Lost Cities in the Digital Era: The Case of Pre-Earthquake Lisbon

Helena Murteira and Paulo Simões Rodrigues

Abstract Lisbon was ruined by a major earthquake on November 1st, 1755. The seismic shocks, the tsunami, and the fire that followed massively destroyed its urban and architectural fabric, and its written and iconographic memory was seriously curtailed. There is a significant historiography on pre-earthquake Lisbon, particularly dating from the last 30 years. However, it was vital to convert this knowledge into a global outlook on the city which was lost. Virtual archaeology provided the necessary tools, from a technical and a methodological perspective. *City and Spectacle: A Vision of Pre-Earthquake Lisbon* was thus devised as a virtual re-creation/simulation of all the area of Lisbon destroyed by the 1755 earthquake and on which the new city was built. Developed at the Centre for Art History and Artistic Research (CHAIA), of the University of Évora, this project aims to re-create the physical, social, and cultural dimensions of Lisbon on the eve of the earthquake, through the use of Second Life®/OpenSimulator technology. The documentary sources available, either primary or secondary, are being tested in an interactive and immersive model and in a collaborative real-time environment, so as to give the project an innovative laboratory dimension. Also, the fact that users are able to interact with the model as well as with other users in realtime transforms the data itself and, as a result, the object of study. The Lisbon that is being re-created/simulated is not just a working hypothesis presented as a glimpse into the collective memory, but is also a means for contemporaneous fruition of this memory.

Keywords Lisbon • 1755 earthquake • Architectural history • Urban history • Virtual archaeology • Virtual heritage • OpenSimulator

H. Murteira (✉) • P.S. Rodrigues
Centre for Art History and Artistic Research (CHAIA), University of Évora, Évora, Portugal
e-mail: hmurteira54@gmail.com

Introduction

On November 1st, 1755 Lisbon was devastated by an earthquake with a magnitude estimated today between 8.5 and 9.0 on the Richter scale. A tsunami and an intense fire completed this destruction. The old city center disappeared and was replaced by a new city built on the same location, although with a regular layout of streets and architectural units.

A significant part of the history of Lisbon before the 1755 earthquake was buried in its ruins. The damage caused by the catastrophe in the city's physical structure, the loss of a large number of valuable documents, and, ultimately, the decision to rebuild on the same location according to a new plan truncated the memory of the old city.

However, not all was lost. From the late nineteenth century, the history of pre-earthquake Lisbon has played a significant role in the Portuguese historiography.

The surviving documentary sources scattered throughout various libraries, archives, and private collections have generated an important field of study on the history of Lisbon, known in Portugal as *Olisipografia* (from *Olisipo*, the Roman name for Lisbon). Travel literature has also been an important source of information on pre-earthquake Lisbon, notwithstanding its highly subjective nature.

Since 1965, with the publication of *Lisboa Pombalina e o Iluminismo* (*Pombaline Lisbon and the Enlightenment*) by José-Augusto França, the study of Lisbon witnessed a significant boost.[1] This study opened the way for an architectural and town planning perspective on the history of Lisbon. Both from an urban history or architectural and town-planning approach, the historiography of pre-earthquake Lisbon is now going through considerable development.

The scarcity of reliable sources and images of Lisbon prior to the 1755 earthquake has hindered a global vision of the lost city. However, virtual archaeology and cyberarchaeology have recently been changing this reality.

The project *City and Spectacle: A Vision of Pre-Earthquake Lisbon* aims to re-create the Lisbon destroyed by the 1755 earthquake through the use of virtual worlds technology.[2]

A team of diverse experts, ranging from the fields of art history, architecture, and landscape studies, to IT resources and virtual worlds, is developing an immersive and interactive re-creation of the city's physical, social, and cultural dimensions in the years that preceded the earthquake.

Through the use of the open source, multiplatform OpenSimulator, this project is allowing us to test the available documentary sources, as well as the formulation

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[1] The book had two extended and fully revised editions in 1977 and 1983, respectively.

[2] *City and Spectacle: A Vision of Pre-Earthquake* is being developed by a team of researchers from the Centre for Art History and Artistic Research (CHAIA), of the University of Évora, in partnership with the company Beta Technologies. See http://lisbon-pre-1755-earthquake.org/ and http://vimeo.com/lisbonpre1755.

and the visualization of a comprehensive working hypothesis on pre-earthquake Lisbon.

City and Spectacle thus becomes a research laboratory on urban history and, therefore, a case study on the methodological and epistemological impact of the digital era on historical research.

Historical Research on Pre-Earthquake Lisbon

The devastation caused by the 1755 earthquake in Lisbon was extensive. The city center, an area of approximately 385 square miles, was completely destroyed, causing the death of approximately 12% of the city's population.[3]

Houses, streets, goods, money, and a significant amount of the city and the country's artistic and cultural heritage vanished.[4]

The rebuilding process was guided by efforts to modernize and regularize the city and, therefore, a new plan displaying regular and uniform building blocks was developed on the site of the old city (França 1983).

On the morning of 1st November 1755, Lisbon could be seen as a medieval urban maze, afflicted by the same evils that plagued other premodern European cities: insufficient building control, deficient or inexistent sanitary, lighting, and policing systems (Murteira 1999). However, efforts towards modernization were being felt since the sixteenth century, particularly after the end of the Restoration War with Spain, in 1668 (Rossa 1998; Murteira 1999; Carita 1999). Streets were opened and enlarged, quays and public buildings were constructed or refurbished, and legislation aiming for a more controlled and regular building process was issued by the Crown and Lisbon's City Council (França 1983; Rossa 1998; Murteira 1999).

The seventeenth-century austere architecture, heavily influenced by military engineering's formal solutions, was briefly interrupted at the beginning of the eighteenth century, due to the architectural program implemented by King D. João V (1689–1750) (Ayres de Carvalho 1962; Bottineau 1973: 341–353; Mandroux-França 1989; Calado 1995; Delaforce 2001; Pimentel 1991, 2002, 2012; Pimentel and Henriques 2013).[5] This can be seen in some of the pictorial representations of Lisbon in this period as well as in descriptions in contemporary accounts related to the city. It is precisely this Baroque Lisbon, embellished during

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[3] Contemporary estimations of the death toll range from 10,000 to 100,000 people in Lisbon alone. The lack of reliable census or demographic records in Lisbon at the time and the instability that followed the earthquake make this information hard to ascertain. Today historians believe that between 10,000 and 20,000 people may have perished in Lisbon as a result of the 1755 earthquake.

[4] On the 1755 earthquake see Sousa (1919–1932), Estorninho (1956): 198–233, Davison (1938), Boxer (1956):113–129, Kendrick (1956), Buescu and Cordeiro (2005), Araújo et al. (2007), and Murteira (2004).

[5] On the nature of seventeenth century Portuguese architecture, see Kubler (1972).

the sovereignty of King D. João V, which has mostly vanished and whose memory is more fragmented and unclear.

The documentary sources related to this period are scarce and thus not able to provide us with a consistent image of early eighteenth-century Lisbon. The traces of the old city center are also rare inasmuch as the rebuilding plan demanded the leveling out of the surviving buildings. Although the two main squares of the old city, *Rossio*, at the north end and the *Terreiro do Paço*, at the south end, were kept, albeit according to a regular layout, the existing architectural elements of the ruined city are few and embedded in the new plan.

The old neighborhoods on the Castle hill shed some light on the urban character of the old city. These areas were not as damaged as the city center and were not included in the rebuilding plan. However, since the early sixteenth century, this area was no longer within Lisbon's city center, where the main squares and the royal palace, the political and economic heart of the city, could be found (Carita 1999; Senos 2002; Caetano 2004).

The main documentary source related to the destroyed city is the *Tombo Pombalino* (Pombaline Survey) requested by the State Secretary of Foreign Affairs and War to King D. José I (1714–1777), Sebastião José de Carvalho e Melo, the future Marquis of Pombal.[6] This major survey registers the location and size of all the properties ruined by the earthquake as well as the identity of their owners. Due to the detailed nature of this work, it has not yet been extensively studied.

Maps and plans of pre-earthquake Lisbon are scarce. Essentially, there is a well-known mid-seventeenth–century plan of Lisbon signed by the Portuguese military engineer João Nunes Tinoco and a 1730s plan of part of the city center signed by the military engineer Manuel da Maia (Figs. 1 and 2).

Regarding the architectural and social aspects of pre-earthquake Lisbon we have revealing pictorial representations of the city, particularly of its main square, the *Terreiro do Paço* (Palace Courtyard), where the royal palace and the most significant public buildings were located (Figs. 3 and 4). Another fundamental historical source is the collection of engravings representing the ruins of six of the most noteworthy buildings in Lisbon, by the French engraver Jacques Philippe Le Bas. It represents the only known depictions of the baroque urban and architectural units of the Patriarchal Square and the Royal Opera House, although they were depicted when already in ruins (Figs. 5 and 6). There is, however, a detailed plan of the Patriarchal Square, which is kept at the National Library of Portugal (*Biblioteca Nacional de Portugal*). This document was crucial for the re-creation of this area of Baroque Lisbon (Fig. 7).

Decades of research provided a substantial body of information for the study of Lisbon. Nonetheless, a global vision of the city was still missing. It was thus crucial

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[6] The *Tombo Pombalino* is kept in the *Arquivo Nacional da Torre do Tombo* (Portuguese National Archives), in Lisbon. There is an abridged version of this survey, compiled in the nineteenth century by Valentim de Freitas, in the *Biblioteca Nacional de Portugal* (National Library of Portugal).
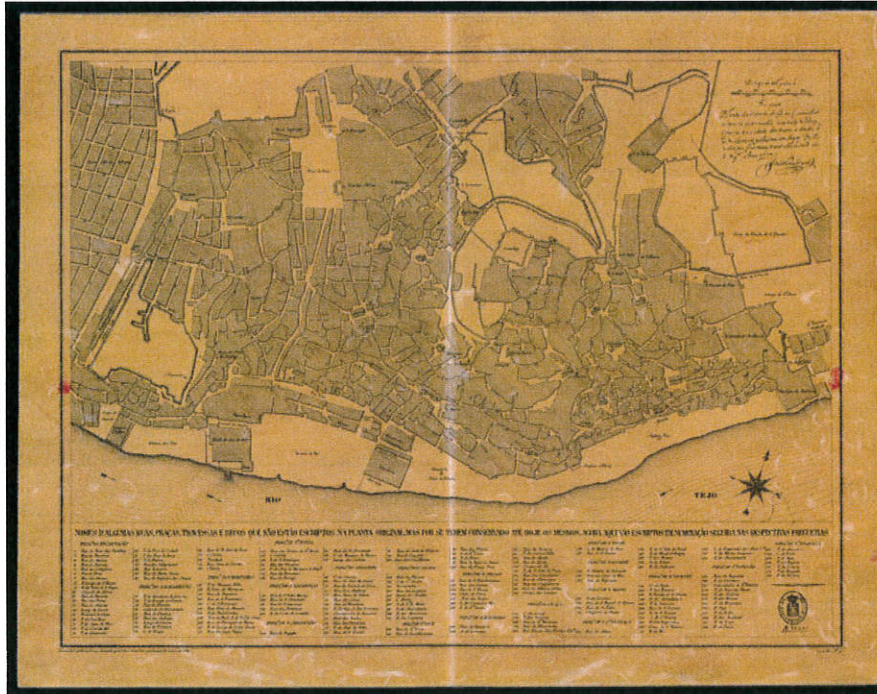
Fig. 1 João Nunes Tinoco. Plan of Lisbon (ca. 1610–1689). National Library of Portugal

to carry out a swift and reliable comparative study of all the existent data, written and pictorial, on pre-earthquake Lisbon.

Digital technology provided the necessary tools. The result exceeded our expectations. We were confronted not only with ground-breaking research tools but also with a new object of study, which led to questions on the scope and the ontological value of the research itself.

Pre-Earthquake Lisbon as Virtual Reality

In 2005, on the 250th anniversary of the 1755 earthquake, a team led by Alexandra Gago da Câmara developed a 3D model of the old Royal Opera House in Lisbon using Second Life® technology (Câmara 2007).[7] There is no known picture of this short-lived building, apart from the above-mentioned engraving of its ruins by Le Bas. The Royal Opera House was the first of its kind in Portugal, praised in contemporary accounts for its magnificence and opera programming (Câmara

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[7] See http://operadotejo.org/.

Fig. 2 Manuel da Maia. Plan of the Lisbon city center before the 1755 earthquake. Drawing: watercolor on paper (1756). DGAIE, Lisbon

1993, 2006, 2007, 2013; Januário 2008; Gallasch-Hall 2012). It was built on the west end of the Royal Palace complex by King D. José I (1714–1777), according to a project signed by the Italian architect Giovanni Carlo Sicinio Galli Bibiena. The inauguration of this building took place on March 31st, 1755, six months before the earthquake ruined it. There is a plan and a cross-section of an Opera House in the archives of the Fine-Arts National Academy (*Academia Nacional de Belas-Artes*) in Portugal, which until recently was believed to portray the Royal Opera House. Recent studies have suggested that these documents are probably a draft and thus do not correspond to its final layout (Januário 2008; Gallasch-Hall 2012).

The re-creation of the Old Opera House was therefore a difficult task and required a reliable and low-cost technology. Second Life®/OpenSimulator technology was used to put forward a first hypothesis of a 4D model of the building. The success of the project encouraged us to widen the research scope so as to include the whole Lisbon area destroyed by the 1755 earthquake.

City and Spectacle: A Vision of Pre-Earthquake Lisbon was thus devised as a re-creation/simulation of the part of Lisbon devastated by the 1755 earthquake. The urban area that is to be re-created corresponds to the whole area included in the rebuilding plan (Fig. 8). However, this re-creation is not only urban and architectural in terms of its nature; it aims also to include aspects of the social and cultural life of early eighteenth century Lisbon through the simulation of the city's daily life

Fig. 3 Dirk Stoop. The Palace Courtyard in the seventeenth century (1662). Oil on canvas. Lisbon City Museum

and some of its major events, such as religious processions, bullfights, opera performances, and the infamous *autos de fé*.[8] Therefore, the model will also have an audio component, as well as text boxes with historical information.

The project combines the history of art, urban/architectural history, and cultural heritage studies with computer science and thus presents not only a scientific dimension but can also be used for education, leisure, and commercial purposes, that is, edugames, virtual tourist guides, and the film industry (Câmara and Murteira 2008, 2010; Câmara et al. 2009; Sequeira and Morgado 2013).

The first challenge that the research team faced was the selection of a reliable and an operational cartographic source for re-creating pre-earthquake Lisbon.

As mentioned above, plans of Lisbon before 1755 are scarce and, with the exception of the old layout inscribed in the plans for the rebuilding project, they do not represent the city on the eve of the earthquake. To make matters worse, the layout of the old city that appears in the sketches for the new Lisbon by the military engineer Eugénio dos Santos is not detailed enough to allow us to develop a comprehensive urban re-creation. On the other hand, the plan of Lisbon in the early eighteenth century does not represent the Lisbon that we hope to re-create: it does not include the Patriarchal Piazza (completed circa 1749) and the Royal Opera

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[8] *Auto de fé* was the ritual of public punishment and execution of the condemned by the Inquisition.
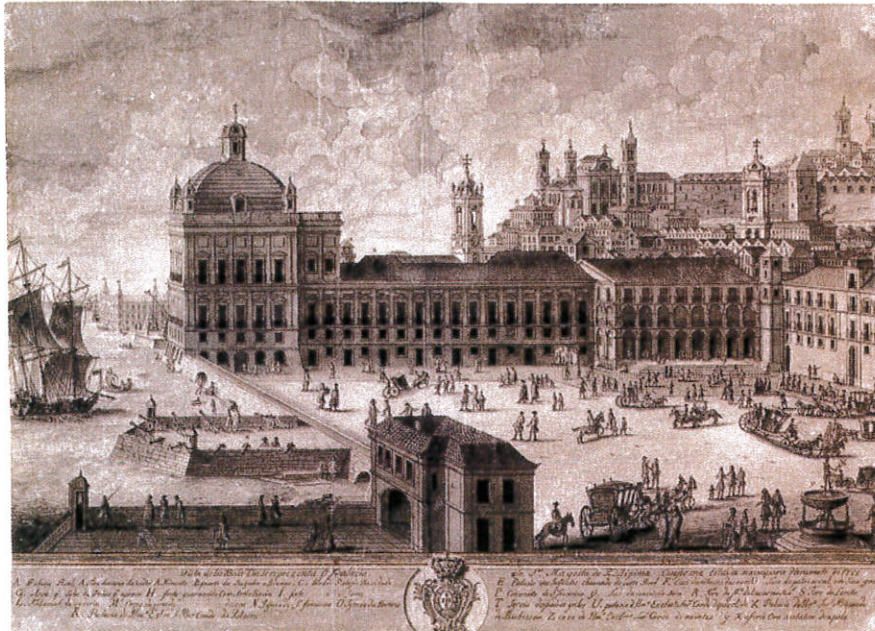
Fig. 4 Francisco Zuzarte (attribution). The Palace Courtyard at the eve of the 1755 earthquake (n.d.). China-ink drawing. Lisbon City Museum

House (dating, as previously mentioned, from March 1755). For this reason, we decided to use a plan drawn at the beginning of the twentieth century by the engineer Augusto Vieira da Silva, an early and fundamental contributor to the history of Lisbon (Fig. 9). This plan uses some relevant information that the author selected from the plans already referred to as well as the Pombaline survey. Hence, the plan we used is not a primary source, but a working hypothesis itself.

Secondly, and given the ambitious scope of the project, it was necessary to establish the various phases of the re-creation.

We decided to work first on the most important area of the city, the old *Terreiro do Paço* (Palace Courtyard), which is the location of the *Ribeira* Royal Palace compound, including the old Royal Opera House and the Patriarchal Church and Square (Figs. 10, 11, 12, 13, 14, and 15).

Some written primary sources, namely the only known description of the old Royal Palace and the few surviving representations of Lisbon before the 1755 earthquake, were also used as relevant sources of information.[9] The extensive historiography on pre-earthquake Lisbon, and particularly the studies carried out during the past 30 years, provided the necessary theoretical context.

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[9] There is a detailed description of the Royal Palace in the eighteenth century that was published in the nineteenth century by Camilo Castelo Branco, a renowned Portuguese writer. See Branco (1874). *Noites de Insomnia offerecidas a quem não póde dormir*. Porto: 10–11.
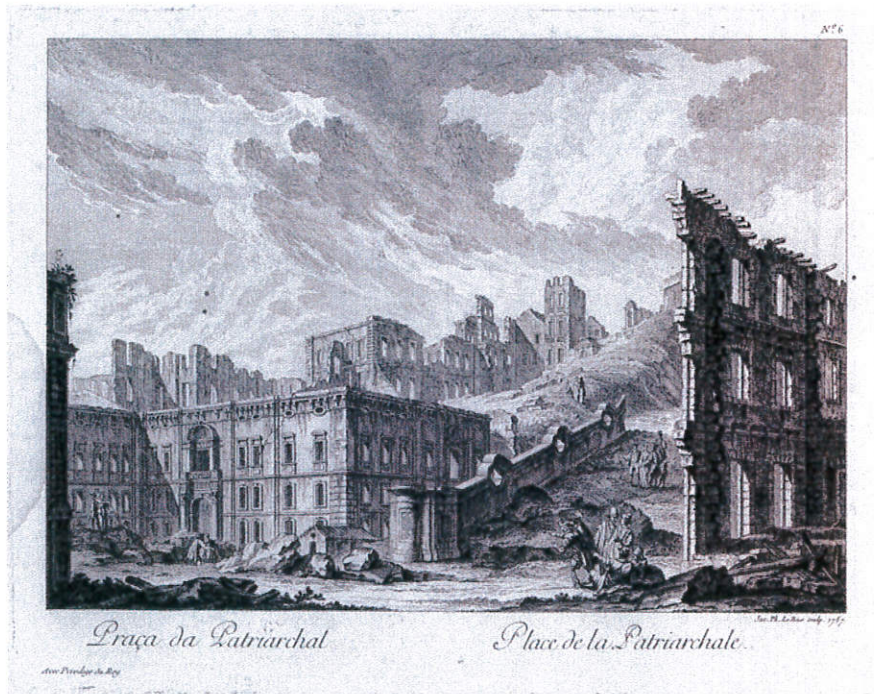
Fig. 5 MM. Paris, Pedegache and Jacques Ph. Le Bas, Colleçaõ de algumas ruinas de Lisboa causadas pelo terremoto e pelo fogo do primeiro de Novemb.ro do anno de 1755 debuxadas na mesma cidade por MM. Paris et Pedegache e abertas ao buril em Paris por Jac. Ph. Le Bas [n.d.]. Ruins of the Patriarchal Square. Engraving. National Library of Portugal

The process of setting up the model enabled us constantly to examine the validity of the information gathered in the various available documentary sources, both primary and secondary. OpenSimulator technology acted simultaneously as a technical and as a conceptual framework, inasmuch as it tested the workability of the information mentioned above and also its adequacy in responding to the demands of a visual and all-inclusive working hypothesis. All this was achieved through collaborative work carried out on the virtual model, in realtime.

The results of the research process are presented as an interactive image that needs to be filled in with information (Fig. 16). However, this information rarely reflects similar stages of research and equally consistent evidence. It was as if we were putting together a jigsaw puzzle with several missing pieces. In addition to this challenge, models are increasingly more complex in their interactive and immersive features and are thus open to a multitude of interpretations and to different inputs by users.

For the general public, the assertiveness of a visual working hypothesis is easily mistaken for an exact reconstruction. This has been extensively discussed during the last decades (Frischer et al. 2002; Beacham et al. 2006; Lopez- Menchero and
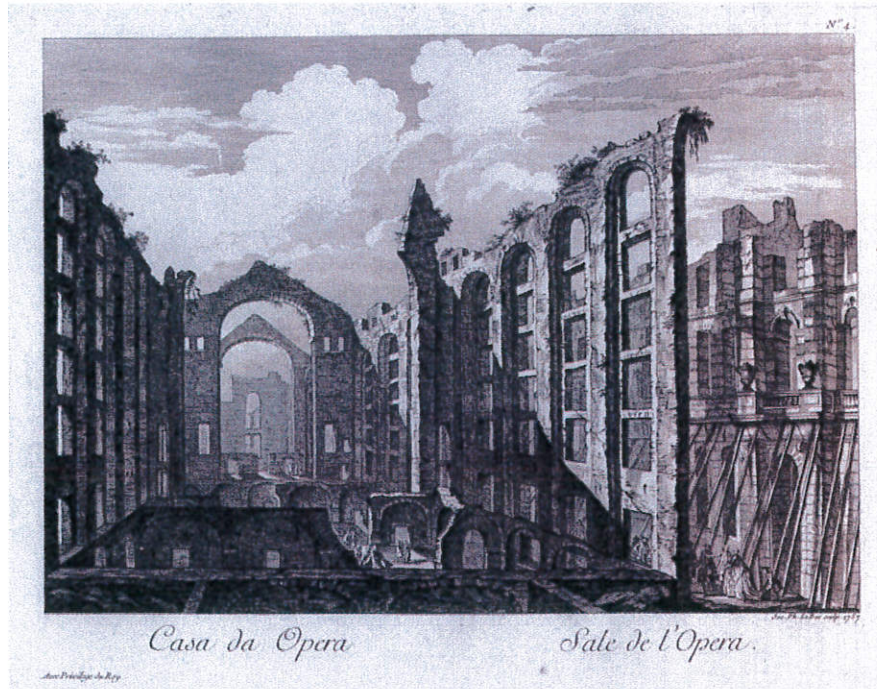
Fig. 6 MM. Paris, Pedegache and Jacques Ph. Le Bas. Colleçaõ de algumas ruinas de Lisboa causadas pelo terremoto e pelo fogo do primeiro de Novemb.ro do anno de 1755 debuxadas na mesma cidade por MM. Paris et Pedegache e abertas ao buril em Paris por Jac. Ph. Le Bas [n.d.]. Ruins of the Royal Opera House. Engraving. National Library of Portugal

Grande 2009; Denard 2012). Therefore, it was crucial to secure transparency and historical rigor, as well as facilitate access to all the information produced by the project. According to the guidelines of the London Charter (2009) and the Principles of Seville (2012) for virtual heritage visualization, we have meticulously documented our research process, referencing the various documentary sources that were used and highlighting the various re-creation choices made. A website was created providing information about the project and on how to access the 3D virtual model (http://lisbon-pre-1755-earthquake.org/). This included a virtual museum on the history of eighteenth century Lisbon and the development of the project itself (Figs. 17 and 18).

The purpose, the conceptual framework, and the various stages of the project were presented in different national and international conferences (Câmara and Murteira 2008, 2010, 2012; Câmara et al. 2009, 2010, 2011, 2012; Murteira 2012; Murteira and Rodrigues 2014; Câmara and Rodrigues 2014) and the project has generated studies on crowd simulation for virtual historical re-creations (Sequeira and Morgado 2013; Sequeira et al. 2014).

This was, of course, an innovative way of working for our research team. It was clear from day one that we were engaged with a simulation of the past. We were
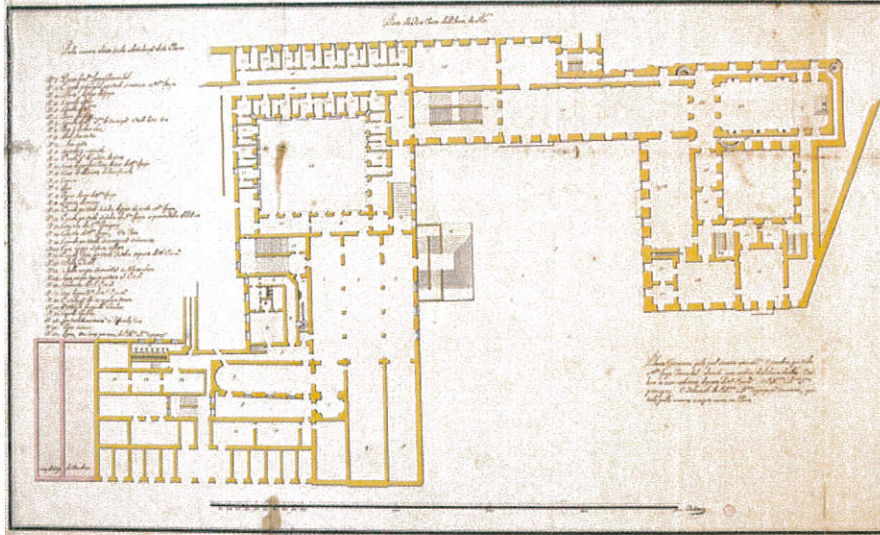
Fig. 7 Plan of the Patriarchal Church and Square. Drawing: China ink and watercolor on paper (ca. 1775). National Library of Portugal
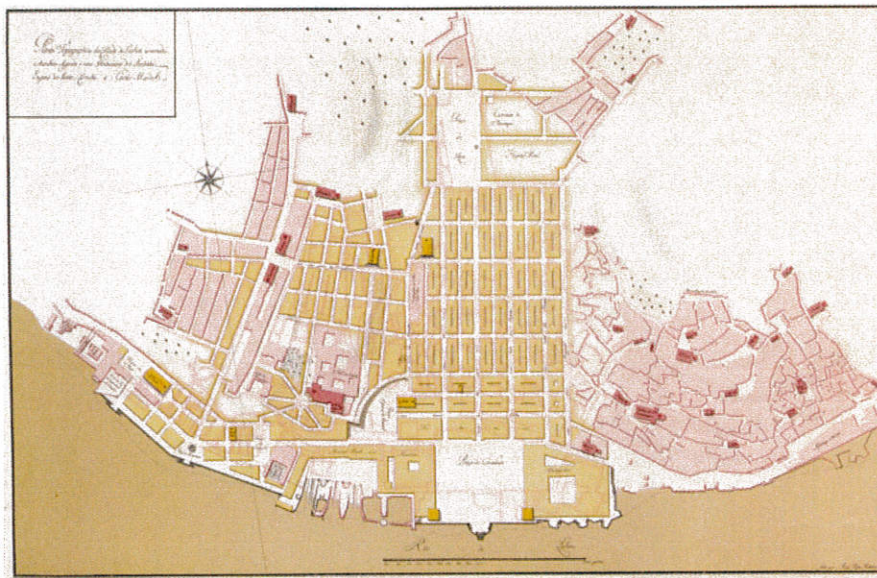

Fig. 8 João Pedro Ribeiro. Copy of the adopted plan for Lisbon by Eugénio dos Santos and Carlos Mardel. Lithography (1947). Lisbon City Museum
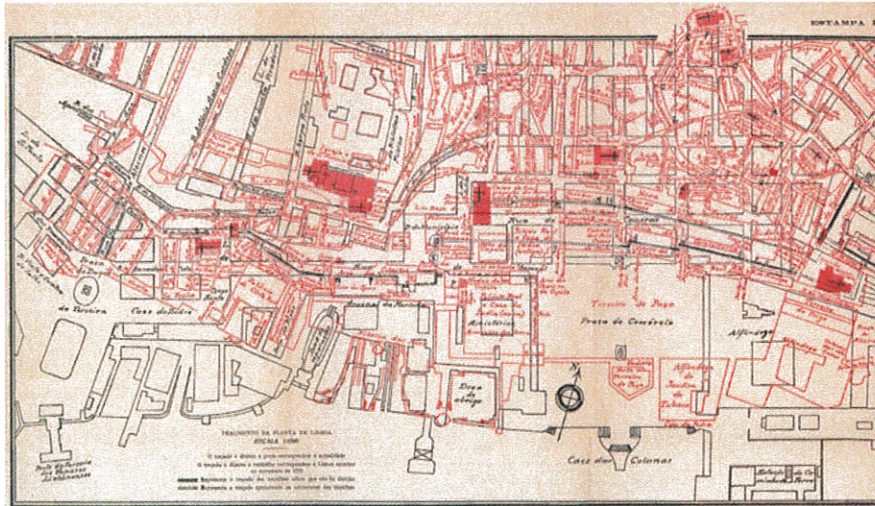
Fig. 9 Plan of the Lisbon city center before and after the 1755 earthquake. The plan shows the old layout in *red* and the new in *black*. A. Vieira da Silva. 1940. As Muralhas da Ribeira de Lisboa, vol. I. Lisboa
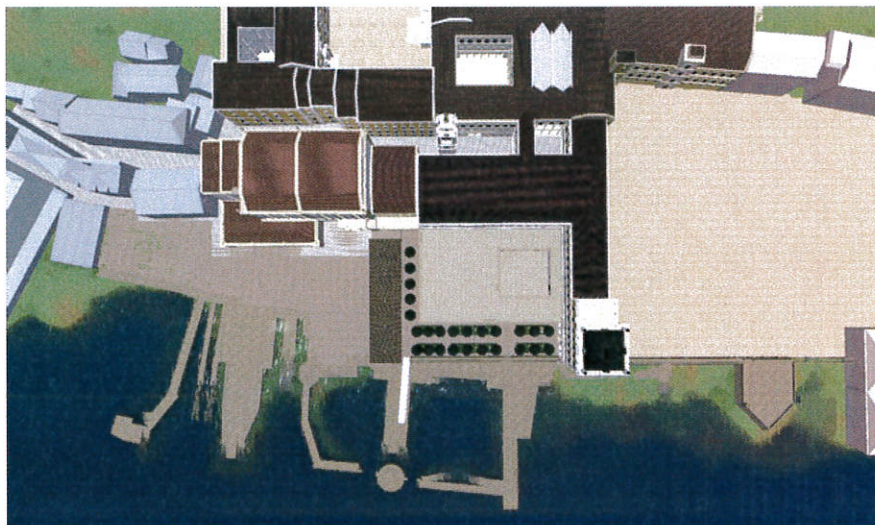

Fig. 10 Aerial view of the Royal Palace complex. City and Spectacle: a vision of pre-earthquake Lisbon, OpenSim version 0.7.5 Dev, November 2012

never attempting to produce a reconstruction, not only because we were dealing with scarce sources of evidence and information, but also because re-creation and simulation are the very essence of the historical scientific process. The fact that the results of the research were being translated as image reinforces the previous
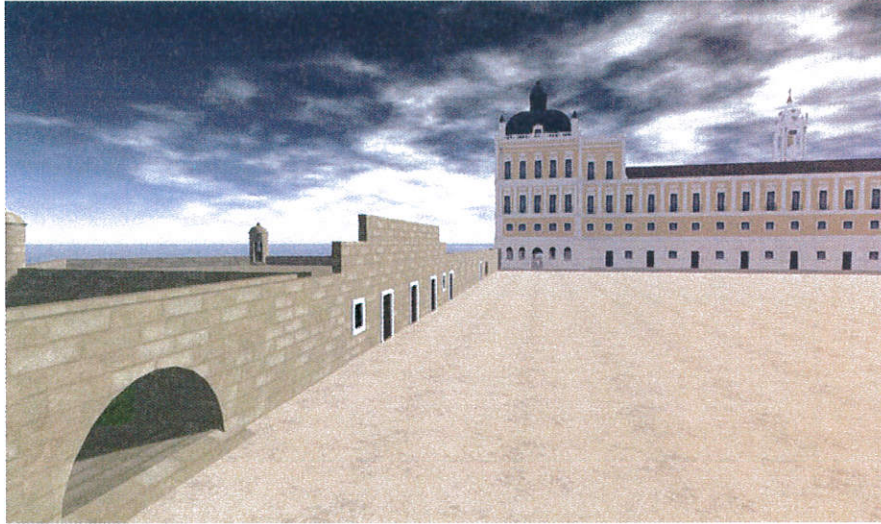
Fig. 11 The Terreiro do Paço (Palace Courtyard). City and Spectacle: a vision of pre-earthquake Lisbon, OpenSim version 0.7.5 Dev, November 2012
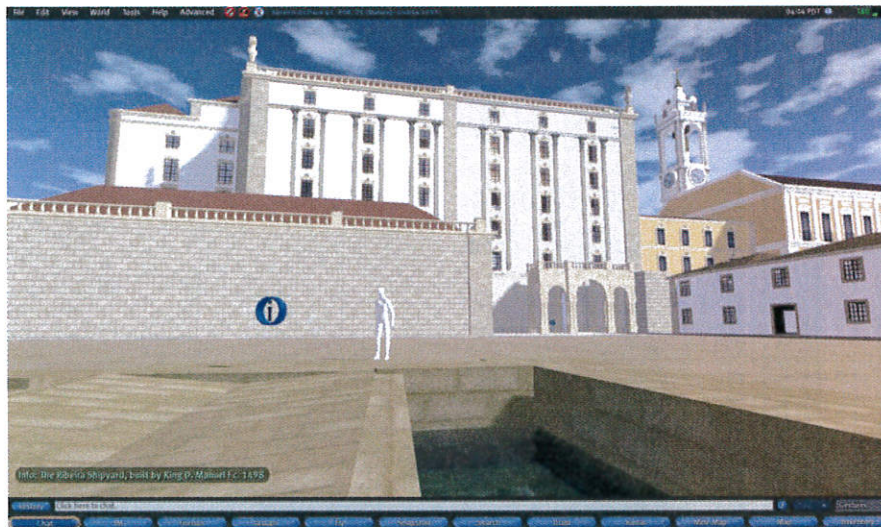

Fig. 12 The Royal Opera House, the Royal Palace, and the shipyard. City and Spectacle: a vision of pre-earthquake Lisbon, OpenSim version 0.7.5 Dev, November 2012

assertion. It was also clear for us that we were not only processing and testing pre-existing information but we were also dealing with data that the model itself was providing us. Thus the project acquired a laboratory nature that would not have been possible through the conventional process of historic research.
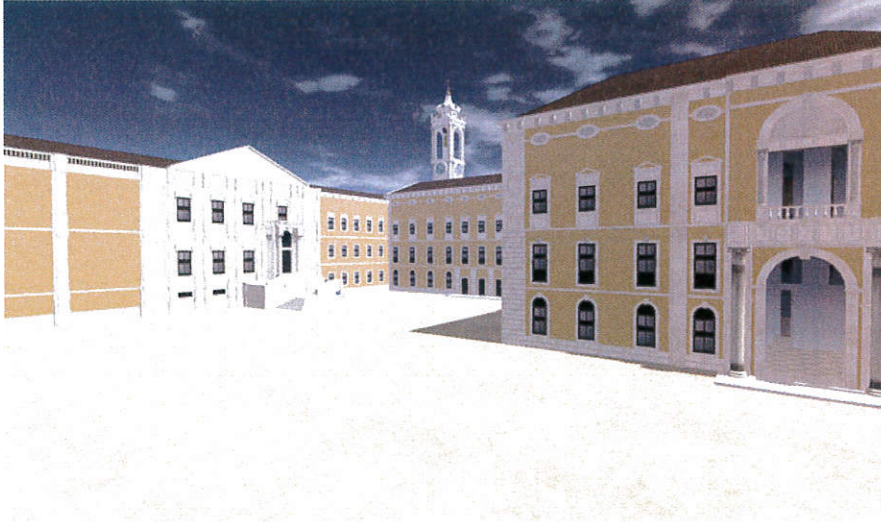
Fig. 13 The Patriarchal Square and Church. City and Spectacle: a vision of pre-earthquake Lisbon, 0.7.5 Dev, September 2013

Fig. 14 The Royal Palace and entrance to Chapel Street. City and Spectacle: a vision of pre-earthquake Lisbon, 0.7.5 Dev, September 2013

There is still a long way to go in terms of achieving the goals we have set up for this project. The model needs constant amendments as a result of the continuous character of the historic research. The animation of the model will be another significant challenge given the scarce and fragmented data available for the social and cultural aspects of early eighteenth century Lisbon.

hmurteira54@gmail.com

Fig. 15 Virtual model of Chapel Street in the Royal Palace Compound. City and Spectacle: a vision of pre-earthquake Lisbon, OpenSim version 0.7.5 Dev, November 2012
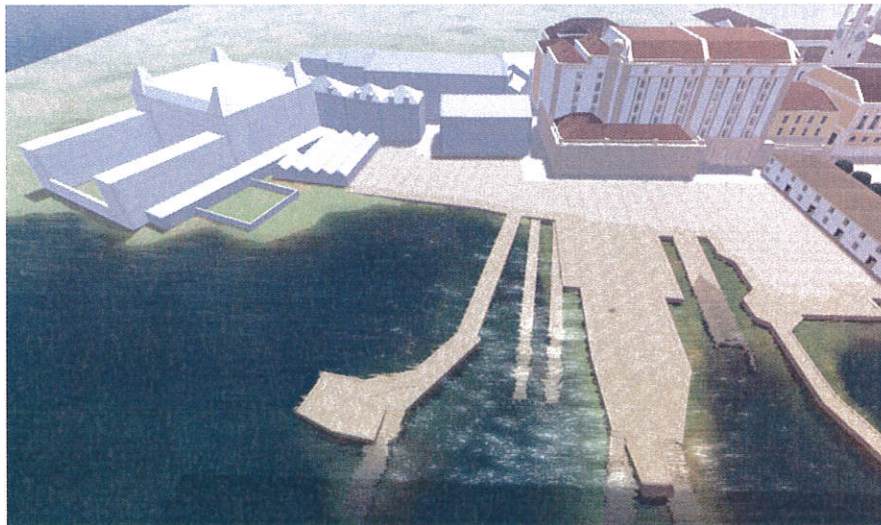

Fig. 16 Virtual model of the Royal Opera House and the shipyard. Aerial view. City and Spectacle: a vision of pre-earthquake Lisbon, OpenSim version 0.7.5 Dev, November 2012

However, more important than the working hypothesis that we are putting forward is the fact that the model itself is able to interact with users in such a way that they become a part of it and as such, they provide a new variable to the historic research: contemporaneity through social interaction.
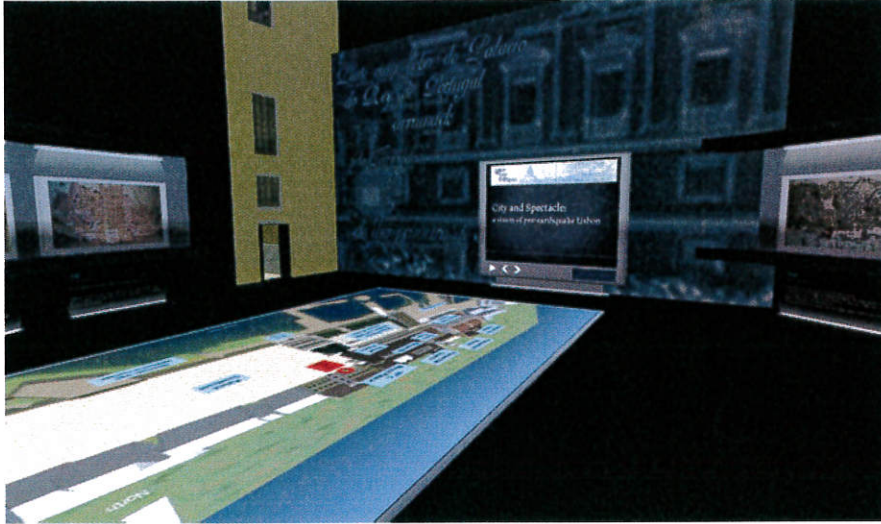
Fig. 17 Virtual Museum. City and Spectacle: a vision of pre-earthquake Lisbon, OpenSim version 0.7.5 Dev, August 2013

Fig. 18 Virtual Museum. City and Spectacle: a vision of pre-earthquake Lisbon, OpenSim version 0.7.5 Dev, August 2013

Conclusion: Towards a Novel Field of Research

Imagining has always been a crucial part of historic research and of the scientific process: "Once we appreciate the role of imagination as a standard means for evaluation conditionals and modal claims, we should be much less inclined to

regard the use of thought experiments in philosophy (or natural science) as constituting any highly distinctive method" (Williamson 2016: 16).

In Marguerite Yourcenar's short story "The Salvation of Wang-Fô," an old Chinese painter (Wang-Fô) and his young assistant Ling escape from a death sentence declared by the Emperor, by disappearing into the sea waves in a landscape painted by the painter himself (Yourcenar 1938). Yourcenar's short story is a metaphor about the power of artistic imagination, through its ability to manipulate time and space in ways that conventional thinking could never achieve. This is because the past is something we can never fully obtain. As Larry J. Zimmerman accurately states revisiting Lowenthal's, *The Past is a Foreign Country*, "We incorrectly imagine that the past is relatively simple and understandable. We may travel to the past, and though we may know something of the foreign country's language and customs, we will never actually be part of it because we are strangers from the present."[10]

The past is a fragmented memory that we can only represent or portray as a distant landscape. Like painters, historians are also able to manipulate time and space. They can compress these dimensions, expand them, measure them, and even transcend them. The past is a landscape and history is the way we represent it (Gaddis 2004).

Virtual reality enhances the historian's ability to represent the past as a landscape. The representation of the past thus becomes a simulacrum, as models make visible what until then was only an idea, as a new dimension of existing but not perceptible space (Ferry 2003). Virtual Heritage Visualization requires imagination to play this unusual role in historical thinking, particularly when we are dealing with lost urban environments.

Scientific transparency and accuracy in Virtual Heritage Visualization require new methodological tools, which documents such as the Beacham et al. (2006), London Charter (2009) and the Principles of Seville (2012) attempt to provide.

However, we are not only in the presence of an exercise of converting existing data into a 3D or a 4D model. As previously mentioned, digital technology provides virtual environments, often immersive and increasingly receptive to interaction with users. Therefore, we are confronted with the novelty of the methodology in use and, on the other hand, with the ontological value of the model itself.

Virtual heritage should deal with these two aspects as one. Memory is transformed by the way we view it and by the way we are able to share it with others. Therefore, the process of building virtual models and the models themselves is not only processing and testing data in a way and at a rate never done before, but is also producing new data, digital from the start. From virtual archaeology we have evolved to cyberarchaeology (Forte 2009). With virtual heritage we are confronted with a nonverbal domain that we can experience and transform through our own experience, in a context of social interchange. From "the scenography of memory"

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[10] Zimmerman. *The Past Is a Foreign Country* at https://www.usd.edu/arts-and-sciences/upload/Harrington-Lecture-Zimmerman.pdf. Accessed 9 February 2015.

(Bostenaru Dan and Panagopoulos 2014) we have evolved into living the memory, although in a new sensory environment. Therefore, the object of study is not just a conceptual exercise but also the continuous result of our own virtual experience, or, in other words, "the mind embodied in the environment" (Forte 2014).

The concept of cultural presence as defined by Erik Champion is paramount in order to understand what these models represent as scientific and as learning tools (Champion 2005). The feeling of being "there and then," instead of "here and now," according to each individual's cultural perspective acquires (Foucault 1984) a particular meaning within this project (Champion 2005; Forte 2014). In fact, visitors are not only able to take part in the simulation of the major events of baroque Lisbon, but they also become a part of it. Their experience of a past reality becomes part of the model itself and, as such, produces data that can be manipulated and reinvented both by the research team and by other users. Therefore, the memory of the past is experienced and changed by our own actions and experience. Quoting Larry J. Zimmerman once more, "'[T]he past' is something we create, it is a product of our present," which is absolutely true in the realm of cyberarchaeology.

Virtual models of past urban environments need to be open to continuous historic and technical updates and their methodological and epistemological framework should always be receptive to the demands of the constantly interchangeable relationship between past and present.

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