# ArcheoPackPro!
# A Software System for Digital Data Management for Archaeologists

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Abstract

The authors are presenting the software package that will unify all the elements of computer usage during archaeological campaigns and provide an interactive research tool for data analyses after campaign ends. It uses a unique graphics user interface in 3D environment, allowing simultaneous and interactive work with the 3D terrain model, Databases, Statistical and mathematical analysis, 3D models of archaeological finds, etc. It will open a new chapter in archaeological documentation and interactive fieldwork, offering an ultimate context preservation tool for versatile field documentation, its safekeeping, flexible presentation and publication possibilities for a new age archaeology. 3D Scanning technologies will also be introduced in function of better site preservation techniques and material 3D scanning options.

Until recently there was a big gap between the potential offered by computer technologies and the traditional methods of archaeological field work, recording and data processing. Data collected and recorded in archaeological excavations are a combination of images, videos, drawings, and various kinds of numerical data and textual descriptions. In the pre-computer era, browsing through field documentation was a complicated and time-consuming task.

When computers appeared in archaeology during the late 70s and 80s it seemed we had finally found the way to manage the data. However, they were mostly used for statistical analysis of finds and other numerical operations. While databases flourished it was almost impossible to link them to the archaeological context and make them interactive. GIS systems offered a significant breakthrough in this field and managed to integrate maps and plans with databases. Using computers in the "traditional" manner as text, image and data base processors has revealed few serious limitations. However, there has been no real interactivity between data scattered in different archives. Digital data from sites were rarely linked to the plan or drawings of the sites. Images, videos and drawings of finds were accessed through different file directories and not directly linked to the data bases.

Computer experts and archaeologists working together at the Vinca site in over the last 6 years have produced a software system able to equip archaeological teams with a complete data management system for archaeological fieldwork. Our primary aim was to establish an interactive system allowing researchers to move easily from one database to another focusing on the data rather than the underlying system. ArchaeoPackPro! has been successfully tested in both a grid and unit system at Vinca, a prehistoric, Late Neolithic site with 10 meters of cultural deposit. The system has proved efficient, easy to use and reliable in data input and management and for work with complex and demanding methodology at this stratified site.

## The System

ArchaeoPackPro! is designed as a single software package that communicates with the SQL database on a server system. The focus of the design was to build a link between different data structures used in archaeological field documentation. The key concern is a successful correlation of scattered archives. The archaeological data (texts, images, videos, databases) are ideal for this purpose since all the data in archaeological documentation systems represent logically defined and organized structures. Archaeological material and objects which are excavated and analyzed have their physical coordinates. Textual and numerical descriptions of the material and objects are stored in different, interrelated structures. Excavated material is spatially static so 3D coordinates can be taken as a basic organizational element. These 3D coordinates (or EDM points) are the starting point for linking databases of specific archaeological material such as pottery, polished stone, flint, etc; they contain both 3D coordinates from the field and the exact time and description that can be used to link them to other data structures. EDM points are the basic structural elements of the system and everything is

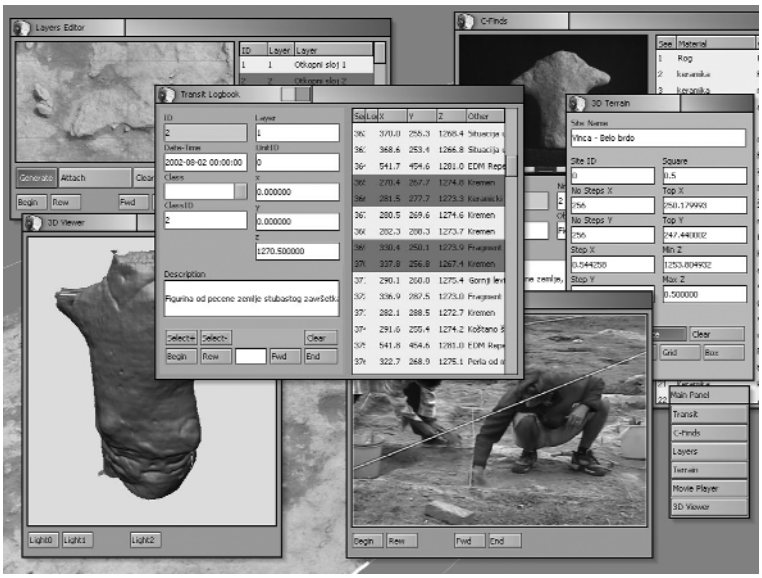


Figure 1

appended to them. Each database involved in archaeological field work is linked to a specific EDM point.

THE PROCEDURE

The basic procedures, which are fundamental to every methodology of archaeological excavation, run as follows:

3D coordinates input is necessary for the 3D configuration of the terrain, small finds, architecture, photo grid and other classes of coordinates. Careful thought is required to determine the amount of points for topography. These will later be intersected with the texture or orthogonal photograph. The larger the number of points, the better and more accurate the 3D mapping of the terrain.[3] The data can either be downloaded directly from the EDM in the form of a table or entered data manually. The latter is suitable for digitalization of archive field documentation or when working with "traditional" levelling equipment such as theodolite. In both cases all three values must be entered. If an artefact or other specimen has been discovered out of its primary context, i.e. in a flotation process or in the sieved earth, it will have a "virtual EDM". In this way all finds from an excavation can be displayed on a 3D terrain with a clear mark which indicate which of them have a "virtual EDM".
Attributing the class of EDM entry allows a researcher to map and distribute each class of artefact and other finds. The operator - usually the same person that operates the EDM - selects a point and attributes it to one of the classes. Classes contain basic categories of archaeological material and objects and can be easily upgraded to match the exact needs of the excavator.

Unit managing. The unit system is a method of excavation which is directly reflected in the structuring of EDM points.[4] Units correspond to specific features of the excavated surface and can be represented by shapes and/or 3D objects. They can be inter-connected to form different horizontal or vertical relations (stratigraphy, parent-child relationship or horizon). Organized into a full graphical and logical representation of an excavated site, they are a tool for organizing EDM points, materials, artefacts, excavated objects and features.

Determining horizontal and vertical relationship of units. One implementation option of the unit system would be a Harris matrix which is fully supported and additionally expanded. By offering many different types of relations between unit elements the dendrogram becomes more elaborate, offering new options for unit management and organization. Structures, objects, features and units can be organized in a dendrogram based not only on stratigraphy but also on parent-child hierarchy (e.g. house - trench - post) or horizons cross-linked with parent-child hierarchy. If possible, this procedure should be performed during the day in the field or at the end of each day in order to obtain updated and accurate relations between units.

Images and video input. The system contains the database for images and videos from a campaign. The process of input is simple - downloading the photographs or video material to a specific folder. The next step is classification and attributing the image to the unit/square or other EDM entry such as specific find, sample for analysis etc. The database for images contains classes related to the type of image (field, orthogonal, journal entry, pottery, flint, studio photograph etc). Once images are downloaded, attributed and cross-linked with EDM points and the unit system a search can then be performed according to the classes, description in the photo diary or the position on a 3D terrain. This makes search and browsing the photo diary fast and seamless. The same applies to video material. The description for the image is standard and includes reference to the unit/square, find, orientation etc.

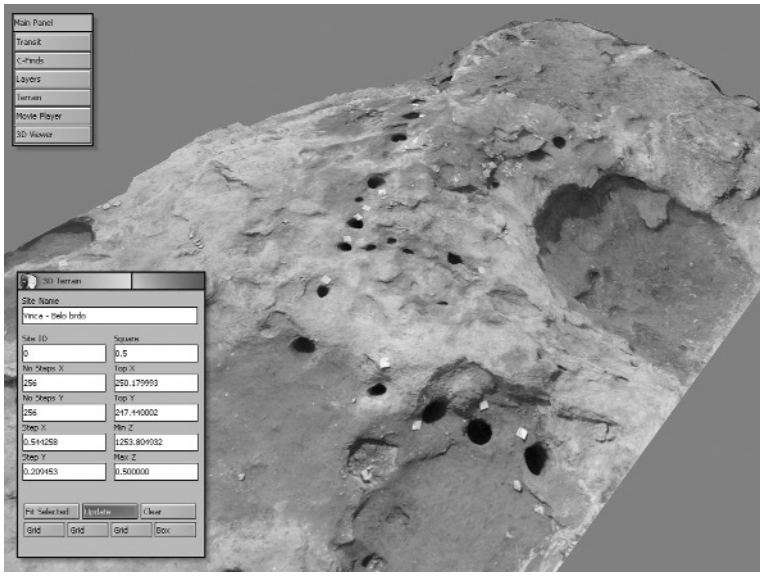


Figure 2

When these basic procedures have been completed it is possible to browse through the field documentation and carry out different search actions including mapping, statistics, unit managing, drawing and printing. All the elements of field documentation can be displayed on the monitor and analysis becomes just a click away. Since the 3D plan of the site and every database and log book is instantly available for the researcher, spatial analysis of finds becomes routine. For example, if one wishes to map flint discovered during the excavations it is enough to select entries with this description (or a code) in the EDM log book and the next click will show its exact position on the 3D terrain model. These points obtained can be highlighted or hidden. It is also possible to analyse more than one category: e.g. the relation of flint to a house floor, an oven or the site. One can then overlap graphical displays of different analysis performed and compare or print them. The diversity of such spatial analysis is, of course, related to the amount of information recorded and EDM points taken during the excavation.

The module "research organizer" that will save the process of analysis and prepare elements for a report is in preparation and will be available soon.

## The System

ArchaeoPackPro has been developed in C++ with usage of OpenGL. OpenGL is a standard graphics library for managing and drawing 3D objects using modern graphic card hardware. New generation of graphic cards allow extremely detailed 3D models to be processed in real-time, thus allowing our system to work simultaneously with different 3D objects such as terrain model, 3D scanned artefacts, User Interface elements, etc.
As both C++ code and OpenGL code were developed to be easily portable we hope that in the near future ArchaeoPackPro will be available for all platforms and operating systems that support 3D hardware. These would include Windows, Macintosh, UNIX, Linux, BeOS or any other system that has hardware support for OpenGL.

One important issue not to be forgotten is that not all institutions and archaeologists have computer systems capable of running ArchaeoPackPro. 3D graphics cards are extremely cheap and affordable now but we are aware that many older computers are still in use. As ArchaeoPackPro! is connected through server and SQL database located on the server, we are developing a special package feature that will allow data to be entered the using older computers - the option of accessing databases through standard Internet web pages. Designed in pure HTML and DHTML, web forms will be an interface with databases used by ArchaeoPackPro. Through local network or internet connection it is possible to access and manage the data even using old 486 or Pentium I computers and Internet Explorer, Netscape Navigator or any other compatible browser.

Introduction of digital technologies in archaeological fieldwork does not only simplify and speed up the process. It also influences the basic methodological techniques and practices. Unforeseeable possibilities of a 3D representation and context preservation of archaeological material and objects resulted in a radical shift in the field documentation. In previous systems the backbone of the system was the field journal with all the details concerning the dynamics of the fieldwork, context of finds and links to the technical documentation and databases. The abundance and diversity of textual input in field journals has been constantly narrowing the search so within this software package the starting point for linking became the EDM log book i.e. the 3D image of the data. The EDM enables archaeologists to acquire both the absolute height for the find or object and the X and Y values instantly. It makes 3D representation possible and extremely suitable for linking information about the exact position of small finds and objects, photo and video documentation, contexts and other information from various databases for every activity undertaken during an archaeological fieldwork. This is probably the most important change in the field documentation and indicates the most likely direction of its development. There are no methodological obstacles in applying this system to any type of excavation or site. It is equally efficient at excavations using either the grid or the unit system and for emphasizing either the vertical or horizontal dimension. The accuracy of the 3D representation depends exclusively on the number of x-y-z points taken during the excavation - which is in the hands of the site director. With the grid system the minimum requirements would be to take the points of each square, position of the finds and the contours of objects and features. With the unit system more EDM points should be taken if greater accuracy and precise position and contours are required. Hence, regardless whether one is digging mounds, graves, ditches, pits, prehistoric subterranean, medieval donjon or any other structure, whether one is doing trenching, gridding, open stripping, Wheeler box-grid or open-area excavation the procedure of recording will be identical: entering the data in the EDM log book, attributing the points and linking with the unit/locus/square log book, field journal, photographs, plans etc. ArcheoPackPro! is designed to replace the old-fashioned procedure of data input with the numerous possibilities offered by modern computer systems. It will speed up fieldwork, improve the quality of the documentation and introduce new methods of data input, processing and analysis.

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[3]This, however does not apply when working with a 3D scanner.

[4]It should be noted that units can be also treated as squares for those that apply that methodology of excavations.