DIGITAL MODEL OF THE HISTORIC CENTRE OF GRANADA

L. Gómez Robles [a], J.A. Fernández Ruiz [b]

[a] Instituto Municipal de Rehabilitación del Excmo. Ayuntamiento de Granada, España, lucia@ugr.es
[b] Dept. de Expresión Gráfica Arquitectónica y en la Ingeniería, Universidad de Granada, España, jafruiz@ugr.es

KEY WORDS: Proceedings, Digital model, Virtual Heritage, Granada

ABSTRACT:

Granada Council's Rehabilitation Institute has sponsored the implementation of a digital model of its historic centre as it was at the beginning of the 19th Century. The research co-ordinated historic planimetry, photographs, prints and drawings by the Romantic travellers, as well as bibliographic descriptions to obtain a new cartography from which the digital model has been developed. Ethical and scientific criteria had to be established that would render a sufficiently truthful outcome, to transmit and convey the space and urban atmosphere of the time. Handling images and animations of such dense geometry and textures also meant establishing a methodology able to economise on the resources of the respective meshes. The objective is to put the project on-line in the Institute's Web page to disseminate knowledge about the history of the city. The multimedia package will later be available at Interpretation Centres located in strategic touristic and cultural points. The novel aspect of this investigation has been to respond to the assignment by creating a mesh with urban features based on the combination of different graphic and bibliographic sources.

1. INTRODUCTION

1.1 Objectives

This research focuses on designing a Web product which contributes to the knowledge of the historic centre of Granada around the first half of the 19th Century. It will shortly be displayed in local interpretation centres.

1.2 Initial Conditions

The assignment should be accomplished within a short time on a small budget, using standard software and PCs. In fact it has been produced by two people over 8 months using two Pentium III computers and a budget of approximately 60 000 €.

1.3 Conceptual Base

No longer a technological novelty, digital modelling can now be considered under the light of ontology when it responds to a scientific formalisation based on research on the history of architecture. In cases like these we believe that these files should become "true heritage" per se, in the same way that an early music score constitutes an intrinsic heritage asset. The differential interpretations can be found in the concept of "faithfulness" to the vanished work. Although every musical piece allows an interpretative performance that would produce different versions of the same piece, the music itself remains closely faithful to the original. However, in architecture, it is necessary to put ourselves within the domain of spatial perception in order to establish the frontiers of scientific interpretation, art and science fiction.

In our case, this domain is difficult to establish since to a certain extent it is a historic urban model with uncertainties, divergent opinions, and formal blanks impossible to fill in.

Therefore, answering the following question becomes crucial in this domain: Is it possible to acquire a vision of the historic city which is closer to reality than the one we already posses through romanticised drawings, paintings, planimetries and isolated and incoherent descriptions? The answer is that though it is unfeasible for the model to render a truthful representation, it is however capable of evoking the emotion of being an eye-witness to a great number of images of the historic city. In these images, the "urban space" is conveyed regardless of problems concerning inaccuracy or indefinition and indetermination.

1.4 Brief history of Granada

The city of Granada became Christian in 1492. It was the last Muslim stronghold in Spain, with a legacy of a strong cultural background which is reflected even in its urban layout. During the 19th century, the urban plan was drastically modified when big avenues were opened up and streets were widened, leaving little trace of the previous layout.

One of the most important developments was the paving over of the Darro river which runs under the present day *Reyes Católicos* street, as well as the re-alignment of the buildings. The change of image that the city experienced was drastic, and there are only a few photographs and romantic prints of the old plan, silent witnesses for specialist study, of what the city was.

The project's objective is to bring the citizens closer to their history in a simple way, providing information from the vast volume of documents in Granada's archives.

Figure 1. Print of the Darro river before paving over

1.5 Sources

The first step was to co-ordinate a team to search through any relevant information in the archives and libraries of Granada, in order to build a scientific and documentary body of work to fulfil the project's objective. After the bibliographic search we continued with the localisation of the originals of each representation to obtain the best quality information available. However, this search provided an unbalanced outcome. We obtained a great deal of information about some places, while others remained virtually unknown. We dealt, anyway, with a great volume of information which in some cases was anachronic in relation to those parts that were well documented - descriptions that didn't coincide with the graphic documents, representations by different authors that were similar in the general features but were quite different after a close study, as happened with the *Del Carmen* Convent (Anónimo, s.XVIII; Pancorbo 1760) representations which were contradictory despite being contemporary.

Figure 2. Both versions of Convento del Carmen

The next step was to classify the information by date, because some areas had been drastically altered in the space of a few years, not only in their buildings but also in the alignment. After an analysis of the chronology of major changes in the morphology and city plan and of our objectives themselves,

the team decided to consider the year 1835 as the reference date. From that date, and taking only as valid information coming from photographs (Clifford, 1862; García, 1880-1900) which frequently dated from after the reference date, we considered that both descriptions and prints or pictorial representations were unreliable documents due to the evident subjectivity which an author can have over real facts. At this point with a photographic and historical compilation posterior to the date that we were trying to represent and the subjective literary and pictorial documents by some authors, we felt the need to establish a trustworthy reference item as a foundation for our work.

Thus we referred to one of the most well know historic city maps of Granada: Dalmau's 1831 plan (Dalmau, 1796). We started the work by superimposing the current city plan onto the historic plan using orthophotography and taking as axial points important buildings: the Cathedral, *Santa Ana* Church, and *Del Carmen* Convent. In was amazing to discover the accurateness of Francisco Dalmau's planimetry, which confirmed our idea of using his work as the primary source for the project.

Figure 3. Dalmau's 1831 plan

Of invaluable help also were the drawings of the alignments made by the Council's technicians in the 19th Century made while paving over the river and designing the new plan for the main avenues. These drawings, of great precision and even numbered by lots, were decisive in those areas for which there was no photographic or pictorial data. Starting from a standard model, and seeking to provide a general atmospheric idea rather than specific details of each building, we were able to recreate unknown spaces whose absence would otherwise have spoiled the model's clarity.

After a co-ordinated use of all the documentary sources, literary, graphic, planimetric or romanticised views, we were finally able to design a digital model of Granada in the 19th Century.

Figure 4. Drawings of the alignments

2. METHODOLOGY

2.1 Analysis of retrieved documentation from archives

With the information classified by areas and chronology we started the analysis using as the base the digital version of Francisco Dalmau's plan. The data from the alignments (Anónimo, 1855; Anónimo, 1873) was then added to the plans in order to begin drawing the elevations.

For those cases where there was no information, we opted for using standard typologies suiting the plot and the height, if these were known. In the opposite case when we found plenty of information but all contradictory, we carried out a comparative data analysis, preferring that which was closest to the reference date. However, we also took into account those documents from a later date that offered more information.

We always kept in mind that what we sought to recreate was an atmosphere rather than an exact reconstruction of the buildings, therefore we tried to find the right balance that would help us to attain to our established objective.

2.2 The modelling of the un-documented buildings

One of the main problems we came across was the decision of how to represent the unknown. What was the best way to represent those buildings that had an unknown morphology? A first attempt was made with transparent digital masses, but these were discarded as they had an ambiguous aspect. They were opaque buildings with openings that corresponded to the typology. The attempt to use empty buildings and lots, filled in with solid masses without openings, only revealed a major mistake since it totally altered space perception. In consequence, since a tridimensional object has a plastic value in itself, the representation of these unknown models couldn't be represented by transparent or empty space, as these expression tools aren't neutral and would represent a falsehood. At this point we considered applying Aldo Rossi's concepts (Rossi, 1982) on invariable historic typologies in order to establish a criteria for achieving a digital model for an atmospheric and integrated building. After a study of the typologies and the compositional features of the elevations we decided on a set of balconies and windows that adapted to the alignments and heights, opting for standard three-floor and three-corridor buildings when we these were unknown. The alignments and heights were known through the historic planimetry (the alignment plans carried out for redesigning different streets in the centre and the paving over of the Darro river).

Figure 5. Standard building

2.3 Repetitive architectural features

Optimising a mesh from a model that considers most of the historic centre of Granada is of great importance, both from the point of view of its accomplishment and its size in terms of bytes in the final file. In consequence, the typology criteria mentioned before (Rossi, 1982) has been also applied to define architectural elements such as windows, balconies, window bars, railings, drying areas, terraces, etc.

For each element various types have been modelled conveying in a simplified manner the totality of those appearing in the segment of city represented, unifying dimensions and decorative elements that aren't evident at an infographic scale.

2.4 Textures

Historically the absence of a digital modelling technology over-rated geometry against other fundamental semantic variables of the architectural language, however the textural value of façade fronts is essential, consequently large bitmaps obtained from reality have been used. In any case we have tried to avoid serial repetitions. These maps were obtained form the present architecture of the city using high resolution digital photography, which was retouched to eliminate blatant decay that would give away the repetition of a map.

Before being applied to the model the texture was also manipulated with symmetric multiplication to augment its size, only to be retouched again to get rid of any traces of repetition. In this way the resulting bitmap will have a single dimension avoiding repetition in the application.

2.5 Roofs

We have thought of a resolution for a type of roof that would be very "light" -in computer terms- but which offers a realistic appearance. Its geometry has been devised using parametric software and the maps include the under ridge tile. The roof valley and hips have been resolved with max rendered lines with their corresponding lineal map.

Figure 6. Roofs

2.6 Portals

All along the mesh there was a series of buildings that, without being outstanding in their function, had decorative elements around windows and doors, especially around the main entrances. These portals were modelled to allow a relief view in the subsequent viewings because of the lineal

configuration of the streets, in which all the elevations would otherwise be foreshortened.

2.7 People

An urban recreation such as the one we are presenting needs people. We have used old photographs from the turn of the century which have been coloured and manipulated with maps of opacity. Sometimes as in the case of Muriel's painting (Muriel, 1834) we have used a photomontage of the painting to include the reference in a more direct way (figure 11).

2.8 Vegetation

Realistic vegetation is a complex element in a tridimensional model, therefore we decided to retouch the bitmap images. This has been carried out with cloning techniques using Photoshop and Photopaint for the river bed vegetation and prefixed dissemination techniques for the geraniums in balconies and windows.

Figure 7. Vegetation

In order to do the retouching we used photographs of the river and its vegetation as base material, while for balconies and windows we used photographs recently taken in the neighbourhood.
The tree areas have been included as individual mapped regions which rotate perpendicularly to the camera in each render. Several basic maps were taken and later modified with symmetries and changes of scale to simulate variety.

2.9 Backgrounds

One of the advantages, in terms of the digital dimension of our modelled city, was the fact the streets were basically narrow which meant that there weren't many backgrounds to be dealt with. However, some of the recreated spaces had a view of the *Sabika* hill, where the Alhambra stands, in the background. In order to solve this problem, we took photographs of the hill with the palace complex, removing the residential buildings in the lower areas, which are from later than the model's reference date, but leaving untouched the view of the palaces. Despite the fact that in the last 180 years the Alhambra has undergone several restorations and its interiors have changed radically the truth is that most of those alterations are at roof level. Since they only appeared as background and they weren't the subject matter of this study we agreed to include the current view of the building without any changes (figure 11).

2.10 Hardware and Software

We used two Pentium computers with Autocad and 3Dstudio. The bitmaps were handled using both Adobe Photoshop and Corel Photopaint. For the roofs we have used Architectural Desktop.

2.11 Web Page

The Web Page: http.//www.rehabilitacion.org has been managed using the following multimedia tools:
1. Navigation Orthophotograph of the city with a "stop" (Hotspots) system as general information area. We have also set up Hotspots in some buildings where necessary.
2. Bitmap 360° immersive views of the current state of each "stop" through attached current digital photographs.
3. Equivalent virtual immersive historic views of the same areas.
4. Bitmap images of the "stop" area.
5. Transition bitmaps of equivalent photographs of identical images comparing past and present views.
6. Reproductions of the photographic and pictorial sources we have used.
7. Descriptions.
8. Special downloadable animations.

This same typology repeats at building level in which we add an item on planimetry.

Figure 8. Web Page

3. SINGULAR BUILDINGS

Last but not least, a series of important buildings, characteristic of each area, appear in the mesh. In such a wide range model, this helps the visitor to place himself in context, otherwise he wouldn't have any references and would hardly know where he is at a given moment.
Due to their importance in 19th century Granada some of these buildings have also been developed as individual meshes in their interior or through some of their more well-known features. These buildings, lost forever, are now recreated for those who want to have a glimpse of the past.

3.1 Buildings which have disappeared

Among the important buildings which have been closely surveyed, there is a type which despite the existence of some remains (archaeologically speaking), is unknown to the people of Granada.

This is the case of the Nasrid *Maristán*, a 14th century psychiatric hospital. Its structure was very similar to an Islamic "funduq", of which the current *Corral del Carbón* is an outstanding and perfectly conserved example in Granada. The hypothetical reconstruction was carried out by two researchers from the *Escuela de Estudios Árabes* (CSIC) - College of Arab Studies, Antonio Almagro y Antonio Orihuela, who took as reference material the elevations carried out before its demolition, archaeological surveys and its structural and constructive similarity to the contemporary example mentioned before.

In the same way, though this time with greater existing remains, the baths *Baños de Hernado de Zafra (House of the tombs),* the gate *Puerta de los Tableros*, and the arches *Arco de las Orejas* and *Arco de Elvira* have been reconstructed after a survey of the preserved remains and close study of historic documents (Gómez Moreno, 1892) and contemporary buildings.

Figure 9. Nasrid *Maristán.* Singular building

3.2 Partially preserved buildings

In some other cases the buildings had completely disappeared leaving only the historic planimetry, as is the case in the *Casa de los Miradores*, of which the original project elevation plan, by the architect Diego de Siloé (Siloe, 1560), is still conserved. Sometimes we had photographs from just before the demolition as is the case of *San Gil* church or a print as in the *Santo Espíritu* church (Lewis, 1835), the *Santa Ana* or *Encarnación* hospitals (De Prangey, 1836, 1837 y 1839), the *Del Carmen* Church and Convent (now only the first section remains as Granada's Town Hall) or the *Santa Ana* fountain (De Prangey, 1836, 1837 y 1839). In all these cases only the documented parts were included, leaving the rest as simple volumes taken from our original plan by Dalmau, already mentioned before.

Figure 10. *Santa Ana* fountain. Singular building

3.3 Preserved Buildings

Lastly, there was a group of important historic buildings that were well preserved and were within our study areas, such as the *Santa Ana* and the *San Pedro & San Pablo* church, the Archaeological Museum, the *Corral del Carbón* and the *Real Chancillería* (the current Law Courts). First we thought of introducing textured solids because the buildings were well preserved and we could obtain orthophotographs of its elevations, but we withdrew the idea, taking into account that the mesh was mainly lineal and that the viewpoints would be forced when making the renders. So, we modelled the buildings to obtain volume and shade, as well as a fully integrated model, unachievable if we had used textured solids.

Figure 11. *Real Chancillería*, on the left.

4. RENDERS

4.1 Illumination

Due to the size of the mesh and the hardware capacity, we decided that the lighting of the model would be based on simple lights without radiation that would have a self-running device for each render. After several tests we improved the lighting to a single main light with a ray-trace and luminous points that would soften the dark areas.

4.2 Fixed Images

The fixed renders were made in a tga format with a 1.024*768 to 72 dpi resolution. Afterwards, this format was compressed in order to be inserted in the Web page.
The current equivalent of some of these fixed images was used to make morphings which displayed a transformation from past to present time and vice versa.

4.3 Panoramic views

As well as the fixed renders we also prepared 360º immersive views with their current equivalents which allow travelling in a single shot throughout the whole historic city as well as the city today.

4.4 Animations

We have set up animations for several important buildings which provide an improved spatial knowledge of the architecture for those visitors using mpeg format archives downloadable from the internet.
We also made an animation that would tour along the river in order to show the streets' spatial plan in a more dynamic way. In order to implement it we had to reconsider all the previous decisions on lighting and atmospheric decor since it was unpractical to retouch each image or modify the lighting on each section without seeing flashes in the film. Finally we decided to remake the water texture, creating a complete map of the river without repetitions. We tried to position the lights in such a way that would make it uniform without sudden changes, once more with a main light with shadows and two light points to soften it.

5. OUTCOME

A digital replica of the historic city of Granada is the main outcome of this project, bringing new light to the interpretation of historic and urban heritage. The model rescues the city's past from oblivion or being a subject matter only for historians. We have moved from the cultured and institutional concept of Heritage to Heritage perceived as more emotive and community-based. The revaluation of a past culture through the image has made us reflect on the possibility that these models could be considered as "Intangible Heritage" by the UNESCO, since this possibility has already been discussed in this forum. Early Music could set the example. A digital model, even if only from the representational point of view, is in itself a tool which reinforces the concept of heritage and creates awareness through its dissemination on the Internet and in Interpretation Centres. This model also makes a cultural contribution with a much more truthful morphology than that which the romantic and nostalgic descriptions and fantasies provided. Its completion within the established term and the small-scale budget offers us a financial framework for this type of commission in other historic centres, plus the possibility of dynamic image studies to render the historic evolution of cities.

REFERENCES

Anónimo, Mediados del siglo XVIII. *Convento del Carmen en Granada.*. Museo Casa de los Tiros, Granada, España.

Anónimo, 1855. *Plano de la plaza de la Constitución [Plaza de Bibrambla] y la de los Hospitalicos de la ciudad de Granada; su regularización y apertura de una nueva calle.* Archivo Municipal de Granada, Granada, España.

Anónimo, 1873. *Proyecto de alineación de la calle Zacatín.* Archivo Municipal de Granada, Granada, España, Leg. 757, p.37.

Clifford, C., 1862. *Recuerdos Fotográficos de la visita de SSMM y AARR a las provincias de Andalucía y Murcia en setiembre y octubre de 1862.* España.

Dalmau, F., 1796. *Mapa Topográfico de la ciudad de Granada.* Granada, España.

De Prangey, G., 1836, 1837 y 1839. *Monuments arabes et moresques de Cordou, Seville et grenade.* Paris, Francia

Garcia Ayola, J., 1880-1900. *Fotografías de Granada.* España.

Gómez Moreno, M., 1892. *Guía de Granada.* Granada, España

Lewis, J., 1835. *Sketches and drwaings of the Alhambra made during a residence in Granada in the years 1833-1834.* Hodgson Boys and Graves, London, Reino Unido.

Muriel, 1834. *La plaza de Bibarrambla en 1834 acuarela sobre papel.* Museo casa de los Tiros, Granada, España.

Pancorbo, 1760. *Convento del Carmen en Granada.* Museo Casa de los Tiros. Granada, España.

Rossi, A., 1982. *La arquitectura de la ciudad.* Gustavo Gili SA, Barcelona

Siloe, D., 1560. *Proyecto de alzado de la casa de los Miradores.* A.H.N. Madrid, España.