City & Spectacle: A Vision of Lisbon Before the 1755 Great Earthquake

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Origins and Concept

City & Spectacle: a vision of pre-earthquake Lisbon consists of a virtual recreation of the city of Lisbon on the eve of the great earthquake of 1 November 1755, giving shape to a laboratory model for research into the city's history.

As its starting point the project has the virtual recreation of one the most emblematic of spaces from 18th century Lisbon, the Royal Opera House, which disappeared during the 1755 earthquake. The recreation of the Opera House was developed in the scope of the commemorations of the 250th anniversary of the 1755 catastrophe as an attempt to restore this space of the highest artistic quality to memory and to return it to the inventory of the Portuguese heritage of architectural history.[1]

Using Second Life® technology it was possible to put forward a model of both the structure and interiors of the Opera House as well as its animation combined with a small piece of the opera presented at the inauguration of the building in April 1755.

The public presentation of this virtual model at the conference *1755: Catástrofe, memória e arte* (1755: catastrophe, memory and art), which took place at the Centro de Estudos Comparatistas, Universidade de Lisboa, led to a debate on the study and critical analysis of documentary sources and their selection and application on recreations using virtual world technology. It also emphasized the need to extend the research on pre-earthquake Lisbon.

City & Spectacle: a vision of pre-earthquake Lisbon was thus devised as a recreation of the entire area altered by the rebuilding plan designed by the military engineers Eugénio dos Santos (1711-1760) and Carlos Mardel (1696-1763), which corresponded to the city centre and extended from the Castle Hill to the east, the Rossio square to the north, the Chiado area to the west and the Terreiro do Paço (Palace Courtyard) to the south (fig. 1).

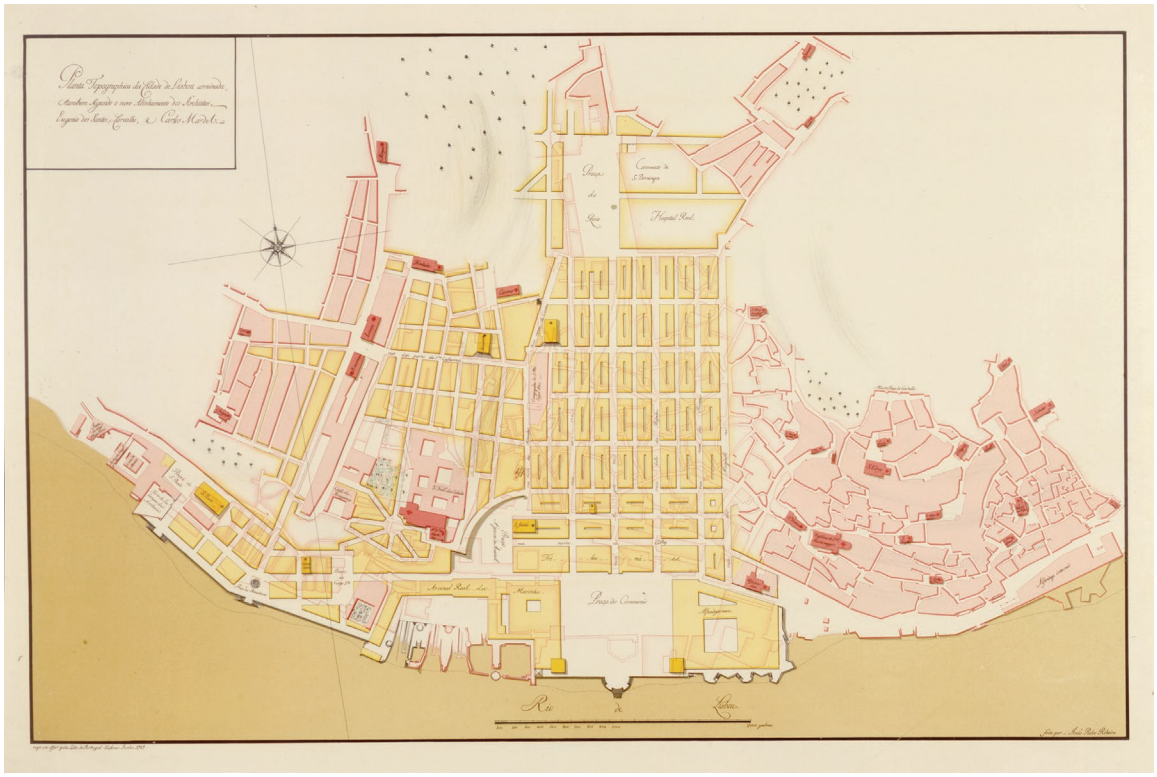

Fig. 1 Eugénio dos Santos and Carlos Mardel, adopted plan for the rebuilding of Lisbon (lithography), 1756.

However, cities are more than a collection of urban physical features. The architectonic fabric and the urban layout of pre-earthquake Lisbon were the framework of a living entity, with its own social and cultural characteristics. This reality was profoundly changed by the catastrophe and the rebuilding process. Therefore, the project quickly acquired a more comprehensive scope. The work, which is still in progress, will thus not only include the architectural and urban structure of the city, the interiors of some of the most noteworthy buildings, such as the Royal Palace, the Patriarchal Church, the Opera House, the Corpus Christi Convent and the All Saints Hospital, but also some of the most significant events of the time in Lisbon. Audio and animation components will be used to portray the social and cultural scenario of the city and text boxes will provide the historical context. The project therefore aims to recreate the spatial, architectural, social and cultural aspects of early 18th-century Lisbon.

The first phase of the project consisted of the recreation of the western side of Lisbon's Palace Courtyard just before it was destroyed by the 1755 earthquake. It includes the Royal Palace, the surviving part of the early-16th-century original palace, the Royal Opera House, the Royal Palace Garden, the Clock Tower, the Patriarchal Church and Square, as well as connecting streets. The aim was to integrate the Royal Opera House in the ensemble of buildings which developed from the Royal Palace and simultaneously propose a first recreation of the whole complex (fig.2).

Fig. 2 Aerial view of the Royal Palace complex
(photo of the virtual model, OpenSim version 0.7.5 Dev, 2012).

The first Lisbon public theatre, *Pátio das Arcas*, was also recreated according to its 17th-century layout (fig.3).

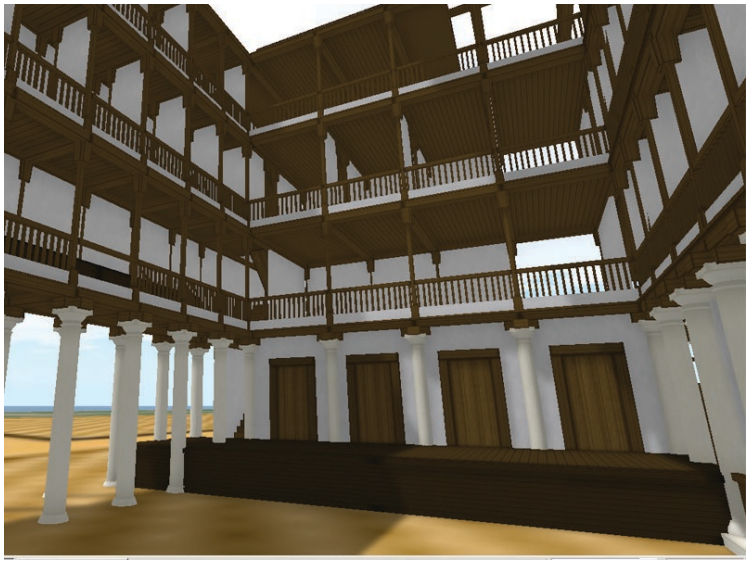

Fig. 3 *Pátio das Arcas*, the first Lisbon public theatre, in the 17th century
(photo of the virtual model, OpenSim version 0.7.5 Dev, 2012).

Innovative and experimental in its conception and methodology, this project can be considered as a laboratory in which virtual language is used as a means to broaden and optimise the scope of historic research. Based on a comprehensive study of urban phenomena from a historical and sociological perspective, it allows the results of a wide-ranging historiography of Lisbon to be tested in an interactive and immersive three-dimensional representation. Available online, the project will also contribute to the scientific debate and the sharing of documentary sources about the history of Lisbon and Urban History in the international context.

The project team includes researchers in the history of art, specializing in architectural history and town-planning, and experts in the creation of virtual realities and in the application of IT resources for research and the dissemination of history. The project benefits from the collaboration of Beta Technologies, which has worked with other virtual recreation projects in Second Life® technology, notably in the Theatron project of King's Visualisation Lab (King's College London).

Object of Study

Lisbon suffered the impact of one of the largest recorded earthquakes in history on 1 November 1755.[2] On the eve of the catastrophe, Lisbon was one of the most populated cities in Europe – the political and economic centre of an empire that extended from India to Brazil and a major seaport with a significant role in the maritime trading network of the period.[3]

Lisbon had been a highly cosmopolitan city since the early 16th century when the sea expedition to India in 1498 and the discovery of Brazil in 1500 had laid the foundations of the Portuguese overseas expansion. Nonetheless it had retained a mainly medieval, organic urban character. From the late 17th century, as a result of the initiatives of Kings D. Pedro II (1648 - 1706), D. João V (1689-1750) and the City Council with the providential help of Brazil's gold and diamonds, the city was undergoing efforts for its modernization and the changing of its image in the context of a Baroque and absolutist Europe.[4]

When the 1755 earthquake struck Lisbon, the City Council had exhausted its financial resources in trying to make the city more convenient and spacious. Concurrently, King D. João V had developed a vast programme of works in the main square of the city, the Palace Courtyard, and in the Royal Palace complex, following his aspirations to place Lisbon amongst the most prestigious capital cities in Europe.[5]

The Royal Palace was first built in the early 16th century by King D. Manuel I (1469-1521), who moved the royal residence from the Castle Hill to the riverfront. Surrounding the vast area in front of the palace, King D. Manuel I also erected a number of buildings directly linked to the management of the newly prosperous Portuguese maritime trade (fig. 4).[6] This area, the above-mentioned Palace Courtyard, became the most important square of the city, and the Royal Palace its most emblematic building.[7]

Fig. 4 Georg Braun and Frans Hogenberg, *Civitates Orbis Terrarum* (1598). Lisbon in the 16th century (engraving). At the centre of the image, the Palace Courtyard, the large square built as a result of the programme of works ordered by king D. Manuel I (1469-1521) in the context of the Portuguese maritime expansion. On the west side of the square, the new Royal Palace built on the riverside.

King Philip II of Spain (1527-1598), who ruled Portugal from 1581, used the skills of the architects Filippo Terzi (1520-1597) and Juan de Herrera (1530-1593) to carry out major renovation works in the Royal Palace.[8] These works consisted in the building of an imposing tower at the south end of the Palace and the closing of the gallery that shaped the original eastern façade (fig. 5).

Fig. 5 Dirk Stoop, the *Terreiro do Paço* (Palace Courtyard) in the 17th century (oil on canvas), 1662. This painting shows the Royal Palace after the renovation works ordered by King Philip II of Spain.

In the early 18th century, King D. João V renovated and extended the royal apartments, built a Clock Tower designed by the architect Antonio Canevari (1681-1764) and opened a new square, the first to be planned as an ensemble in Lisbon. This square was the location of the new Patriarchal Church, following the plans of Johann Friedrich Ludwig (1673-1752) (figs. 6, 7).[9] In April 1755, just six months before the great earthquake, King D. José I (1714-1777) added the Royal Opera House to the western side of the ensemble, according to the project of Giovanni Carlo Sicinio Gali Bibiena (1713-1760).[10]

Fig. 6 Francisco Zuzarte (attribution), the Palace Courtyard at the eve of the 1755 earthquake (china-ink etching), undated. Behind the Royal Palace are pictured the clock tower designed by the Italian architect Antonio Canevari and the Patriarchal bell tower designed by the German architect Johann Friedrich Ludwig. Both towers were built during the sovereignty of King D. João V (1707-1750) as part of a major renovation programme carried out in the Royal Palace.

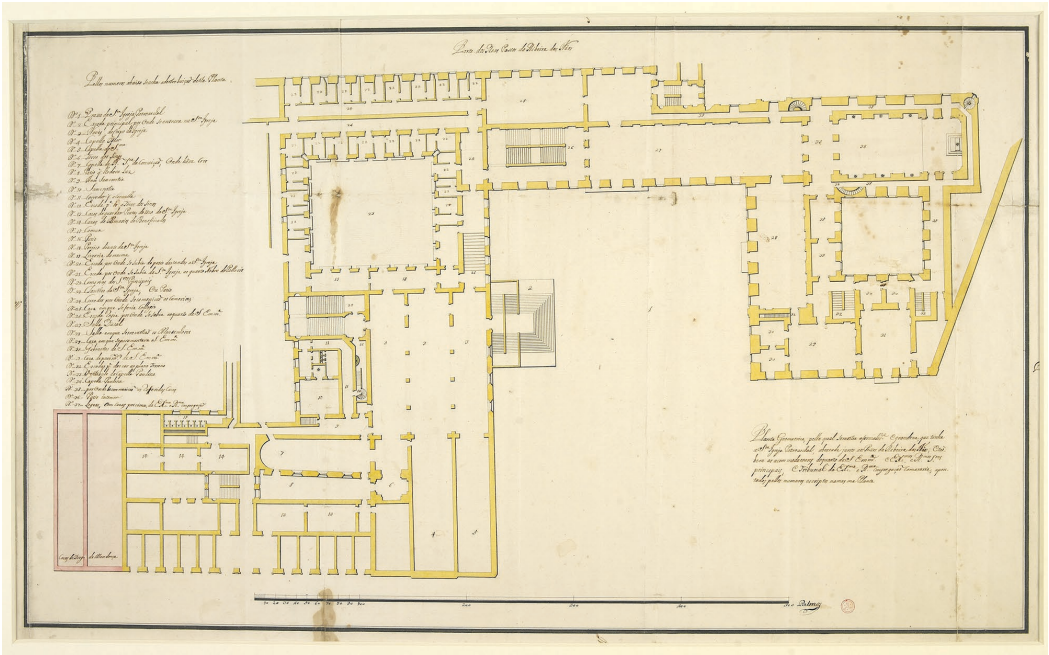

Fig. 7 Plan of the Patriarchal Church and Piazza.

On All Saints Day 1755, three strong seismic shocks, followed by a tsunami and a raging fire reduced most of the city to ruins.[11] According to contemporaneous accounts, approximately 10,000 to 15,000 people were killed in Lisbon alone; roughly 10% of the buildings were ruined and two thirds suffered such destruction that they were unsafe for habitation.[12] An important number of the city historical records, libraries, art and science collections, money and a large quantity of goods disappeared under the wreckage and were burnt by the fire.

The city centre, the large area between the two main city squares *Terreiro do Paço* (Palace Courtyard) and *Rossio*, was completely ruined. To the west, the riverside district of *S. Paulo* suffered the damaging effect of the seismic shocks and the tidal waves. The *Terreiro do Paço* disappeared under the rubble of the Royal Palace and all of the other important adjacent buildings, the Royal Opera House, the Patriarchal Church and square, the Custom House, the City Hall, the Tribunal and the newly built quay. The *Chiado* area, the hill to the west up to the gates of *Santa Catarina* location of the large convent of *S. Francisco*, was also severely damaged.[13]

The earthquake was also felt in other areas of Portugal and Spain, particularly in the south, and in North Africa. Several seismic events were reported all across Europe, from France to Britain, Germany and Finland, making the 1755 earthquake the first to be registered in detail and throughout such a wide geographical area.[14] The magnitude of the catastrophe shocked enlightened Europe.[15] The destruction of Lisbon made the headlines in the European press and inspired various texts of different kinds, notably Voltaire's *Candide ou l'Optimisme* (1759), and had a significant impact on European 18th-century thought.[16]

The 1755 earthquake provided the definitive opportunity for a large-scale rebuilding plan. After the catastrophe, Sebastião José de Carvalho e Melo (1699-1782), the minister to King D. José I and future Marquis of Pombal, with the essential assistance of Portuguese military engineers, built a city with a regular layout structured in uniform blocks (fig. 1). These quarters, known today as the Pombaline Lower Town, were built on the ruins of the old city centre. The rebuilding changed the image of the city irreversibly. The old Lisbon with its particular morphological and social characteristics disappeared.

Lisbon prior to the 1755 earthquake is a wide-ranging theme that incorporates distinct periods of history. As it refers to a lost city it has always aroused interest, but it is only in the last twenty years that it has been the target of systematic studies either in the fields of urban history, or in the areas of the history of architecture and town planning of the broader discipline of history of art.

The publication of the first detailed study that raised questions about the Pombaline project for Lisbon opened an important line of research on the urban phenomenon in Portugal and, more specifically, in the city of Lisbon, but now also seen from the history of art perspective.[17]

The analysis of Portuguese architecture from this period, particularly with regard to military architecture, as well as the skills of its technicians, notably that of the military architects and engineers, became a preferred context for the analysis of urban creation in Portugal and the Empire.[18] The first studies on Lisbon urban development using this kind of approach revealed that the Crown and Lisbon's City Council had developed a coherent strategy from at least the 16th century and had given military engineers extended powers and duties, thus explaining the speed and consistency of the Pombaline intervention after the earthquake. These studies also examine the close link that was established between these actions and the maturing of an idea of the city as a total organism, so that consistent dynamics of growth and modernization could be felt until the eve of the 1755 earthquake.[19]

The Lisbon of King João V belongs to this context of modernization of the city, and projects for urban land use and the city's facilities were put into practice and extended that originated from the previous reign. But what most identifies Baroque Lisbon is the building of the capital's new image as the stage for the representation of the Crown's political and ideological project. The articulation between the conceptual dimension of this urban strategy and its physical expression has been the focus of a number of studies, notably those from the 1990s.[20] The European contextualization of these dynamics of urban intervention has been the focus of emerging, albeit less frequent, research.[21]

This project will contribute to re-evaluating and furthering these lines of research, not only by the laboratorial dimension that the use of virtual worlds technology allows but also through the debate forum and exchange of information that it affords.

History and Virtual Worlds: a Laboratory of Research

Researchers and scholars of the history of Lisbon prior to the 1755 earthquake were always confronted with the same problem, the scarcity of documentary sources and the lack of urban and architectural remains significant enough to allow the verification of the information collected in the former. In fact, what was not destroyed by the earthquake, the tsunami and the ensuing fire, disappeared with the Pombaline reconstruction or was assimilated by it.

This situation resulted in a knowledge about pre-earthquake Lisbon, which has until now been contingent on a high degree of uncertainty, the relative abstraction of the narrative discourse, the two-dimensional aspect of the maps, drawings and engravings, and the social, economic and cultural background of their authors and the circumstances of their production.[22]

If we examine the documentary sources that were used as the basis for this phase of the project, the rebuilding of the Royal Palace complex, we will find that they are scarce and mostly pictorial material. These constraints make the research more dependent on literary sources and the rebuilding plans carried out after the earthquake. For instance, there is only a detailed

description of the Royal Palace in the early 18th century, which reached us via a transcript published in a book by a renowned Portuguese author, Camilo Castelo Branco, in 1874.[23]

Fig. 8 Georg Balthasar Probst, *Vue du palais du roy de Portugal, à Lisbonne* (engraving), undated (ca 1730).

In relation to the iconographic sources, there is a clear predominance of the Palace Courtyard's depictions, in which the Royal Palace Tower built by King Philip II of Spain in 1584 acquires a prominent character structuring the whole perspective. The representations of the Royal Palace by Dirk Stoop dated from 1662, Georg Balthasar Probst dated circa 1730 and the china-ink drawing attributed to Francisco Zuzarte, dated circa 1750, are all examples of the above-mentioned assertion (figs. 5, 8, 6). For the north and west blocks of the Palace, inner-courts, interiors and other buildings of the complex the documentary sources are even scarcer.

With regard to the Opera House there is only a cross section of the building, which is controversial and a depiction by the French engraver Jacques-Philippe le Bas (1707-1783), which is part of a series on the ruins of Lisbon after the 1755 earthquake (fig. 9).

Fig. 9 MM. Paris et Pedegache and Jacques Ph. Le Bas, Royal Opera House (ruins), undated. *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*.

The Patriarchal Church and Square, built by king D. João V between 1719 and 1749 after several building campaigns, are also portrayed in the series of engravings by Jacques-Philippe le Bas (fig. 10). There are also some descriptions of the Patriarchal Church interiors, as well a plan of the whole area kept at the National Library of Portugal (fig. 7).

Fig. 10 MM. Paris et Pedegache and Jacques Ph. Le Bas, Patriarchal Square (ruins), undated. *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*.

Therefore, the documentary information, being rare and limited, should be cross-referenced with the most recent research on the urban layout and architectonic fabric of early-18th-century Lisbon, and compared with similar urban and architectural projects, signed by the referred to architects and engineers.

In order to achieve this central objective, the research team must, throughout the entire project, make a comprehensive and systematized survey of the manuscript, printed and iconographic sources related to the city of Lisbon, deposited in the repositories and documentary and bibliographic resources of archives and libraries. This process ought to be extended to the various exhibition catalogues and other publications about the 1755 earthquake and the history of Lisbon of the period. The aim is to gather not only the varied documentation scattered in different archives, libraries and museums, but also the contributions of the researchers on the subject.

In relation to the iconographic sources, this process is simplified by the selection of panoramas and landscapes of Lisbon or more detailed views, based in its accuracy and consistency. The selection needs to be more meticulous when it comes to the printed or manuscript documentation. A critical and comparative analysis of the documentation must be carried out so that the descriptions of Lisbon found in the written documents can be cross-referenced with each other and with the images. This will enable us to build a well substantiated picture of the city's urban layout, its architecture, the interiors of some of its most important buildings and the most relevant social events.

It is essential that a selection of the documentation collected and inventoried will be made available on the website that houses the progress of the project.[24] Not only will this give other researchers access to the information but also encourage contributions from outside the team as well as debate about the urban history and the specific area of the project itself at international level. The same spirit will dictate the inclusion of articles and other studies by the team members. The online availability of the primary and secondary sources conforms to the Principle 4 of the London Charter,[25] which states the need to document and disseminate the information used in the virtual recreations, in such a manner that the procedures applied and the results obtained can be understood by users and assessed in relation to the contexts and purposes for which they were developed. It also emphasizes the need to register all the analytical, deductive, interpretative and creative evaluation procedures performed in the construction of the virtual models.[26]

The sharing of criteria and assumptions between the project team and users allows the distinction of the different degrees of knowledge that shaped each element, thus differentiating a plausible recreation proposal from an exact reproduction of Lisbon in the first half of the 18th century. However, this approach seeks to overcome the contingencies of the crypto-history of art insofar as it goes beyond trying to describe the form of the work of art in question by giving a perception and understanding of its physical appearance and making it measurable (figs. 11, 12).

Fig. 11 Royal Palace, detail of the 16th-century surviving element
(photo of the virtual model, OpenSim version 0.7.5 Dev, 2013).

Fig. 12 Chapel Street – Royal Palace complex
(photo of the virtual model, OpenSim version 0.7.5 Dev, 2012).

The virtual recreation acquires a laboratorial scope by projecting the knowledge gathered about the history of Lisbon in a sensorial dimension through the use of Second Life® technology. This laboratorial dimension is apparent in the continuous process of critical analysis and testing of the written, iconographic and archaeological sources through the simulation of the urban setting, the buildings' exterior and interior designs, as well as the spatial, landscape and environmental context of the built environment. It is also present in the relationship between the scientific and technical teams. In fact, the recreation of the city ought to be undertaken by a transdisciplinary group of researchers, and the experts in virtual reality must be constantly accompanied by specialists in history of art so that the application of the information gathered is kept under permanent scrutiny (fig. 13).

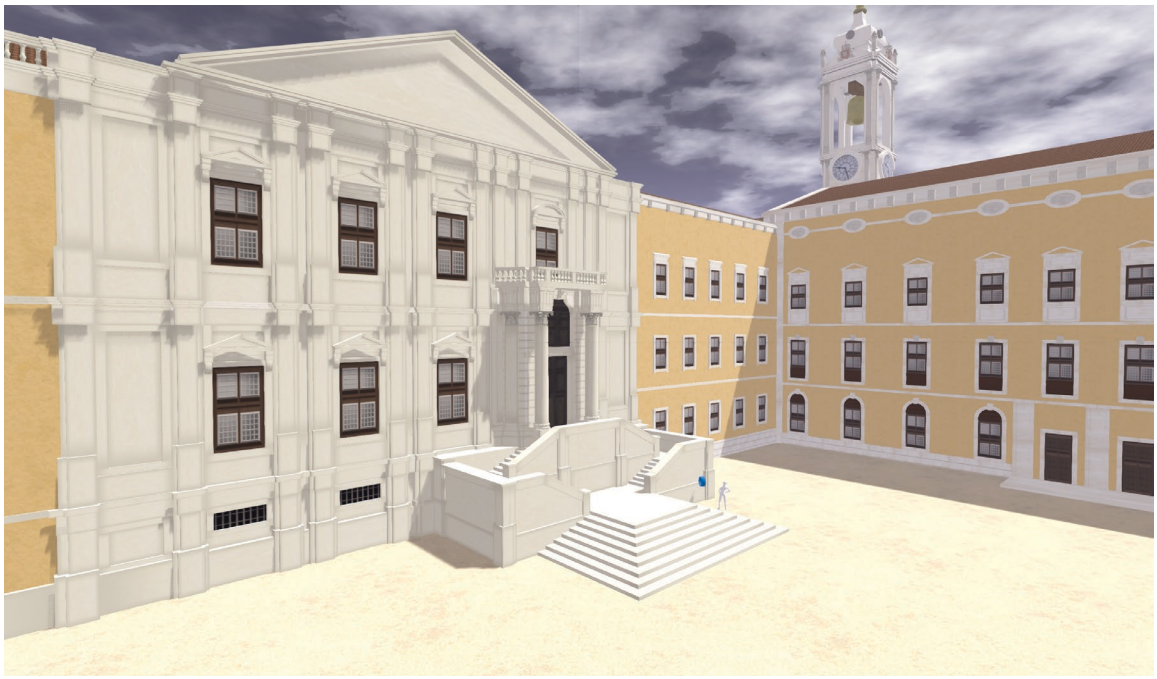

Fig. 13 Patriarchal Church (photo of the virtual model, OpenSim version 0.7.5 Dev, 2013).

Several team members can simultaneously and interactively work online in the virtual world to create the architectonic and urban models. Each building can be validated by the research team as to its accuracy, using the documents and sources as guidelines, adjustments can be made and overseen as each element is brought to the virtual world and made to fit into the existing layout.

Virtual worlds are extensive networks that allow the construction of interactive and immersive virtual realities, highly credible virtual models and realities, at a low cost and without lengthy schedules. They also allow real-time interaction between technicians and users, and the free exploring of the built model by the latter, in a synchronous virtual environment through the use of avatars (a graphical representation of the user) (fig. 14).

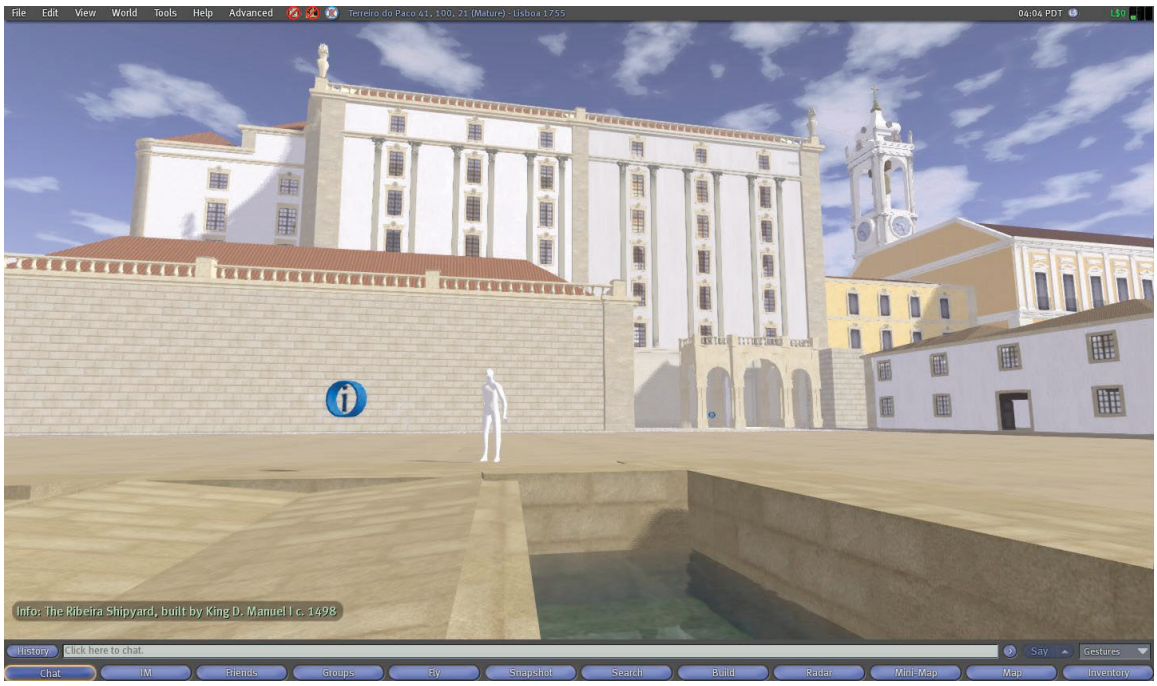

Fig. 14 Royal Opera House (photo of the virtual model, OpenSim version 0.7.5 Dev, 2012).

Each user in Second Life® is represented by a virtual manifestation or avatar. Avatars are usually life-like and conform to human proportions. Thus, a chair is not simply a 'decorative element', but an item inside the virtual world which can be used by an avatar to actually sit down. This means some compromise must be reached between visual accuracy and detail and the ability to make many of the items on display actually usable by the avatars. This interactivity that can take place with objects in the platform allows solutions of augmented reality for didactic purposes. Therefore, users no longer have a purely contemplative perspective. They can freely explore the environment, interact with the model and share these experiences with others, in contrast with more rigid technologies that base themselves in pre-defined routes. These characteristics add a social dimension to virtual recreations. It is the possibility of interactivity between the users themselves that allows the featuring of guided tours for didactic purposes, or the creation of events for wider audiences.

There are countless academic and cultural entities currently using the Second Life® platform and its audience is estimated to be 17 million people worldwide, with a positive yearly growth of 20%. This evidence heightens the educational potential of this project and the innovative creative synergies that it is able to create.

The ability of constant updating of the model in real time and its immersive dimension conform to Principles 5 and 6 of the London Charter, reliability, sustainability and access. Principle 5

of the London Charter states the need to select sustainable and reliable computer-based visualisation in order to enhance the research outcomes and to extend its dissemination. Principle 6 refers to access and states that computer-based visualisations should be planned so as to ensure the greatest number of benefits in relation to the study, understanding, interpretation, preservation and management of Cultural Heritage.

We can thus affirm that Second Life® technology allows the proposition, discussion and updating of a virtual recreation, without the need for high budgetary resources and extended deadlines, directly promoting the scientific, didactic, and leisure character of the project and in correlation with its ample dissemination. It means we have overcome the plain formal and picturesque reconstruction from the beginnings of Virtual Archaeology.[27] A set of computer applications allowed for a three-dimensional viewing and realistic virtual representation of objects and buildings, which have already disappeared or suffered severe destruction, and thus had been very hard or impossible to interpret.[28] It was not yet possible to meet the goals of those who have worked the hardest to apply the new technologies to Cultural Heritage in order to make this tool not just an auxiliary technique, but an independent subject, with its own methodologies, techniques, and specific study goals.[29] However, it was possible to develop a computer epistemology applied to virtual historic recreations, seeking to study past phenomena, and providing a method for viewing ideas, organizing and summarizing facts, identifying, analyzing, understanding, representing, and transmitting the complex character of history, while more clearly presenting it in its many expressions: architecture, territory, or social context.[30]

Conclusion

In 1964, in his *Le Pensée Sauvage*, Claude Lévi-Strauss refers to a form of scientific thought that approaches the notions deriving from perception, imagination, and sensitive intuition, as the 'Science of the Concrete'.[31] It is in this 'Science of the Concrete' that we should therefore integrate art as a system of reasoning and symbolic representation of the world, as defined by the German historian, Hans Belting, when pondering the possible ending of the history of art. This is especially true, as this issue calls for the need to go beyond the boundaries between art and its social and cultural context, requiring different study tools, different interpretation goals, and an experiment-oriented approach, which is the only way to search for new answers.[32] The interactive and immersive dimensions that Second Life® technology conveys to the study of Lisbon prior to the great earthquake, reproduced by the *City and Spectacle* project, create a new scientific approach that we can consider analogue to the 'Science of the Concrete', by Lévi-Strauss, and that we may risk designating as the 'Science of the Virtual'. This 'Science of the Virtual' is also based on perception, and implies an experiment-oriented approach as well. However, in a time when the new technologies and the audio-visual means have altered our own concepts of reality and visibility, it does so through a simulacrum. By means of the ability to project a physical absence in the world (to represent it in space and time), of the sense that human conscience is capable of going beyond the body's physical boundaries, allows the cognitive, which can only be present in the intellectual sphere and that

is only of the dominion of ideas, to be exposed to the sensitive sphere.[33] This means that just as in the case of the Renaissance's pictorial invention, which we call perspective, the technological creation of the virtual reality is a revolution of our way of viewing, since it suggests that we are seeing with our own eyes what we can only see represented – epitomizes the human vision renouncing the biological basis of that sense.[34] The transforming power of its impact over the production and transmission of historiographical knowledge, namely of urban history and architectural history, remains an open matter.

We can see that, after going from verbal to visual, and from analogical to digital, multimedia learning environments, mainly computer-based, are going from passive to interactive, giving computers the power to be the most important cognitive tool.[35] Technicians and researchers may also work simultaneously online, building, experimenting, and validating virtual re-creations, through a process that is similar to lab processes. We can actually say that the re-creation through virtual models of urban historical realities that have already ceased to exist or that have been deeply altered by the passage of time, not only allows researchers to visit past environments in real time, and to experience the effects of urban evolution, but also leads them to acquire a different perspective of the studied cities, particularly concerning the kinetic aspects of virtual historical environments. They may generate new knowledge since they require data and critical interpretations that differ from those required by narrative history, mainly structural and contextual information that relates in the same vision of the city aspects usually individually studied, such as architecture, population, movement, urban infrastructures, etc. Also unlike books and articles, virtual models and electronic databases are not static and, as we already mentioned, can be constantly updated and studied.[36] However, we do not think that books and articles are being replaced by virtual models, for right now they complement each other, since virtual worlds' technologies can be powerful problem solving tools, due to their ability to associate internal or mental representations with the external ones (objects, images, charts, videos, animation, etc.).[37]

Therefore, just as in the *Mnemosine Imagery Atlas* of Aby Warburg (1866-1829), the virtual pre-earthquake Lisbon is a notional place, where the history of art as a scientific field is subject to an ordained disorientation (the visitor may chose his/her own path), and becomes an almost non-verbal scientific domain.[38]

Bibliography

Araújo, Ana Cristina et al. (eds.), *O Terramoto de 1755: Impactos Históricos* (Lisbon, 2007).

Belting, Hans, *The End of the History of Art?* (Chicago, 1987).

Belting, Hans, *Art History after Modernism* (Chicago, 2003).

Belting, Hans, *Florence & Baghdad. Renaissance Art and Science* (Cambridge, 2011).

Bottineau, Yves, 'Le Goût de Jean V: Art et Gouvernement', *Bracara Augusta*, 27 (1973) 64, pp. 341-353.

Boyer, M. Christine, *The City of Collective Memory. Its Historical Imagery and Architectural Entertainments* (Cambridge, 1994).

Boxer, Charles Ralph, 'Pombal's Dictatorship and the Great Lisbon Earthquake, 1755', *History Today*, 5 (1955), pp. 729-736.

Boxer, Charles Ralph, *Some Contemporary Reactions to the Lisbon Earthquake of 1755* (Lisbon, 1956).

Branco, Camilo Castelo, *Noites de Insomnia offerecidas a quem não póde dormir* (Porto, 1874).

Buescu, Helena Carvalhão and Cordeiro, Gonçalo (eds.), *O Grande Terramoto de Lisboa: Ficar Diferente* (Lisbon, 2005).

Buescu, Helena Carvalhão et al., *1755: Catástrofe, Memória e Arte* (Lisbon, 2006).

Caetano, Carlos, *A Ribeira de Lisboa. Na Época da Expansão Portuguesa (séculos XV a XVIII)* (Lisbon, 2004).

Câmara, Alexandra, *Lisboa: Espaços Teatrais Setecentistas* (Lisbon, 1996).

Câmara, Alexandra, 'Relembrar o Património perdido: a Real Ópera do Tejo, obra emblemática de encomenda régia na Lisboa Setecentista', in *1755, Catástrofe, Memória e Arte* (Lisbon, 2006), pp. 202-211.

Câmara, Alexandra, Murteira, Helena and Rodrigues, Paulo, 'City and Spectacle: a vision of pre-earthquake Lisbon', in *15th International Conference on Virtual Systems and Multimedia VSMM 2009* (Vienna, 2009), pp. 239-243.

Carita, Hélder, *Lisboa Manuelina e a Formação de Modelos Urbanísticos da Época Moderna* (1495-1521) (Lisbon, 1999).

Castilho, Júlio, *A Ribeira de Lisboa* (Lisbon, 1940-44).

Castro, João Baptista de, *Mapa de Portugal Antigo e Moderno* (Lisbon, 1763).

Correia, J. Eduardo, *Arquitectura Portuguesa: Renascimento, maneirismo, estilo chão* (Lisbon, 1991).

Correia, J. Eduardo, *Vila Real de Santo António. Urbanismo e Poder na Política Pombalina* (Porto, 1997).

Correia, J. Eduardo, 'A Importância da Arquitectura de Programa na História do Urbanismo Português' in *Actas do V Colóquio Luso-Brasileiro de História da Arte* (Faro, 2002), pp. 161-169.

Courtils, Charles-Christian, 'Une description de Lisbonne en Juin de 1755', *Bulletin des Études Portugaises*, 26 (1965), pp. 145-180.

Davison, Charles, *The Founders of Seismology* (Cambridge, 1927).

Davison, Charles, *Great Earthquakes* (London, 1936).

Favro, Diana, 'Meaning and Experience. Urban History from Antiquity to the Early Modern Period', *Journal of the Society of Architectural Historians*, 58 (1999), pp. 366-368.

Faria, Miguel Figueira de (ed.), *Do Terreiro do Paço à Praça do Comércio: História de um espaço urbano* (Lisbon, 2012).

Ferrão, Leonor, *A Real Obra de N. S. das Necessidade*s (Lisbon, 1994).

França, José-Augusto, *Une ville des lumiéres: la Lisbonne de Pombal* (Paris, 1965).

Frugoni, Chiara, *A Distant City. Images of Urban Experience in the Medieval World* (Princeton, 1991).

Grande, Alfredo and Lopez-Menchero, Victor Manuel, 'The implementation of an international charter in the field of Virtual Archaeology' in *XXIII CIPA Symposium* (Prague, 2011), proceedings at http://cipa.icomos.org/index.php?id=69, (accessed on 7 August 2012).

Hermon, Sorin and Nikodem, Joanna, '3D Modelling as a Scientific Research Tool in Archaeology', in *Beyond Illustration: 2D and 3D Technologies as Tools for Discovery in Archaeology*, eds. Bernhard Frischer and Anastasia Dakouri-Hild (Oxford, 2008), pp. 36-45.

Ivo, Miguel Tibério Pedegache Brandão, *Nova e Fiel relação do terremoto que experimentou Lisboa e todo Portugal no 1 de Novembro 1755, com algumas observações curiosas e a explicação das suas causas* (Lisbon, 1756).

Januário, Pedro, 'Teatro Real da la Opera del Tajo (1752-1755), Investigación sobre un teatro de ópera a la italiana, para uma posible reconstituicion conjectural basada en elementos iconográficos y fuentes documentales' (doctoral thesis, Universidad Politécnica de Madrid, 2008).

Kendrick, T. D., *The Lisbon Earthquake* (London, 1956).

Lévi-Strauss, Claude, *La Pensée Sauvage* (Paris, 1962).

London Charter. For the Computer-based Visualisation of Cultural Heritage. Version 2.1 February 2009 at http://www.londoncharter.org/downloads.html (accessed on 7 August 2012).

Mandroux-França, Marie-Thérèse, 'La Patriarcale du roi Jean V de Portugal', *Colóquio Artes*, 83 (1989), pp. 34-43.

Martinho, Bruno, 'O Paço da Ribeira nas vésperas do terramoto' (master thesis, Universidade Nova de Lisboa, 2010).

Mendonça, Joaquim Moreira de, *História Universal dos Terremotos* (Lisbon, 1758).

Moreira, Rafael, 'A Arquitectura Militar', in *História da Arte em Portugal – O Maneirismo*, VII (Lisbon, 1986), pp. 137-151.

Moreira, Rafael, 'Do rigor teórico à urgência prática: a arquitectura militar', in *História da Arte em Portugal – O Limiar do Barroco*, VIII (Lisbon, 1986), pp. 67-85.

Murteira, Helena, *Lisboa da Restauração às Luzes* (Lisbon, 1999).

Murteira, Helena, 'A Place for Lisbon in Eighteenth Century Europe: Lisbon, London and Edinburgh a comparative town-planning study' (doctoral thesis, University of Edinburgh, 2004).

Murteira, Helena, 'A praça na Lisboa Seiscentista e Setecentista: função, desenho e simbologia', in *Praças Reais: Passado, Presente e Futuro* (Lisbon, 2008), pp. 241-254.

Nechvatal, Joseph, 'Towards an Immersive Intelligence', *Leonardo*, 34 (2001), pp. 417-418.

Nozes, Judite (ed.), *The Lisbon earthquake of 1755. Some British eye-witness accounts* (Lisbon, 1987).

Pimentel, António F., 'Absolutismo, Corte e Palácio Real - em torno dos palácios de D. João V', in *I Jornadas sobre Formas de Organização e Exercício dos Poderes na Europa do Sul, Séculos XIII-XVIII*, vol. II (Lisbon, 1988), pp. 685-710.

Pimentel, António F., 'Les grandes entreprises du roi D. João V', in *Triomphe du Baroque* (Brussells, 1991), pp. 33-41.

Rieber, Lloyd P., 'A Historical Review of Visualization in Human Cognition', *Educational Technology Research and Development*, 43 (1995), p. 54.

Rodrigues, Paulo S., *Lisboa, a Construção da Memória da Cidade: Do Monumento ao Lugar* (Évora, 2006).

Rossa, Walter, 'Lisbon's Waterfront Image as an Allegory of Baroque Urban Aesthetics', in *Circa 1700: Architecture in Europe and the Americas*, ed. Henry A. Millon (New Haven and London, 2005), pp. 161-186.

Rossa, Walter, *Além da Baixa. Indícios de planeamento urbano na Lisboa Setecentista* (Lisbon, 1998).

Ryan, Nick, 'Documenting and validating Virtual Archaeology', *Archeologia e Calcolatori*, 12 (2001), pp. 245-273.

Samain, Etienne, 'As "Mnemosyne(s)" de Aby Warburg: Entre Antropologia, Imagens e Arte', *Revista Poièsis*, 17 (2011), pp. 29-51.

Senos, Nuno, *O Paço da Ribeira, 1501-1581* (Lisbon, 2002).

Shaw, Jeffrey, 'Interactivité et virtualité', *Revue d'esthétique. Les technimages*, 25 (1994), pp. 105-106.

Sousa, Luís Pereira de, *O terramoto de 1755 em Portugal e um estudo demográfico*, 4 vols. (Lisbon, 1919-1932).

Stoichita, Victor, *O Efeito Pigmalião. Para uma Antropologia Histórica dos Simulacros* (Lisbon, 2011).

Vries, Jan de, 'Patterns of urbanization in pre-industrial Europe 1500-1800', in *Patterns of Urbanization since 1500*, ed. Henk Schmal (London, 1981), pp. 77-109.

Illustrations

Fig. 1 Eugénio dos Santos and Carlos Mardel, adopted plan for the rebuilding of Lisbon (lithography), 1756. Museu da Cidade (Lisbon City Museum).

Fig. 2-3, 12, 14 *City and Spectacle: a vision of pre-earthquake Lisbon*, OpenSim version 0.7.5 Dev, November 2012.

Fig. 4-6 Museu da Cidade (Lisbon City Museum).

Fig. 7-10 Biblioteca Nacional Portugal (Portuguese National Library).

Fig. 11, 13 *City and Spectacle: a vision of pre-earthquake Lisbon*, OpenSim version 0.7.5 Dev, September 2013.

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[1] This recreation was carried out under the supervision of Alexandra Câmara. See http://operadotejo.org/

[2] See Davison 1927; Davison 1936, pp. 27-28; Kendrick 1956.

[3] In 1700, the largest European cities (more than 100,000 inhabitants) were London, Amsterdam, Paris, Milan, Venice, Rome, Naples, Palermo, Madrid, Lisbon and Vienna. See Vries 1981, pp. 77-109.

[4] See Bottineau 1973; Pimentel 1988, II, pp. 685-710; Pimentel 1991; Ferrão 1994; Rossa 1998; Murteira 1999.

[5] See Pimentel 1988, II, pp. 685-710; Pimentel 1991, pp. 33-41; Rossa 2005; Martinho 2010.

[6] The building of the Royal Palace and adjacent administrative buildings near the riverfront is part of a wider programme designed to dignify the city and render it more functional. Developed by King D. Manuel I, it represents the first major attempt to change the strict organic layout of the city. See Carita 1999.

[7] See Senos 2002.

[8] The Union of the Portuguese and Spanish Crowns lasted until 1 December 1640, when the Portuguese Braganza family reclaimed the rights to the Portuguese Crown and proclaimed the independence from the Spanish Crown. This event was followed by a war between the two countries, which ended in 1668 when the Spanish Crown signed a peace agreement which formally ended the Iberian Union established in 1580.

[9] See Mandroux-França, 1989; Pimentel 1988, II, pp. 685-710; Pimentel 1991, pp. 33-41; Martinho 2010; Faria 2012.

[10] See Câmara 1996, 2006; Januário 2008.

[11] The 1755 earthquake is today attributed a magnitude of 8,75-9 on the Richter scale.

[12] Mendonça 1758. See also Ivo 1756; Castro 1763; Sousa 1919-1932.

[13] The vast survey of the destroyed city, ordered by Sebastião José de Carvalho e Melo (b.1699-d.1782), Secretary of State of the King D.José is the most valuable document of the extensive devastation caused by the earthquake to Lisbon. It is a thorough measurement of the city centre properties, also providing information about the extension and type of damage suffered by each one, the layout and name of all of the streets, alleys and squares of the areas destroyed by the earthquake. It is kept at the *Torre do Tombo* (National Archives) in Lisbon.

[14] See Davison 1936, pp. 27-28.

[15] The letters sent by the many British traders residing in Lisbon at the time to their families in Britain were published in various British newspapers giving a vivid and dramatic picture of the catastrophe. To this day, they represent the most expressive picture of the occurrence. See Nozes 1987.

[16] See Araújo 2007; Buescu 2005, 2006.

[17] França 1965.

[18] Moreira 1986, VIII, pp. 67-85; Moreira, VII, pp. 137-151; Correia 1991, 1997.

[19] Ferrão 1994; Rossa 1998; Murteira 1999; Carita 1999; Caetano 2004.

[20] Bottineau 1973; Mandroux, pp. 34-43; Pimentel 1988, II, pp. 685-710; Pimentel 1991, pp. 33-41; Câmara 1996; Câmara 2006, pp. 202-211; Rodrigues 2006; Januário 2008.

[21] Rossa 2005, pp. 161-186; Murteira 2004.

[22] Favro 1999, pp. 366-368. See also Boyer 1994 and Frugoni 1991.

[23] Branco 1874, pp. 10-11.

[24] http://lisbon-pre-1755-earthquake.org/

[25] London Charter. For the Computer-based Visualisation of Cultural Heritage. Version 2.1 February 2009, at http://www.londoncharter.org/downloads.html (accessed on 7 August 2012).

[26] London Charter. For the Computer-based Visualisation of Cultural Heritage. Version 2.1 February 2009, pp. 8-9 at http://www.londoncharter.org/downloads.html (accessed on 7 August 2012).

[27] Ryan 2001, p. 245.

[28] Grande 2011.

[29] See note 27.

[30] Ryan 2001 p. 246; Hermon 2008, p. 36; Grande 2011, f. 2.

[31] Lévi-Strauss 1962, p. 24.

[32] Belting 1987, pp. 29-33.

[33] Belting 2003, pp. 161-166; Stoichita 2011, pp. 9-11.

[34] Belting 2011, pp. 13-14.

[35] Rieber 1995, p. 54.

[36] Favro 1999, p. 370.

[37] Nechvatal 2001, pp. 417-418.

[38] Samain pp. 35-36.