

Reconstructions of the past – How virtual can they be?

Alexandrino Gonçalves
Escola Superior de Tecnologia e Gestão do Instituto Politécnico de Leiria - Portugal
Centro de Informática e Sistemas da Universidade de Coimbra - Portugal
alex@estg.ipleiria.pt

Fernando Silva
Escola Superior de Tecnologia e Gestão do Instituto Politécnico de Leiria - Portugal
fernando.silva@estg.ipleiria.pt

António José Mendes
Centro de Informática e Sistemas da Universidade de Coimbra - Portugal
toze@dei.uc.pt

Abstract

Since the Middle Ages, perhaps even before, the questions related to the historical and cultural past, mainly to the level of archaeological findings, have exerted an enormous and mysterious allure on Man. Ever since then, Man has come up with methods and forms to recreate such places, in order to satisfy this recognized natural and ancestral curiosity associated to the human being.

In these last few years, the number of projects involving historical reconstruction has increased significantly, due to two main factors: the technological developments that allow such designs to be accomplished more easily, with a larger impact, affecting a greater number of people; and the continuous and increasing interest of humanity about these questions related to cultural and architectural patrimony.

This paper intends to present two virtual models developed using some optimization techniques that allowed the creation of realistic historical environments, but keeping low file sizes, so that they can be accessed anywhere by anyone.

As a result, you can make your own historical tour at:

- *The Flavian Forum of Conimbriga: <http://www.forumflaviano.web.pt>*
- *House of Skeletons (Conimbriga): <http://www.casadosesqueletos.web.pt>*

Keywords: Virtual Reality, Web, VRML, Optimisation, Conimbriga

Résumé

Depuis le Moyen-âge, peut-être bien avant, les questions se rapportant sur le passé historique et culturel, surtout au niveau des découvertes archéologiques, ont exercé d'énormes et mystérieuses attractions sur l'Homme. Dès lors, l'Homme surgit avec des méthodes et de modèles pour recréer ces lieux, de façon à satisfaire cette naturelle et ancestral curiosité de l'être humain.

Lors de ces dernières années, le nombre de projets qui s'engagent à cette reconstruction a significativement augmenté, à cause de deux facteurs: les développements technologiques qui permettent d'accomplir plus facilement ces recherches, avec un impact plus large, qui atteint ainsi un plus grand nombre de personnes; et la continuation et l'augmentation de la curiosité de l'humanité à propos de ces questions sur le patrimoine culturel et archéologique.

Ce mémorandum ambitionne présenter deux modèles virtuels qui utilisent certes optimisations techniques qui recréent les réels temps historiques, garantissant cependant des archives légères, afin de permettre leur accès à quiconque quel que soit l'endroit où l'on soit.

Ainsi, vous pourrez faire votre propre tour historique dans:

- *Le «Flavian» Forum de Conimbriga: <http://www.forumflaviano.web.pt>*
- *La demeure des Squelettes (Conimbriga): <http://www.casadosesqueletos.web.pt>*

Mots-clés: Réalité Virtuelle, WWW, VRML, Optimisation, Conimbriga

1. Introduction

In 1899, Queen D. Amélia gave orders to initiate the archaeological excavations in Conimbriga (Portugal), but it was after 1930 that these excavations had been complemented and deepened, in such way that they show undeniable vestiges of a city constructed by the Roman civilization. The amount and quality of the archaeological findings presented an architectural and cultural capital of such order that it was considered to put available to the general public the contact with such reality, significantly distinct to the present.

Any visitor of this space, when facing the scene of buildings in ruins, degraded floors or damaged columns, unconsciously is led to an imaginary time travel, where he tries to recreate, through the set of sensations assimilated at that moment, all the urban, social and architectural environment lived at that time. Given the distinct ability of abstraction of each human being, even based on drawings and blueprints, this task of imaginary recreation will be always full of flaws due to the individual interpretation of each one, which can vary with the mood, age or even the cultural level of each person.

The work developed, and presented in this paper, had the main purpose to make it possible for everyone to pay, thorough the Web, an interactive visit, although virtual, to some of the emblematic architectural places of the ancient Roman Empire, which, in our case, was the three-dimensional recreation the most reliably as possible (from the number of steps of staircases to the number of columns, patterns of the time, colours, etc.) and at real scale, of the Flavian Forum of Conimbriga (Mendes, Gonçalves 2004) and the House of Skeletons (Silva, Gonçalves 2004), also in Conimbriga and, at the same time to test the viability of the working method used in the first project (The Flavian Forum), due to the remarkable final results, now applied to an architectural scenario (House of Skeletons) significantly different, not so symmetrical, from the first one.

As we wanted to allow its utilization by any interested person, there were two often contradictory requirements: It was necessary to create a realistic environment that could show how the “buildings” really were, but we needed to keep the environment file size and computational complexity as low as possible, so that there weren't access difficulties. The result of this project can be appreciated in <http://www.forumflaviano.web.pt/> (Flavian Forum of Conimbriga) and <http://www.casadosesqueletos.web.pt/> (House of Skeletons).

2. Case Studies

2.1 The Flavian Forum of Conimbriga

The twelve campaigns of excavations, carried out between 1964 and 1971 in the ruins of Conimbriga by the French Archaeological Mission in Portugal and the Monographic Museum of Conimbriga, led, in particular, to the discovery of the foundations of the former Forum in this ancient Roman city. The Flavian Forum of Conimbriga was built between the years 75 and 80 AD, by the municipality during the reign of Flavius Vespasianus dedicated to the Imperial Cult. The architectural revolution took place with the destruction of some existing monuments of the Augustus era, which led to the creation of an Imperial Forum. For such, nothing was left to chance: since the subtleness of the mathematical proportions of the dimensions (96m x 48m), to the relation between covered spaces and free spaces (Alarcão 1994).

Three monuments composed the Flavian Forum of Conimbriga: The temple, the porches of the temple and the porches of the Forum (the square). The temple of the imperial cult was raised in the highest point of

the city, precisely in the middle of a sacred area. This location and its characteristics confer impressive dimensions, as was originally desired. This entire sacred area was surrounded by a porch whose function was essentially architectural. The square, the only monument that remained from the Augustus era, was the civic place par excellence. Its two lateral porches were placed at an inferior level relatively to the porches of the temple and the floor was now covered with a meticulously lined up pavement.

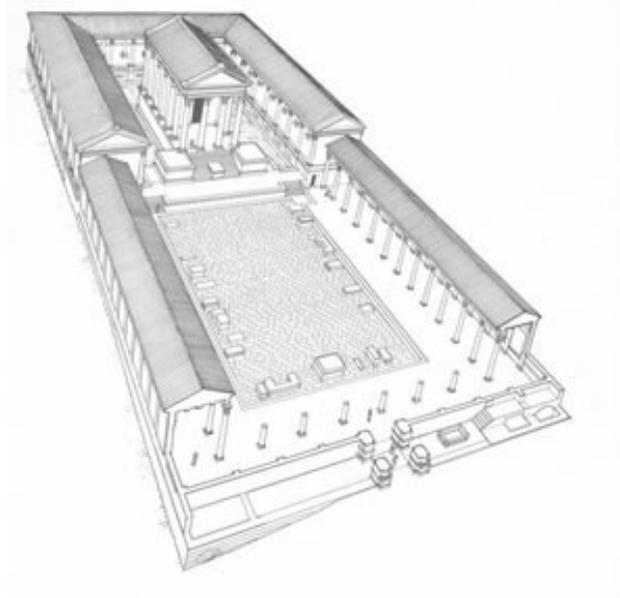


Fig. 1 Conimbriga's Flavian Forum

2.2 House of Skeletons

In its reduced dimensions (945 m²) the House of the Skeletons can be taken as a paradigm of the Roman residences of Conimbriga: quality of the architectural plan, economy of means, emphasis in the ornamental program of the mosaics, intelligent use of the autonomous part of the construction. The analysis of the house comes across, though, with some inherent difficulties because the façade was destroyed by the construction of the late-imperial wall.

The main part of the house is articulated by an axis of canonical drawing (guided E / W), of the small atrium to the great triclinium going by the axis of symmetry of the central peristyle. The peristyle gives access to six service dependences, to the North, besides which an open space would exist, as a deadlock, that would probably belonged to the house (although with independent access for the street, effectively working as service entrance). A small corridor in the Southeast corner gave access to a great cubicle, with mosaics, and to a secondary entrance; besides this there just one other a small division near the entrance. A substantial part of the area of the building was occupied by autonomous units three of them probable cauponae or popinae opened for the lane that divided the house from the Baths of the Wall, serving as access to the services of these, and another one more complex, of three divisions in row.

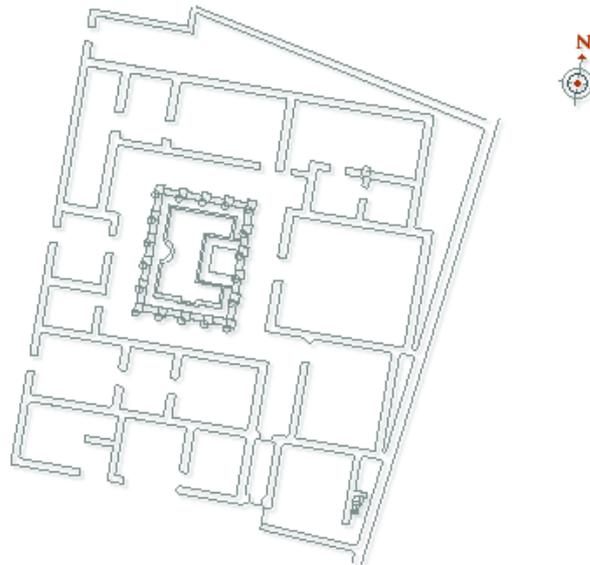


Fig. 2 House of Skeletons plant



Fig. 3 Ruins of the Forum (left) and the House of Skeletons (right)

3. Development process

Here we present the various development stages in both projects, which have been linked chronologically

3.1 The technology

Having in account the characteristics of the project and the main goals, the technology to use should have the capacity to achieve good visual results, but at the same time to supply the author the necessary potentialities to carry out an efficient development. The Virtual Reality Modeling Language (VRML), is a language that allows the development and publishing of virtual environments on the Web. It as it's own syntax and generates a simple text file, which is interpreted in real-time by a web browser. There are, although, native VRML development tools that generate the VRML code (like an HTML editor). In our case, we use Cosmo Worlds 2.0 from Silicon Graphics.

3.2 Modelling

The virtual “reconstructions” began with the modelling of the various geometric surfaces using a modular and gradual “building” strategy, where each piece or object was created individually and separately from the

main file and only later placed in its correct location, as in a puzzle. In this phase, special attention was given to the existing repetitive geometric patterns, as they would simplify (and optimise) the development process, by requiring one single model of the geometric pattern and using the properties of the VRML to promote its repetition.



Fig. 4 This wall has a repeated geometric pattern

3.3 Assembling

Throughout the modelling process, all the components were disposed in the scene. This simultaneous process allowed us to visualize the virtual scenario's aspect and simultaneously enabled us to make some corrections to the model in real time. The assembling process has taken into account the displacement of the objects in the virtual scenario; which has helped to hierarchize the model.

3.4 Textures

Textures are extremely important to the final result. Not only because they cause the visual impact of the scene, but also because they can act as an optimization to the work carried out. For example they can simplify the representation process of some complex elements like the columns. Using a detailed texture, transparencies and repetitive patterns is a way of simplifying the modelling process.

Next we describe only some of the most important textures used:

3.4.1 Column

The columns used in both projects were the result of combining a simple model of a half-cylinder with a texture. This combination has provided a very realistic representation, maintaining all the reflexions and lighting effects of the scene. This has allowed a representation that makes use of a reduced number of polygons, maximizing the performance of the virtual scene.



Fig. 5 The Corinthian column of the Forum (left) and the Tuscan column of the House of Skeletons (right)

3.4.2 Floor/ Pavement

As it is of the common knowledge, the Roman houses are characterized by the detail presented in the mosaics that coat its soil. In the case of the House of Skeletons, despite the mosaics of two rooms being in perfect state of conservation, it was not possible to get its image. In the remaining divisions of the house there are some incomplete mosaics or none at all.

The Monographic Museum of Conimbriga considered was that the soil should be represented with an identical repetitive standard for the entire house. The aspect of the mosaic should be in accordance with some models conserved by the museum, representing simple geometric forms in tones of blue-dark with deep white, having an exterior decorative bar to the central drawing. Photographs to a mosaic with characteristics that allowed arriving at the intended texture, through techniques of graphical composition had been taken off.

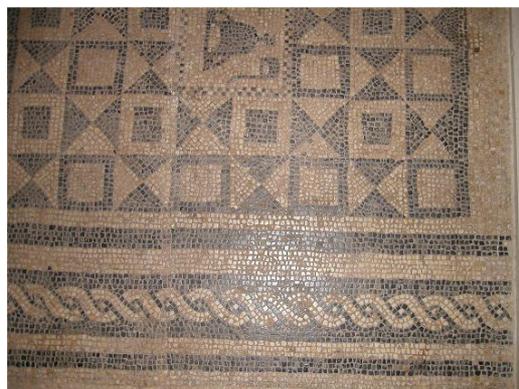


Fig. 6 Mosaic used to create the floor texture (House of Skeletons)

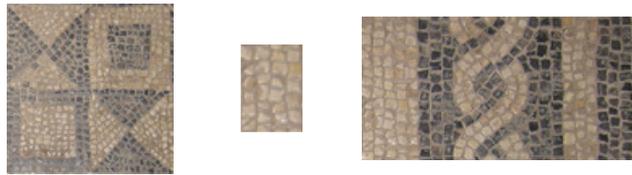


Fig. 7 Textures used in the peristyle floor (House of Skeletons)

The rather large stones (80cm x 60cm) that covered the square and other areas of the Flavian Forum of Conimbriga, have an important visual impact for visitors who enter through the entrance. After several tests, digital photos and graphic handling, we created a stone with visual characteristics which, according to the experts, are similar to the original ones.



Fig. 8 Texture of the square pavement

3.4.3 The Pediment (Forum)

In order to replace some hundreds of polygons, we used a texture and transparencies to create the pediments. Since they were only visible at some high, this procedure does not neglect the realism.



Fig. 9 A pediment in the Forum

3.5 Colouring

Whilst preparing the textures, we were alerted by the director of the Monographic Museum of Conimbriga that due to the natural erosion process throughout the centuries, the existing stones no longer show the original tones and colours. Therefore, after preparing the textures and using a graphic tool, we applied a colouring that the experts believe to be very similar to the originals.

3.6 Optimizations

Optimization wasn't a real development step. It was a concern that was present during all project phases. As we wanted to achieve a low file size without reducing realism, the need to optimize as much as possible was obvious.

Probably the most important optimization technique used was cloning. As mentioned before, there were many repeated structures, for example the columns. Instead of using the common copy/paste we opted by using VRML cloning feature. The former duplicates the code that builds the structure while the later just reuses the code already in the file. This results in lower file sizes.

Cloning can also be used when one object can be obtained from other through some geometric transformation. For example, the Flavian Forum left side corridor's wall is a repetitive pattern. We created one of those patterns and used cloning to create the corridor. However, the right side corridor is equal to the left side one if we apply to it a 180° rotation and a translation. Hence, the left corridor, which was built with cloning, is itself cloned to build the right side corridor. It is also possible to use cloning to obtain a similar object with a different size. This feature is also used, although less frequently.

As we mentioned before, textures play a central role in this kind of work. So, special care was taken to keep them as small as possible. Considering quality and size we decided to use PNG format to store textures that use transparency and JPG to store textures not using transparency.

Another optimization technique used was billboard. In VRML a billboard is a surface that follows the avatar's movement (the avatar is an entity that represents the user), so that it is always facing the user. This feature allowed the columns texture to represent only half of it. When the user goes around the column, the billboard also rotates keeping the texture facing the user and creating the illusion that he is seeing different parts of the column.

These were the main optimization techniques used in both projects. They gave an important contribution to the small file size achieved and consequently to facilitate user access and utilization of their virtual representation. It was necessary some work and careful planning, but we feel the result compensates all the effort.

The results obtained were very different from those that would be possible using a 3D modeling tool to create this virtual scenes and then exporting them to VRML. This type of approach is much more common and comfortable, but can hardly achieve good results in terms of file size and performance.

4. Main characteristics

Here are some of the main characteristics of this work:

4.1 Realistic Model

As mentioned before, the virtual models are a realist representation (and up to scale) of the original buildings. It gives the possibility to visit them in the perspective of an inhabitant of that period, and thus have a real perception of the colours and forms of the architecture of the ancient Roman Empire. Simultaneously, from that same perspective (about 1,70m high), it gives the visitor the real magnitude and impressive surrounding areas, especially the Forum.

4.2 Interactivity

Another main characteristic of this work is its interactivity. We created a virtual space where the visitor (the user) can have complete autonomy of movements in the area of the Forum and the House of Skeletons, which means, she/he can go where she/he wants, following the path she/he chooses, just using an interaction device (keyboard or mouse).

The visitants of these virtual spaces can take advantage of an important characteristic of virtual worlds elaborated in VRML: it is very easy to use. Simply by pressing the directional keyboard keys or clicking and dragging the mouse, any person will be able to move in the virtual space without any difficulty. All the movements are made trying to give the visitor a realistic perception of what would physically happen in a real visit, such as the notion of climbing stairs or falling off a high place.

4.3 Guided Tour

We also created versions with a guided tour that goes through all the areas of the monuments. The idea is allowing the user to visit them without having to manipulate the mouse or the keyboard to control the movements.

4.4 File Dimension

This was one of the main achievements of this work. Due to the optimisation techniques used in both projects, we were able to obtain a very small total file size. For example, the main, and only, VRML file that generates the Flavian Forum of Conimbriga has approximately 21Kb and the total file size (including textures) is lower than 150Kb (the House of Skeletons VRML file has 17Kb). It is possible to store both virtual representations in a small and obsolete floppy disk, and practically without losing any of the realism obtained.

4.5 Performance and accessibility

Still due to the optimisations made in the development of this work, the performance of these virtual spaces is fully satisfactory in any current domestic equipment. Often, performance in low end computers is a complex problem, since the runtime processing necessary to view VRML worlds is too much for those computers. That doesn't happen in our case due to the optimisations introduced in it.

Accessibility is also a problem in many virtual reality projects. Many times special requirements in terms of hardware and/or software seriously difficult the access by all people interested. In our case the only condition to view the work is an Internet connection and a freely VRML plug-in installed in the Web browser. This makes it widely available to any person and, especially, to archaeologists and historians interested in the roman civilization.

The Flavian Forum of Conimbriga is available at: <http://www.forumflaviano.web.pt>.

The House of Skeletons is available at: <http://www.casadosesqueletos.web.pt>.

4.6 Cost of the project

This is a type of work that is not very expensive, financially speaking, in contrast to others with similar objectives, namely the conception and the time required to implement it or the tools to make it possible (in VRML), where, for instance, all the applications needed to the visualization are available for free.

Even after its conclusion, it is possible to make improvements to the realism of the recreated space, without any alteration in the VRML file. For such, a simple improvement of the textures used in the scene, automatically updates the visualization.

5. Conclusion

The Flavian Forum and the House of Skeletons, both in Conimbriga, supported the work presented in this paper, which aimed to recreate with accuracy, in a virtual way, those impressive but disappeared monuments. This is a work, which was only possible due to the effort of the archaeologists and historians, and intends to be faithful to the reality of the monuments and the drawing of its creator. Moreover, it constitutes a way to allow the great public to contact those monuments. The interactive three-dimensional representation allows a deeper contact, better than any drawing or written description. The work has thus a double function: a pedagogical and social one; therefore it enables the "reading" of the past to some levels

and it assures the transmission of the culture. And since anyone, with no exception, can access it, this work contributes to a true democratisation of knowledge

Thus and for the accomplishment of this design, all areas of the monuments were modeled three-dimensionally to the real scale and always with a special care in preserving its geometric characteristics, so that the historical precision, always essential in these situations, is unquestioned.

This work also intends to contribute, even if modestly, to the spreading, preservation of spaces forever lost and to disseminate a better knowledge of a past, which is important for both the historical interest and the values of our culture.

Other main goal of these projects where to test the viability of a working method. The results produced indicate that they are perfectly reliable to make other kind of (virtual) "reconstructions".

To conclude, with the increasing Internet "broadband", the last generation computers and graphics cards and some care in the development of the virtual environment, mainly at the optimizations level, it is possible to bring, through the web, virtual archaeological reconstructions to anyone.

6. References

Alarcão, J., Etienne, R. e Golvin, J.-C.. 1994. A Maqueta do Centro Monumental Flaviano. Instituto Português de Museus/Museu Monográfico de Conimbriga

Mendes, A., Gonçalves, A., "Virtual Reality to Visit Historical Settings: Conimbriga's Flavian Forum", in Proc. of the ED-MEDIA - World Conference on Educational Multimedia, Hypermedia & Telecommunications, pp. 2158-2163, Lugano (Suíça), June-2004

Silva, F., Gonçalves, A 2004. House of the Skeletons – A Virtual Way. In Proc. of the XXXII CAA – Computer Applications and Quantitative Methods to Archaeology Conference, Prato, Italy, April 2004