"KARABOURNAKI-RECORDING THE PAST": THE DIGITIZATION OF AN ARCHAEOLOGICAL SITE

D. Tsiafakis, N. Tsirliganis, G. Pavlidis, V. Evangelidis, C. Chamzas
Cultural & Educational Technology Institute, Xanthi, Hellas

Abstract – "Karabournaki-Recording the Past" is a project regarding the digital documentation of an archaeological site using as a case study the site of Karabournaki located in the area of Thessaloniki (Greece). Focus of the project is to design, develop, and implement a multimedia cultural database system capturing the full amount of the available information regarding the site, including extended search and visualization capabilities that can deliver its multilingual content over the Internet. The meta-data that are produced with the completion of the project contribute significantly to the study and publication of any archaeological site as well as its preservation, succeeding the final goal of making it universally accessible.

INTRODUCTION

Archaeology as a discipline is usually based on the systematic collection, analysis and interpretation of data through excavation and other forms of fieldwork. Data collected in an excavation are often complex, multivariate and three dimensional, making the development of new ways to efficiently and accurately record and manipulate those data, an absolute necessity for archaeologists.

Traditionally the collection of data was based mostly on a systematic description and recording on paper (notebooks, forms etc), while the visual components of the archaeological information were captured in a variety of 2D means like photographs, architectural and topographical drawings, maps etc. Three major unsolved problems rise out of those traditional methods:

1. *Vast amounts of data* recorded using these methods is the major concern of every large-scale excavation (usually lasting many years or decades) in respect not only to their storage and preservation, but also to their handling, analysis, study, and publication. Although exhaustive systems of recording, labeling and storing have been devised and employed through the years, the problem of handling, combining and retrieving data "randomly" (and at will) remains a much wanted necessity in archaeology.
2. The majority of *data are visual and three-dimensional (3D)*. Therefore, it is obvious that the limitations imposed by the nature of two-dimensional (2D) formats put significant constraints to our perception of both geographical space and context.
3. Finally, there is always the problem of *effectively presenting spatial and 3D data* to scholars and the general public, especially when interactivity and accessibility are listed among the basic intentions of the publication.

The emergence of information technologies offers presently powerful solutions to these problems, with additional benefits such as less consumed time greater analytical insight.

Facing the problem of recording the total amount of the available excavation material of the archaeological site at Karabournaki in combination to its presentation and publication, an Integrated System of Digital Management of an Excavation was developed [1]. Karabournaki is located in North Aegean, in the area of Thessaloniki.

The site dates from the Late Bronze Age down to the Roman times, with a flourishing period during the Archaic times (7th - 6th centuries B.C.) and it preserves the architectural remains of a settlement including a harbor and its cemeteries.[2],[3].

RECORDING THE PAST IN NEW WAYS

Contemporary methods in digital *recording, data management*, *visualization* and *dissemination* offer today the ability to completely record and disseminate an archaeological site and its findings. In the following paragraphs, we show our approach to solving the problems involved in an attempt to integrate all methods and data into a complete digital archaeological site.

Digital recording

First step in every digital representation application is the *digitization* that leads to a "sampled" and "discretized" version (or representation) of the real world. Digitization is targeted upon every data form, but since visual data are playing the most significant role in comprehension, digital representation of visual data is a field of continuous research and development. Digitization of an archaeological site involves many aspects. The "Karabournaki-Recording the Past" system, as a collaborative project of experts in various fields, had to take under consideration all these aspects. The product involves three major categories of digitization that correspond to the total amount of data coming out of the excavation:

- *Landscape (site) and structures digitization*: complete digitization of the archaeological site using contemporary 3D scanning methods applicable to landscapes, structures and buildings. These methods involve the usage of either laser devices, either photographic/photogrametric methods and remote sensing, either hybrid-combined methods. Traditional methods were also employed: usage of (digitized) standard 2D topographical maps and 3D digital reconstruction through specifically designed software tools. Furthermore, since the site is described both in drawings and documents, 2D visual data were also included in the digitization process.
- *Objects (findings) digitization*: complete digitization of all objects in 2D and 3D. The present practice guides that objects are recorded through multiple photographs and entries in the excavation notebooks, as well as other referencing documents. Our first approach was to digitize all 2D visual material concerning the findings of the excavation. The next step was to record the objects in 3D. As will be explained in a following section, 3D technologies offer the ability to completely reconstruct objects with missing parts using scans of the findings and archaeological data. Fig. 1 shows two methods of 3D object scanning (laser and photographic) and a method of surface physicochemical properties extraction.
- *Documents (notebooks and forms) digitization*: complete digitization of the documentary material in the form of 2D images. This process could also include the digital reproduction of all texts, so that full text search capabilities can be integrated. In its present form the system processes all documentary material as 2D digital images.

To produce and maintain a completely digital archaeological site, it is imperative that after the digitization of the existing material, digital recording of new facts and findings is continued through the usage of specifically designed software tools that permit the archaeologists to go on with the digitization without any help from

technical staff. To this very end, special purpose, user-friendly software tools are provided, with the additional ability to record data on-site: the archaeologists can record current findings using a PC or a laptop on-site, and have the ability to easily integrate the new data into the overall data management system.

Summarizing, for the needs of Karabournaki, a 2D and 3D digitization strategy have been adopted, accompanied by 3D digital reconstruction (where possible) and GIS functionality. According to this strategy, all visual material is being digitized using high resolution 2D scanners and 3D laser and photographic techniques [4]. Archaeometry data are being produced by using contemporary analysis tools, like XRF scanners [5], and object surface data are being acquired and recorded. These data involve physical or chemical properties measured in a point-wise manner, on significant areas of the objects' surface.

(a) (b) (c)

Fig. 1. 3D scanning of object geometry, texture and surface properties

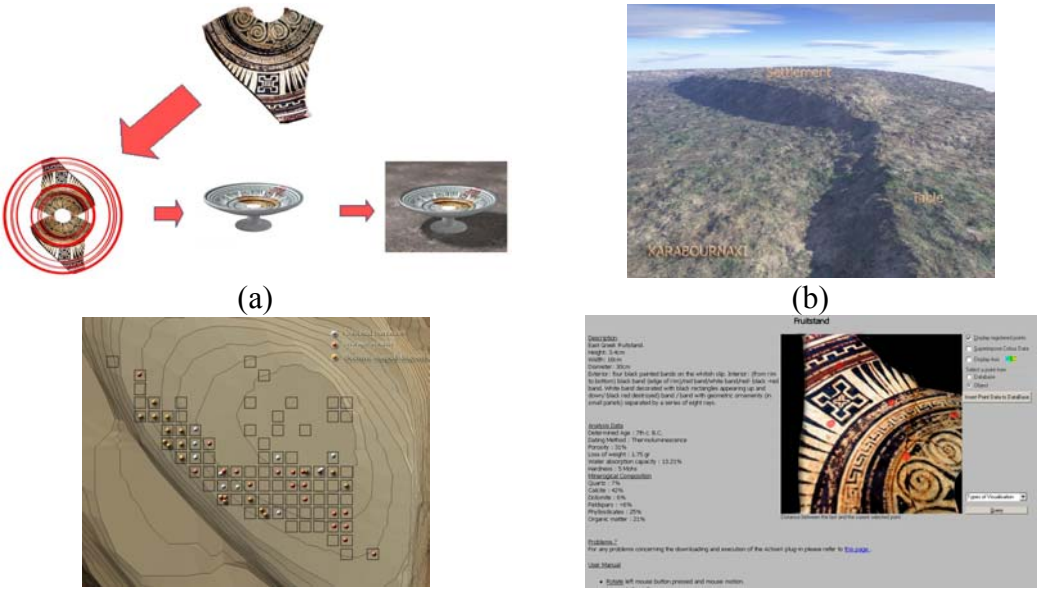
Digital data management

All digitization processes produce a large amount of digital data in many digital file forms. This amount of information no matter how precise and complete is, can be rendered virtually useless if one is not able to manage it efficiently. Traditional methods of data management involve the design and usage of relational models to represent and combine the data, by imposing relations on each other imitating human cognitive processes [6]. For the purposes of Karabournaki, we have adopted a relational data model to represent the data. In this model, information unit-entity is the finding, *object.* Side information is provided by *bibliographic* entities, data from *conservation* and *archaeometry*, as well as other complementary data entities. An important aspect of our implementation is that it is based on open-source MySQL database that significantly cuts the costs of the integrated system. MySQL is a database engine that uses the standard relational model to represent data. Access to the content is achieved by using SQL queries. Data management as well as data retrieval is web based, portable and straightforward. Data input in Karabournaki database is done in a twofold way: either explicitly, by accessing the central database through an account with administration privileges, or implicitly, by using specifically designed software data input forms that provide with the flexibility to collect data even during on-site works (using a laptop). Data input forms include versions to handle data produced from archaeological, archaeometrical and conservational research and works.

Digital data visualization

Since the eighties of past century Computer Aided Design (CAD) systems have been systematically used in archaeology [7]-[10] not only as a sophisticated means of digitization, but also as a tool for reconstructing archaeological context. CAD and 3D

modeling allows archaeologists for the first time to record, integrate, organize and handle the visual parts of archaeological information (plans, drawings, maps etc). CAD has a number of advantages over traditional architectural and topographic design methods like the unique ability to work on different layers in the same drawing, but its true power lies in its ability to integrate and display multivariate data on a single canvas. The integration of data in a 2D or 3D model enables the researcher to gain a stronger understanding of the archaeological context and to seek spatial relationships between the different elements. Moreover, 2D and 3D mapping have evolved to a necessary preparatory stage in order to advance to the application of Geographical Information Systems (GIS) technology or the use of Virtual reality [11] as a means to approach ancient landscapes. In other words GIS promises the archaeological community the ability to record, analyze, seek, retrieve and represent vast amounts of complex spatial data in a homogeneous manner. The adoption [12] of such a powerful spatial tool in intra site analysis can revolutionize the manner we reconstruct archaeological context.



(a) (b)

(c) (d)

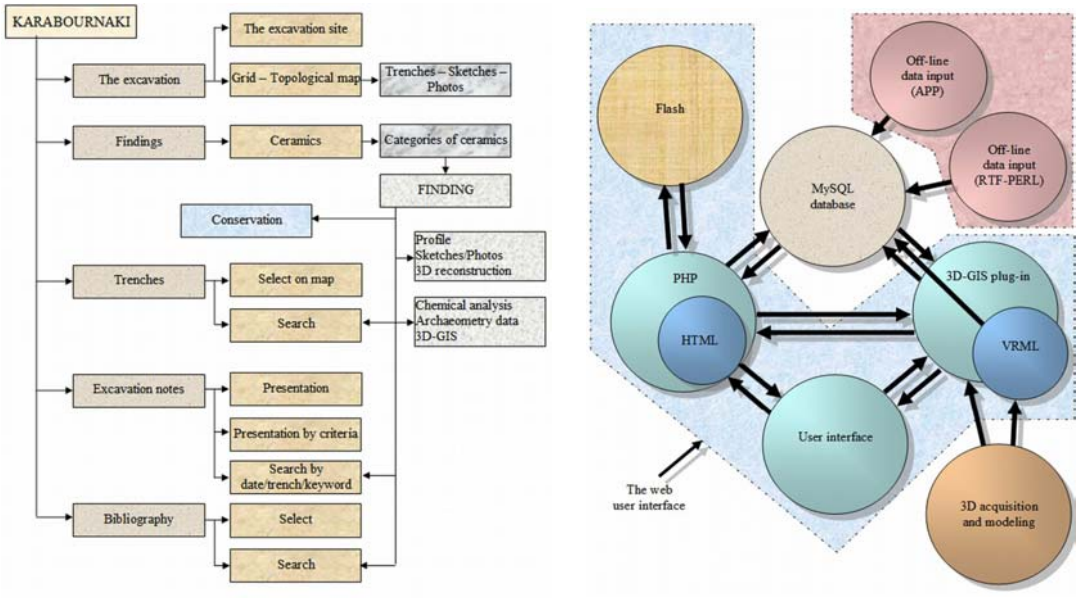
Fig. 2. (a-b) 3D virtual reconstructions, (c) GIS and (d) 3D-GIS of objects

In "Karabournaki-Recording the Past", accepting the notion in these and many other works, a 3D visualization approach was employed; an approach that is twofold:

- *visualization of the site* itself Fig. 2, using standard CAD design and GIS techniques, fed by digitization data either from 2D scanning or 3D scanning methods, and
- *visualization of the objects* Fig. 2, using an extension of a standard GIS system, that has been specifically implemented. This system is targeted upon the construction of a virtual "3D-GIS" environment for cultural objects, where the object itself is treated as a geographical entity. In its present form, it is a browser client plug-in, that gives the user all the known 3D viewing capabilities, while extending the interactivity by providing with the option of selecting surface areas and reading archaeometry or complementary data stored in the database that concern the selected area. This way, the system is promoted to a GIS-like environment for objects.

Digital data dissemination

In order to integrate the overall database management system into a web-enabled information dissemination system, one has to design an Internet front-end with extended search capabilities to be able to exploit the reach information content to the maximum. The scheme adopted for the purposes of Karabournaki was based on MySQL database using PHP as the main programming language for constructing the dynamic web content and accessing the database. The whole system is dynamic, displaying data straight from the database, using only minimal static information needed mainly for customizations. It is based upon well known and tested technologies that are successfully combined into a single and meaningful integrated interface, which is able to provide with extended search and visualization capabilities. The structure of the final web application as well as all involved technologies is shown in Fig. 3.



(a) (b)

Fig. 3. Overview of (a) the Internet application scenario schematic and (b) the underlying system technologies

CONCLUSIONS

Complete and integrated digital recording and dissemination of an archaeological site is a complex and multivariate problem. To solve this problem, several existing technologies have to be combined and some new have to be developed. In "Karabournaki – Recording the Past" a first attempt is being made to overcome the difficulties of such a task and to provide with an integrated system with extended management and dissemination capabilities over the Internet. In order to ensure universal accessibility the system was designed as bilingual. So far, most of the system is implemented, while the whole strategy is already developed. Finally, its flexibility and capability of being expandable in data structure secures the integration of relevant future archaeological demands and needs.

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