Fusion of Cultures

Abstracts of the XXXVIII Annual Conference on Computer Applications and Quantitative Methods in Archaeology,

CAA 2010

F. Javier Melero · Pedro Cano · Jorge Revelles

Editors

FUSION OF CULTURES

Abstracts of the XXXVIII Conference on Computer Applications and Quantitative Methods in Archaeology

Fco. Javier Melero, Pedro Cano & Jorge Revelles (Editors)

Granada, Spain
April 6-9, 2010

Edited and written by Francisco Javier Melero, Pedro Cano and Jorge Revelles, with contributions from José Luis Gutiérrez, Juan Gabriel Jiménez, Maria del Carmen Jiménez, y Sergio León

Front cover and logo designed by Jorge Revelles. 3D Lion model courtesy of the Council of the Alhambra and Generalife. Background photo courtesy of José Manuel Rabasco.

Fusion of Cultures.

Abstracts of the XXXVIII Annual Conference on Computer Applications and Quantitative Methods in Archaeology, CAA2010.

ISBN: 978-84-693-0772-4

Depósito legal: GR 1114-2010

IMPRESO EN ESPAÑA –PRINTED IN SPAIN

3D Documentation in Architectural History: A case study of the 16th c. Church of Stavros tou Missirikou in Nicosia, Cyprus

Solomidou-Ieronymidou, M.[1], D'Andrea, A.[2], Bakirtzis, N.[3], Iannone, G.[3]

[1] Department of Antiquities, Republic of Cyprus
[2] University of Naples "L'Orientale" – Interdepartmental Archaeology Center (C.I.S.A.)
[3] Cyprus Institute – Science and Technology in Archaeology Research Center (STARC)
dandrea@unior.it ; {n.bakirtzis, g.iannone}@cyi.ac.cy

1. Introduction

The study and preservation of architectural monuments with complex building histories can greatly benefit from recent developments in 3D documentation surveying techniques and modeling applications. Thanks to the increasing availability of digital and spatial technologies, the documentation task is now easier and more simple; innovative and fast devices have become indispensable for the survey in detail of structures or architectural elements. The use of 3D documentation tools in the systematic structural documentation and study of architectural monuments opens a wide array of new research possibilities. These opportunities can help researchers and scholars to solve complex problems in architectural history and to revise our current state of knowledge.

Among these new tools, laser scanning presents an optimal solution for the acquisition of large amounts of spatial data, and at the same time guarantees a high level of accuracy.

This procedural step will foster the semantic understanding of the targeted object so that it can be used for e-learning and meta-documentation, in our case a complex medieval structure with multiple building phases (Scopigno 2006).

Being able to precisely follow this process can make possible the extraction of a variety of general and specific structural, decorative and geometrical features from the final product: a virtual model which is digital replicas of reality. This 3D model can be used for various application: from the monitoring of state of preservation of the building to the public or scientific dissemination and utilization of its results.

In view of the project's research goals and needs, a digital 3D model of any building, or object at different scale should be: 1. Accurate: Precision and reliability are two important factors, unless the work is carried out for quick visualization and simple navigation. 2. Inexpensive: Many professionals in CH have limited budgets and cannot afford expensive instruments. In order to meet the needs of a successful field survey that would support the creation of a digital 3D model, the chosen equipment should be: 1. Fast: Frequently the survey task requires too much time for on-field data acquisition. To overcome this limit it is necessary to use faster equipment preserving the quality of the documentation. 2. Flexible: The technique should be able to adjust to sites, buildings and objects of variable scale and volume as well as to apply to any possible condition (interior or exterior sides, with or without sunlight etc).

2. The case- study: The Church of Timios Stavros tou Missirikou in Nicosia, Cyprus

At the heart of the old city of Nicosia, northeast of the well-known basilica of the Panagia Phaneromeni (1872), a small domed building echoes the diverse urban culture of the medieval and early modern capital of Cyprus. The edifice, which according to most scholars dates from the 16th century, is known as the church of Stavros tou Missirikou (Figure 1), or as the Arablar mosque, two names that reflect its different uses: as a church and later as a mosque.

Little is known about its history and various hypotheses have been made about its patrons and users through the centuries. Its architecture, which

has been concisely described as a Byzantine-plan building with a "weird mixture of French Gothic, Italian Renaissance and oriental elements" in its exterior facades (C. Enlart, 1987, 165), remains one of the most intriguing problems of the urban history of medieval Nicosia (Figure 2).

Figure 1: *Church of Stavros tou Missirikou (16th c.) in Nicosia, Cyprus*

Figure 2: *Church of Stavros tou Missirikou (16th c.) in Nicosia, Cyprus*

The three-aisled roughly rectangular building is built with well carved ashlar blocks and measures approximately 13.75 by 8.5 meters. It occupies a total area of 129 square meters. The nave, topped by a circular dome on an eight-side drum, is flanked by two narrow aisles. The north is covered with two crossvaults and the south with barrel-vaults. The semicircular apse of the sanctuary puncutates the exterior of the church's eastern side. A short minaret (total height 10.26m/ 4.90m circumference) was built adjacent to the north side of the apse when the building was converted into a mosque during the Ottoman period (1571-1878). The building has three entrances (north, west and south) from which only the north one remains open. A total of four vertical buttresses articulate the northern and western exterior sides of the structure: One in the northern side, two in its wider western side and one resembling a pier supports the southwest corner of the edifice.

The exterior facades and roof of Stavros tou Missirikou bear a rich display of architectural sculpture and spoliated material that manifests the building's variable influences from Gothic, Rennaissance and Islamic architectural styles.

This fascinating medieval structure was chosen to serve as a case study forthe application of laser scanning technology and 3D documentation in architectural monuments proposed by the paper's authors. The virtual model of the church will facilitate the planned historical study of the building as well as the necessary structural observations towards its systematic conservation.

3. The Project

On November 5th, 2009, the exterior facades of the church of Stavros tou Missirikou were scanned using a laser scanner. The on-site project was under the auspices of the Department of Antiquities of the Republic of Cyprus, and involved the expertise of members of the Cyprus Institute- STARC, and UNIOR- CISA. The aim of this collaborative effort was to create a realistic 3D model of the monument that can function as the virtual canvas for further architectural analysis. In addition, this model can be utilized as a tool for the comparative study of the church building's features (typological, structural, stylistic, decorative), with other structures of the medieval and early modern periods.

This research project was developed in the framework of a European Project 3D-COFORM, in particular in a larger workshop that attempted to set up new methodological approaches to digital surveys of cultural heritage monuments and artifacts. 3D-COFORM is a co-funded Large Scale Integrating Project and has received funding from the European Community's Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 231809

4. Laser scanning: system overview

The instrument used in this project was the 3D Imager 5003 produced by the German company Zoller & Frohlich.

The Scanner is based on phase-measurement and has been developed for applications of short and medium range (minimal distance cm 40 till m 53,5). Three different profiles can be chosen for the acquisition of data: Superhigh, High and Medium. At 10 meters distance from the scanned object, the laser scanner acquires points each every 6 mm. in the High profile; at the same distance in the Superhigh profile, the laser scanner measures points every 3 mm. The data (point cloud Figure 3) is also documented in spatial coordinates x, y, z, which in reflectance values can be expressed in tones of gray.

5. Planning and data acquisition

Fieldwork was carried out in just one day following a well-consolidated methodology: first, all possible scanning points were checked in order to eliminate possible shadow areas. Additionally, in order to align the scans, 15 targets were positioned on the ground around the church.

The first step was to make 14 scans in the medium profile; at this resolution level, the acquisition of data lasts less than 2 minutes. The obtained image result is in grey tone and with low resolution. Thus, it was necessary to subsequently carry out a complete photographic documentation in high resolution color photos of the building so to provide texturing for the development of the 3D model. The taken photos have a resolution of 1984×1320 pixels, 300 Dpi with a digital weight of 800 KB.

Figure 3: *Point cloud from laser scanner*

6. Point Cloud Processing

After the on-site activity, all the scans were processed with the software JRC 3D Reconstructor, a package for the process any 3D format.

Imager 5003 acquires data in a proprietary format (zfs). For this reason all scans were imported in Reconstructor with a sub-sampling 1; in this case there is no loss of information as the resolution is the same that of the acquisition. Therefore, it is possible to guarantee a high level of detail in the scans.

The next procedural step of the project was the filtering of any redundant points, the cleaning of the point-clouds, and finally, the alignment of the scans. The 14 scans were aligned with the use of positioned targets. This task was realized through the recognition, in contiguous shots, of at least three common targets. Starting from the first scan, all the subsequent scans were pre-registered and roto-translated as pairs. At the end of the process, the registered scans were merged; the mean error for the alignment was about 4 mm. Then, the digital color photos of the building's facades were embedded on the scans in order to create textured points clouds (Figure 4), colored meshes (Figure 5), and virtual scans. The photo registration process requires the recognition of at least 11 points in common on the scan and on the photo. Thanks to the architectural features of the church (i.e. clearly defined masonry blocks, rectangular windows etc) this task was simple and accurate. In the end of the reconstruction, virtual plans were built in order to extract various sections (Figure 6). Finally, these sections were exported to AutoCad for further analysis.

Figure 4: *Colored point cloud*

Figure 5: *Textured mesh*

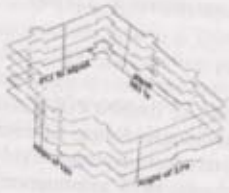

Figure 6: *Sectioned planes with different angles.*

7. Conclusions

The use of 3D laser scanner technology in the study of historic buildings, such as the Stavros tou Missirikou in Nicosia, is an accurate and fast solution that is able to capture the complexity of their historic fabric, as well as, to analyze their structural and decorative details. Field data will be processed to produce a detailed 3D model of the building which can be used as a virtual canvas for its structural investigation.

Although laser scanner technology remains expensive in terms of equipment and process learning, it is an irreplaceable tool for the complete documentation of any monument. Furthermore, the

method's final products can be easily integrated in any application for further uses; the 3D model can be used for a complete reconstruction of the monument, to offer a virtual representation of its building history, to analyze and compare structural and decorative features, as well as, to monitor the monument's state of preservation. Widespread use is streamlining the process and refines important issues such as the management of the huge amounts of obtained data, and the definition of a production pipeline. For the Stavros tou Missirikou monument, its 3D documentation is the important first step towards the extensive study of the structure's history and architecture, viewed within the complex cultural networks of Lusignan, Venetian and Ottoman Cyprus. The study of this significant monument will be led by the Cyprus Department of Antiquities in collaboration with the Cyprus Institute as part of TIEM (Tracing Identity in the Medieval Mediterranean), a research project supported by a Marie Curie Grant (FP7-PEOPLE-IRG-2008).

Acknowledgments

This research is the result of a collaboration between : Department of Antiquities, Republic of Cyprus, CyI Science and Technology in Archaeology Research Center (STARC), Interdepartmental Archaeology Center (CISA), and benefited from the support of the EU-funded project 3DCOFORM (www.3d-coform.eu), which is a co-funded Large Scale Integrating Project and has received funding from the European Community's Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 231809.

References

D'ANDREA A., IANNONE G., SAFFIOTTI L., 2008. Metodologie Laser Scanner per il rilievo archeologico: metodi operativi e standard di documentazione, in "L'informatica e il metodo della stratigrafia. Atti del Workshop, Foggia 6-7 giugno2008, Edipuglia, Bari.

C. ENLART, 1987. *Gothic Art and the Renaissance in Cyprus*, (Engl. Trasl. D. Hunt), London: Trigraph/ A. G. Leventis Foundation, p. 165.

G. GRIVAUD, 1992. 'Nicosie remodelée (1567): Contribution à la topographie de la ville médiévale', *Epetiris Kentrou Epistemonikon Ereunon* 19: 281-306.

G. JEFFERY, FSA, 1918. *A Description of the Historic Monuments of Cyprus. Studies in the Archaeology and Architecture of the Island*, Nicosia. (Repr. London 1983), p. 44-45.

P. LEVENTIS, 2005. *Twelve Times in Nicosia: Nicosia, Cyprus, 1192-1570 Topography, Architecture, and Urban Experience in a Diversified Capital City*, Nicosia, Cyprus Research Centre, p.187.

A. PAPAGEORGIOU, 1987. 'Missirikou Stavrou ekklesia,' *Megale Kypriake Encyclopaedia*, vol. 10, Nicosia.

R. SCOPIGNO, 2006. *Gestione efficiente dei dati prodotti dai sistemi di scansione tridimensionale*, in Campana, S., Francovich, R. (a cura di), *Laserscanner e GPS. Paesaggi archeologici e tecnologie digitali*, All'Insegna del Giglio, Firenze p.41-68.