Reconstructing Sites and Archives: Information and Presentation Systems at Troy

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Abstract

As a result of more than hundred years of archaeology at Troy an immense amount of information has been collected. To make this information accessible for the needs of research, publication and heritage preservation has several dimensions: First, terminology, concepts, methods, and workflows must be modeled to represent them as data and software. Second, working systems must be built. Third, archaeologists must be encouraged to use technology and taught the necessary skills enabling them to do so. Fourth, results must be communicated both to specialists and the wider public.

Presentation of results has been accomplished by means of a virtual reality system and 3d reconstructions. Research is now being supported by an information system consisting of database and geographic information system (GIS) applications linked with other software where needed. Examples are a stratigraphy engine combining GIS, database, and a Harris matrix program, and GIS mapping of archaeological sites and paleolandscapes with the help of high-resolution georeferenced satellite images. GIS is also used in the planning of a national park which will protect at least some of the sites from further destruction.

Keywords: Cultural Heritage and Public - Geographic Information Systems - Database Applications - Virtual Reality

Introduction

More than a hundred years of excavation have reduced the settlement mound of Troy (Northwest Turkey), legendary site of the Trojan War, to a heap of rubble resembling a stone quarry more than anything else. Research results have been re-buried in a huge archive consisting of unpublished documentation, computerised data, and a library of publications. From our own, still ongoing excavation, we have several thousands of hand-drawn plans, hundreds of notebooks, a collection of more than 40 000 photographs, and data that may be anything from texts, a maze of databases, scanned images, CAD-plans, to satellite images - not to speak of three sets of information from earlier excavations under the direction of Heinrich Schliemann, Wilhelm Dörpfeld, and Carl W. Blegen. Trying to access this information has become as confusing and frustrating as excavation at the actual, large, multi-layered and badly preserved site can sometimes be.

Archaeological computing at Troy has to serve the practical needs of this large-scale field project: Documentation of excavation results, archiving information, making the archive accessible, analysis, publication, and presentation of results.

Presentation system

Faced with the magnitude and complexity of these tasks it seems tempting here to use the latest technology and take a shortcut into a more fanciful world of 3d-reconstructions to save oneself from despair, which I admit we did on a grand scale during the past two years (Project "Virtual Archaeology-TroiaVR" supported by the German Federal Ministry of Education and Research: Jablonka et al 2003 and http://www.uni-tuebingen.de/troia/vr/). For use at museums and exhibitions reconstructions were put into a virtual reality presentation system that can be used to give visitors real-time tours through reconstructed Troy and the surrounding landscape at three different points in time. Context information (plans, texts, images, timeline) has also been included.

As archaeologists we need to communicate the results of our work to the wider public. After all, we are being paid from taxpayers' money, and it will certainly be appreciated if we can offer an interesting and beautiful experience especially appealing to younger people in return. Virtual reality systems can communicate and present the results of archaeological work. At least those of us who work for museums or exhibitions will have to make themselves familiar with content and technology of presentation systems. Apart from the presentation system itself another product created is a large and growing library of 3d reconstruction models which can and have been used as images, animations, multimedia content and TV footage (Fig. 1 shows an example).

Fig. 1 Example of 3d reconstruction for virtual reality presentation (Bronze Age chariot).

Towards an archaeological information system

But even the non-specialist will ask at some point how we arrive at this models, on what actual information they are based. Reconstructions are visual interpretations of results. Obviously, for scientific and scholarly research we need to develop an archaeological information system to help us achieve these results.

On the computing level, the architecture of such a system seems fairly straightforward. If we look at archaeology, we see maps or plans, and catalogues or lists, with illustrations. We note that almost everything from sites to finds has a spatial aspect. In fact, archaeology mainly deals with matter distributed in space and time.

Thus we can design an information system consisting of a spatial and a conceptual point of entry, or a GIS and a database user interface (Fig. 2). The data is distributed between a GIS and a relational database (RDBMS). To this tools for analysis (finds statistics, stratigraphy, ...) are added. Other data (images, 3d reconstructions, ...) is stored separately but linked to GIS and Database. In this way, all kinds of data can be closely knit together, and combined to produce different kinds of output (for printed or digital reports, maps and plans, visualisations, ...).

This can be implemented using standard software, in our case ArcGIS 8 and MS Access, and archaeology software (e.g. WINBASP for finds statistics and stratigraphy). Computing skills needed to do this are at the level of simple application programming (SQL, Visual Basic for Applications) to customize applications and transfer data between different software and file formats. This should make it more likely to find at least some archaeologists who have the technical skills to manage and develop the system, or are willing and able to learn them. Several examples of similar systems have been described in the relevant literature. Lock (2003), Wheatley and Gillings (2002), and of course numerous case studies published yearly in the proceedings of the CAA conference are good starting points. Burrough and McDonnnell (1998) is an excellent source on GIS.

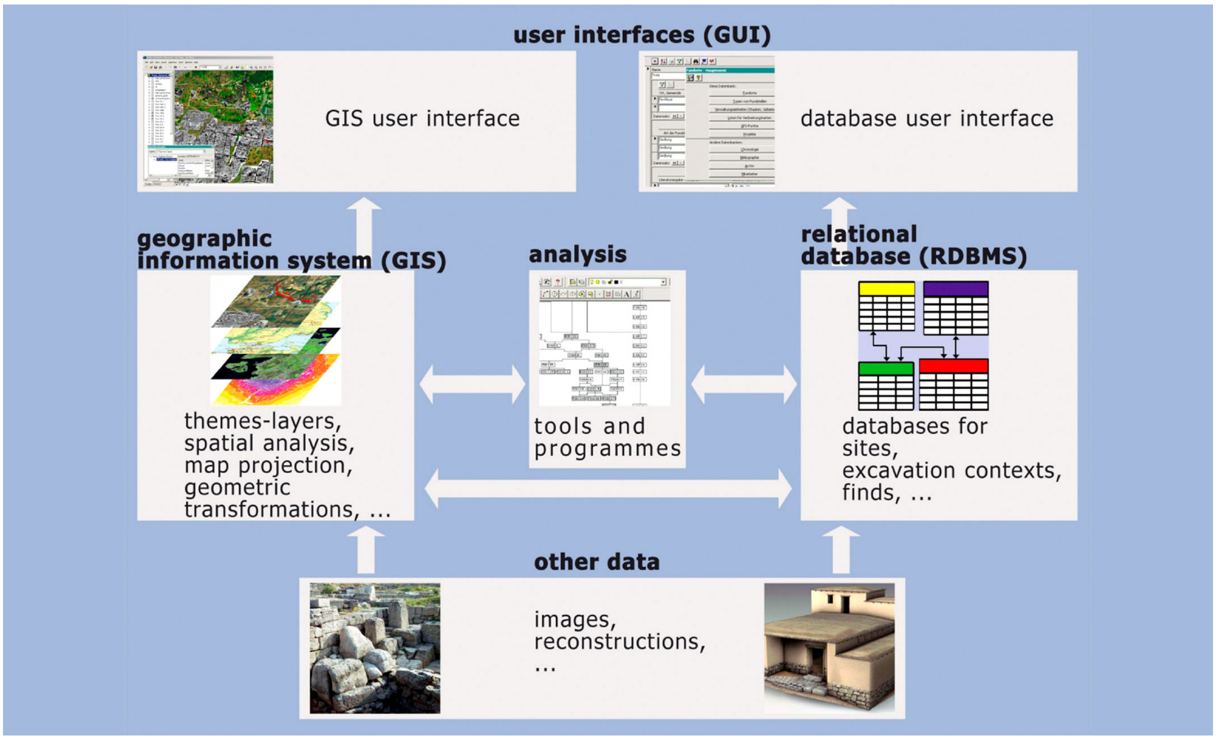

Fig. 2 Information system for Troy, system components.

Modeling archaeological information

While most publications tend to focus on technical aspects of archaeological computing, there seem to be few guidelines telling us how to model the content of archaeological information systems; how to translate archaeology into computer systems. Archaeologists work with landscapes, sites, excavations, pits and postholes, finds, or concepts like stratigraphy, typology or chronology. Information technology deals with alphanumeric, geometric, or pictorial data and procedures to manipulate them. Certainly there is a gap in between. "Enter sites and archives, push button and do archaeology" functions are not on offer. It follows that we need to clarify archaeological terminoloy, methods and theory, model them as collections of data and procedures, and define the tools needed to work with them.. On a semantic level we can identify the following categories and objects in archaeology:

Representations of real-world objects: landscapes, sites, excavation contexts (layers, pits, ruins, ...), and finds.

Conceptual abstractions: time, chronology, stratigraphy, classifications and typology.

Products: Excavation or finds recording systems, catalogues, reports, maps, plans, archives, bibliographies.

Each of these objects can then be described in terms of different data representing it (measurements, textual descriptions, coded values, images, geomnetry, ...), the connections (interfaces) it has with other objects, and methods used on it (order, query, write report, calculate statistic, draw map, ...). For example, landscapes - sites- excavation contexts - finds are obviously connected in a hierarchy. Different classifications will be a property of finds or excavation contexts. Chronology will consist of calendar dates, procedures to calibrate C-14 measurements, and lists of periods or phases.

Details of different excavation recording systems, or particular technical implementations can be separated from the data model. Starting with real-world objects or archaeologically meaningful concepts should ensure that we arrive at a meaningful representations of our data and the tasks we wish to accomplish. Ideally, analysis of similar problems should lead to similar solutions, and information systems designed for different archaeological projects should in the long run converge into common standards.

The result will be a data model describing each object with its associated data and methods in detail. This can be formalised in tables and diagrams showing connections between objects. The process resembles methods used in object oriented programming. It seems worthwile for archaeologists to devote time and effort on this conceptual side of computing rather than hunt for the latest technology, or concentrate on technical details.

Example 1: Stratigraphy

A comprehensive description of an archaeological information system is beyond the scope of this paper. I should therefore like to give two short examples putting the above considerations into practice. Troy consists of up to 15 meters of settlement deposits. Thousands of structures (layers, pits, surfaces, buildings and so on) can be identified and must be brought into a sequence based on the relationship of neighbouring structures, in other words, a stratigraphy has to be derived from observations recorded during excavation or from the study of published or unpublished information (plans, section drawings, textual descriptions). Since the theory of archaeological stratigraphy is well understood (Harris 1989) and has been implemented in several computer programmes (e.g. Gnet, HARRIS, ArchEd) stratigraphy can easily be modeled (Fig. 3). In fact, the method applied here has already been described by Alvey (1993). Two tables summarize excavation contexts and stratigraphic relationships. Contexts are also represented as plan or section drawings linked with the database table in a GIS. From this a sequence is generated by a program calculating the so-called "Harris Matrix" graph. The vertical position (line number) of each context in this graph is fed back into the database as a number which may be called "stratigraphic date". With this number an ordered sequence of all contexts can be produced, finds linked to excavation contexts can be assigned a date, phase plans, sections numbered with layered numbered according to their position in the sequence, or pseudo 3d-representation of phases mapping contexts from low=early to high=late can be drawn. By visual inspection of plans and section drawings errors or gaps in the stratigraphy are easily detected. The stratigraphy will be updated, new phase plans, or catalogue descriptions of excavation contexts will be produced automatically as new contexts are entered.

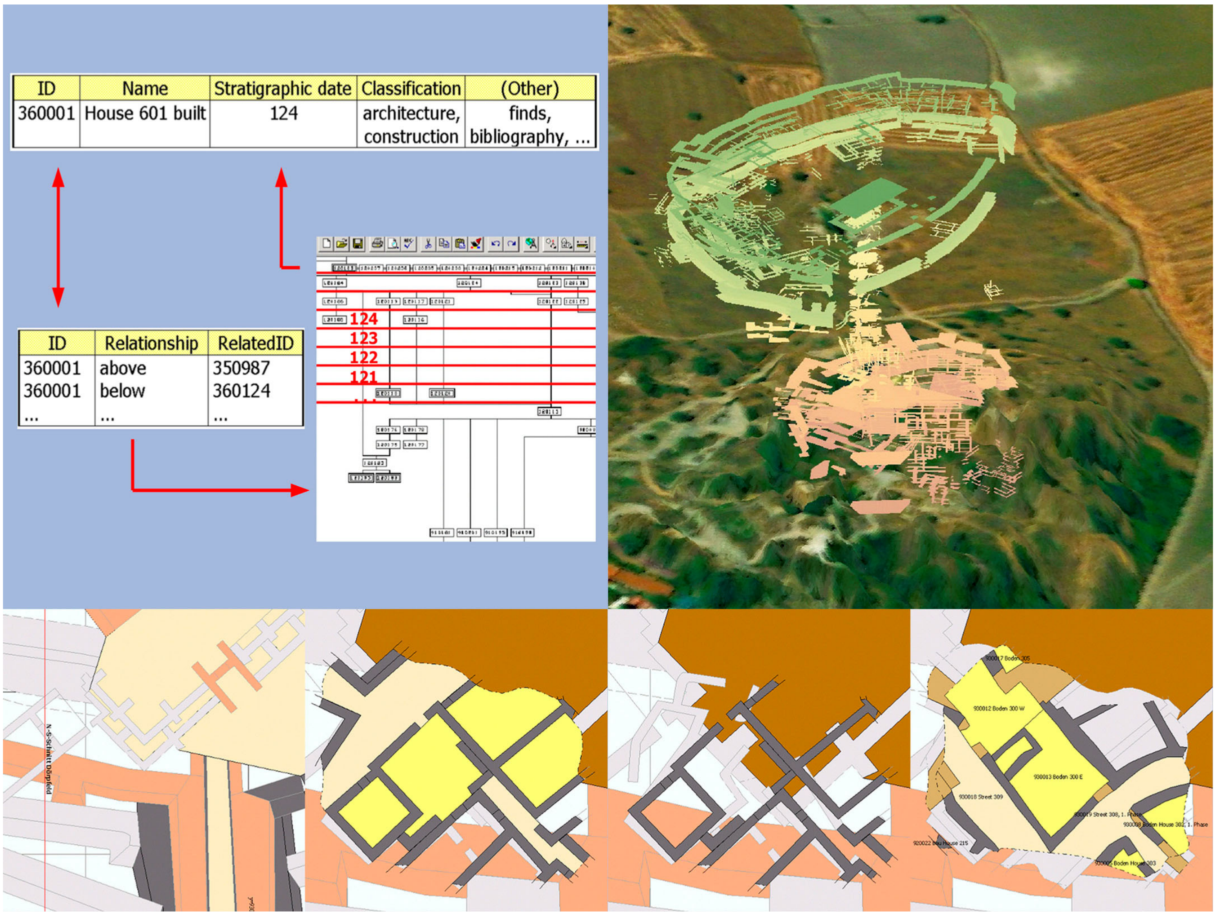

Fig. 3 Stratigraphy example: Database tables and stratigraphy program, pseudo 3d display of layers (old=bottom to young=top), automatically generated GIS-phase plans (colour: functional classification from database).

Example 2: Archaeological sites in the Troad

During the ongoing fieldwork at Troy, the Troad, the landscape surrounding Troy, has been extensively studied. To model a whole landscape, we need the following data and methods:

Archaeological sites: Location and size (space), descriptive attributes, classifications (settlements, burials, ...), time; search, filter, sort, make catalogues and reports, draw maps).

Space: Landscape (set of thematic maps); map projections, transformations, georeferencing, spatial analysis.

Time: Attributes (periods, calendar years), time slice-maps.

Additional information: Bibliography, archive materials (mostly images), data authors, contributors.

This leads to a straightforward GIS application connected to a sites database. Time is represented as a classification into periods, e.g. "Troy I", "Roman", to which "from" and "to" fields (in years) are added. Thus different chronologies can be calibrated against a common scale in years. Sites are classified into different types (e.g. settlement, cemetery, surface find). In a relational database, an arbitrary number of such "period-type" pairs can be associated with each site, and each of these pairs can be represented as an area or by a symbol in the GIS. In this way, a simple classification allows for considerable complexity to be represented in the system.

Fig. 4 shows a data model of an archaeological site as table and GIS representation of sites with a georeferenced satellite image as background map.

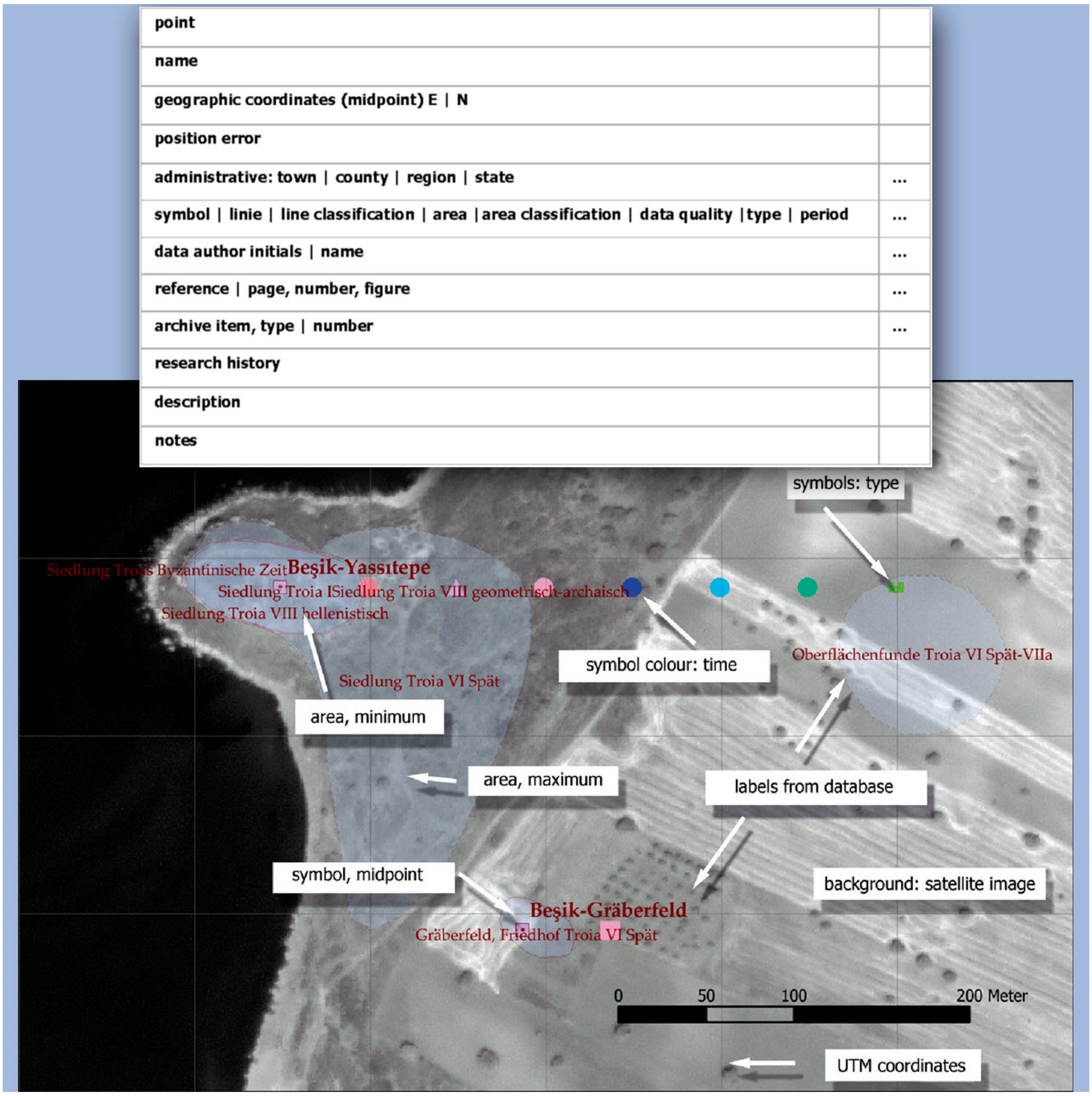

Fig. 4 Data model for archaeological site as table; GIS representation of site data (IKONOS satellite image courtesy Compton J. Tucker, NASA and Space Imaging, Inc.).

Conclusion

During the two-year project "Virtual Archaeology" progress with archaeological computing at Troy has been made in several areeas. It is significant that only the creation of a virtual reality presentation system with 3d reconstructions led to growing awareness for the possibilities and problems of computing in archaeology, and gave us the financial means to acquire hard- and software, train archaeologists in a wide range of computing tasks from 3d modeling to GIS, and pay for long working hours. This would hardly have been possible with a purely research-oriented project.

An important part of the project was the design of an archaeological information system for Troy. Relational databases and GIS are particularly suited to be the "workhorses" of such systems. Relational databases enforce strict and logical data models, help to avoid redundancy, localize data in one place, and can easily combined with spatial data in a GIS.

Perhaps the one shortcoming of GIS archaeologists will regret most is their poorly developed capacity to work with three-dimensional data. We still have to wait for systems that allow 3d-modeling of large archaeological sites, both of actual excavation data and reconstructions, to be seamlessly integrated with databases. Since most existing excavation data is also two-dimensional (plans and section drawings) this is not an insurmountable problem.

In the design of archaeological information systems, and in archaeological computing in general, technology is not the limiting factor. The structure and contents of such systems need much more consideration. It is important to develop formal data models and procedures that can be translated into systems serving the needs of archaeologists, and will be understood, accepted and used by them. A method for this modeling process has been outlined here.

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