

Artefacts of Mass Distinction: Onsite Program for Archaeological Artefact Data Catalogue and Mapping in ArcGIS

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ABSTRACT

Classical archaeological sites date from the Greek Bronze age to the fall of the Roman Empire. Archaeological excavation and surveys of Classical sites take place each year in hundreds of locations throughout Europe and the Mediterranean. These studies yield tens of thousands of significant artefacts that require cataloguing (ceramic, bone, lithic, bronze, glass, gold, silver, marble etc.), thousands of plans, stratigraphic drawings, photographs and other related cultural material.

Generally, all archaeological material must remain in its cultural homeland and therefore researchers are limited in their efforts to study material after the excavation season has ended. Indeed, due to the complex nature of archaeological information and interpretation, preliminary excavation reports are often shared at archaeological proceedings and conferences, often long after the field seasons are complete.

Ideally, an integrated GIS containing a digital outline for each layer including mapped and appropriately symbolized artefacts, photographs of excavated trenches and artefacts, stratigraphy and a full catalogue of artefact information in a geodatabase would enable the research team to pursue continued observations and spatial analyses during the post-excavation season. A preliminary step in creating this integrated GIS is to produce a tool that could be employed in the field to catalogue and map artefacts.

Key words: artefact mapping, classical archaeology, GIS.

1. Introduction

Archaeological material, by its very spatial and temporal nature, lends itself extremely well to representation in themes, layers, points and polygons. Indeed, archaeologists working with prehistoric materials have long been advocates of the use of GIS in archaeology. Early integrations of computer cartography, computer-aided drafting and linkages of computer drawn maps with relational databases occurred in the 1970's (Kvamme, p.155). Overall, the three most typical uses of GIS in archaeology have been for visualization, management and the development of predictive models (Church, p. 135). Archaeological predictive modelling, undeniably one of the earliest uses of GIS in archaeology, has become the basis of a multimillion dollar archaeological industry (Kvamme, p.156)

Classical archaeologists, however, have been comparatively slow to employ GIS in the field. Regional surveys have most frequently been the subject of GIS applications. While some of the most well known have been published with information that is easy to access via the internet, such as the survey of Chersonnesos in the Ukraine by the University of Texas at Austin (Institute of Classical Archaeology), the Corinth Computer Project and its regional survey and site architectural mapping by the University of Pennsylvania under the direction of Dr. David Romano (Romano) and the very ambitious JADIS project designed by the American Centre of Oriental Research (Savage), within-site applications are less well known and certainly less abundant.

Since a GIS could provide a tool to search and map spatial queries based on cultural association, date, material, and artefact type (Kvamme, p.165), an on-site tool to create, map and store information directly in a geodatabase would be extremely useful. We here describe the development of such a tool using ESRI's ArcObjects with Component Object Model (COM) compliant classes and interfaces within ArcGIS.

2. Archaeological Catalogue Data

Creating an spatially enabled archaeological catalogue extends the three basic purposes of cataloguing which are to:

“(1) determine the extent of the artefact corpus in a file for ready reference; (2) to furnish an exact description of each artefact; (3) to furnish data in a systematic form for site publication.”
(Jukowski, p.228)

The function of the catalogue can now include another aspect, (4) to furnish data in a spatially reconciled manner in order for data to be analysed spatially within-site and within the larger environmental milieu with little or no further modification.

Within our preliminary tool, only the most obvious (the necessary rather than sufficient) artefact attributes are used, several cataloguing fields needed to be identified for each artefact:

- a site identifier
- trench location
- pail number
- catalogue ID number
- estimated date
- dimensions
- coordinates (X,Y,Z)
- description
- shape
- Munsell Color Chart identifier
- Photograph

In order to map the artefacts, a polygon was required to represent the trench^{*} location as well as an empty point layer containing an attribute table arranged to conform to the data input fields within the form. The 1 m² polygon was created to fall within the WGS84 UTM Zone 34N which is specific to Greece where this tool is expected to be used.

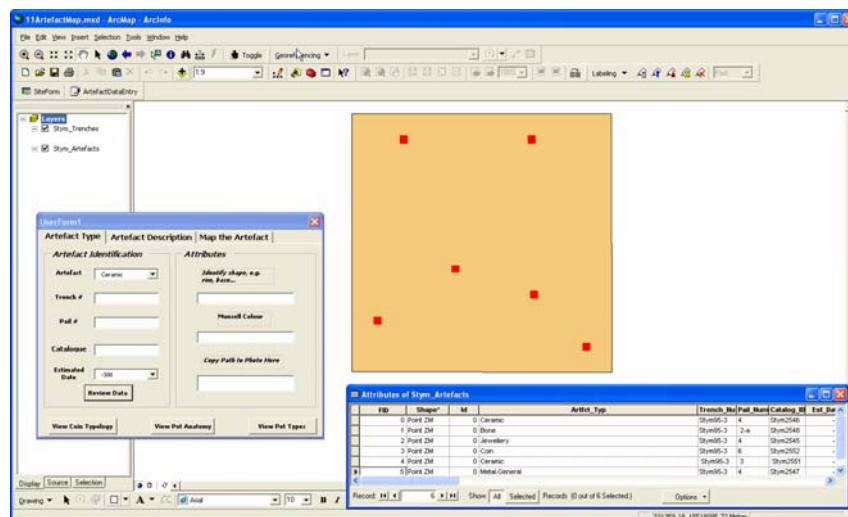


Figure 1: Screen-grab illustrating a trench and artefact locations as well as application window.

*A trench signifies one unit of the excavated area, usually identified by the abbreviated site name, year of excavation, trench number and subordinate alphanumeric. The dimensions are usually n m² though they sometimes can be irregular.

3. Methodology

3.1 General Database Design

For each database field, corresponding ArcObject Component Object Model (COM) code had to be written. The basic outline of the database is given in Table 1.

Table 1: Basic Database fields and definitions.

PROPERTIES	REQUIREMENTS FOR ARCOBJECT COM
<p>Artefact Type Page</p> <ul style="list-style-type: none"> -Artefact -Trench -Pail -Catalogue # -Estimated Date -Shape -Munsell Color -Photo Path -Review Button -Coin Typology Button -Pot Anatomy Button -Pot Shape Button 	<ul style="list-style-type: none"> -Combo box populated with artefact types, linked to the review button and to a field in the database -User input box, linked to the review button and to a field in the database. -User input box, linked to the review button and to a field in the database. -User input box, linked to the review button and to a field in the database. -Combo box populated with dates, linked to the review button and to a field in the database. -User input box, linked to the review button and to a field in the database. -User input box, linked to the review button and to a field in the database. -User input box where user must insert the path to the photograph, linked to a field in the database. -Message box appears with information to review. -Composite chart of coins appropriate to the archaeological area. -Chart of pot anatomy for user reference. -Chart of various pot shapes for user reference.
<p>Artefact Description Page</p> <p><i>Description:</i></p> <ul style="list-style-type: none"> -Length -Width -Height -Weight -Description 	<ul style="list-style-type: none"> -User input box, linked to a field in the database. -User input box, linked to a field in the database. -User input box, linked to a field in the database. -User input box, linked to a field in the database. -User input box of up to 250 characters in length, linked to a field in the database.
<p>Map the Artefact Page</p> <p><i>Coordinates:</i></p> <ul style="list-style-type: none"> -x: -y: -z: -Review coordinates button -Map the artefact button 	<ul style="list-style-type: none"> -User input box, linked to the review button and to a field in the database. -User input box, linked to the review button and to a field in the database. -User input box, linked to the review button and to a field in the database. -Message box appears with coordinate information for review. -Program associated to this button will map the artefact and update the fields in the attribute table.

3.2 User Interface Design

In order to create a user interface that would contain all the necessary input boxes it was necessary to create three tabs within the form in order to provide a user interface that was not too large to comfortably use on a laptop in the field (Figure 2)

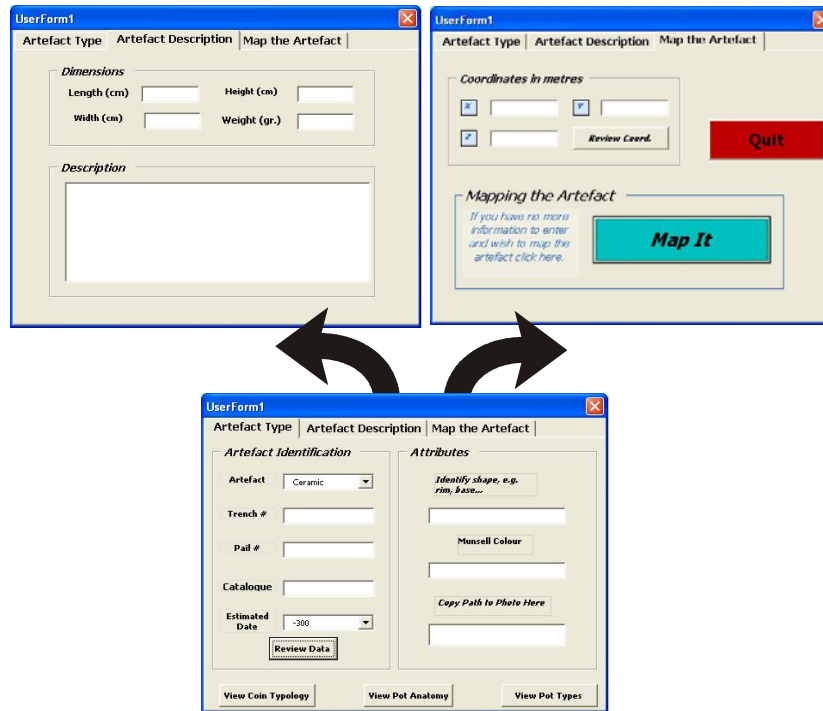


Figure 2: Example of the three pages of the form which were combined into one user interface.

3.3 Validation

Entering archaeological data within the field directly into a GIS database removes user transcription errors during data-entry from analogue records. In addition, errors can be reduced via validation within the user-forms, that is to say, not allowing for incorrect entries as well as handling exceptions when necessary. Our application contains a number of automated validation procedures that minimize entry errors, particularly with regard to the location of artefacts within trenches. For example, the length and width and weight of an artefact must be non-zero entries, while the height is allowed to be zero. The coordinates entered for each artefact by the user are automatically checked for containment within the trench using ArcObjects code for polygon containment (as trenches can be non-rectangular and not necessarily convex or simple). All possible artefacts for a given site are included in a drop-down list and for each there are example pictures from the literature that allow researchers to assess the degree to which their artefact conforms to an ideal version.

3.4 Component Object Model and linkages

The Component Object Model (COM) is a Microsoft technology that establishes a standard way of both creating Windows-based software and exposing that software's functionality to the programmer. A COM based software can be customized and programmed in any COM compliant language such as Visual C++ or Visual Basic among others.

Because COM exposes functionality via classes (objects), there are significant advantages to utilizing a COM approach in GIS application development in archaeology. For example, the application can operate in the software that contains the data, no format conversion or input/output are required, data can be immediately visualized, and coordinate systems can be modified, created or customized. Moreover, contemporary GIS contain sophisticated data manipulation algorithms within their COM classes and interfaces, new interfaces can be added by the software vendor for new functionality while maintaining existing interfaces for legacy applications.

Each of the input boxes that receive information had to be linked to a database in order to fill in and update each field in the attribute table of the point layer that represents the artefacts.

4. Results and Discussion

Several tests were implemented to map artefacts with coordinate values that did not fit within the trench boundaries and each time the user was prompted to re-enter valid coordinates. Where dimensions did not conform to the one decimal place rule, the user was also prompted to re-enter the values.

The sample data used in this tool was created specifically for the experiment. Real world archaeological data would need to be derived using GPSs on-site using a total station with correction to the appropriate mapping projection for the area and for the intended outcome, required accuracy etc.

Moreover, in-field comparisons of artefacts can be difficult, particularly when only fragments are encountered. To help alleviate this problem, reference pictures of ideal artefacts are included in our database and can be browsed and/or opened by the user when they choose an artefact category or artefact type. This picture database has been developed largely from the classical Greek archaeological literature. One of our next steps is to create 3D models of these artefacts within modelling software such as 3D Studio Max and Maya so that instead of simple 2D pictures, the field archaeologist can bring up a Virtual Reality Modelling Language (VRML) viewer and manipulate the artefact in 3D for more easy comparison.

Employing 3D modelling software allows for VRML models to be dynamic, we can for example, illustrate also how a given artefact such as a clay jar or pot would look in fragments using physical modifiers within the modelling software. This VRML approach to in-field identification could represent a considerable step forward both for the novice and expert archaeologist alike, allowing field-classification and mapping to accelerate more quickly, thus allowing for more study to be accomplished during short field seasons and or rapid cataloguing.

5. Conclusions

Results indicated that a preliminary attempt to map artefacts in the field, once the system is secure so that modification of the program is impossible, would not be overwhelming. Indeed, recording the data while in the field would save time at the end of each excavation day for other tasks such as conservation and planning. Since excavation seasons are extremely short and archaeologists must maximize the use of manpower, the results of this mapping tool are particularly useful for reviewing the excavated areas and planning in which trenches to focus workforces. In addition to its usefulness in the field, later spatial analysis can be performed on the data with relatively little modification. In fact, for some spatial analyses, one would merely need to export the attribute table as a .csv file with its coordinates already recorded and use the file within other analyses programs, such as the R programming environment (Gentleman and Ihaka 2000).

6. References

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