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VIRTUAL PLATFORMS FOR HERITAGE PRESERVATION IN THE MIDDLE EAST: THE CASE OF MEDIEVAL CAIRO

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Abstract

Much of the effort in virtual heritage (VH) is directed towards accurate representation of historic structures, objects or artefacts. There is little attention paid, however, to the human aspects of city life, the intangible heritage to which people can actually relate. Digital models of historic buildings and spaces only give a sense of precision. Yet, rituals, human attitude and cultural traditions remain a gap in current research and advanced technology in heritage visualisation. Virtual Heritage Environments (VHE) suffer from the lack of 'thematic interactivity' due to the limited cultural content and engaging modules largely used in photorealistic video gaming systems. In order to approach virtual fidelity and accurate reproductions of historic environments, this paper reports on a research process to investigate and incorporate a Cultural-feed into digital platforms of Virtual Heritage. In doing so, the paper focuses on the Middle East in general and Medieval Cairo in particular. It discusses a conceptual and practical framework for the development of virtual heritage platforms as a research, educational and engagement tool that brings historic spaces and buildings back to the recognition of the public eye; the ordinary user. It analyses current practices and projects of virtual heritage technologies and reports on field work that took place in Islamic Cairo with five Start-Up entrepreneurs.

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INTRODUCTION

> *"We understand that the past did not happen in 2D and that it cannot be effectively studied or taught as a series of disconnected static images"* Sanders (2008).

Iconic heritage is increasingly threatened by terror, climate change, rampant commercialisation, and overexploitation by tourism; and in some cases, by significant disinvestment. Lack of responsible planning, maintenance and preservation strategies have equally caused unmitigated dereliction and irreversible damage to many heritage sites and cultural traditions in the medieval Middle East. With the increasing rate of destruction of heritage sites, such as Palmyra in Syria, digital preservation of historic artefacts and cultural heritage has become an international priority (Denker, 2016). Hence, strategies, practices and technologies that can protect and sustain these places in other forms of reproduction - such as digital modelling, immersive virtual and augmented reality, and cinematography and Audio-visual archives - have been key aspects of cultural heritage preservation over the past decade (Roussou, 2008). Virtual environments which encompass cultural heritage offer the possibility to experience virtually reconstructed historic sites as visitors or travelers.

Much of the effort in digital archaeology over the past two decades had primarily been directed towards accurate documentation, recording and representation of historic sites and buildings with not much emphasis on the socio-spatial patterns of human aspects of city life (Yang et al., 2006; Goodrick & Gillings, 2000). Although virtual heritage, by contrast, possesses great potential to reconstruct our heritage and memory, critics often blame high cost, sophisticated hardware and software requirements, inaccessibility of technology and training, and high maintenance for preventing widespread dissemination and use of virtual heritage platforms (Mosaker, 2001). Recent virtual heritage applications recognise the necessity of incorporating non-human controlled characters in order to enhance presence and provide the user with an engaging experience (Vosinakis & Avradinis, 2016). Cultural content of Virtual Heritage focuses on the potentials of reducing technical limitations and addition of sub-grid cultural terrains to attain a degree of 'reality' and photorealism of culture as a measure for virtual environments; leading towards the amorphous nature of history. Trends in virtual reality applications, as a consequence, have become increasingly motivated by the use of immersive technology for real-time interaction.

Virtual, visual and digital display of lost heritage in the Middle East has inherent values in both the tourism industry and the education process for students in pre-university as well as graduate education. For architecture and archaeological students, in particular, it transfers theoretical courses of archaeology and conservation into real simulations of narratives and historical atmosphere. It helps enlivening the socio-cultural memory of local communities as essential part of their historic continuity and appreciated of heritage (Abdelmonem & Selim 2012). For conservators, historians and archaeologists, it helps develop a rich library and digital archive of details, information and data necessary in restoring historical sites (Abdelmonem, 2017). In this paper, we aim to uncover a conceptual framework for the development of virtual heritage platforms as a research, educational and engagement tool for the Middle East's historic cities that brings historic environments back to the recognition of the public eye of ordinary users. The paper analyses current virtual heritage productions both globally and regionally with focus on the centrality of narratives where life is explored and practiced in motion. The paper introduces an analytical approach to virtual heritage platforms including techniques, contexts, and outputs that are suitable to different purposes.

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THE INTERFACE BETWEEN ARCHITECTURE, CULTURAL AND VIRTUAL HERITAGE

The first use of virtual heritage emerged with the first 'walk-through' of a 3D reconstruction of Dudley Castle in England as it was in 1550, through virtual tour settings in 1994. This consisted of a computer controlled laserdisc-based system designed by British-based engineer Colin Johnson (Sanders, 2008). Queen Elizabeth II was one of the first users of this new virtual environment, when she officially opened the visitor centre in June of the same year. As part of the opening ceremony programme, the system was named Virtual Tour, being a cross between virtual reality and Royal Tour. Ever since, computer and digital applications for heritage have vastly progressed over the past two decades on the back of huge leap in technological innovations to approach the problems of archaeology and heritage preservations (Ch'ng, 2013). Early methods of digital archaeology or archaeological computing were seen as methods for the elaboration of archaeological data using quantitative computing. Later versions, however, contributed to the representation of archaeological data using cognitive procedures. Virtual Archaeology, in this context, has become a primary discipline in the analysis of the procedures of management, interpretation and representation of archaeological evidence using 3D computer graphic techniques.

The breakthrough in the digital reconstruction of historic events, lost structures or disappeared heritage enabled both theoretic and applied research to test different propositions and narratives, and undertake forensic examination and analysis of archaeological remnants of the past (Guttentag, 2010). However, Virtual Archaeology (VA) remained a specialised platform for researchers and archaeologists for research-led activities. The public was not involved in its applications, and nor were its outputs intended for public consumption and use. The proliferation of the use of 3D modelling techniques, nonintrusive imaging, geophysics and augmented reality cameras has offered a multiplicity of platforms to simply store, archive and communicate vast amounts of information on cultural heritage sites, traditions and contents.

The Neues Museum in Berlin, for example, has collaborated with CultLab to scan and develop a virtual Model of the Nefertiti Bust to enable a larger audience to visualise the details of the masterpiece without exposing the invaluable artefact to damage. Similar to the Neues Museum, the Louvre and Victoria & Albert both offer online Virtual Tours curated for public audiences and children (Kidd, 2015). It is not uncommon to find museums rendered in Minecraft, built by an invisible crowd of tech-savvy fans, as in the British Museum's Museumcraft, or Tatecraft. The EU's DigiArt project use drones, 3D Laser scanners, and 60 cameras to "capture" inaccessible cultural artefacts, before creating advanced 3D representations of them. It uses augmented and virtual reality technologies for viewing, or interacting with the 3D models as a pathway to deeper understanding of artefacts. DigiArt (2017) provide innovative 3D capture systems, including aerial capture via drones, automatic registration and modelling techniques for post-capture processing, semantic image analysis and digital 3D representations via a "story telling engine".

In this discourse, the rhetoric of authenticity has been debated and contested as opposed to originality. Authenticity has traditionally been key to the way museum experiences are packaged and displayed to the public users. What is remarkable is how far we have come to offer realistic interactivity with historic environments, and the way in which the boundaries between virtual and physical experiences have begun to blur. Being able to test new forms of reality that no longer exist raises intriguing aspects of re-reading and reinterpreting history in the eyes of the audience, rather than the curator. For example, a Mummy never existed in

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daylight, nor the setting in which pharaonic artefacts were mostly discovered. Virtual models enable these experiences in a way the normal museum could never offer.

VIRTUAL HERITAGE AND IMMERSIVE ENVIRONMENTS

> "[*Virtual Heritage is] an attempt to convey not just the appearance but also the meaning and significance of cultural artefacts and the associated social agency that designed and used them through the use of interactive and immersive digital media*" (Champion, 2015: 95).

According to Erik Champion (2016), virtual heritage has eluded clear and useful definitions and it has been even more difficult to evaluate. Virtual heritage aims to recreate cultural heritage environments as well as presenting historic information, context and practices as accurately, authentically and engagingly as possible. Virtual heritage is the fusion of virtual reality technology with cultural heritage content (Addison, 2000). Stone and Ojika (2000: 73) defined virtual heritage 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." (Champion, 2016). However, the idea of cultural content is rather limited and increasingly is under representative of several intangible aspects of cultural heritage; which were summarised by Pujol and Champion (2013) & Ch'ng (2013) as "practices, representations, expressions, knowledge, skills – 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".

As history is increasingly contested due to different interpretations of evidence, being tangible or intangible, virtual heritage becomes accustomed to interpretation, contestation and analytical debate. Virtual heritage and cultural heritage, in such theoretical contexts, pose different and independent meanings; cultural heritage refers to sites, monuments, buildings and objects with historical, aesthetic, archaeological, scientific, ethnological or anthropological value, whereas virtual heritage refers to instances of these within a technological domain, usually involving computer visualisation of artefacts or virtual reality environments. Virtualisation is, however, much more complex and multi-layered than visualisation that is to form a mental image of something incapable of being viewed or visible at a certain moment (Pujol and Champion, 2013). It involves the verification of not only the specific moment, site or context, but also narratives, practices and habits (Madary & Metzinger, 2016).

While the 'London Charter' of 2009 defined computer-based visualisation as 'the process of representing information visually with the aid of computer technologies', scholars have demanded that this narrow definition is extended to include the non-visual aspects of visual experience, the haptic, auditory, olfactory and generally multi-sensory. Pujol and Champion (2013) stressed that it is not enough to reproduce a set of artefacts and archaeological objects as individual items separated from the story and context that give them meaningful representation. According to Yaram et al. (1997), perceiving the intangible is at the foundation of all human culture. Then, as cultural heritage refers to historic periods and societies that no longer exist, we face the troubled task of how to virtualise aspects that are not visible, and whose evidence of existence is scattered items, objects, spaces and series of unconnected narratives. In fact, Virtual Heritage Cairo argues that while visualisation of archaeological sites, objects and artefacts offer a detailed record of physical environments,

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those intangible aspects of heritage experience, namely, cultural-feed, would enable effective human interaction and understanding of the historic narratives in line with modelled objects. As we focus on cultural heritage, in contrast to archaeological preservation, we have to refer to the human sensory experience with history. Cultural geographers, in particular, tend to associate culture with what is not seen.

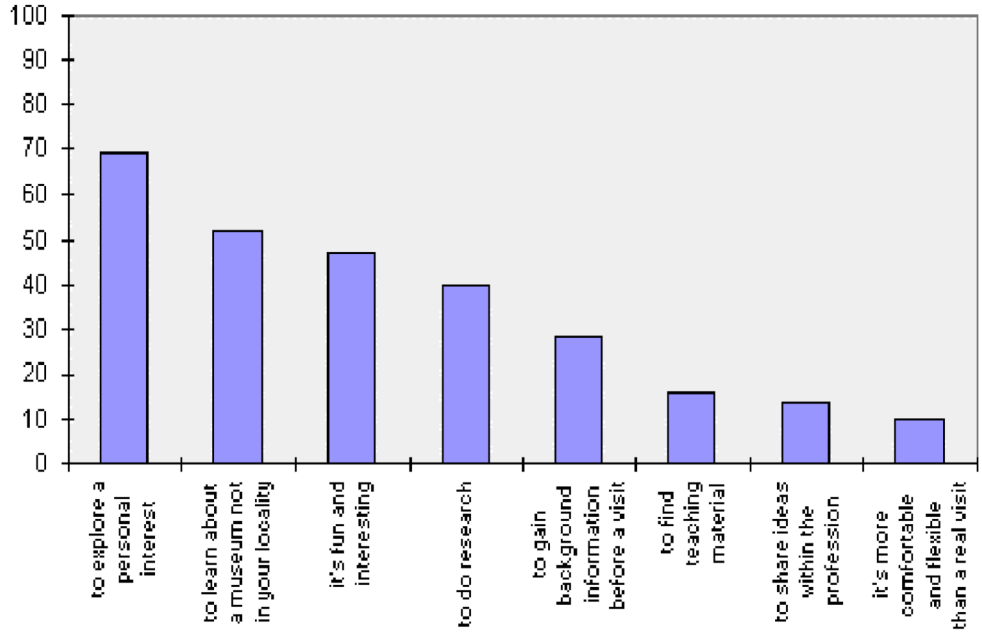

Figure 1. Benefits of Accessing Museums' collections by the Internet
(Source: Pietsch & Steinmann, 2004).

METHODLOGY: VIRTUAL INTERPRETATION OF HERITAGE

Virtual production of heritage is centred around a three-phase process: 'Collect, preserve and display', which we will analyse below:

Collect: Virtual museums cannot handle objects in the way that a physical museum can, as collecting is not only referring to physical objects. It is, however, possible to collect information through different layers of narratives, of which physical and spatial characteristics is only one aspect. It involves several disciplines that not only combine archaeological records, digital surveys and scans, but overlay several socio-cultural and historic narratives collected from literature, archives, or a variety of other resources. Through this sort of collecting, the audience could contribute with various types of multimedia to create or increase the collection through crowdsourcing.

Preserve: Though the virtual born digital collections would not require the same preservation strategies as per physical ones, there would still be a need of critical process of preserving the record, authenticating the data and certifying the original digital record and immaterial content. Being interpretive as well as descriptive, preserving ideas have to be put into consideration. In addition, storage media is becoming increasingly cost efficient, however, files also tend to grow larger with the introduction of new, and better-quality file formats (Addison, 2008).

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Display: All virtual museums have some way of interpreting and displaying heritage in a customised manner, that is particular to its creator, that is commensurate to the original artefact production. Such interpretations promote various types of activities and are designed to engage the user in different themes (Chen & Kalay, 2008). Not only does this accessibility turn the museum global but it also contributes to a sort of democratisation of the museum, making museum collections available to theoretically anyone (Malpas, 2008). Putting content online in the shape of databases, virtual museums, personalised exhibitions etc. let not only people of various cultures enjoy each other's cultural heritage, but would let societies to get a virtual access to its own heritage that is being exhibited elsewhere. (Fahey, 1995).

Although a virtual exhibition cannot replace or diminish the value of experiencing the original exhibits, there are cases where it can enhance the visitors' experience and draw new visitors to museums (Lepouras et al., 2001). Exhibition designers can easily change a collection's contents and the mode of presentation to suit a target audience. The system's VR/AR technologies extend standard Web presentations and allow visitors to interact with digital models of cultural objects in an intuitive and exciting manner (Walczak et al., 2006). The revolutionary exhibition 'Sensorium' at the Tate Britain in 2015, tried to transform the visitor's experience of displayed paintings that should be perceived not only with eyes, but also with all five senses in a real, tangible experience. The exhibition, conceived by London-based studio Flying Object, was established by Tate and the Porter Foundation to promote digital creativity. In the exhibition, four paintings by Francis Bacon, David Bomberg, Richard Hamilton and John Latham were on display around which a complex multi-sensory experience develops. Visitors can "touch", "smell", "taste", "hear", and of course see, each painting by a series of cutting-edge interaction solutions and technologies, aimed to expand their experience and trigger engagement and imagination.

Similarly, in the Uffizi Gallery in Florence, an interactive installation was on display in October 2014 that aimed to allow visitors to virtually visit the Tribuna, a space not physically accessible to the public because of conservation issues and visible only through side openings. The multimedia and interactive installation not only allowed people to virtually tour the octagonal space of the Tribuna but also provided details and infographics on its architecture and history as well as on the precious artworks it contains (Figure 2). In an ideal scenario of a virtual museum's tour, the "visitor" is placed in the virtual environment (CAVE) of a 3D heritage site scene with a first-person perspective of the site's terrain, seeing the scene and its monuments as it would be seen in real life. The terrain should be of the highest detail with a high-resolution texture. CUTURAMA Exhibition of Egyptian History is another immersive technology application of virtual heritage that enables the visitor to navigate through accurate recordings and displays of different dynasties and buildings (CultNat, 2017). Using the keyboard and/or mouse, the visitor should be able to manipulate the view to create a sense of place and the atmosphere of walking through the scene (flying could also be incorporated). The visitor should then be free to "visit" 3D heritage structures. When arriving at a structure the visitor should be able to view 360 degree photographic panoramas of the environment to add sense of reality.

Musée du Louvre in Paris (Louvre, 2013) has constructed a virtual tour of its collection that consists of a simple web site containing 360 degree photographic panoramas. An overall map allows navigation and indicates the various available points of view in the visit. The virtual visit of Oxford (2017) uses interactive web pages which allow users to explore and to manipulate 360 degree photographic panoramas of the city and university, constructed from hundreds of high quality photographs of the city, with a photography tutorial blog about how these panoramas were captured and created. Google Foundation's World Wonders Project

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(WWP, 2012) offers a virtual exhibition of 130 historic sites in more than 18 countries that it documented within a website, comprising panoramic views, associated information in descriptive index sheets, videos of users and more rarely 3D models. Integrating these into its flagship Street View technology, Google has a unique opportunity to make world heritage sites available to users across the globe. The World Wonders Project presented a valuable resource for students and scholars alike.

Figure 2. The virtual Tribuna, the installation at display in Uffizi Gallery in Florence (Source: Federica Luiardi, January 23, 2017; www.inexhibit.com).

Figure 3. Culturama CAVE Project, by Egyptian Centre for Documentation of Cultural and Natural Heritage (Source: CULTNAT).

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VIRTUAL HERITAGE FOR THE MIDLE EAST

> *"The worlds can be created, dynamically revised, visited, and populated in ways that offer near first-person simulations of the ancient world"* (Sanders, 2014).

Two projects in particular provide evidence on both the benefits as well as the problems that face the production of Virtual heritage in Middle East's historic cities. The first is the virtual modelling and Egyptian History interface developed by the Egyptian Centre for Documentation of Cultural and Natural Heritage (CULTNAT), called Culturama. CULTURAMA is a display that allows the presentation of a wealth of data layers, where the presenter can click on an item and go to a new level of detail. The hardware part contains a huge 180 degrees' panoramic interactive computer screen with a diameter of 10 meters that consists of nine separate flat screens arranged in a semi-circular shape and nine video projectors controlled by a single computer. Interactive multimedia software was especially developed to enable the display on the panoramic screen. It has increased public awareness of Egypt's heritage using all available modern technology and helped to build capacities of professionals in the fields of conservation and documentation of cultural and natural heritage. It, however, suffers from the limitation of engaging socio-spatial practice of everyday life that are yet to be integrated into the digitally produced models. The digital models of historic buildings are also primitive in their construction and details captured.

The second project is the HIP Pyramid Scan. In parallel to the exploration missions, the company Iconem realised a photogrammetry campaign using drones and laser scanners, to rebuild Giza plateau and the site of Dahshur with all their monuments in 3D, with a unique centimeter precision. This campaign is entirely dedicated to the advancement of knowledge either to restore or to discover pyramids. It is implemented by a team of international professional experts. The laboratory of the Japanese team, dedicated to the development and analysis of the images captured by muons radiography, has already been installed in Cairo. If these technologies are effective, they can even be implemented in other countries. Two-infrared thermography was used to establish a thermal map of the pyramids to reveal differences in density and to identify any voids behind the faces of the pyramids. Additionally, there are two missions using muons radiography that aim to verify and accurately visualise the presence of unknown structures within the monuments.

Working with the Ministry of Antiquities and the Department of Islamic Monuments in Cairo, Virtual Heritage Cairo Project developed a series of Virtual Heritage platforms for the use of virtual reality models of historic monuments in the medieval Islamic Cairo. Those included Sultan Hasan Mosque, Bayt Al-Suhaimy, Shar'i AL-Muizz and Souk Al-Khayamiyyah. Each building or street has been used as case studies for scanning and photogrammetry exercise to generate a virtual realty model of the historic environments. Al-Muizz virtual Tour, has been awarded best Mobile App for Virtual reality in Egypt by Samsung Egypt for 2017. Visitors used the virtual tour app to navigate through the historic monuments of the medieval city. Souk Al-Khayamiyyah VR Model has provided an insight into the methods through which rug trades could be reproduced virtually to generate income through virtual platforms.

Implementing the three-phased approach of collect, preserve and display, five teams of researchers and entrepreneurs have been trained on the recording, processing and development of virtual heritage platforms in Cairo. Each has worked on one of those buildings and spaces using either photogrammetry, scanning and digital modelling. Whilst this paper does not focus on the technical aspects of each project, it highlights the attributes

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of each application. In Souk Al-Khayamiyyah, for example, the whole market has been photographed, and surveyed not only for its physical characteristics, but also in the process of craft making and trading in the past. Throughout the recording and documentation process, suspicion was prevalent towards the production of virtual environments for Egypt's historic places. Both governmental officials as well as local craftsmen were wary of the unauthorised and unethical copying of authentic products in the open-access online and virtual interfaces that could lose them significant profit. The field work had to continue following either exemplar products or pilot samples to display. Whilst the VH products are still under development, the potentials of these products and output have become significant.

Figure 4. Souk Al-Khayamiyyah virtual model, Medieval Cairo: (top) internal passage; (above) View inside textile and rug shop (Source: AVRST & Virtual Heritage Cairo Project, 2017).

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Elsewhere in the Middle East, Virtual heritage applications have taken technical and safeguarding purposes. The Digital records of Petra Historic Site in Jordan, as part of Zamani Project, proved very effective in its sustainable preservation. This project is part of the African Cultural Heritage Sites and Landscapes Database. It has been run by a research group at the University of Cape Town since 2005, and has been spatially documenting heritage sites in Africa and the Middle East. They acquire models and present and manage spatial and any other data. A large database of spatial material has been generated over this time. This data has been widely used by heritage and conservation experts to manage and conserve these sites. The virtual tour in this project is designed to allow interactive virtual walk-through sites using the spatial data. The project allows users to check virtually online: 3D model viewer and texturing, virtual tour, topography in the virtual tour (laser scan), panorama tours, GIS layouts, architectural drawings, and videos.

NAVIGATING CITIES' HISTORIES

British cities, likewise, have become more accustomed to creatively experiencing their historic fabric in virtual environments and tours. Completed in 2017 by Alan Miller & Keith Millican of the School of Computer Science & Smart History at the University of Edinburgh, the virtual reconstruction of pre-reformation Edinburgh has evolved out of collaboration between historians and computer scientists to investigate an important layer of the city's history. Miller and Millican (2016) used mobile phones and the Google Day dream platform to produce an onsite dual reality experience. As visitors explore the sites of Edinburgh, they can see its historic layers using their digital time travel binoculars. The application they developed is a comprehensive reconstruction of parts of the city and allows the visitors to move along a series of houses and streets. It is mobile and orientation aware, automatically delivering the correct view with a map interface that offers an equally engaging experience for remote virtual visitors.

Similarly, Jarlshof in the Shetland Islands is a short computer-generated film by Kieran Baxter that offers research-led analytical narratives of the story of settlement at the Shetland Islands' archaeological site, using speculative scenarios and built structures from different historic eras (Baxter, 2014.) The project was funded by Historic Scotland, as part of PhD research at Duncan of Jordanstone College of Art and Design, University of Dundee. It was completed in 2016 and has won the Arts and Humanities Research Council (AHRC) award for the same year. Baxter based his film on aerial photographs taken from a kite-suspended camera over the site, inserting and overlaying the speculative reconstructions of disappeared buildings mapped towards aerial photographs of other sites across Scotland. Using limited reconstructed elements and incorporating photographic and cinematic considerations, the interpretation of the narrative was conveyed into a visual toolkit for storytelling.

The aerial view reveals the structure and components of the site, parts of which are difficult to grasp from ground level. According to Baxter, the low altitude aerial perspective used in 'Jarlshof' "was intended as a compromise between the relatable ground-level view and the revealing yet distancing qualities available from high altitude" (Baxter, 2014). Camera movement was used to enhance the viewer's perception of depth and the 3D depth and structure of the site. This format bears no resemblance to the normal experience of moving around Jarlshof on foot. Rather, the depth of the site's structure provided by the flying motion enhances the viewer's sense of the three-dimensional space. The camera was also used to create a sense of progression through the distinct chronological phases of the site through annotated interplay of views, camera movement and chronological display.

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Figure 5. Pre-reformation Edinburgh. University of St. Andrews (Source: www.st-andrews.ac.uk).

Figure 6. Jarlshof in the Shetland Islands by Keiran Baxter (Source: http://www.topofly.com).

CONCLUSION

The London Charter for the Computer-based Visualisation of Cultural Heritage developed its first draft, in 2006, as “a means of ensuring the methodological rigour of computer-based visualisation as a means of researching and communicating cultural heritage. Also sought was a means of achieving widespread recognition for this method”. (London Charter, 2006). The Charter introduces a set of principles which, when adopted, ensure that digital heritage visualisation is seen to be at least as intellectually and technically rigorous as longer established cultural heritage research and communication methods. The challenge of scholarly validation of heritage visualisation is similar to those facing media and art

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productions in that some subjects, and arguments, do not so readily lend themselves to textual description and author's work and product are inherently non-linear or synthetic. The production, be it a visualisation, or expressive medium of choice, reflects the author's perception as integrated in the selective production process itself, be it a static image, real-time model or printed object (Denard, 2012).

The effort to address and organise the industry and practice of virtual heritage needs to address the use of visualisations through influencing not only research, academic and curatorial contexts, but also those aspects of the media and entertainment industry involving the reconstruction of architectural and cultural heritage. Computer-generated visual interpretation of history and culture plays an increasingly influential role in shaping public perceptions of the past, despite being highly selective, subjective and in many instances inaccurate. It is of considerable importance that a generation's impressions of the past should integrate the contours of historical understanding. The commercial and industrial sectors, hence, need to work on documentaries and other media productions to enable users and audience to distinguish between fact and fiction.

The past did not happen in 2D and it, therefore, cannot be effectively studied or taught as a series of disconnected and selective still images that display incomplete aspects of one coherent and missing story. The development of an interactive, 3D platform that will enable people to re-live history in a reconstructed environment is the best way for them to engage and understand how medieval cultures existed, lived or to grasp the implications of the evidence that we have (Sanders, 2008). It is also true that this reconstructed world would be contested as based on different and at times disputed accounts and evidences. History after all is a subjective matter. Nevertheless, the argument-driven nature of historical evidence would be better scrutinised through examining events within 3-dimensional environments.

But the main argument to be developed is to engage with archaeologists, who are conventionally wary of technologies, to embrace it to their advantage as assistive tools to see the ancient world in realistic settings and environments. This would not only support the documentation of specific physical aspects of history, it would offer unprecedented opportunity to test theories, findings and narratives in virtual environments. It would also engage a much broader range of audience, like children, school pupils, old people and non-specialist ordinary people. The power of the moving image, animation and virtual environment has attracted interest in understanding the past that was otherwise limited.

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