIENCE	Narrative / Storytelling	Voice over narration/ Story design / Branching design/ Interactive design
	Digital characters	Avatar/ Personalised Avatar/ Role-play/ Multiplayer
	Stimulating senses	Five senses
DESIGN INTERACTION		Moderate motion: walk, fly, examine, turn head, rotateobject of interest, go ahead/back, pan, change camera optics, jump to another viewpoint, etc. Location Reference: Time and space
	Navigation	
	Manipulation and contribution	Move, add, change, edit etc.
	Ludic activity	Quiz, challenges, missions, achievement, levels
	Dialog and collaboration	Multiplayer in virtual social space

Figure 4. Elements of Game design for an engaging virtual environment (source: authors)

age is made through navigation, access to data and information, digitalised archive etc. Exploration can occur through VR a 360 grade photographic exploration or 3D reconstruction in which visitor can navigate. Ex: Walk through Ancient Myletus; The Virtual Egyptian Museum etc.

3D model prototypes – that simulate architectural heritage, but have also an interactive content on historical buildings or sites given in some cases also by virtual characters (Ex. Historical video game "Pompei: The Legend of Vesuvius"; Serious game 'Roma Nova'). They aim is to teach notions of history by providing not only realistic and historical fidelity exploration but also political, religious and artistic living

background and virtual characters that act within the virtual environment and offer interactive communication to the user.

Entertainment Video Games for Heritage

Entertainment Video Games for Heritage are fun games that provide players knowledge of historical content by offering them the possibility to engage with the past. Players are invited to be part of events such as battles, construction processes, rituals etc and to learn about people, objects and history. (ex. Napoleon: Total War (2010), is a strategic and tactic video game set during the napoleon period. Player immersed in this historical setting learns about. Below a series of virtual heritage will be analysed considering the methods, techniques and outcomes related to the purpose of the project.

Analyses of Case Study

Serious game for Virtual heritage analyses

Virtual tour and virtual platforms in Albania

In the last years, in Albania have been implemented a series of projects related to virtual heritage. Most of them were virtual tours or platforms based on 360 VR technologies, such as Museum “House of Kadare, Historical National Muzeum Historik, National gallery of Arts, and the platform for cultural heritage in Italy (Puglia), Albania and Montenegro. In Virtual tours is possible to navigate in 360 photographic VR, to make measurements of the space and to access text-based information on particular objects inside the space. The virtual platform part of the project 3Dimpact is an online documentation platform on historical castles and provides digitalised archive with large information (textual, web-GIS maps, 3d scanned model of monuments, 360 VR) about selected castles in both countries. Hyperlinks are used as navigation tools in the navigation map in the top right part of the interface. In both cases the level of interactivity is very low and only basic game tools has been used, mostly related to navigation map and basic blueprints used for detailed information about specific elements in the visual frame.

Virtual heritage and virtual platforms worldwide

VIRTUAL ROME platform (2008)

Virtual Rome is an online platform build by Virtual Heritage Lab of ITABC-CNR in collaboration with CINECA. This platform is built to visualise and explore in real-time the archaeological landscape of Rome in the 2nd century AC. (Pescarini et al, 2008). It includes also open-source technical information, data and 3D models that create a cooperative environment that involves different professionals that work for interactively reconstruction of Rome.

Project workflow is based on the following steps:

- the development of the plug-in for Internet Explorer and Mozilla Firefox; 3 OSG4WEB PLUGIN
- the development of 2D and 3D contents (Highly detailed 3D terrains, vegetation, optimized 3D models, multimedia hyperlinks, a 3D Internet site).
- Reduction and optimisation of 3D contents for interactive web deployment

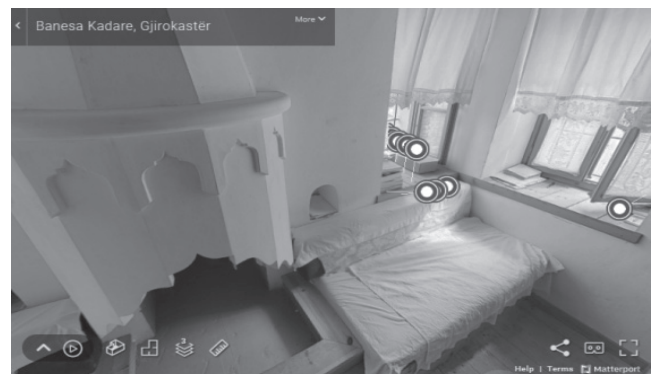


Figure 5. Screenshot of Virtual museum of Kadare House (source: <https://kultura.gov.al/3dsite/banesa-kadare-gjirokastrë/>); Screenshot of virtual platform “3D impact” for castles of Albania, Italy and Montenegro (source: <https://3dimpact.poliba.it/>)

the development of a Plug-in for 3d space navigation: Open SceneGraph,1

- The creation of a front-end 3D interactive environment for on-line exploration of large archaeological landscapes. This allows users to explore the scene, acquire information (orientation, height, speed, position, and other useful data for immediate feedback) and interact by switching between two different terrain models.
- The development of ViRo, a navigation system that provides the user with a simple and usable tool to explore the virtual world. Users can walk inside the monument and fly up to different historical periods. Advanced collision detection and obstacle avoidance algorithms, joined with different exploration modes, are provided together with the walk mode, using basic physical effects such as gravity and surface adaptation.
- The development of a BACK-END collaborative system (VR webLAB) in order to enable the integration of the reconstructed 3D terrain dataset, high resolution 3Dmodels, vectors, vegetation information, and metadata edited dynamically.

ROME REBORN (2007- 2018)

Reborn is a series of 3D digital models that presents information and illustrates the urban development of ancient Rome in 320a.c. The model has detailed information about the identification, location, and design and accurate visualisation of approximately 250 buildings belonging to Class I monuments, while Class II buildings, lacking detailed information, are very schematic and rely on textures instead of geometry for architectural

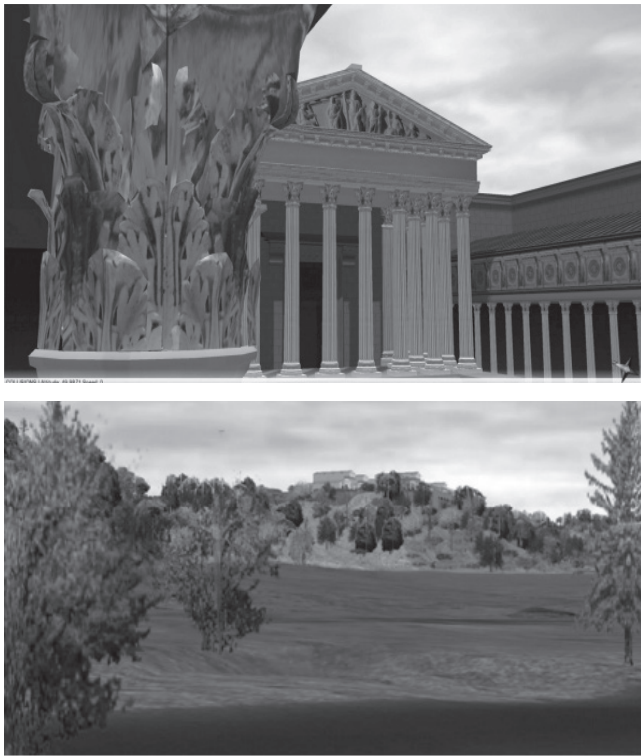


Figure 6. Virtual Rome (source: Pescarin, et al 2009)

al details. The overall image is based on realistic environment with interactive lighting. This platform is used for knowledge about the urban topography, infrastructure and monuments of ancient Rome at various periods of time. The model has data such as on built features in the city and can be used to run urban or architectural experiments, such as how well the city or the buildings within it functioned in terms of heating and ventilation, illumination, circulation of people, etc. Its purpose was to present to students or public the image of the city and the main architectural monuments of a particular period and to create a collaborative platform for professionals to discuss theories and ideas regarding the urban history of ancient Rome and its hypothesis of reconstruction. Rome reborn was first displayed on PCs as a real-time interactive urban model using Open Scene Graph. In the new version 2.2 were added animations of humans moving on the city streets (Dylla, et al 2010). This digital characters, although are passive, contribute in giving the model a sense of scale. As regarding interactivity design, this platform offers a smooth walking and flying navigation from ground level to bird's-eye view of the city. While moving in VR and come up against monuments, user can listen to the story of that particular object. Still the level of interactivity is limited to ordinary type of navigation and audio interactivity.

VIRTUAL KYOTO (2008)

Virtual Kyoto is a virtual representation of the historical development of the city of Kyoto in Japan. The platform displays first a 3D modelling of the city reconstructed referring to the main historical periods of development. It includes also an organized archive of materials of the development phases of the

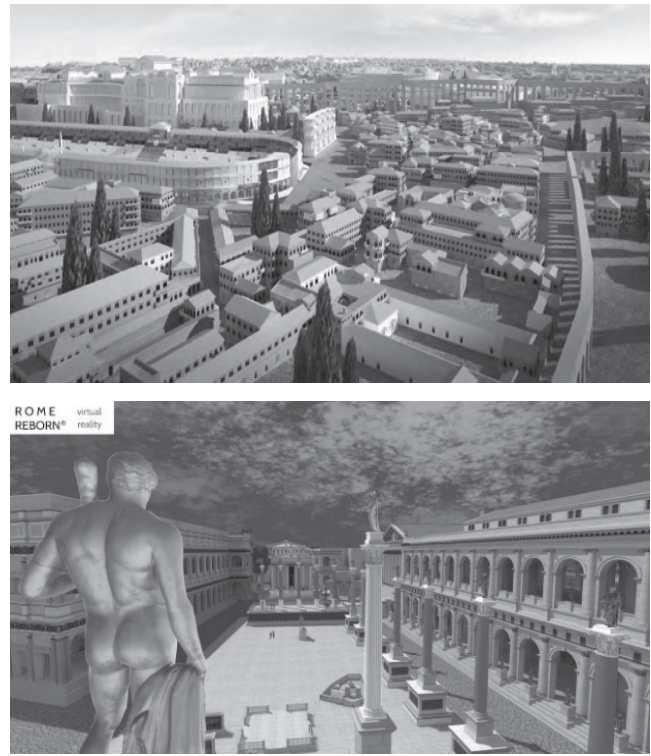


Figure 7. Snapshot of Rome Reborn bird eye view of the 3D model (source: <https://www.romereborn.org/>)

city: different type of maps (historical, topographic, cadastral maps, aerial photographs, historical landscape painting and photographs, historical documents, street and buildings photographs). Moreover, it provides a digital infrastructure which contains a database of all existing buildings and historical or cultural heritage archive, in particular numerous temples and shrines which were also created in 3D. The 3D models were not detailed and therefore the overall reconstruction and visualisation of the city is in low quality. The aim of the platform is to simulate the land use and landscape changes in the different development periods and to disseminate the cultural and historical heritage of the city. The system provides a user-friendly interface and allows users flying-through city, viewing detailed building models and access associated information on each of them. User, by walking through the city, in real time, to have the possibility to change the configuration of the city at the same viewpoint turning from present to past.

SIRACUSA 3D REBORN (2013)

Syracuse 3D Reborn is 3d documentary that described and analysed monuments of Syracuse and war mechanism and devised conceived and designed by Archimedes in that context, offering the opportunity to learn about history. The whole context has been reconstructed digitally including the main buildings. After building accurate 3D models and rendering them, all scenes were processed in with “Adobe After Effects” program in order to create realistic effects of smoke, fire, sea foam etc. Since the Virtual reality in this project was used in the context of cinematographic, a narrative was incorporated, divided in two themes which represent the two historical phases of the

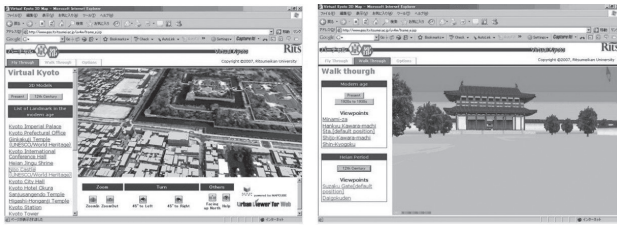


Figure 8. Fly through and walk through Virtual Kyoto (source: Takase at al, 2012)

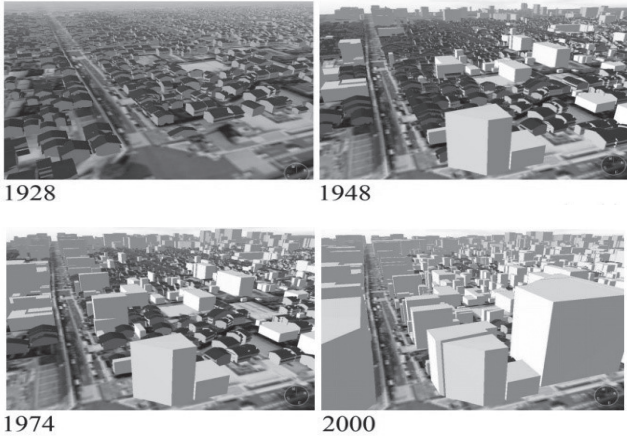


Figure 9. Changes in urban landscape of Kyoto- Virtual Time-Space of Kyoto (source: Takase at al, 2012)

site development. The first phase was illustrated through the road network, houses blocks and the public area configuration including the main temples. The second phase was based on the transformation and destruction of part of the city and the construction of new buildings, fortifications and monuments. Narration was conceptualised and visualised through storyboard, in which was given particular emphasis to the detailed recreation of artefacts and digital characters animating space which through their acting provide knowledge about the historical and social context. Images and 3D reconstruction of site was overlapped by illustrative texts and audio. In this case, documentary aim was didactic and the story as based on the historic urban development and the main events happening in Syracuse during that period. For this purpose, initially was the interpretation of historical context. Therefore, an intentionally didactic narrative was translated into a storyboard in which was chosen to provide passive cognitive tools (typical of documentaries) to transmit knowledge without diminishing the emotional aspects.

VIRTUAL TIME TRAVEL OF PRE-REFORMATION EDINBURGH (2017)

The virtual reconstruction of pre-reformation Edinburgh is a project that offers the opportunity to see the old city of Edinburgh as it was prior to the reform and to move along houses, marketplaces, and streets connecting the virtual with the real. This platform offers the possibility to experience dual realities (virtual and real) on the same space by using digital time travel binoculars. Visitor are considered as virtual-time travellers as they can contemporary see the various historic layers while moving along the city streets. “Position and orientation within the two worlds are synchronised enabling intuitive exploration



Figure 10. Snapshots from Siracusa Reborn documentary (source: <http://www.archeotour.eu/en.html>)



Figure 11. Snapshots from Virtual time travel of pre-reformation Edinburgh

of both worlds through movement in the real world” (Miller and Millican 2016). Moreover, visitors can navigate inside important historical buildings. This project is based on 360 photographs of a reconstructed historic model developed in the UN-REAL4 Game Engine. This offers also a friendly interface, and an interactive navigation with video fly-throughout the city and interactive map.

INCEPTION - Inclusive Cultural Heritage in Europe through 3D Semantic Modelling (2015-2018)

Inception is a platform for cultural heritage documentation and dissemination among different stakeholders such as scholars, professionals, authorities and visitors or non-expert users in order to promote the accessibility and spread the knowledge of European heritage. The platform is based on the development of time-dynamic 3D models of buildings, sites and artefacts, which are semantically enriched in the digital content with documentation, analysis and management tools. It includes different categories of data recording such as historic material, geometric and architectural model, building materials, structure and structural analyses, external condition assessment, risk definition and conservation interventions that contribute in creating a library of parametric objects. These objects (BIM models) contain geometric information in order to be updatable for professionals and useful for conservation purpose. The platform in itself contains not only a digital representation of object in H-BIM, but includes also the management of data from different disciplines. Every user was enabled to upload data, materials and information in relation to BIM models, updating a single file in real time. (Maietti et al 2018). Herein, the platform is open and interactive, and allows experts of various disciplines to give a contribution and actively collaborate with each other sharing updated content and facilitating cross-disciplinary researches and public users for education purpose. The dissemination of content was based on in situ applications for tourists and professionals and remote applications for audience that is interest in accessing knowledge about cultural heritage.

This platform has structured an methodology for data acquisition based on Heritage Building Information Modelling (H-BIM) which facilitates time-dynamic update and online collaboration. However, referring to an engaging virtual heritage the platform is not highly immersive.

First, interactivity is limited, because real time navigation is slow and the navigation tools used are zooming, clipping planes, change shades, walkthrough, pan, rotate, filter elements, etc. (Maietti et al 2018). Changing viewpoints, fly-modes and other type of navigation that offer new insight of the buildings or site are not used. Moreover, it there is limited interaction with objects. Users can perform action on the model, “such as visualize and download videos and images, select elements of the model, measure distances or surfaces or move within the model.” (Maietti et al 2018). In addition, objects and their components can be visualised separately based on filters, but they cannot be manipulated, moved or transformed. Moreover, there is no ludic activity included, as the platform is mainly for professional use.

Referring to experiencing of virtual heritage, there is only the possibility to be engaged by running virtual guides (Maietti et al 2018). For the rest users can not really immerse themselves in virtual heritage, since there is no narrative and non tangible cultural aspects of historical buildings and sites are not covered. As regarding representation, the visualisation of historical buildings is low quality texture resolution.



Figure 12. Inception Platform interface. 3D model and possible interactions (BIM model, point cloud, images, documents, videos, etc.) (source: Maietti, F et al (2018)

GAME ELEMENTS		Virtual Rome	Rome Reborn	Virtual Kyoto	Siracusa 3D reborn	Edinburgh	Inception Platform
REPRESENTATION	Sub- Elements						
	Realism and accuracy	Yes and no	Yes and no	no	yes	yes	Yes and no
DESIGN EXPERIENCE	Interpretation of visual and auditoria reality	no	no	no	yes	Yes	no
	Narrative / Storytelling	no	no	no	yes	no	Yes and no
	Digital characters	no	yes	no	yes	no	no
DESIGN INTERACTION	Stimulating senses	limited	limited	no	no	no	no
	Navigation	yes	Yes bird eye, human	yes	predefin ed	Yes Time and space	Yes, limited
	Manipulation and contribution	no	no	no	no	no	Yes and no
	Ludic activity	no	no	no	no	no	no
	Dialog and collaboration	yes	yes	no	no	no	yes

Figure 13. Analyses of game elements in Virtual heritage museum or platforms (source: Authors)

Entertainment Video Games for Heritage ASSASSIN’S CREED (Ubisoft Montreal, 2009-2020)

Assassin’s Creed is a 3D action adventure game set in different historical contexts such as the Renaissance epoch in Italy, the Revolutionary Paris of 1798, the Victorian London of 1868; the Ancient Greece and Egypt, etc... The games recreate digitally famous historical sites and characters with great cultural, visual and behaviour fidelity and accuracy based on historical documents, in order to transit realistically the spirit of that epoch. In this way it serves players t learn about that epoch but can serve also the scientific community as the reconstruction of historical sites or buildings for this game were high accurate. However, some alterations to historical facts or material evidences were made for the sake of the game. For virtual heritage this game becomes important, not only because of the 3D VR representation of particular sites in time and place, but also because of the incorporation of database, in particular in the latest series. The game’s database means detailed information about characters, objects or locations which the player meet during his adventure journey in the game world. Moreover, as a video game, it presents high interactivity, in terms of navigation possibilities, manipulation of the game world. Objects and characters part of the game world are movable within certain limits. (ex. houses can be taken and used to speed up the player and to accomplish the game challenges). In advanced series, Assassin’s Creed presents dialog choices with text options. Navigation mode is also more flexible, with the possibility of scaling viewpoints.



Figure 14. Snapshot from Assassin's Creed Video game. Reconstruction of Notre Dame Paris and Reconstruction of Renaissance Florence.

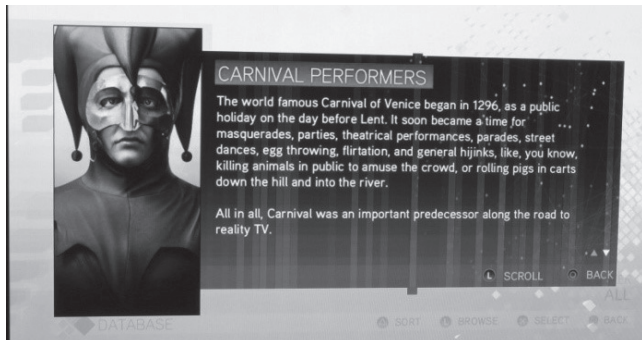


Figure 15. Snapshot from Assassin's Creed Video game. Database on characters and dialog choice.

RED DEAD REDEMPTION' (Rockstar San Diego, 2010).

'Red Dead Redemption' is a 3D action adventure game set in American-Mexican border at the turn of the 20th century. The geography of the site mirrors highly realistic and sublime landscape in the United States. Redemption is built on third-person perspective, following protagonist John Marston, who plays the role of an historical character, the cowboy archetype. The introductory sequence of the game is based on a dialog between virtual characters which introduce the protagonist, the story and set the historical background. Along the way, the player meets different characters, learn about their backgrounds and their life's. The development of the narrative structure offers the, player high degree of freedom and allows emergent game narrative. The player can chose between different characters and

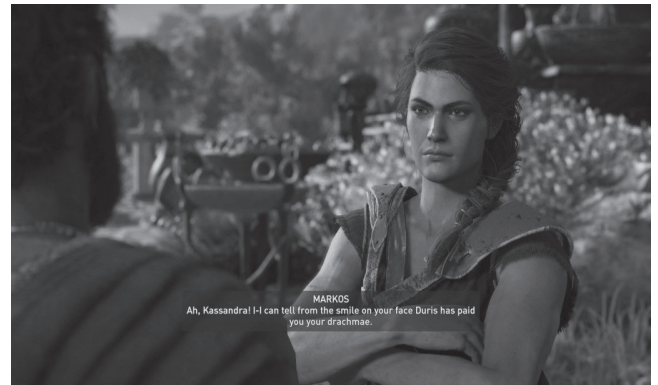


Figure 15. Snapshot from Assassin's Creed Video game. Database on characters and dialog choice.



Figure 16. Screenshot from Red Dead Redemption: protagonist in the realistic game world (on the left the interactive map); on the right weapon options and information wheel)

GAME ELEMENTS	Sub- Elements	Assassin's Creed	Red Dead Redemption
REPRESENTATION	Realism and accuracy	Yes and no	Yes
	Interpretation of visual and auditoria reality	yes	yes
DESIGN EXPERIENCE	Narrative / Storytelling	yes	yes
	Digital characters	yes	yes
	Stimulating senses	limited	yes
DESIGN INTERACTION	Navigation	yes	Yes bird eye, human
	Manipulation and contribution	yes	yes
	Ludic activity	yes	yes
	Dialog and collaboration	yes	yes

Figure 17. Game elements used in highly engaging video games (source: Authors)

different activities to do like free exploration, hunting treasures or animals, etc. In addition, there are multiplayer options available, which make the game a collaborative platform.

Conclusions

Virtual reconstructions and interpretations of history and culture is becoming increasingly important in shaping our perception of the past. In the past, virtual heritage was limited to the accurate and realistic visualisation of objects and sites. The above case studies of 3D, virtual tours or interactive platforms as virtual representations of historical heritage, are a tentative to enable people to relive historical space, to understand it and learn about the past in an engaging and entertaining way. They open up to the opportunity to create interactive storytelling experiences by combining interactivity with narratives in virtual environments. In entertainment Video Games for Heritage, it's evident that the level of representation, design experience and interaction is higher and complete in all elements that guarantee engaging space in virtual reality. Therefore, game design tools need to be taken into account when designing virtual heritage. Game engines supporting highly detailed game worlds and being equipped with artificial intelligence, are able to offer interaction while being guided by a story model.

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