Introduction

Our research is focused on finding a scientific place for the digital architectonic representations of Heritage. This space shall be defined by certain interpretative and expressive criteria, favouring itself as an ethical proposal of digital representation. As we shall see also, this annotation that is circumscribed to the professional world of architecture and archaeology, is that which shall enable the decision of the digital variables of the Heritage models. This is the route that we have followed in the digital models that we have developed at the Escuela de Estudios Árabes.

The primordial aim of this research in Heritage is to place its results at the disposal of the citizens. The question is in updating the concept of diffusion of knowledge with the emerging technology of digital modelling having appeared in the scientific spectrum. Until now, everything ended with research and subsequent diffusion by official means consisting of library books. The classic techniques of Renaissance perspective involved so much work that it was not favoured as a dynamic mean for representing the reconstructive hypotheses of architecture; the points of view were often erroneous and there was insufficient strictness in the technique, which frequently led to incorrect proportions in volumes. In the majority of cases, they failed to transmit light or colour. Therefore, the most frequent works consisted in the drafting of planimetrics and descriptive articles; that was the system that was constituted as unique and acquired an official nature and prestige. Any approach to the transmission architectural beauty without its presence was attributed to literature, poetry and painting, in short, to the world of art, which has assigned the communication of feelings; in this case, the transfer of feelings derived from a contemplative act of architecture, when this has disappeared. In the field of painting, on occasion good paintings have been made reflecting the chiaroscuro, the colour and the texture, but after great efforts, they obtained exclusively a point of view, a sole perspective, whilst the true observation of architecture comprises a set of images that constitute a spatial experience, another type of perception in short. [1]

There is, however, another method with digital techniques and it is the three-dimensional representation with sufficient accuracy so that the interpreter of the sentiment is the user himself and not the artist, thus using a more direct transmission of a cloned element. Consequently, once digital modelling is discovered we have the obligation of converting known scientific Heritage into perceptive scientific Heritage, although only virtually, the architectonic space to the observer, evaluating in this case, more the conceptual interpretation than the physical value of the relics.

We all know the feeling of frustration when visiting extensively destroyed ruins. It is very difficult to mentally reconstruct these historical buildings, even for architects and archaeologists. Many architects consulted, whose job is the constant translation of a planimetric language into a cerebral spatial language, state that they find many surprises when their buildings are constructed; unsuspected points of view, uncontrolled scale and errors in the adaptation to the surroundings etc, are the most common interpretations. In fact, each time more pedagogical experiences arise that completely disregard the planimetric representations in the devising stage of architectural projects. [2]

In spite of everything, due to the physical nature of the remains, the people continue to visit these stone spectacles simply for the illusion of the transfer of a psychological bridge with their ancestors.

On the other hand, the ruins are not neutral in their plastic expression and, in general, due to the great level of destruction, transmit spaces of an open nature that many buildings never had. In many cases, that open nature betrays the enclosed and domestic nature of many settings. Serious errors are often perceived, tending to think that the buildings and urban units would be similar to the open-plan spaces that we now see.

Abstract

This work details the experience of the Escuela de Estudios Árabes (Granada School of Arabic Studies) in the process from photogrammetry to digital modelling, establishing the necessary criteria to model the reconstructive hypotheses of Heritage, entirely or partially non-existent, directing the objectives on the side of architecture and archaeology.

Keywords

Virtual heritage, Architecture, Archeology, Digital modeling.

Introduction

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On the other hand, the ruins are not neutral in their plastic expression and, in general, due to the great level of destruction, transmit spaces of an open nature that many buildings never had. In many cases, that open nature betrays the enclosed and domestic nature of many settings. Serious errors are often perceived, tending to think that the buildings and urban units would be similar to the open-plan spaces that we now see.
In Figure 1 we see the remains of the Northern Hall of the Umayyad Palace of Amman. [3] [4]. We observe walls, the start of a vault; we can imagine, but does our imagination reproduce the nature of “building knocked down into an interior patio”? In Figure 2 we reproduce the same image with a render representing through transparency the reconstructive hypothesis:

![Figure 2](image)

We can say that there is a level of destruction whereby architecture loses the most important of its qualities: space. We are only left with materials remain, proof, essential from the point of view of research and attachment to the physical, but they cannot transmit to us the architectonic space.

Due to their tangible nature, however, the places of Heritage link us to the past and although the digital model can be diffused in many ways, interactive CDs, Internet, books etc., we think that the most suitable location for the images is in those tourist sites for the following reasons:

a) They help to understand the architectonic and urbanistic qualities of the building that existed, being able to compare the place, the remains and the virtual representation in a single process. Learning is greater with the representation located in the very geographical surroundings, the same mountains and the same landscape, etc. using the physical bridge to approach the past through virtuality.

b) Restoration instructions impose strict restrictions on the rebuilding decisions. The anastilosis operations (relocation in their original position of architectonic elements that have fallen, are out of their primitive position, however, scientific bases may exist to guarantee their original position) are permitted under strict scientific documentation, but the analogical operations of addition of style are prohibited even in simplified forms.[5]. This correct criterion in the scope of real restoration completely impedes the recreation in situ of the original architectonic space. The digital modelling supplements the argument used that it is necessary to relocate and reconstruct the pieces to understand. This function, the pedagogical function, can be assigned to a more flexible medium, a model susceptible to change with subsequent research.

c) An increase in income may occur that can lead to the restoration of the monument itself.

Coinciding with large investment in three-dimensional applications, specially interactive games and 3D software, in order to increase the demand of hardware, the first representations of Heritage have come from the hand of non-specialists in archaeology and architecture; nevertheless we must thank them for the technology and energy developed as well as the demonstration of viability through the practical examples presented. But from the point of view of the diffusion of knowledge, they must be, as always the aims and not the means that establish the priorities and must not run the risk of provoking great confusion before the convincing power of an image, as this reaches much deeper than previous scientific articles, as they can be transmitted world-wide on the Internet in only a few hours. Consequently, with regard to the authorship of this type of work, we believe that it must correspond, in all cases, to the specialists in archaeology and history of architecture, who, in their great majority are currently found on the margin of these representations under the excuse that they are a source of misinformation. It shall be the responsibility of those who work in the field of archaeological and architectonic research to provide the necessary seriousness to the proposals. With these specialists failing to do, as expressed by Professor Antonio Almagro in a speech not yet published “doubtless others, without appropriate scientific bases, will do so, and in any case, this type of representation shall reach society, because society demands it.”

**Digital Semiology**

The most important elements of architectonic language are geometry, light, colour, texture, space, function and context. Once we have the reconstructive hypothesis expressed in planimetric mode we must observe the archaeological ruins and determine which of those variables or aspects have disappeared, totally or partially, and therefore which must be dealt with through digital techniques. Our mission therefore, shall be to recover, as far as possible, the semiological elements that define it. Consequently, we can initially sense a level of detail of the digital mesh, in such a way, that the model correctly transmits space, geometry, light and texture and serves to illustrate a professional hypothesis.

Another problem is the correspondence between the level of security and accuracy of a reconstructive hypothesis and the method of illustrating this level of interpretation: up to what point are we sure of our reconstructive hypothesis? How do we express something schematic with a digital technique that requires the finest detail? Our method of representation must also reflect a level of conceptual simplification so that it is coherent with our hypothetical uncertainty, but that configures, in all cases, the space lost. In general the hypotheses that we develop are made with limited information, supported in the majority of cases by contemporary analogies and those pertaining to the same culture. The proposals that we usually make are mainly hypotheses with a relative level of uncertainty, whereby the corresponding exercise is to decide on the mode of expression of the uncertainty.

But once we have opted for the route of austerity and coherence, budgetary matters start to be settled. Let us bear in mind that a computer has the capacity to represent stone by stone, but it would involve an enormous amount of work and the budget would be so high that it would be unthinkable for the majority of research departments. A simplified model is cheaper and therefore high budgets are unnecessary. Consequently, we are defining a method that finds a point of equilibrium. It appears that we can reach an optimum point between budget and the level of detail; something we could call *infographic scale*. [6]

Examples such as that of “Virtual Olimpia” are of excellent quality but have doubtless been developed with larger budgets and subsidies. This type of work moves away from our hypotheses in the sense of establishing reduced costs that enable their generalisation to small-scale administrations, with the aim of highlighting the value of Heritage, currently only bibliographical, which has never been able to be observed through image. [7]

In short, our type of representation, our level of definition, shall be that which configures the qualities of the non-existent architecture in a simplified manner, coherent with the level of uncertainty of the scientific hypothesis and that may be dealt with on a domestic scale. In this way, the spectrum of these representations would be opened up even to the smallest municipal areas that have great informative Heritage and not, like now, exclusively, to the great monuments.

Specifying a little further, we shall observe that the spatial qualities cannot be appreciated without their defining elements, the walls and the surface properties. The architects are well
aware that, if space is their objective, the system of configuration is its continents.

Generally speaking, initially the proportions and global idea must be expressed correctly, so that if the interpreter of the hypothesis is uncertain of the specific details he/she can pass them by as long as the global idea is represented through its proportions. That is, we can define architectonic space with masses without the need for detailing its elements. In Figure 3, which corresponds to the image of reconstruction of the main Almohade mosque of Seville, [8] it is probable that there is a problem with the correct interpretation in the capitals but we have no doubt that the space was very similar to that of the image.

In view of geometry, the main annotation that we make, is the regularisation of the plan, carrying out theoretic planimetry that overcomes all the irregularities of the original model. Logically, the limit of this distortion is in the fact that the visual perception does not note the change. Consequently, this enables the application of copies and serialised symmetries.

Insofar as decoration, at most we can express the idea of a decoration without it being exactly identical. The textures do not necessarily have to express the figurative image that can be unknown, but an alternative that informs that there was an image there that transmitted the same sensation as that observed. In a word, we try to conserve the perception although we do not have the correct pictorial source. For example, in the building of the Northern Hall of the Umayyad Palace of Amman a small piece of original mosaic is preserved. Through copies and symmetries we have obtained the complete bitmap of the mosaic (Figure 4). We have used the tiles of the building in the building itself (Figure 5) and in the building close to the Entrance Hall (Figure 6) where there are no tiles. It is highly likely that the drawing of the tile is not the same, but the transmission of a bare floor would deprive the observer of an extremely important detail: The floor with all likelihood was mosaic, with small tiles and a similar design to that presented by us.

As for the sources of obtaining textures we are presented with two types of problems: the textural expression of a material more or less smooth such as stucco or render and the textural expression of a figurative theme such as a bas-relief or a frieze. In both cases our experience leads us to avoid obtaining bitmaps of photographs of the reality or if we use them, these shall be enhanced and digitally modified. We observe that the photographic sources of bitmaps comply with certain lighting conditions that do not coincide with those corresponding to the surfaces, providing latent rejection with the observation of images. This type of reflection by contradictory light is well known in photomontages.
On the other hand, neither are we too interested in being too realist, as by doing so, due to the great transcendence and diffusion of the synthesis images, it is advisable to distinguish between what is virtual and what is real. Consequently, we have introduced austere levels of texture and when we do this we base it on pictorial sources.

With regard to size of the bitmaps we shall say that the textures are large (high-resolution bitmaps) with the minimum levels of repetition, in order to avoid too industrialized and technological images.

We consider, however, that from a level of volumetry it is necessary to carry out the modelling. The criteria in this case shall be purely perceptive; that is, if the observer detects the “trick” that it implies that it must be modelled.

We must insist, however, that these images must not be passed off as real, but they must be digital models that have correct expression, in accordance with their condition and that endeavour. What we cannot do is to make a technological display, to trick the observer, making him or her believe that it is a photograph.

This route points towards the opting of a border between scientific and superficial representations that are developed for dramatic or purely commercial ends. We must remember that in the world of scientific written publications it is also so; the scientific articles pertain to the scientific world.

Methodology

Our suppositions are on a domestic scale therefore, for the examples we present, we emulate a small office of two or three individuals with personal computers.

There are three software packages used: a vectorial modelling program that in our case is AutoCad as it is the most extensive in our country, a render program, which in our case is the 3D Studio Max or Viz and an image enhancement program such as Adobe Photoshop, Corel Photopaint etc. The use of the most extensive programs enables great flexibility in the exchange of data and personnel.

Initially, The Escuela de Estudios Árabes through its research carries out a survey and site study.

Subsequently, according to its historical and architectonic knowledge it carries out a two-dimensional model of the reconstructive hypothesis. These drawings are accurate and conserve exactly the entire geometry and deformations of the remains found. These works are done by Doctor Antonio Almagro Gorbea, Director of The Escuela de Estudios Árabes.

We then embark on a project of a virtual model, where we shall define a level of detail in accordance with the criteria that we have expressed in the previous section. Nevertheless, it is worth knowing the media in which they are expressed in order to also adjust the precision to the scale of detail required.

Regularisation of the planimetries then takes place, restoring the imperfect models of the photogrametry into ideal models. In this phase small deformities and irregularities shall be disregarded that do not influence the perception of the images. This will enable us to model symmetries and multiple serialised copies.

The following step is the drafting of a catalogue of elements that must be modelled independently. The rest of the pieces shall be obtained by copies and symmetries.

Next we study the contemporary buildings of the same culture and function that may be better preserved in order to obtain expressive criteria regarding colour and texture.

After, we apply the colours and the textures to the basic independent elements.

Later we make multiple copies and symmetries.

During the modelling period the hypotheses are reviewed in order to ratify or change the reconstructive hypothesis.

Show of Results

Finally we execute the images that are shown in books, exhibition panels or multimedia settings. Their elaboration process must respond to the idea that our objective is that of supplying the clone of a visual experience. Consequently, the choice of certain variables is important:

a) The viewpoints shall be, in the majority of cases, of human height as architecture is observed generally from that position.

b) In the animations we try to avoid walkthroughs that emulate a speed similar to the human and refrain from speeds that fail to reflect a pleasant stroll around the monument. Sometimes, we accelerate a little in order not to bore the observer.

c) We go to great lengths to ensure that the light appears to be real in the orientation of the building. This is quite easy on current software. (Due to the domestic nature of the studies, our experience in radiosity is not very developed as it requires considerable processing time, but it is obvious that if the light is a semiological element of architecture, this must be represented with accuracy and recently with the new processors it is more feasible). Nevertheless, we work with test models made by bounding box. These models are quick to complete and enable us to carry out many lighting tests. In Figures 7 and 8 we see an image of the test model and its equivalent in the main Almohade mosque of Seville.

d) Insofar as expressive typologies that we have used we have the Renders on paper, Animations, Panoramas and Serialised panoramas, Virtual stereoscopes and Panoramic anaglyphs. The most fruitful method is the Serialised Panorama as the user is able to link a panorama (view from a point of the entire room through a bitmap) with that of the adjoining room.
Our projects
Below, we show some images produced by various members of our work group:

The Building of The Dar al Yund in Medina Azahara. Cordoba. Spain. (Figure 9)

The Rest of The Medina Azahara site. (Figure 11)

The Umayyad Palace of Amman. Jordan. (Figure 1 to 6 and 10)

The main Almohade Mosque of Sevilla. Spain. (Figures 7-9 and 12)

The Crossing Courtyard of The Alcazar of Sevilla. Spain. Almohade, gothic and baroque period. (Figure 13 and 14)

The Royal Room of Saint Domingo. Granada. Spain. (Figure 15)

The Maristán of Granada. Spain. (Figure 16)

Conclusions
Scientific digital modelling of Heritage favours a conceptual surrounding defined by the perceptive restoration of architectonic space.

It is not necessary to make a model with a high level of detail but an optimised model that expresses with correction spatial objective pursued.

This annotation resolves various types of problems:

It enables projects with more modest budgets thus extending the scope to more domestic Heritage.

It is possible to overcome the indecisiveness of the interpreter of the conceptual reconstruction.

It produces a model that does not endeavour to be realist, which avoids misunderstandings given the great capacity of emulation of reality of the computer medium. (The render could be confused with something already existing).

This conceptual scope constitutes the necessary and subsequent step from that established in the restrictions of the restoration charter, permitting prohibited reconstructions.

The choice and agreement on the scientific scope eliminates sensational and non-professional interpretations that generally arise in the world of computing. (Currently, there is considerable lack of co-ordination on this matter and distinction is not made between scientific representations and those non-professional).
References


Figures

Figure 1: Photograph of the Iwan of The Emir’s Residence in The Umayyad Palace of Amman. Almagro, A.

Figure 2: Integration image of the hypothetical model of the precedent photograph. Almagro, A. (reconstruction hypothesis). Fernández Ruiz, J. (model). Santana, F. (Integration).

Figure 3: Render of the mihrab of the main Almohade Mosque of Sevilla. Spain. Jiménez, A. Almagro, A. (reconstruction hypothesis). Fernández Ruiz, J. (model).

Figure 4: Bitmap of the hypothetical mosaic of The Emir’s Residence in The Umayyad Palace of Amman. Almagro, A. (reconstruction hypothesis). Fernández Ruiz, J. (model).

Figure 5: Inside top view of the Emir’s Residence in the Umayyad Palace of Amman. Almagro, A. (reconstruction hypothesis). Fernández Ruiz, J. (model).

Figure 6: Inside top view of the Entrance hall of the Umayyad Palace of Amman. Almagro, A. (reconstruction hypothesis). Fernández Ruiz, J. (model).

Figure 7: Testing model about the interior of the main Almohade Mosque of Sevilla. Spain. Fernández Ruiz, J.

Figure 8.- Inside render of the hypothetical reconstruction of the main Almohade Mosque of Sevilla. Spain. Jiménez, A. Almagro, A. (reconstruction hypothesis). Fernández Ruiz, J. (model).


Figure 10: Render of the hypothetical reconstruction of the Entrance Hall building of The Umayyad Palace of Amman. Almagro, A. (reconstruction hypothesis). Fernández Ruiz, J. (model).

Figure 11: Really aerial view and hypothetical integrated reconstruction of the whole archaeological site of Medina Azahara. Córdoba. Spain. González Garrido, M. Fernández Ruiz, J. (model).


Figure 13 and 14: Render of the hypothetical reconstruction of the Crossing Courtyard of The Alcazar of Sevilla. Spain. Almohade period. Almagro, A. (reconstruction hypothesis). Almagro Vidal, Ana (model)

Figure 15: Royal Room of Saint Domingo. Almagro, A. Orihuela, A. (restoration proposition). González Garrido, M. Roldán. F. (model)

Figure 16: Render of the reconstruction of the Maristán of Granada. Spain. Almagro, A. Orihuela, A. (reconstruction hypothesis). Gómez Robles, L. (model)