Dear CAA2010 participant,

The CAA2010 Organizing Committee and the University of Granada welcome you to Granada!

Granada is an historic place where you can enjoy a large number of diverse experiences from the different cultures that have lived in the city (Romans, Arabs, Jews and Christians). Our city is said to be a fusion of cultures, and this is perfectly in tune with the aim of the CAA Conference: the interdisciplinary and complementary work of archaeologists, computer scientists and mathematicians. So, the title of this book and the conference, Fusion of Cultures, refers both to the scope of the conference and to the spirit of the city that is proud to host you.

Every year, our University hosts almost 2,000 European students under the auspices of the Erasmus programme, and many students from other nationalities come to our city to learn Spanish and enjoy our culture. This young unofficial UN assembly, this Fusion of Cultures, enriches our day to day life, in exactly the same way that we expect the four days of the conference will motivate all of us to work together in the future, combining our knowledge and experience to work towards shared goals.

The CAA Conference is like our city. At the conference, we will meet people from different countries and cultures. Although archaeologists and computer scientists belong to different cultures, in that one extracts knowledge from the past and the other always tries to advance the future, they coexist and collaborate in a symbiotic manner. This has always been the raison d’etre of CAA: archaeologists working with computer scientists to produce new theories and discoveries, and computer scientists working with archaeologists on new challenges that are solved by new algorithms and data structures.

We would like to thank all authors for submitting their most recent and innovative results, all reviewers for their hard work in reading so large a number of papers, and all of you, CAA2010 participants, for visiting us in these days.

The scientific programme includes more than 250 contributions, that will offer you the most innovative results in the application of new technologies in archaeological research. The social programme also offers a complete overview not only of the city of Granada, but also of the whole of Andalucia. Each day of the conference has one social activity, where participants can talk to each others and exchange comments and opinions about the conference, the city or the nice weather. On the days around the conference, we have planned some optional excursions to show you the variety of the Andalusian cultural heritage, visiting our most famous UNESCO World Heritage Sites.

We have worked very hard for several months to put together this exciting and diverse agenda. We hope you have an interesting, challenging and educational few days, and never forget your stay in Granada.

Javier Melero
CAA2010 Chair
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Computer Applications and Quantitative Methods in Archaeology

CAA is an international organisation bringing together archaeologists, mathematics and computer scientists. Its aims are to encourage communication between these disciplines, to provide a survey of present work in the field and to stimulate discussion and future progress. Membership is open to anyone on payment of a nominal fee.

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# XXXVIII Annual Conference on Computer Applications and Quantitative Methods in Archaeology

Granada, Spain, 6-9 April 2010

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**Virtual Archaeology and Scientific Communication**
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**Illuminating Historical Architecture: The House of the Drinking Contest at Antioch**
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**The Church of the Charterhouse of Mirafleres in Burgos: Virtual reconstruction of an artistic imaginary**
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**Cost-Distance Histograms and Their Use in the Study of Ancient Architecture**
Hacigüzeller, P

**On the road to nowhere? least-cost paths and the predictive modelling perspective**
Verhagen, P.

**Time geography, GIS and archaeology**
Mlekuž, D., Vermeulen, F.

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**Finding the Language of Stereoscopic Technologies for Archaeological Sites and Artefacts**
Georgiou, R.

**Integrating 3D data acquisition techniques for comprehensive study of the ancient Hellenistic-Roman Theatre of Paphos, Cyprus**
Amico, N., Angelini, A., D’Andrea, A., Gabrielli, R., Iannone, G

**Towards an integrated platform for urban planning rescue archaeology and public inclusion**
Hermon, S., Kapsian, I., Vassallo, V.

**Vector 3D Mapping and Visualization Techniques for Multi Story Structures in Montezuma Castle National Monument**
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GIS Applications in Developing Models of Rock Art Protection in the Valencian Community
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The management of archaeological information at the site of Vascos (Navalmoralejo, Toledo): Approach, data integration and representation in an intra- and intersite model
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Spatial data for large size archaeological projects – an example
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Methodologies and techniques for the reconstruction of ancient architectures
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Combining photogrammetric survey and 3D laser scanner of archaeological remains. First campaign in the Alberca Rota and Pozos Altos of the Cerro del Sol archaeological site at the Alhambra

Towards the Collaborative Algorithmic Rendering Engine (CARE) Project
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GIS answers for historical questions: a GIS project of spatial analysis applied in the middle Douro Valley (Castilla y León region, Spain).
García, M.

Using GIS in French rescue archaeology The choice of Inrap: a tool for research at the scale of excavation.
Rodier, X., Ciezar, P., Moreau, A.

Localization of the cities of Margiany of Parthian time: The analysis of Claudius Ptolemy’s work “Geography” by means of GIS-TECHNOLOGY*.
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Landscape and Mapping technologies at the High Atlas (Morocco): ASTER GDEM and GIS.
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Integrated method to study the Late Antiquity and Mediaeval landscape along the Via Traiana Apulia stretch: dynamic route for a project of knowledge.
Castagnolo, V., Maiorano, A.C., Franchini, M.

Historical and territorial analysis: A Contribution to the Study of the Defence of the City of Lisbon – The Peninsular Wars.
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**Approaching 3D Digital Heritage Data from a Multitechnology, Lifecycle Perspective**  
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**Integrated system for the study and management of the historical buildings**  
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**3DWS - 3D Web Service Project**  

**VisArq 1.0. : interactive archaeology and 3D data**  
Diarte, P., Sebastián, M., Guidazzoli, A., Delli Ponti, F., Diamanti, T.

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### Room Manuel de Falla  14.30  3D Technologies in Cultural Heritage

Prior to the invention of photography, there was only limited possibility to capture the real world in an objective way, main reason being that all kind of literature and arts, especially paintings and sculptures, contain an intrinsic subjective component. Although photography, and later on digital image processing, have provided complete new possibilities for archiving and documentation tasks, any 2D-technique is inherently characterized by strong limitations to reproduce the 3-dimensional world. However, within the last 10 years, advanced 3-dimensional surface scanners have been developed, now opening the 3rd dimension to digital image processing techniques.

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**Aramus Excavations and Field School. Experiences in Using, Developing, Teaching and Sharing Free/Libre and Open Source Software**  
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**Open Source Software in Archaeology: beyond passive users**  
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A procedural approach to the modelling of urban historical contexts
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WILD-GOAT. Towards a virtual “Corpus Vasorum” of wild-goat style vessels of museum collections
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The Iron Age Shock Doctrine – a GIS analysis of property rights in the landscape.
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Rock Art, landscape and prehistoric settlement at the High Atlas (Morocco).

Implementation of GIS techniques for a information management and graphic representation of the andalusian city of Vascos (Navalmoralejo, Toledo).

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Rodier, X., Ciezar, P., Moreau, A.

GIS Use in Open-Air Rock Art Conservation: the Case of the Côa Valley, Portugal.
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GIS as a research resource for the study of the transition from the Mesolithic to the Neolithic in Atlantic Europe: The case of the Picos de Europa region (Northern Spain).
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Visualization of CH Models: Seeking for Just Visual Quality or Also Informative Content?
Invited Talk: Roberto Scopigno
Combining photogrammetric survey and 3D laser scanner of archaeological remains. First campaign in the Alberca Rota and Pozos Altos of the Cerro del Sol archaeological site at the Alhambra

L.J. García-Pulido¹, J.C. Torres², P. Sánchez³, M. Pérez³, Mª. M. Villafranca⁴, F. Lamolda⁴

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³ Arquemus Medievalia, S.L., Spain
⁴ Patronato de la Alhambra y del Generalife, Spain
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1. Introduction

This paper presents a case study of combined use of photogrammetric survey with 3D laser scanner. The work has been carried on some of the hydraulic structures from the Alberca Rota and Pozos Altos of the Cerro del Sol (Broken Pool and High Wells of the Hill of the Sun) archaeological site, places in the Dehesa del Generalife over St. Helen’s Hill, that belongs to the Monumental Ensemble of the Alhambra and the Generalife, manages by the trust of the same name.

In this Nasrid archaeological site some remarkable features has been preserved, including several vestiges and associated infrastructure. With regard to hydraulic structures they consists of the remains of a large water reservoir, known as Alberca Rota, and two wells, known generically as Pozos Altos, located to the east and west of this great pool.

Thanks to the interest shown by the Patronato de la Alhambra y el Generalife towards patrimony preserved in the territory historically linked to the Nasrid Citadel, along 2008 a first archaeological campaign has been carried on, focused mainly to clean, maintain and protect this site. This first campaign acted on various elements, which were surveyed using both photogrammetry and 3D laser scanner before and after the excavation process.

Figure 1: Aerial view of the Broken Pool and High Wells of the Hill of the Sun archaeological site after the first archaeological campaign (Photograph: AeroGraph Studio, 2008/09/10)

Figure 2: General view of the broken pool

Along 2008 a first archaeological campaign has been carried on, focused mainly to clean, maintain and protect this site.

This first campaign acted on various elements, which were surveyed using both photogrammetry and 3D laser scanner before and after the excavation process.
2. **Photogrammetry**

The architectural survey of the “Alberca Rota” has been made from data taken with total station and digital photographs with calibrated cameras. These images have been restored photogrammetrically from the checkpoints taken in the field, and the set has been georeferenced in the environment. Lifting surface of the more than 900 $m^2$ required to carry on 9 stations to close the polygon.

Similarly we proceeded in the upper gallery of the East Well, that, after the archaeological intervention was easily accessible to be able to place the total station used in these methods of survey. Here we use another twelve stations placed in line.

Finally the total station was introduced in the lower gallery of the East Well and on its underground network, doing a caving fall.

![Figure 3: Photogrammetric survey on surface](image)

**Figure 3: Photogrammetric survey on surface**

**Figure 4: Topographical works inside the East Well lower gallery**

3. **Laser scanner**

Laser scanner survey has been done using a Calidus CP-320. This is a medium range time of flight scanner. The 3D scanner survey has been carried on at three different times. The first survey was done before the first excavation works. So its capture the terrain level before the restoration process. Allowing to compute volume of soil deposited over the original structures.

The second survey was performed during the excavation works, when part of the original stone pavement has been dug up.

The third one was done after the excavation process. This one includes also the first gallery of the east well, to which it was then possible to enter the scanner.

![Figure 5: Topographical survey of the East Well and its galleries](image)

**Figure 5: Topographical survey of the East Well and its galleries**

![Figure 6: Laser scanner on surface before archaeological workings](image)

**Figure 6: Laser scanner on surface before archaeological workings**
4. State of the work

The data obtained with total station, and photogrammetry survey has been processed. The general georeferenced photo plans of the site have been developed from restitution of photography obtained from a raised platform and by a captive balloon. We are also working with this methodology to elaborate the detail plans for archaeological structures.

The data obtained with the 3D laser scanner have been downloaded, obtaining the point clouds. These data are being processed now. Both techniques are perfectly complementary in an archaeological site like this one; photogrammetry survey has allowed define the contours of each archaeological structure and profiles, developing 2D and 3D (volumes) plans, and laser scanner survey is allowing to detailed terrain orography, micro-topography and relief contours before and after archaeological excavation. This survey also allows to calculate removed earth volumes and precision volumetric definition of the site. Once it will be completely excavated, this will enable future 3D representation and infographics with hypotheses about the initial spatial configuration of this hydraulic and architectural complex.

The underground workings present numerous irregularities that can not be captured with the total station. There, laser scanner survey is defining accurately the volume and the relief excavated.

5. Conclusions

Data obtained with these two complementary measurement methods have yielded to obtain better results in the representation and definition of the archaeological remains of this site.

References


