Virtual Archaeology - VR based knowledge management and marketing in archaeology first results – nexts steps

Steffen Kirchner[1] email: steffen.kirchner@artcom.de
Dr. Peter Jablonka[2] email: peter.jablonka@uni-tuebingen.de

[1] ART+COM AG, Kleiststrasse 23-26, D-10787 Berlin, Germany
[2] Eberhard-Karls-Universität Tübingen, Institut für Ur- und Frühgeschichte und Archäologie des Mittelalters, Troia-Projekt, Schloss, D-72070 Tübingen, Germany

Abstract. Looking at the perception of archaeology within our society, and the development of new technologies, we discover that we are faced both with new challenges and new opportunities. Ideally, our own research from excavation and documentation to analysis and publication, and a popular presentation of it, could somehow be combined within one consistent workflow, using technology tailored to meet the purpose. Given the limits of resources and know-how in academic archaeology - even at Troy - such ideas are mostly bound to remain science-fiction. How can we archaeologists actually be enabled to meet the challenge and make the best of new opportunities a new millenium has to offer?

The general aim of the project ”Virtual Archaeology“ is the introduction of fundamentally changed working methods in archaeology with the aid of the most modern technologies, not only in the area of primary data acquisition but also in data processing and editing for scientific purposes and for the presentation of archaeological knowledge to a broad general public.

Key words: virtual reality, information management, presentation systems, reconstructions, 3d computer graphics

1 Introduction

For more than a century archaeologists have been excavating at different archaeological sites. The results of these projects are usually presented in two different ways:
1. Printed publications for scholars and scientists.
2. Publications, media coverage, exhibitions, and museum displays for a wider audience.

In the case of typical archaeological missions, both are based on information collected during many years of research. This archive consists of a vast and confusing amount of data in a bewildering number of different formats. The crucial piece of information one needs may be buried anywhere in a huge mound of unpublished documentation, computerized data, and a library of publications. From normal excavations we have several thousands of hand-drawn plans, hundreds of hand-written notebooks, a collection of thousands photographs, and data that may be anything from texts, a maze of databases, scanned images, CAD-plans, to satellite images. Mining this data has become similar to archaeological excavation at a very complicated site. As a result, number, scope and size of individual results are steadily growing, while the broader picture has become increasingly hard to grasp. The dauntingly difficult task is to really bring scattered pieces of information together, to structure and integrate the data, and make it accesible, both for scholars and scientists, and the general public.

Traditional scientific and scholarly publication of excavation results has its limits. Monumental "final" publication will in fact never be final. It can only utilize a fraction of the information available, and in one linear order starting with page one of volume one. It is weakly connected with earlier results. Anyone with a specialized interest will soon have to re-arrange the publications, and go back to the archive for missing information. Obviously we can overcome these limits by creating some sort of information system that allows us to access and combine data in various ways. More information than ever before can be published cheaper and faster in electronic form, on storage media like CD-Rom and DVD, or online on the Internet. The challenge is to use these new possibilities in a sensible way. Whereas there are established rules on how, for example, a catalogue of finds has to appear in a printed book, we are still far from having an accepted and standardized way of doing this in electronic form.

Public interest in archaeology is at a peak. Within three months, 250 000 visitors saw the exhibition "Troy - Dream and Reality" in Stuttgart, Germany. Archaeology has become part of a growing tourism and culture industry. As archaeologists, we should find ways to benefit from the popularity of our field. Using taxpayers' money to do our work, we owe the public. And we want to influence public perception of our work. Very often, archaeologists are reluctant to leave their ivory tower of pure research. Archaeology is popularized, displayed, reconstructed by journalists, museum designers, artists, computer specialists, film directors, and a new species of multimedia experts. We archaeologists do all the tedious work. Then we complain because our results are taken out of our hands and presented in a superficial, distorted, if not outrightly wrong, way by others who get all the attention, and sometimes even make money using our work.

2 The project

A group of archaeologist, multimedia and IT-specialists take part in a new project called "Virtual Reality - based knowledge management and knowledge marketing in archaeology", in short "Virtual archaeology". This idea has grown into one of 15 winning projects - out of more than 150 - in a "Competition on Virtual and Augmented Reality" issued by the German Federal Ministry for Education and Research. Of course this is pure adventure - archaeologists who do not know much about computers, let alone "Virtual Reality", work with programmers and designers who do not know much about archaeology. Two very different cultures - university department versus commercially orientated high-tech company - clash. But so far it has been fun. We see a chance here to explore new possibilities for archaeology and in the end maybe even create something useful.

2.1 Project partners and data

We are working on IT-components for presentation and information systems and two archaeological applications: Troy ("TroiaVR"), and Ancient Egypt and Sudan ("Ancient Nile VR"). Project partners are:

- ART+COM AG, Berlin (leader of project consortium)
- Troia Projekt, Institut für Ur- und Frühgeschichte und Archäologie des Mittelalters der Eberhard-Karls-Universität Tübingen (Troia Project, Department of prehistoric and medieval archaeology, Tübingen university)
- Deutsches Archäologisches Institut (DAI), Abteilung Kairo (German Institute of Archaeology, Cairo)
- ixl Satelliten-Informations-Aktiengesellschaft (ixl-AG), Oberpfaffenhofen (ixl satellite information corporation)

Project duration for the whole project is from February 2001 to July 2003.

The budget for "Virtual Archaeology" is around. Euro 3.600.000. The two partners from the industry only receive 50% of their budget as government funding. The other half is a true investment based on their judgement that at least some aspects of this project might ultimately lead to a profitable product, produce know-how gains that can be used in technically similar projects, or open new market segments. Here are the archaeologists moving from consumption of research funds and sponsorship money to playing an active role in a research and development partnership with the industry - something very unusual for academic archaeology. One condition of the competition was that the projects be oriented towards the creation of new jobs. Unlikely as it is that we are about to create future high-tech-archaeologists working in the industry, it seems worthwile to seek for new working opportunities for archaeologists.

ART+COM AG coordinates the project as a whole, is responsible for overall planning and design, builds the technology, does part of the modelling, and explores marketing opportunities.

The Troia Project prepares archaeological, environmental and other information for Troy and the Troad, processes and edits the data, provides detailed specifications, has been involved in systems design, will do much systems testing, and will provide marketing opportunities starting with an installation of a working system at the Troy exhibition in Bonn in November 2001.

The German Archaeological Institute provides their data on archaeological sites in Egypt.

Ixl-AG processes satellite data for DEMs (Digital Elevation Models), the environment and the landscape around archaeological sites.

2.2 Project aim

The idea is to create a presentation system and an information system and integrate both with actual archaeological data. By the end of the project archaeologists should have the technology and know-how they need to create and manage such systems themselves.

Figure 1: Concept study of the presentation system

The visible front-end will be an installation for museums or exhibitions. It will consist of a 120-degree film screen and a hand-crafted interface. The surface displayed will be a three-dimensional landscape-model with reconstructed archaeological sites. At some points there will be scenes with fully-modelled character figures. Details of the landscape - ancient coastlines and rivers, vegetation and land usage -, as well as some furniture inside houses, and objects, for example pottery, will also be included in the model. Other contents will be linked to "hot spots" in the model, for example pictorial and text information on finds, or images showing how the actual remains of a reconstructed building looks like, plans, visualisations of other data, for example the results of magnetic prospection. The model will include a "probability slider" to demonstrate how well reconstructed buildings and features are actually documented by letting them fade out according to their state of preservation.

The system will be installed in an auditorium with the atmosphere of a cinema or theater. Visitors will be offered guided tours by trained guides. These tours will follow paths defined in "user stories". This prevents users from getting lost in a jungle of data. Of course digressions according to demand from the audience will be possible. The experience should resemble a tour at Troy - although visitors probably will see more here than at the actual, badly preserved site.

Interaction with the system will be by way of a specially designed interface. It will consist of a touchscreen mounted on a column in front of the display. The interface will be divided in several areas: A zoomable site plan, a time slider, a window showing the contents of the big screen, and are to display images, texts, and other context information. It will have a navigation device (track ball, space mouse or similar). It will also be possible to jump to certain points on the plan. To accomodate a larger audience, the contents of the interface can also be shown on the screen. Additional features can be added, for example a column next to the interface showing the currently active period of Troy.

Figure 2. Concept study of the presentation interface

In this context, we specify that "Virtual Reality" (VR) means a system with the following features:

- A naturalistic, three-dimensional model, of some aspect of the outside world.
- Interactivity. At any point, users have options to tell the system what they want to do.
- Real-time movement. There are no pre-fabricated images or animations. Users can freely move around to any point of the model in real time.
- A display that is more than a computer monitor. Ideally, users should not see that they are interacting with a computer, and a feeling of immersion into the virtual world should be created

We want the technology to work in the background, while visitors should enjoy an experience with a human touch, like a theater performance or lecture. This is why we do not expose users to technologies like CAVE, goggles or other devices that users have to carry on their bodies. An auditorium with human guides also allows us to cope with large numbers of visitors. Any other system would inevitably be blocked by a few computer kids most of the time.

We can think of the second part of our project, an information system, in terms of layers of information. The surface layer open to the outside world is the presentation system. It is highly visible to a wide audience. It is a powerful tool to communicate archaeology to the public. Archaeologists usually work somewhere in the underlying layers. At the bottom we have the raw, undigested excavation archives. In the case of Troy, the next layer is previous work that has been done before the project started. This already includes databases, plans and other computerized data. We hope that the presentation system will be as attractive to archaeologists as it is to anybody else. Colleagues then should realize that the work that needs to be done is in the layers in between. That is, at least the most important informations on Troy have to be brought together and integrated within one system. This includes thr Troy excavation archive as well as published and unpublished information from earlier excavations. As at any other site there has to be one layer of databases on finds and archaeological features, or measured data like DEMs (Digital Elevation Models) and magnetic prospection. Pictorial sources, mostly drawings and photographs of finds, and unedited field plans, or illustrations from previous publications, must also be linked to databases. On top of this there has to be a layer of mostly two-dimensional spatial data like plans and section drawings in formats suitable for CAD (Computer Aided Design) or GIS (Geographic Information System) programs which in turn has to be linked with the databases. Up to this point, most features of the system can be integrated with the help of existing GIS programs. The VR-System can be a visualisation front-end connected to a GIS-program with the help of new data standards, for example XML (Extended Markup Language), and it can also integrate some additional functionality.

Figure 3. IKONOS (1m) with overlayed geomagnetic prospection

Apart from a high-end presentation, output from such a system can be generated at any level, from simple database lists, plans and images to CD-Roms, or Internet pages that include some of the features of both the presentation and the information system. Depending on the needs of the Troia Project during a phase devoted mainly to post-excavation analysis and publication, several lines can be followed here. During the project archaeologists will be trained to work with most components if they do not create them themselves. At the end a workbench that can help with post-excavation analysis, written and electronic publication, reconstruction, and high-end presentation should be available.

We hope to create an impact large enough to make our work stay alive after the end of this tw-and-a-half-year-project. At the end of the project we will have new hard- and software and archaeologists trained to work with it. Components of the system should be helpful with several different types of archaeological work. More information on Troy will be brought together in one place than ever before, and access to different combinations of information should be better. There will be a growing demand for presentation systems for museums and exhibitions. Together with our partners, we have the financial and personal resources to create other applications and market them. Returns can be used for further development, and we hope that in the long run there will be new work opportunities for archaeologists.

3 Present – first results

Working on the presentation model during the past few months we have focused on reconstructions. Troy is a site with very bad preservation due to continuous reoccupation for several millenia, and the digging away of large parts of the mound by archaeologists. Because of this reconstructions are much needed here, but they are also more difficult to build than at better preserved sites. The main criticism of reconstructions and computer visualisations has always been that they are too suggestive, and may convey an image that shows more than we actually know for sure - in short, that they are too attractive. But nobody ever said that a text on archaeology must not contain any interpretation, or has to be written in bad style and printed using an ugly typeface in order not to seduce people into believing the argument. Although reconstructions - by definition - show what is no longer there, they are by no means pure phantasy. Instead, they are an interpretation of the evidence derived by way of the same theoretical and methodological principles as any other statement in archaeology.

Figure 4. Mudbrick building in Troy (VR)

The building stones of a reconstruction are:

Documentation of the evidence. The archaeologists try to put together a collection of photographs, drawings and plans for each feature we reconstruct. The sources, and a description are entered into a database. At a next step, we try to complete fragmentary evidence where plausible. For instance, when we have some stones in a row, we may conclude there once was a wall. Thus we end up with a ground plan, and with architecture at Troy, for the most part this is how far we can get.

Usually there are some more clues, like fragments of mudbrick or plaster from the walls, but rarely enough evidence to reconstruct a building as a whole. When trying to actually model the third dimension, many conclusions can be made. For example, a second floor is impossible if the walls of a building are not strong enough. I admit we do not have a professional architect among the people working in the project, but we screen the literature, and seek advice from architects where necessary. In fact, some work on these lines has been done at Troy. Wilhelm Dörpfeld, who worked at Troy with Schliemann was an architect by training, so his book Troia and Ilion is an especially valuable source. For Megaron II A there are several static calculations regarding the viability of different roof constructions. As it turned out, they are inconclusive - so we have of course some freedom.

Figure 5. Different reconstructed houses in Troy (VR)

In addition we have to infer from other sources how a building could have looked like. We first look at other, better preserved archaeological sites from the same broader region, which are datable to about the same period, and culturally similar to Troy in the widest sense. A good example is Thera-Santorini, with Bronze Age buildings still standing to the second floor under the protective layer of volcanic ashes that covered this Bronze Age Pompei.

Next we look for representations of architecture, people and their daily life, or artifacts in the arts. Here we find a rich body of evidence including depictions of houses and cities on wallpaintings and reliefs, or models of houses, sometimes even completely furnished. Of course things will be easier for our partners working on sites in Ancient Egypt, but there is also a large number of sources from the Aegean or Anatolia.

Figure 6. Ghost man in Troy (VR)

We also look into written sources for more information. This applies especially to the Classical periods of Troy VIII and IX,

Finally we draw conclusions from ethnoarchaeological studies for the details of architecture as well as for the lives people once led between those bare walls. Even if the region around Troy for the most part has entered the age of concrete there is some traditional architecture left in remote villages which is currently being studied by members of the Troia Project. And women still bake bread in domed clay ovens similar to those we find in our excavations.

Figure 7. (hyper)realistic man in Troy (VR)

We document the evidence used and explain the conclusions made. Then we construct a visualisation in a way similar to the construction of any other argument or interpretation in archaeology.

We take the evidence at hand, add other evidence pertaining to the subject, and draw conclusions based on plausibility and analogy. By this we draw an image that does not show how something actually looked like, but how we imagine it did. As a cursory glance into any textbook on theory will show, this is all archaeology can do.

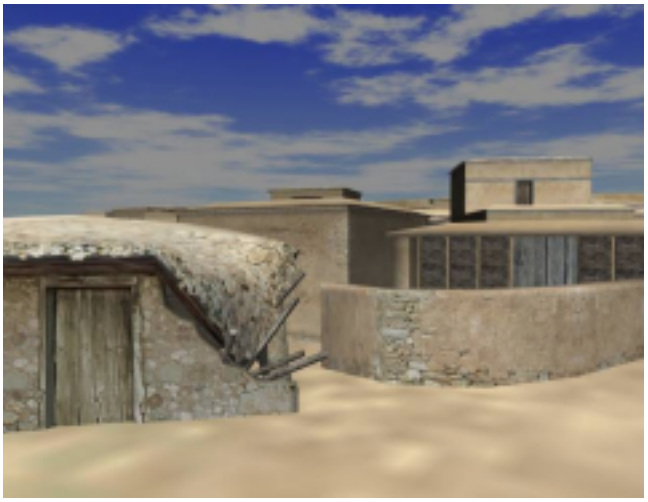

Figure 8. Destroyed house in Troy (VR)

The front-end of the presentation system is a VR-program developed by ART+COM. This program is designed around a rough model of the earth into which detailed content can be woven at the actual geo-referenced location of a project. The program was originally developed for Silicon Graphics ONYX work stations, but is being ported to run on high-end personal computers. Thus the costs of museum installations can be greatly reduced. There is a much higher likelihood that archaeologists, who can rarely afford expensive work stations, will use a PC-system. The VR-program is fully data-base driven. This means that any information can be linked to any point of the model. Of course, both the interface and the VR presentation can be brought to an ordinary computer screen.The obvious ordering principles for archaeological data are space and time. Within this framework, thematic information can be arranged. It follows that the presentation system already includes basic features of an information system with respect to both technology and content.

4 Future – next steps

We are also working on improvements of some of the reconstructions we have done so far, and we still need to add some more buildings to Troy VIII. Apart from this, we selected some areas from other phases for detailed reconstruction case studies which will also include the interior of buildings with objects found in them.

Besides further improvements of the VR software, ART+COM is developing a toolkit that will enable archaeologists to work with the VR system without further assistance by computer specialists. We also want to develop production tools for the automatic creation of output like animations or internet pages from the VR system, and for linking external information to the VR system.

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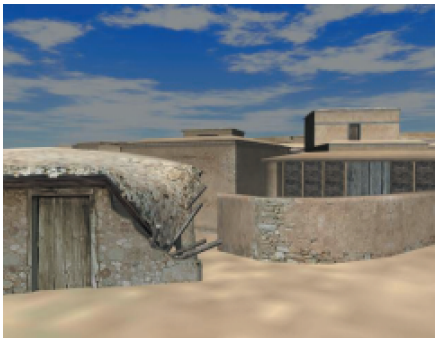
Concept study of the presentation system.

Concept study of the presentation interface.

IKONOS (1m) with overlayed geomagnetic prospection.

Mudbrick building in Troy (VR).

(hyper)realistic man in Troy (VR).



Destroyed house in Troy (VR).

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