COLOUR & SPACE IN CULTURAL HERITAGE

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3D visualisation of a fragmentary Snake Kantharos

Date of call: 15 May 2014

Deadline for the applications: 15 June 2014

The CS must be completed by 31 July 2016 Report due by 1st September 2016

1. **Title of the proposed case study**:
'Kantharos. From a buried fragment to the virtual artefact'

2. **Duration/dates:**
September 2014 – January 2016

3. **Description and image of the subject (object/site), its significance and suitability for the proposed case study:**:
A key issue in the study of cultural assets is their often fragmentary condition. That causes serious problems and questions regarding their study as well as their presentation for both scholars and general public. A second similarly important issue for cultural heritage and in particular archaeology, is the field of pottery studies. Ceramic vessels and vase fragments are the most numerous findings in every excavation and archaeological site. Furthermore, pottery plays an essential role for the reconstruction of the past, since it provides information for all the aspects of life (private, public, religion, death, economy, society, trade etc).

Object of the proposed case study is a fragmentary kantharos (drinking cup) that was unearthed during the excavations at the settlement of Karabournaki (ancient Therme) in the area of Thessaloniki (Greece) (fig. 1).

Fig. 1. Aerial view of the ancient site at Karabournaki, Thessaloniki (Greece)

The site preserves the remains of an **ancient settlement** placed on the top of a low mound, with its **cemeteries** at the bottom of the hill and a **harbour** just next to it. The site dates from the late Bronze Age down to the Roman times, with its peak to be in Geometric (9th-8th c. B.C.) and particular in Archaic period (7th-6th c. B.C.). The location of the site at the edge of a promontory in the centre of the Thermaic Gulf make it very important for trade and military reasons. Therefore, at the settlement (figs. 2-3) are unearthed imports from all over Aegean. Pottery findings are the most common and they come from all the known pottery workshops of Antiquity.


Figs. 2-3. The excavation of the ancient settlement at Karabournaki.

The vase (figs.4-5) dates in the Archaic period (7th-6th c. B.C.) and it was found among the settlement's architectural remains. Although the shape of kantharos is widespread in ancient Greece and in particular in the region of ancient Macedonia and Thrace, the specific example is unique in terms of its decoration and for not fitting sufficiently into any of the known workshops so far. There are also archaeological issues with its profile that does not follow the typical known examples of its time. Regarding the decoration, it has four (4) added snakes (made by separate piece of clay) on the upper part body of the vase. The snakes surround all the body of the vessel with their heads being inside its rim, as if they are about to drink the liquid inside the vessel. Kantharos is the vessel of the god Dionysos and a typical drinking vase for symposion (social gatherings with food and drink). This decoration points to a ritual vessel, however, that might be able to contribute a lot to the knowledge and reconstruction of the life in this area. Its fragmentary condition (although preserved in a large extent) is challenging in its completion and in particular for its lower part (base and foot).

Fig. 4 Fragmented kantharos from Karabournaki

Therefore its study and exhibition is of great importance for scholars and general public. Its fragmentary condition sets limitations for the study, since we cannot have a complete picture of it and for its exhibition since the public cannot get a full image and understand it well. Furthermore, a 3D model would facilitate its study since it could be seen from every side and as close as needed, something not possible with the 2D photos. A closer look at the color used for the decoration and the examination for existence of dilute glaze (pale color) will be enabled through the 3D model. The brownish color seen through naked eye will be studied better and examined for different hues.

At the same time through this process the technique will be tested and the model will be evaluated in comparison to the original. Certain research questions will by set by the researcher and it will be checked whether they are properly answered through the result. At the same time the technological sector will be able to test the technological results and check the advantages and disadvantages of the technique.

Fig. 5. Fragmented kantharos from Karabournaki.

4. **The rationale for and the purpose of proposed case study**:
The proposed case study regards the visualization of the fragmentary drinking vessel (kantharos) that is decorated with added snakes. It is a unique in terms of decoration and shape for its time and region piece while at the same time it is a typical case of a fragmentary clay vase that offers challenges in terms of its visualisation and reconstruction. Therefore it can be used as a model for other fragmentary vases that come from: a) the Karabournaki excavation, since the excavation wants to create a showcase of 3D models of vases for study, education (teaching the students) and presentation (through the web site http://karabournaki.ipet.gr , and b) or any other archaeological site or collection.

That way will be benefited the scholars for the study of the object itself as well as the general public that will have the opportunity to see an intact version of the vessel and to understand it better.

Although the project regards the visualization of only one vase it consists a typical case of any fragmentary clay vessels since it includes all the principal challenges for the turning of the real kantharos fragments to a 3D model that will present a complete vessel. Those challenges regard: a) enough information for reconstruction, b) challenge for missing parts, especially the foot & base (no info for that) and the tails of the snakes that meet in the center of each side of the body of the kantharos. The final product (after its evaluation and tentative improvement) may serve as a guide for similar archaeological issues.

Furthermore, for the contributors from the technological field the purpose for the realisation of the project regards

- ✓ Evaluation of the technique for the specific type of CH

- ✓ Question the applicability of a commercial low-cost software for Multi-Image 3D Reconstruction
    - Shape From Motion - Dense Multi View 3D Reconstruction
    - …Of Low cost and efficient 3D digitisation method
- ✓ Evaluation of the data produced
- ✓ Evaluation of the created model for research purposes

The 3D model will contribute to the better understanding and communication of the cultural heritage.

5. **Contribution to the objectives of a particular COSCH Working Group, or Groups, and generally, to the COSCH Knowledge Representation schema**:
    - Contribution to a global knowledge of the use and application of 3D in one of the major fields of Archaeology, the pottery studies, and in particular the fragmented objects, which is the rule in Archaeology (intact objects are the exception).
    - Contribution to visualization of pottery and its diffusion
    - Contribution to the reconstruction of fragmentary objects
    - Contribution to the color examination
    - Contribution to WG5 (Concepts, methods, processes and issues in historical visualisation of CH; scholarly applications),
    - Contribution to WG2 in terms of the techniques used for the 3D reconstruction,
    - Collaboration of COSCH members for issues of conservation & evaluation
    - Through the evaluation in which will be invited to contribute COSCH members from different fields and WGs, will be benefited COSCH in general and possibly other WGs than the mentioned above
    - case study for COSCH KR.
    - the proposed case study deals with a different material and category of cultural heritage assets that other case studies included so far in COSCH. Pottery is one of the most widespread and popular categories of cultural heritage. The proposed case study can contribute to the needed evaluation and the guidelines that will be set at the end of the COSCH project.
    - it will serve as a model and guide for other similar projects

6. **Target users and their needs**:
    (Please name the user groups likely to benefit from the proposed case study and list likely research questions they may ask, e.g. Museum curators: can the proposed method support the authentication of the object under study?)
        - Museum curators: use of a complete 3D model of a fragmentary object in museum exhibitions; use of the 3D model for multiple museum exhibitions
        - Archaeologists: use the 3D model for the study of the pottery, get a better sense of the vessel than the 2D photos of individual fragments, get better

knowledge of the shape of this unique so far vessel for the ancient Greek culture
- University professors: use the 3D model of the vessel for a number of teaching courses related to pottery, ritual, practices, daily life etc.
- General public (museum visitors, internet users, students, schools): gaining knowledge about ancient Greek pottery, ceramics, rituals etc.

7. **Proposer:** ***(****name, position, affiliation, contact details)*
Dr. Despoina Tsiafaki , Principal Researcher, "Athena": Research & Innovation Center in Information, Communication & Knowledge Technologies (**Archaeologist & co-Director of the Karabournaki excavation**) (see Appendix 1 for cv)

8. **Other collaborators**: *(names, positions, affiliations, contact details)*
Dr. George Pavlidis, Principal Researcher, "Athena": Research & Innovation Center in Information, Communication & Knowledge Technologies (**2D/3D imaging**) (see Appendix 1 for cv)

Dr. Anestis Koutsoudis, Associate Research Fellow, "Athena": Research & Innovation Center in Information, Communication & Knowledge Technologies (**3D expert**) (see Appendix 1 for cv)

Fotis Arnaoutoglou, Scientific Associate, "Athena": Research & Innovation Center in Information, Communication & Knowledge Technologies (**3D expert**)

Anastasia Michailidou MA, Museologist, Scientific Associate, "Athena": Research & Innovation Center in Information, Communication & Knowledge Technologies (**Museologist**)

Members of the COSCh community coming from different disciplines will contribute to the evaluation of the 3D model in order to get a global input.

9. **Description, techniques and schedule of the work to be carried out:**
- set the questions and the needs of the archaeological point of view
- literature review for similar projects in order check similarities & differences and comparison of the results
- literature review of internationally-recognised principles (such as the London Charter and the Seville Charter) for the use of computer-based visualisation for use by researchers, educators and cultural heritage organisations will be done in order to ensure the transparency of historical visualisation.
- 3D digitisation of the artefact based on image based 3D reconstruction methodologies (Structure-From-Motion (SFM) and Dense Multi-View 3D Reconstruction (DMVR) methods). September 2014 - September 2015, "Athena" RC.
- Use of photogrametric targets during the digitisation phase for accurate scaling of the 3D model to real world dimensions. September 2014 - September 2015, "Athena" RC.
- The 3D digitisation will be implemented in a controlled environment (lighting conditions, white balance, remote controlled turn table and DSLR cameras). September 2014 - September 2015, "Athena" RC.
- Generation of different data resolutions in order to provide efficient for various applications data (e.g. dissemination, study, digital archiving, 3D printing) September 2014 - September 2015, "Athena" RC.
- User evaluation in order to check if the requirements and the needs are fulfilled September 2015 – January 2016, ("Athena" RC and COSCH members)
- COSCH KR functionality September 2015 – January 2016, ("Athena" RC and COSCH members)

- The User Evaluation and the COSCH KR functionality would be complimented with Task Force meeting(s) (1-2) in which will participate experts from the different disciplines included in the project.
- testing and evaluation of COSCH KR functionality through this case study ("Athena" RC and COSCH members) September 2014 – January 2016

Methodology of the used technique

- ✓ **Agisoft Photoscan** professional will be used. The digitisation approach that will be followed will include the use of special photogrammetric targets to ensure accurate scaling of the 3D model and colour checkers.
- ✓ **Shape analysis** for the 3D completion using software arsenal: geomagic, matlab, meshlab, cloudcompare.
- ✓ Will probably **use boolean functions between parts of the fragments** in order to generate the missing parts.
- ✓ **Manual modelling** based on measurements is also inevitable.
- ✓ The first approach though will produce a 3D model where scanned and synthetic parts will carry similar properties.

10. **Description of the main results expected, explaining potential benefits for users and how their needs are likely to be attended and solved**:

Results:

- Exploitation of the X3DOM framework in order to provide the access to the produced 3D data over the Web (WebGL,HTML5 technologies)
- Use of real time shaders for the non-realistic visualisation of the artefact
- Virtual completion of the 3D model using 3D modelling techniques and real world completion using 3D printing technology
- application of the visualization project elements for testing the COSCH KR
- analysis of user feedback

Benefits

- Archaeologists, Museum curators, University professors and archaeology students will familiarize themselves with 3D models, easy to use and useful for their work and study
- Archaeologists will gain knowledge about the original form of the vessel and they will be facilitated to their study
- general public will be able to see and understand the shape and the use of a fragmentary piece, that wouldn't have any meaning otherwise
- Museum curators will be able to enrich their exhibitions with digital content and they will be able to use the 3D model simultaneously in different exhibitions or through the web
- Digital preservation of cultural objects
- Dissemination of the cultural object (pottery) through the web and accessibility to everybody everywhere

11. **Relationship to earlier relevant research in the field and literature**:

There is a number of 3D reconstructions in the field of pottery as it is shown through the existing literature. Usually they are made exclusively by the technical sector with none or minimal involvement of the cultural heritage experts.

However, this is going to be a true interdisciplinary approach since it will be done in order to fulfil real archaeological & museological needs regarding the study of the vessel itself and the reconstruction of the life in the settlement of Karabournaki (ancient Macedonia) during the Archaic times (7th-6th c. B.C.).

For the implementation of the proposal they will be collected and reviewed a number of similar projects in order to get the advantages and the disadvantages and to compare the results.

References

- A. Koutsoudis, G. Pavlidis, V. Liami, D. Tsiafakis, C. Chamzas, “3D Pottery content-based retrieval based on pose normalisation and segmentation”, Journal of Cultural Heritage 11 (2010), 329-338.
- A. Koutsoudis, F. Arnaoutoglou, G. Pavlidis, D. Tsiafakis, C. Chamzas, Qp: A tool for generating 3D models of ancient Greek pottery, Journal of Cultural Heritage 10 (2009) 281-295
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- D. Tsiafakis, N. Tsirliganis, G. Pavlidis, V. Evangelidis, C. Chamzas, “Karabournaki–Recording the Past: Digitization of an Archaeological Site” Proceedings of EVA 2004: Conference of Electronic Imaging and the Visual Arts, March 25 – April 2 2004, Florence, Italy, eds. V. Cappellini, J. Hemsley, Bologna 2004, 232-237.
- D. Tsiafaki, “The Contribution of New Technologies in Archaeology: Goals & Issues”, in N. Zacharias (ed.), 2nd Symposium - Archaeological Research and New Technologies ARCH_RNT, University of Peloponnese, DHACRM, Kalamata, October 21-23, 2010, Kalamata 2012, 93-98.
- A. Koutsoudis, F. Arnaoutoglou, G. Pavlidis, D. Tsiafakis, C. Chamzas, “A versatile workflow for 3D reconstructions and modeling of cultural heritage sites based on open source software”, in M. Ioannides, A. Addison, A. Georgopoulos, L. Kalisperis (eds.) VSMM2008 “Digital Heritage”, Proceedings of the 14th international conference on virtual systems and multimedia, October 20. - 26th, 2008 Limassol, Cyprus (2008), 238-244.
- C. Chamzas, A. Koutsoudis, G. Pavlidis, D. Tsiafakis, “Applying 3D Digitisation Technologies in the Culture Heritage Domain”, in T. Mikropoulos, N. Papachristos eds., Proceedings of the International Symposium on “Information & Communication Technologies in Cultural Heritage”, 16-18 November 2008, Ioannina, Greece, 35-48.
- M. Tiverios, D. Tsiafakis eds., The Role of Color in Ancient Greek Art and Architecture, 700-31 B.C., Proceedings of the Conference held in Thessaloniki 12th -16th of April 2000 (Thessaloniki 2002).

12. Potential interdisciplinary value of research carried out and any other comments

This project joins experts from at least the following disciplines: **archaeology, art history, museology, computer science**. Due to the interdisciplinary character of the "Athena" Research Center, all the needed experts are among its personnel and therefore it appears as the major participant in the implementation of the project.

Regarding the reconstruction of the vessel, however, it might be employed the expertise of a colleague in the field of **conservation** during the stage of evaluation or maybe little before its completion. This will be discussed with COSCH members employed in the field of conservation and it will be decided during the implementation of the project depending on the questions that will come up.

Colleagues (COSCH members) from the 3D sector will be involved in terms of consulting and setting additional questions and needs.

Evaluation of the 3D model by COSCH members of different disciplines (**technology** & **Cultural Heritage** experts).

The proposer will be required to submit a detailed report upon the completion of an approved case study. For further details *see* the COSCH Case Study Report Template.

13. Detailed schedule of proposed work with explanation how each phase is to be funded.

The **implementation** of the proposed case study will be by the "Athena" RC, since all the needed experts (e.g. excavator, archaeology, museology, 3D experts) are researchers in the Institution and also all members of COSCH and in particular WG5. That part will be **funded by "Athena" RC**.

The description of the scheduled work is as it is provided in the section 9. Most of the phases of the work will be funded by the "Athena" RC.

COSCH members of different research fields and WGs (technology & CH), will contribute to the evaluation.

A **Task Force meeting** for the Evaluation of the results and the COSCH KR functionality would be included in COSCH work and **funded by COSCH**.

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Listed below are the subjects and keywords defined by the five COSCH Working Groups that may be used as guidelines for applications. The subjects and keywords are intended to be indicative; there are no restrictions on other related questions being considered.

WG1: **Spectral object documentation**

1. Calibration of imaging spectroscopic devices; 2. acquisition, elaboration, exporting, and storing imaging data-cubes; 3. multispectral and hyperspectral imaging; 4. analysis and rendering of spectral image datasets; 5. accuracy and reproducibility of spectral imaging systems; 6. Visualisation case studies (individual and joint). For more information please contact Prof. Markku Hauta-Kasari, markku.hauta-kasari@uef.fi

WG2: **Spatial object documentation**

1. Comparative measurements (two or more techniques applied to a single CH object). 2. Examples and use cases supporting the COSCH Knowledge Representation schema under development. 3. Multimodal measurements. 4. Assessment of the techniques. 5. Metadata standards for 3D. For more information please contact Prof. Robert Sitnik, r.sitnik@mchtr.pw.edu.pl

WG3: **Algorithms and procedures**

Topics related to typical processing chains, algorithms and semantic aspects. For more information please contact Prof. Alain Trémeau, alain.tremeau@univ-st-etienne.fr

WG4: **Analysis and restoration of CH surfaces and objects**

1. Comparison by conservation professionals of spatial and/or spectral techniques and limits of their use on one or a series of CH objects. 2. Documentation of the conservation processes on one or a series of CH objects via imaging techniques. For more information please contact Dr Christian Degrigny, christian.degrigny@he-arc.ch

WG5: **Visualisation of CH objects and its dissemination**

1. Concepts, methods, processes, issues and standards in historical visualisation of CH. 2. Evaluation of visualisation projects; 3. Scholarly and educational applications, incl. virtual museums; 4. Planning and management of visualisation projects; 4. Digital preservation of CH visualisations. For more information please contact Dr Selma Rizvić, srizvic@etf.unsa.ba

STF: **Semantic Task Force**

Main objective of the COSCH Action is to prepare a novel, reliable, independent and global knowledge-base to facilitate the use of today's and future optical measuring techniques for the documentation of European material cultural heritage. This knowledge-base (under development) employs semantic technologies. It aims to connect technologies and heritage applications to support end users in their effort to find the appropriate ways to collect spatial and spectral data. For more information please contact Dr Ashish Karmacharya, ashish@geoinform.fh-mainz.de

THE PROPOSER:

The proposer should be a PhD student, a PostDoc or staff member in an institution located in a COST Country which has been formally accepted to be part of COST Action TD1201 (see http://www.cost.eu/domains_actions/mpns/Actions/TD1201?parties).

The proposer must obtain all the agreements and permissions necessary to conduct the proposed case study, including the consent of any party included in the proposal, prior to its submission. All parties agree to have their work, if deemed of acceptable quality, published by COSCH. COSCH cannot be held responsible for any legal, health, social, personal security and pension matters relating to the proposed work.

The proposer will be required to submit a detailed report upon the completion of an approved case study. For further details see the COSCH Case Study Report Template.

FINANCIAL SUPPORT:

COST has no instruments to fund case studies as such. However, a case study may integrate typical financial COST instruments such as Short-Term Scientific Missions.

APPLICATION PROCEDURE:

- The proposal (a single PDF file) should be submitted to Stefanie Wefers (**stefanie.wefers@fh-mainz.de**) by Monday, 16th June 2014.
- Review by the Steering Committee to be completed by 31st of July 2014. The decision of the assessing panel will be final. Ranking of proposals will be based on their quality. The following will be considered:

Number and depth of COSCH objectives considered (25%)

Scientific/research value of study (25%)

Degree of interdisciplinarity (20%)

Prospect of success for study (20%)

Range of data used (10%)

- Selected proposals will be invited to present their proposed case study during a workshop in Belgrade on 16th of September 2014.
- The final selection will be decided by the COSCH Management Committee in Belgrade on 17th of September 2014.

ACKNOWLEDGMENTS IN SUBSEQUENT PRESENTATIONS AND PUBLICATIONS:

The contributors to the proposed case study are expected to acknowledge COSCH in subsequent presentations and publications using the following statement: The present work represents the Authors' contribution to the COST Action TD1201 "Colour and Space in Cultural Heritage" (www.cosch.info).

Appendix 1

CVs of the key experts participating to the project.

Dr. Despoina Tsiafaki Female She is Senior Researcher, the Head of the Cultural Heritage Unit at ATHENA RC and Co-Director at the Karabournaki excavation. She is a Classical Archaeologist with excavation experience specialised in ancient Greek archaeology and pottery She worked in the Antiquities Department of the J. Paul Getty Museum in Los Angeles, were among others was involved in projects regarding Cultural Technology.and she has collaborated with the Archaeological Institute of Bern, the University of Groningen and the Sopridendenza of Sibari in Italy. She participated in more than 20 international, european, and national R& D projects regarding Cultural Heritage and Cultural Technology. She has published as author and editor, books regarding ancient Greek culture, whereas more than 90 papers on Greek Culture and Cultural Technology have been published in international volumes, conferences, and journals. Her current research involves Mediterranean archaeology, ancient ceramics, application of new technologies in archaeological sites, artefacts & museums with emphasis on the development of cultural databases, multimedia applications and Museum guides, 3D reconstruction, and archaeological GIS.

Dr. George Pavlidis Male He received his Diploma in Electrical Engineering and PhD from the Electrical and Computer Engineering Dept of Democritus University of Thrace. Since 1991 he has been working for many R&D projects with emphasis on multimedia systems in cultural and educational technologies. He is a Senior researcher in ATHENA RC, the head of the Multimedia Research Group and the head of research at 'Clepsydra' Cultural Heritage Digitisation Center. His research interests involve 2D/3D imaging, CBIR, multimedia technologies, human-computer interaction, intelligent user interfaces, multi-sensory environments and ambient intelligence, 3D digitization and 3D representations, 3D-GIS and mixed/augmented/virtual reality.

Dr. Anestis Koutsoudis Male He has a BSc in Computer Studies (Visualisation) from the University of Derby, UK, a MSc in Multimedia Technology from the University of Bath, UK, and a Ph.D. on 3D content based retrieval and MPEG-7 metadata from the Electrical and Computer Engineering Dept, Democritus University of Thrace, Greece. He is a researcher (Associate Research Fellow) in ATHENA RC and a member of the 'CLEPSYDRA' digitisation centre. His research interests and development activities can broadly be classified under the umbrella of creation, processing, analysis and visualisation of 3D data. He has worked on real time 3D graphics programming, content based retrieval and analysis of 3D objects, 3D digitisation and 3D scene metadata annotation and software engineering