

# IMPLEMENTATION OF AN ARCHITECTONIC GIS ON A BRICKWORK FARMHOUSE

J.L. Lerma, S. Navarro, M. Cabrelles, C. Portalés

Dept. Ing. Cartográfica, Geodesia y Fotogrametría. Universidad Politécnica de Valencia. C° de Vera, s/n. Edificio 7i.  
46022 Valencia, Spain – jllerma@cgf.upv.es, sannata@topo.upv.es, micablo@topo.upv.es, criporri@upvnet.upv.es

**KEYWORDS:** Documentation, Cultural Heritage, Architecture, GIS, Photogrammetry, Thermal imagery, Data Management, Visualization

## ABSTRACT:

Management of Cultural Heritage for restoration purposes is a challenge when different surveys are carried out on a multidisciplinary team. This paper deals the implementation of an archiving and managing system for architectural related-work, specifically rehabilitation. All the data collected and delivered by technicians and experts such as drawings, reports, pictures and rectified imagery concerning the restoration were input into an architectural information system. The architectural information system is a Geographic Information System (GIS) particularized for architectural analyses and management. It has been implemented in such a way that it is possible to link alphanumeric data with building maps independently of its spatial attitude and level. The challenges for overcoming a fully 3D documentation project into a 2D management system are addressed. Furthermore, the conceptualization of a specific architectonic management system based on multi-source information is highlighted. Finally, the benefits of developing a management system for architectural surveys and restorations dealing with multidisciplinary teams are also discussed.

## 1. INTRODUCTION

The more number of multidisciplinary personnel involved in conservation and restoration projects, the more difficult and challenging is the efficient management of the data for appropriate decision-making purposes. Additionally, longer time is needed in order to assemble efficiently the multi-source input data, unless an up-to-date information management system is used by all the multidisciplinary team for storing, processing, analysing and plotting.

For many years, GIS has been successfully used to archive, handle, manage, analyse and plot both alphanumeric and graphic data in different fields, such as urban planning, cartography, logistics, land and networks management, etcetera. It is possible to find lots of information related with GIS projects, even in the field of cultural heritage for spatio-temporal analysis and visualization (Hosse and Schilcher, 2003), simple management systems on rock art sites (Ogleby et al., 2003), research, conservation and valorization on the Internet using open source technology (Agosto et al., 2003), or enhancement and systematic reconstructions of archaeological sites (Borgia, 2007).

This paper shows an implementation of an architectonic GIS on a typical two-storey brickwork country house in Valencia (Figure 1). In the near future, this building is going to be rehabilitated for university facilities. The GIS is conceived in order to organize, analyse and share, on the one hand, topographic surveys, on the other, architectural information. Indeed, comprehensive surveys and analyses have been carried out by architects and engineers inside and outside the farmhouse, among them, measuring surveys with a total station, photogrammetry and thermography approaches (Lerma et al 2007), georadar, material and structural analyses, deterioration studies and analytical inspections.

All data regarding the graphic and thematic documentation and architectural prior studies about materials, alterations and damages, styles, and construction knowledge for rehabilitation have been integrated in a GIS. It has been designed as an

architectonic information system focused on managing comprehensive architectural documentation projects. Part of its functionality is examined herein.



Figure 1. Country house placed a few meters away the boundary of the Polytechnic University of Valencia

## 2. MAIN REQUIREMENTS

In architectural projects dealing with country houses and/or farmhouses object semantics are as relevant as the actual geometry. Therefore, it is mandatory to have a strong flexibility for defining and assigning thematic information, on the one hand, to individual geometric objects such as windows, doors, rooms and furniture, and, on the other hand, to entire geometric objects such as facades, floors and roofs.

Besides, there is a need to visualize most of the objects of the GIS system by means of rich and colourful texture coming from hand-held digital cameras. These images will eventually be used for rectification purposes (Lerma and Elwazani, 2006), orthorectification, 3D modelling, inventories and, last but not least, filling in reports.

The larger the number of complex shapes of geometric elements, the better the impact of including pictures in the 3D GIS. The system should be prepared to handle both aerial and close range imagery, although, most of the times, the former will be used for positioning as well as for contextual information, while the latter will be thoroughly used for shooting all the interior objects and façades.

### 3. CONCEPTUALIZATION OF THE ARCHITECTONIC MANAGEMENT SYSTEM

The basic functionality of a management system covers aspects related to acquisition, modelling, manipulation, analysis and integration, presentation and exchange of data. One of the key factors in making architectural models is the effective integration of existing 2D data in different layers into one accessible and exploitable 3D environment with information coming from vast amounts of data: pictures from different sources (visible, Figure 1; thermal, Figure 2; visible mosaics, Figure 3), horizontal and vertical maps with structural and/or thematic information layered onto them, historical and material reports, structural analyses, colorimetric studies and furniture inventories.

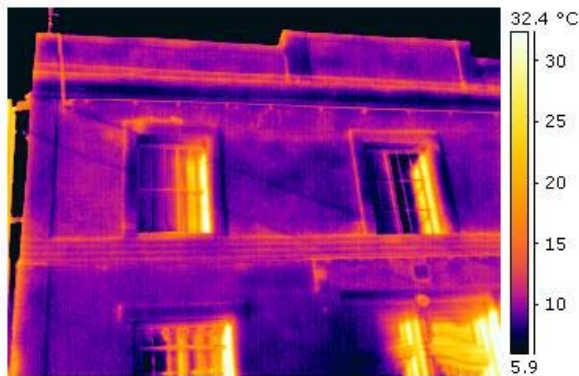


Figure 2. Thermal imagery used to detect and check facade alterations and damages



Figure 3. CAD layer with the Eastern façade rectified imagery

The 3D conceptualization of the GIS is achieved working on topological solutions that run perfectly on existing 2D GIS, mixing altogether all the 2D models that allow the hierarchical construction of 3D models. This behaviour supports specifically the visualization and management of architectural models following a sort of boundary representation. Vertices, edges and faces are the boundary elements that hold implicitly a hierarchy for their data structure. Additionally, the GIS system supports enhancement of architectural objects after draping texture onto the objects' surfaces in 3D. The attributes that alter appearance can be assigned to any geometric feature thanks to its geometric model and can be stored within its database.

Following this architectonic management system concept, the power of the 3D model is achieved due to the power of the database that links the graphical data and its geometry with the rest of the information that integrates the management system.

### 4. BENEFITS OF THE ARCHITECTONIC MANAGEMENT SYSTEM IN HERITAGE

The utilization of a unique system to manage architectural projects helps the multidisciplinary team to follow progresses and advancements on the project. Therefore, the idea of liaisons among the members of the team is strengthened and allows the head of the project as well as the members of the team to validate input data. However, it is recommended that the management system provides some tools (toggles) that visualises approval from several points of view: first, data providers in the team; second, data users; third, project manager. Eventually, another toggle could be included for checking purposes by external parties outside the team.

Dissemination activities are also strengthened due to the possibilities of web-based visualization of architectural 3D models with photorealistic texture. This point greatly depends on the surveying methods used for the implementation of the GIS. Close range and aerial photogrammetry and aerial and terrestrial laser scanning are all stand-alone or in combination optimum techniques to determine 3D related information about the architectural objects. A user-friendly tool in the GIS might help to generate on-the-fly web-based scenes with large numbers of 3D objects, or fully detailed textured scenarios for multimedia products such as movies on DVDs.

The efficient and accurate spatial data storage of object's related information in 3D also guaranties that all the team work is kept save, and contributes to simple data updating. In fact, monitoring is one of the key issues that benefits most from the GIS architecture. It is possible to place up-to-date all the related information and, more importantly, place back information when necessary. All the basic GIS tools contribute to carry out successful analyses and by-products such as plots, profiles and statistics coming from the graphic and/or alphanumeric database. Figure 4 plots some statistical analysis about alterations, while Figure 5 depicts service cost estimate for wood (in percentage) for rehabilitation.

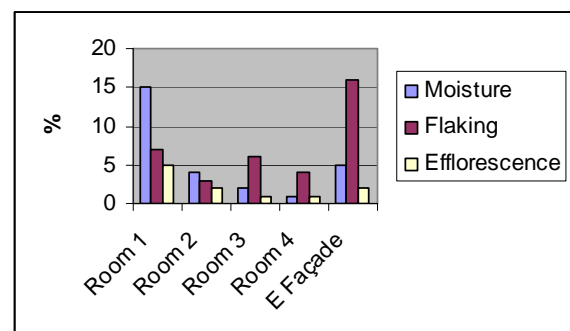


Figure 4. Moisture content, efflorescence and flaking distribution for part of the country house elements

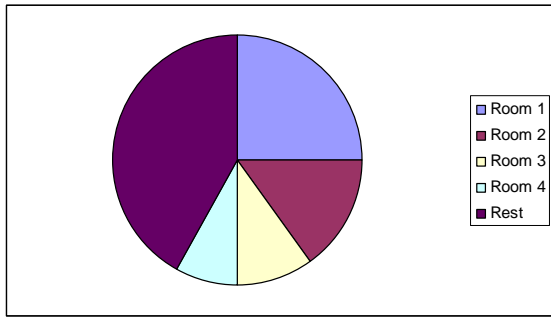


Figure 5. Cost estimate for wood

The GIS architecture allows the users and producers to maintain and keep clean of topological errors the input and output data. This topic is important when graphic and alphanumeric data come from weak data structures or the data do not respect the structural requirements of a GIS. Therefore, the strength of the spatial analysis of the management system is hindered by erroneous information among data sets (Ubeda and Egenhofer, 1997).

Last but not least, the chance of planning activities within the architectural management system is one of the most positive aspects that support multidisciplinary teams. Developed and used GIS up-to-date data has proven to be very useful in, among other applications, the surveys of documentation tasks, reports on material removals and wastes (e.g. on different parts of the building (Figure 6)), computation of new construction materials, elaboration, analysis and print-out of fact sheets.

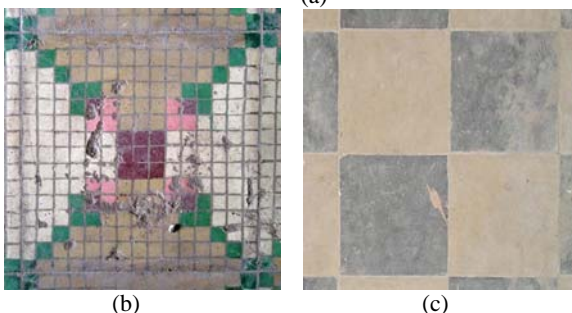


Figure 6. (a) Distribution of the different rooms and yards of the country house. Tiles linked to the rooms PS1 (b) and HA3 (c)

## 5. CONCLUSION

The feasibility and completeness of architectural project management with GIS related technology has been outlined

within this paper. After some experiences developing and using architectural management systems with large-scale projects, there is no doubt of the benefits of linking the graphical database with the alphanumeric information: accessibility, coherence, maintenance, spatial data visualization, planning and monitoring are just a few subjects that permit users coming from the CAD world migrate into the GIS world.

Architectural documentation demands further work up of the information system focusing delivery and visualization on the Web. One of the new challenges will be to explore low-cost products based on open source GIS technology. It will be possible to access and validate architectural resources sharing a Web server and publishing directly on a Web site. Following this way, users and providers will be able to share, update and deliver raw, processed and meaningful data without restrictions.

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## ACKNOWLEDGEMENTS

The authors acknowledge the support provided by the research grant from the Spanish Ministry of Education and Culture, MEC2005-03152/ARTE

