MEDIA AND TECHNOLOGY FOR UNDERSTANDING CITIES: REBUILDING THE PAST AND DESIGNING INTERACTIONS IN FUTURE URBAN SPACES WITH ICT

MEDIOS Y TECNOLOGÍAS PARA ENTENDER LAS CIUDADES: RECONSTRUYENDO EL PASADO Y DISEÑANDO INTERACCIONES EN ESPACIOS FUTUROS CON TIC

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Abstract

Nowadays technology and media allow users and citizens to interact with cities in several spatial and time dimensions. On the one hand, the past and the heritage should be revisited and recreated using reliable resources and scientific knowledge produced, as is stated both in the London Charter and in the Principles of Seville. On the other hand, the available digital technologies (ICT and media) of our time allow for the development of new uses and functions and to project innovative experiences to be experienced in the city. 3D computer graphics, alternate reality games or mixed reality, among others, help us to understand how a city or an old settlement was and represent both material and immaterial heritage, which will aid us in our effort to understand the present and enable us to design and conceive future interactions and experiences based on urban spaces. This paper focuses on the state of the art and innovative experiences conveyed by media technologies, which, on the one hand, allow us to connect with and visualise the past and, on the other hand, project the different potential city for the future, linking the present to both. We therefore aim to ponder on how technologies and the advancements in media may help researchers achieve a high degree of authenticity. Are they founded on veritable historic resources, be they written, graphical or even based on the urban place that is being represented itself? Are they close to what reality could be? Or can they be viewed as "virtual" theme parks? As these proposals create a veritably new kind of digital heritage, how can we protect them? How can the public at large forge a new relationship with them, a connection that goes beyond seeing them as mere gaming scenarios? Or, for that matter, how can the public perceive their message? Advances in digital technologies and immersive and interactive environments can give us a glimpse of how researchers may be able to find ways to reconstruct and represent our past.

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Resumen

A día de hoy, la tecnología y los nuevos medios permiten a los usuarios y los ciudadanos interactuar con las ciudades en diferentes dimensiones espaciales y temporales. Por un lado, el pasado y el patrimonio tienen el potencial de ser revisitados y recreados usando recursos con un elevado grado de fidelidad y el conocimiento generado en el campo científico, tal y como pretenden la Carta de Londres y los Principios de Sevilla. Por otro lado, el avance en las tecnologías digitales (TICs y nuevos medios), a día de hoy. Permiten concebir nuevos usos y funciones y proyectar experiencias innovadoras que puedan ser experimentadas en el entorno urbano. Los gráficos en 3D generados por ordenador, los juegos de realidad alternativa o la realidad mixta, entre otros, nos ayudan a entender cómo una ciudad o un asentamiento de la época antigua era, para gestionar un patrimonio tanto material como inmaterial que nos ayude a entender el presente y trabajar para diseñar y concebir en un futuro interacciones y experiencias basadas en los entornos urbanos. El presente documento pone el foco en el estado del arte y en las experiencias innovadoras mediadas por las tecnologías digitales, que nos permiten conectar y visualizar el pasado, por un lado, y proyectar el potencial de la ciudad en un futuro, ayudando a conectar el presente con ambos. También se pretende reflejar sobre cómo las tecnologías digitales nos permiten reflejar un determinado grado de autenticidad, usando los nuevos avances. La cuestión es: ¿se fundamentan en verdaderos recursos históricos de carácter fideligno, ya sea escritos, ya sea gráficos, o incluso basados en un entorno urbano representado por su propio pasado? ¿Son las representaciones que permiten la tecnología lo suficientemente cercanos a cómo pretenden? ¿O podrán ser categorizados dentro de un parque temático "virtual"? Ya que este tipo de propuestas representan nuevos tipos de patrimonio cultural, ¿cómo podemos protegerlas? ¿Cómo crea el público una nueva relación con estos entornos, más cercanas y percibiéndolas como escenarios en los que es posible el juego? O, incluso, ¿cómo percibe el público este mensaje? Los avances en tecnologías digitales y entornos inmersivos e interactivos muestran cómo pueden los investigadores encontrar nuevos medios para reconstruir y representar el pasado.

Introduction

The word *cyber archaeology* was coined by Jones (1997) at the end of the '90s describe the relationship between digital technologies and heritage. Nowadays, digital (immersive or not) technologies allow us to reconstruct the past (heritage), understand and improve the present (especially in urban design) and design and plan the future. Those digital technologies led us to the question about the relationship between physical and digital environments, especially concerning the issues of improving this relationship and of understanding both environments. The immersive and expressive power of digital technologies, which evolve exponentially every year, allows us to design and conceive more complex solutions for real-world challenges. At the same time, digital worlds are the perfect environment for simulations and for attempting to design solutions for challenges encountered in areas such as urbanism or resource management, among others.

The current framework is, nowadays, complex and many factors and different technologies are involved. For that reason, it is difficult to design a sole solution for a specific area; domains such as heritage and urbanism involve several different factors and layers in their interpretation and presentation to different kinds of public. When one focuses on a heritage site, such as a city or part of a city, there are different kinds of resources, either written or graphic, that must be gathered and analysed, while always having the actual, material city (or what remains of it) as the most important reference point. This should produce different levels of interpretation through the communication of meaning (or meanings) of a city (or part of it) as it is put forward in the ICOMOS Charter for the Interpretation and Presentation of Cultural Heritage Sites (ICOMOS, 2007), which states that interpretation and presentation are essential elements to the effort of preserving Heritage and also act as basic tools for public appreciation and understanding of cultural Heritage sites. In a different way, The Faro Convention on the Value of Cultural Heritage for Society (2005) encourages reflection on ethics and methods of presentation of cultural heritage, as well as being mindful and respectful of the diversity of interpretations (Council of Europe, 2005).

Thus, how do we represent information in a 3D virtual and, mostly, immersive environment? How do researchers obtain this information, and what is the best solution to reconstruct and portray it? How can we optimise the interaction process between environment and users? How can we present the city, or part of it, in its multi-layered meanings, in a rigorous manner and, consequently, avoid creating "virtual" theme parks?

This research paper and literature review attempt to gather some experiences which use virtual reality and immersive environments to reconstruct and redefine our relationship with the physical environment, an approach that has its bases on the past, the present and the future.

Literature Review

The use of digital technologies to reconstruct and represent real-world environments have been employed in a multitude of manners. Urbanism, urban design or heritage are domains in which those technologies have been used. At the same time, the interactive and expressive power of those technologies have strongly evolved,

and nowadays they present many possibilities to reconstruct, project or even imagine a virtual environment that is anchored in a specific location of the physical world.

Digital technologies, especially those pertaining to 3D immersive or interactive technologies, have played a role in how researchers and other professionals such as architects, urbanists, archaeologists or even video game designers portray the real world and integrate new features which allow for the enrichment of those factors.

In the first decade of the 2000s we can find several approaches to the topic, both from technological and conceptual standpoints, trying to depict how virtual reality and other immersive digital technologies will play a relevant role in how researchers and professionals in several areas represent information. Researchers such as Addison (2000) describe in the last decade the potential of interactive digital technologies for fields such as archaeology, education or history research, among others. Addison also differentiates between three levels of applications in which technologies may play a relevant role in the aforementioned domains: *3D documentation, 3D representation and 3D dissemination*.

In that same year, Stone and Ojika (2000) described the potential of the technology to simulate the past, focusing on approaches such as natural, sociological or cultural pasts. They also stressed the possibilities of applying technologies such as video game engines (among others) for reconstructing heritage by using the same tools and game mechanics, among other video game features, to, in this manner, increase the level of interactivity between the person, the information and the environment, and giving the whole experience a more realistic feel.

Pletinckx et al. (2000) also discussed, in the beginning of the 2000s, the potential of those digital technologies and immersive power to emphasise the research of historical and cultural heritage, and how we can portray it through information present in other sources. They focus, through a project called "Ename 974" (op. cit.), on goals based on the development of new technologies and standards for information gathering, reconstruction and representation of heritage.

Rubio Tamayo et al. (2017) also focused on new approaches in immersive environments and virtual reality as mediums to depict ideas and concepts. Virtual reality and immersive environments are new media with interactive and expressive powers that can help us to build and configure new messages and design experiences. As new (emergent) media, many communicational factors and features of this area need to be explored, and many different approaches would aid us in redefining some aspects related with how people interact both with computers and environment.

Rubio-Tamayo and Gertrudix (2016) also created a taxonomical classification of digital (immersive) environments and virtual reality in order to ascertain which levels of interaction may be applied to an immersive experience, depending on the immersive potential of environment and the current state of the technology. Thus, those taxonomical classifications help us understand how virtual reality and immersive environments

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may be a useful tool to design new experiences and interactions with our past, based on reliable information, and how it is possible to develop new ways of portraying and conveying information using the wide range of human senses.

To support these assertions, and to go beyond the mere technological issue while considering the content presented to the public, one must perforce ponder on the storytelling devices behind the presentation of cities in a digital environment, which will compromise the digital technologies used. What is one supposed to present? How will it be done? Do we want to create digital visualisation as tourism products or as pedagogical tools? As Forte says, "the new challenge in virtual environments is to develop advanced narrative mechanisms. The experience is the very new way of storytelling" (Forte, 2011). And the author adds "the more we have learnt, the more we can tell; but also the objects, the places, the sites, tell" (Forte, 2011).

Literature review also showed theoretical approaches on the topic since the 2000s. Researchers such as Cameron and Kenderline (2007) have theorised about the possibilities of new media for reconstructing the past under a necessary critical approach. Other studies, such as those of Noh et al. (2009), focused on the power of augmented reality to represent the past, as this technology allows for the integration of digital information in a real-world environment. In the same decade, Wojciechowski et al. (2004) focused on the potential application of virtual and augmented reality in the designing of virtual museums. Bruno et al (2010) also propose a methodology for archaeological exhibitions, applied to the field of virtual archaeology.

In the present decade, Cuadrado Alvarado (2014) proposed the interface as a metaphor for the environment itself, connecting the possibilities of digital interfaces with disciplines such as art, videogames, or cinema. Richards-Risetto et al. (2014) employed a gesture-based GIS to develop interactive experiences in an archaeological site and Mortara et al, (2014) applied serious games dynamics to the domain of reconstructing and representing cultural heritage with technologies. Caggianese et al. (2014) focused on factors, such as natural interaction with physical environment, to develop technologies that may help us grasp the potential of human-real world interaction. Other researchers, such as Farella et al. (2016) also highlighted the potential of 3D technologies to portray cultural heritage and to allow users to connect with the past when it is represented in diverse approaches.
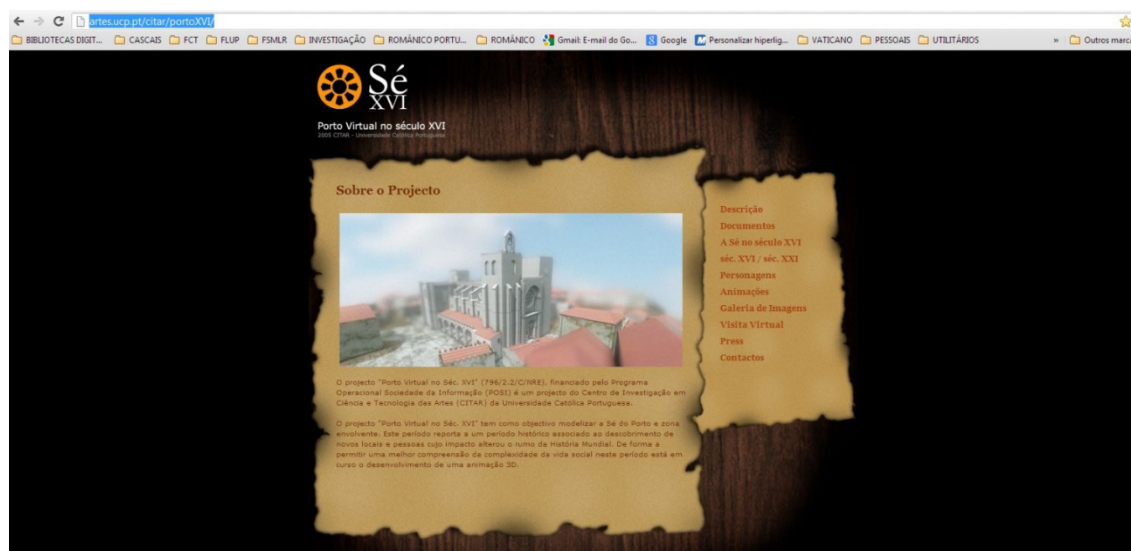
Image 2. Mediaeval Swansea: Acessed on: 2017-10-10 [http://www.medievalswansea.ac.uk/en/]

The London Charter and Principles of Seville

There's often a long and arduous path between the historical researches that must be trekked to produce rigorous virtual heritage visualisation. When one does not have access to visual sources, the creation of an accurate reconstruction of cultural and historical heritage sites is even more demanding. Sometimes we can find other kinds of documental resources, such as chronicles, stories, descriptions, judgements or even construction contracts. These documents constitute a range of invaluable assets, veritable repositories of knowledge, that can aid us in the process reconstruction of heritage sites – and the City Witness Project is a perfect example of this.

In general, the type of approach undertaken in the visualisation of the city through the lens of digital technologies and portraying it throughout time follows the operating principles of "Crypto-History of Art" proposed by Serrão (2001). This is one of the branches of study of History of Art. In fact, the study of what once existed and has since disappeared or otherwise stands entirely transformed due to the artistic fads of the various centuries is increasingly relevant. This is the cities' most common scenario. In this field, we particularly emphasise two of the operating principles proposed (Serrão, 2001: 3): 1) the slope of the deduction, in other words, the approach to those already missing works, which we try to reconstruct as much as possible, through visual analysis, documentary, stylistic and iconographic, of the other works' set; 2) the slope of the reconstitution, in other words, the analysis of a fragment of an artistic ensemble, which is nowadays partially nonexistent, in order to unravel its possible initial structure.

So, this necessity for transparency and the importance given to the documents used avoids the creation of "products" to the general public, fashioned together by consumption and entertainment, that could be perceived as "theme parks" (Sola Morales, 1999), but in this case "virtual theme parks", and offer instead true and real virtual experiences, either in virtual exhibitions, gaming scenarios or even in immersive experiences

(Guidazzoli, 2002, Abadala et al., 2010, Jackson & Kidd, 2010, Smith et al., 2012).

Hence, when presenting a heritage site, despite the depth of the knowledge we have concerning it, we should support it with a scientific, rigorous and multidisciplinary research. Historical and urban research will interpret and present contents that the digital technologies will portray.

In this way, we value highly some principles present in the London Charter (2006 and 2009). Applied to the digital reconstruction (computerized reconstruction, that is), this international document advocates the requirement of transparency and the importance given to the documentation "behind the scenes"; that is, it is focused on how the information is imparted upon the user. The London Charter presents several principles for the use of computer-based visualisation methods and results in the field of cultural heritage research and dissemination in an attempt to foster consensus in this area. These are the London Charter objectives (Denard 2009): a) Provide a benchmark by having widespread recognition among stakeholders; b) Promote intellectual and technical rigour in such uses; c) Ensure that computer-based visualisation processes and outcomes can be properly understood and evaluated by users; d) Enable computer-based visualisation authoritatively to contribute to the study, interpretation and management of cultural heritage assets; e) Ensure access and sustainability strategies are determined and applied and f) Offer a robust foundation upon which communities of practice can build detailed London Charter Implementation Guidelines. Within this line of thought, and among its Principles (Denard, 2009), we must focus on the third one, related to the research sources (in order to ensure the intellectual integrity of computer-based visualisation methods and outcomes, relevant research sources should be identified and evaluated in a structured and documented way) and to the fourth, focused on the documentation (Sufficient information should be documented and disseminated to allow computer-based visualisation methods and outcomes to be understood and evaluated in relation to the contexts and purposes for which they are deployed).

According to Seville Principles, «The London Charter takes full account of the Cultural Heritage as a concept, and therefore the specific needs required by each of its constituent parts» (The Seville Principles). Although directed to the Archaeological Heritage, this document which aims to expand the content of the London Charter, introduces a few definitions which are easily applied to the study of the city and to its digital representation in its various dynamics. Furthermore, the fact that it presents a patrimonial object endowed with multiple layers, the interpretation and presentation of the city makes use of the representation methodologies proposed in the Seville Principles, such as (The Seville Principles): a) Virtual restoration (this involves using a virtual model to reorder available material remains with the aim of visually recreating something that existed in the past. Thus, virtual restoration includes virtual anastylosis); b) Virtual anastylosis (this involves restructuring existing but dismembered parts in a virtual model); c) Virtual reconstruction (this involves using a virtual model to visually recover a building or object made by humans at a given moment in the past from available physical evidence of these buildings or objects, scientifically-reasonable comparative inferences and in general all studies carried out by archaeologists and other experts in relation to archaeological and historical science) and d) Virtual recreation (this involves using a virtual model to visually recover an archaeological site at a given

moment in the past, including material culture (movable and immovable heritage), environment, landscape, customs, and general cultural significance).

Reinforcing the idea of transparency and the importance given to the documentation "behind the scenes" conveyed in the London Charter, the Seville Principles goes even further and presents two principles which seem fundamental to us in order to understand the cities by rebuilding the past and designing interactions in future urban spaces with ICT. We speak, of course, of Principle 4: Authenticity, which must be a permanent operational concept in any virtual archaeology project, and of Principle 5: Historical rigour, which depends on both the rigour with which prior archaeological research has been performed and the rigour with which that information is used to create the virtual model.
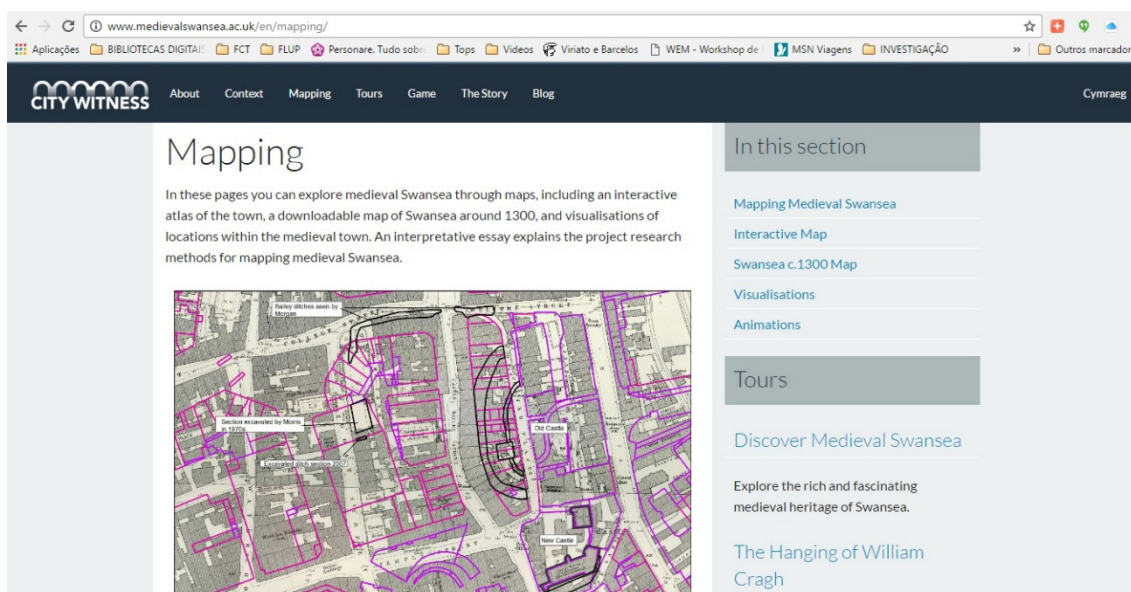

Image 2. Mediaeval Swansea: Acessed on: 2017-10-10 [http://www.medievalswansea.ac.uk/en/]

Visualise and Reconstruct the Past

ICT and 3D immersive environments present the issue of the manners in which sites can be portrayed by having the collected data as a basis. The question is how we can design an effective user experience while keeping in mind human factors such as interaction design or human-interaction. On the one hand, it is necessary for ICT and 3D immersive environments used to reconstruct the past to be reliable, and, on the other hand, and for them to be optimised for the experience. Thus, the collaboration between professionals of various interdisciplinary fields (historians, urbanists, engineers, architects, artists – including 3D artists, designers or ergonomists, among others) shows us to what extent this is necessary.

Nowadays, in order to design immersive experiences (in virtual or urban real spaces) based on historical data and archaeological remains to be applied to research and education, one must first design a process integrating the aforementioned interdisciplinary domains.

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In addition, we can visualise the past in the myriad of manners of its portrayal, but we can also explore techniques for collecting data from diverse sources and design interactive scenarios in urban or virtual environment allowing users to "relive" the past within an interactive and immersive experience.

To optimise this process and reconstruct the past, in order to find optimal ways to represent it, one must have utmost regard for the following steps:

- Gather and compile data about the site: this can be achieved by following the data and information *from sources*, *historical references and documents*. Other useful sources of information are the archaeological site itself, and the type of information that the archaeological presents to its researchers, its state of preservation, etc. Advances in technology will also allow for researchers to collect data by resorting to techniques based on chemistry and physics.

- Compare data with current status: What does the compiled data show us and how it can be used to design immersive experiences based on the past? What is the highest degree of reliability we can achieve by employing that data? How can we optimise the usability of the environment with reliability?

- Design an interaction process: When data is collected, it is important to process it and turn into information. Information may be represented in different formats: a text, a story, a book, an audio-visual production, a voice recording, and now, with new ICT, we have a wider range of possibilities to build an immersive and interactive scenario where users can "relive" this history and recreate it. But designing an immersive and interactive environment with ICT is also complex, and many human factors play a key role in it, as do technological or spatial handicaps. Just a film or a novel need a documentation process and a script, an immersive experience based on ICT requires the design of the interaction process, much like, for instance, video games do.

- Choose the more suitable technology to be employed in the experience: The evolution of technology is a rapid, ever-improving process. Its current problems and limitations will surely be overcome in the near future. Therefore, to opt to use the more suitable technology is an issue that is invariably linked to present capabilities of current devices, but also depends on computer graphics and the different manners in which they are generated. Likewise, it also depends on game engines and the possibilities which they offer in terms of interaction with the environment. In the other hand, we should be aware of the necessity – or lack thereof – of such degree of interaction (in which human factors play a decisive role).

- Human factors: Strongly related with the design of the interaction process and the technology applied to it, human factors are relevant components for research in designing and optimising experiences, especially in 3D and/or in immersive virtual environments. When designing experiences and interactive processes with ICT applied to cultural heritage, such as virtual reality or augmented reality, it is necessary ponder on the complexity of the interactive process between individuals and environment, in which several factors are involved. As we desire realistic video games – but not overly realistic (because it would be not possible to

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play them) –, we also want reliable virtual environments based on heritage; however, this reliability should not influence unfavourably the communication process. The interaction and communication should be fluid and easy to learn, as well as intuitive. In addition, one, while designing digital environments (especially 3D environments), must keep in mind the fact that user can interact with them through his/her various senses (sight, sound, touch, proprioception, spatial sense, etc.) and tailor the experiences around those senses. Interdisciplinary fields such as human-computer interaction (Barfiel, 2015, Shneiderman & Plaisant, 2017), interaction design (Pontonnier et al., 2014, Lin et al., 2017), ergonomics (Fan et al., 2017, Geiger et al., 2017) or affective computing (Chittaro & Sioni, 2014, Parsons & Courtney, 2016), applied to the area of virtual reality will be a key aspect in the improvement of our experience when interacting with a digital environment created to depict cultural heritage.

Image 3. Minecraft & 3D Cultural Heritage Modelling: Accessed on: 2017-11-15 [http://www.playthepast.org/?p=5381]

Technological Approaches and Conceptual Approaches

But how have technology and human factors evolved together and how can we employ them in order manage and improve physical environment?

Currently, many different techniques are being used for reconstruct and portray cultural and historical heritage. Some of those techniques are used to compile information regarding the features of physical historical sites. Other techniques are being used to optimise the depiction of those sites, while minding major factors involved in it, such as accuracy (by designing a reliable virtual replica of the original site) and usability (by designing an environment whose interaction process will be ease-to-use and intuitive for users). And others are currently being used to experiment with the narrative and storytelling potential of the environment and

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heritage, such as game engines or virtual exhibitions (Botelho, 2017), which allow for the development of more interactive environments and the integration of new factors, such as gameplay. And, of course, when we focus on historical heritage, we must also consider the principles for computer-based depiction, such as the London Charter and the Seville Principles, particularly those related to the requirement of transparency and the importance given to the sources used.

Among the different trends that employ techniques for reconstructing, representing and making heritage an interactive experience, some of them are currently being used successfully. Some of them have been used in other disciplines and domains, such as engineering. It's important to emphasise that the reconstruction of cultural and historical heritage is a field in which techniques and methodologies of other disciplines have being tried and experimented with. Thus, virtual reconstruction of cultural and historic heritage has always been an experimental field, in which technologies, procedures and tools employed by other disciplines have been constantly used and have yielded interesting results.
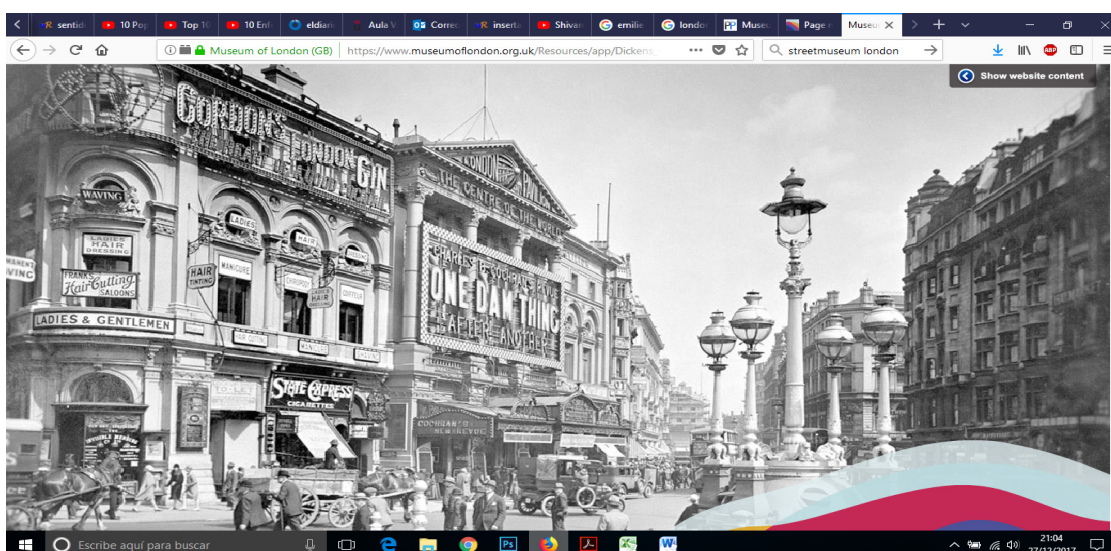

Image 4. Street Museum is an Augmented Reality App developed by the Museum of London.
The app allows one to visualise old pictures of the city superimposed with the current environment:
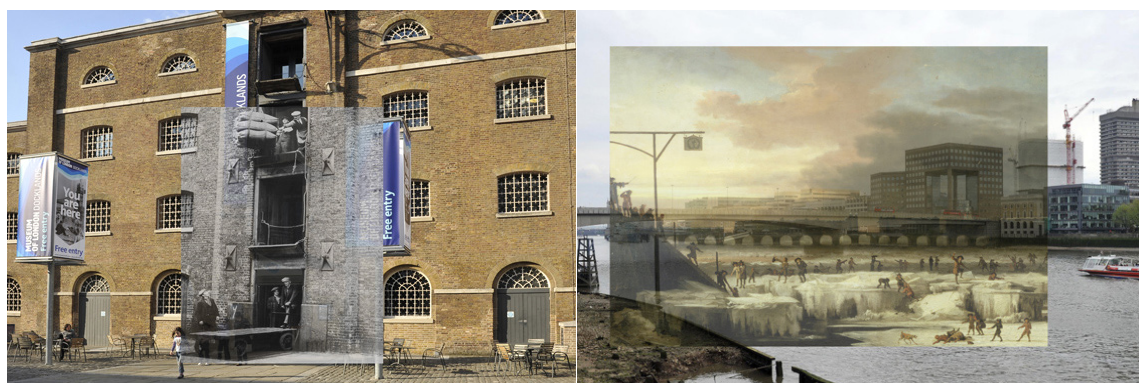Accessed on: 2017-11-15 [https://www.museumoflondon.org.uk/Resources/app/Dickens_webpage/home.html]

Image 5. Two more examples of the Street Museum, London:
Accessed on: 2017-11-15 [https://petapixel.com/2010/05/24/museum-of-london-releases-augmented-reality-app-for-historical-photos/]

Technologies such as photogrammetry are nowadays – and have been for some time now – being applied to fields such as engineering. This technique consists in obtaining information about environment by using images or patterns (ASPRS online, 2015). It is currently being employed in areas such as engineering, architecture, forensics or archaeology. For that reason, it is a technique that can now be applied to the reconstruction of cultural and artistic heritage through digital technologies. This technique has been in use since the last decade (2000s) and there are relevant instances in this field of applied photogrammetry to reconstruct old cities, (Koutsoudis et al., 2007). Portalès et al. (2009) use this technique combined with augmented reality to develop applications related with the optimisation of the reconstruction of cultural heritage. Remondino (2011) has also employed this technique, the author used using remote sensors to capture data which later will be used as base to build a reliable 3D model.

Conclusions and Possible Future Endeavours

At the present time, we can affirm that the future of reconstructing heritage and redefining urban spaces is inextricably linked to factors such as researching sources and the implementation of human factors. This will allow researchers and professionals in fields related to urbanism, history, technology or arts, to rely on a new framework to develop new immersive experiences with several applications. Technology (and, in this particular instance, digital technology) is an essential tool to understand our relationship, as users (and conceivers) with our environment and the information and its transformation throughout time. This fact will allow us to understand how should design artificial environments (sometimes based on real-world environments) and how we should add information to them. Further yet, how will we differentiate these layers, that is to say, how will we show users what is the real world environments, based on transparency, and what is exactly the artificial environment that conveys the real one?

Digital (or virtual, or artificial) environments are nowadays helping us understand our physical world. And we understand them better because we use those available digital tools to simulate these environments (in order to improve them), to reconstruct them and to comprehend them in their stratigraphy (in order to let users remain in contact with them and know more about the past). And we also use those digital tools to design a more interactive and user-friendly digital world.

It should be stressed, however, that we should regard the digital experience a not as a substitute of the real, physical experience, of Heritage, but instead as an invitation to its comprehension, to the reading of its multiple layers and, ultimately, to make heritage and history accessible through more democratic and user-friendly tools.

In essence, if we want to better understand cities and the places we inhabit, we must always strive to conceive and design new ways to realise their past, interact with their present, and plan their future.

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