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Robert Vergnieux

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ARCHEOGRID :

TOWARDS A NATIONAL CONSERVATORY OF 3D DATA OF CULTURAL HERITAGE

Robert Vergnieux
 AUSONIUS (UMR 5607 du CNRS)
 Université Michel de Montaigne
 33607 Pessac cedex
 robert.vergnieux@u-bordeaux3.fr
<http://archeovision.cnrs.fr>

Abstract : The use of 3D digital models has become inevitable for the scientific reconstruction of ancient edifices now lost. The Plate-Forme Technologique 3D of the Institut Ausonius uses a validation process for this type of research. This begins with the creation of an initial electronic model (V1) which alone can make it possible for researchers to speak together with precision over the validity of the reconstructions up to the attainment of model V3, representing the total sum of the hypotheses deemed the most probable.

This type of research on antique spaces (with more or less scientific quality) is now widespread and called for the creation of a “Conservatoire National des Restitutions archéologiques 3D” (Archeogrid), an objective set by the PFT3D.

Keywords : 3D Conservatory — Reconstruction — Models — Virtual Reality — Archaeology — 3D Platform.

The Archeovision Conservatory is developed within the framework of the Plate-forme Technologique 3D (PFT3D) of the Ausonius Institute (UMR 5607) of the CNRS (Centre National de la Recherche Scientifique). This PFT3D is the result of research initiated in 1985-86 during pioneering experiments regarding the use of C.A.D. (computer-assisted design) for archaeology. At the time we participated in the project of modelling the temples of Karnak thanks to powerful industrial C.A.D. programs (Albouy 1994), as well as the use of Artificial Intelligence for the automated manipulation of ancient iconographical sources (Vergnieux 1999; Albouy 1994). After taking a secondment, as Egyptologist in the research department of EDF (1991-92 : Direction of Studies and Research of EDF – TIEM Department – C.A.D. Group and A.I. Group – Clamart), I wanted to carry the experience further via a real technological transfer of C.A.D. tools to human science laboratories. It was in this spirit that, from 1994 after my appointment to the Maison de l’Archéologie de Bordeaux, we set up an industrial type C.A.D. work station (Indigo unix workstation, then Indy then Octane of Silicon

Graphics), equipped with PDMS and REVIEW software from the company Aveva.

The test models developed within this framework were 3D reconstructions of the amphitheatre of El Djem followed by the limestone temple and the tufa temple of Delphi created for the fiftieth anniversary of the Ecole Française d’Athènes (Brommelaer 1997). These early works made us realize the immense methodological potential of virtual reality in archaeology. Thanks to this technology, the act of “reconstruction” becomes a scientific act enabling us to recover lost or damaged ancient structures from a given era. The limestone temple of Delphi was modelled “stone by stone” so granting a virtual validation of the building which was impossible to carry out physically.

With this experience behind us we set up a large-scale research project which could allow us to explore and bring all these techniques into operation for scientific objectives. The first site to be chosen was the *Circus Maximus* of Rome. The work conducted in collaboration with the Archaeological Superintendence of Rome and the researchers of the Ausonius Institute made it possible to set up a scientific procedure of elaboration and validation of the 3D reconstruction of ancient edifices. From this initiative the 3D Technological Platform of the CNRS. of the Institute Ausonius came into being. Sponsored by the Conseil Régional d’Aquitaine, the platform specialises in the use of 3D in archaeology.

A) The use of 3D digital models for the scientific reconstruction of lost buildings

1) Setting up an initial model – level V1

Before embarking on a reconstruction project it is necessary to clearly define the scientific objectives involved in the work of reconstruction (sector concerned, chronological bracket) beyond the simple fact of producing computer-generated images. In the case of the circus maximus, to use this example again, the objective was to reconstruct the state of the circus as it was in the 4th century as faithfully as possible in order to induce a better understanding of the organisation of the races

and shows that were held there.

The creation of a 3D digital model requires specific skills from a variety of fields. If 3D modelling and computer graphics skills are indispensable, archaeological and historical knowledge on the site studied are equally fundamental as well as topographical expertise of the vestiges still in place. Special skills, depending on the aspects undertaken, such as those pertaining to engineers, acousticians are also necessary.

Reconstructing a major archaeological site involves teamwork and can no longer be carried out by one person alone.

For example, a 3D project on the archaeological site of Barzan involved reconstructing a water lifting device from the Roman period. The team of archaeologists and historians in charge of the project was reinforced by the presence of an engineer in mechanics, specialising in water lifting systems (Virtual Retrospect 2003).

The difficulty in setting up such multidisciplinary projects resides in the possibility of getting all the specialists to communicate with one another and of managing to bring together all significant progress for the validation of the reproduction of the ancient spaces. This is precisely where the 3D digital model takes on all its importance. As long as the 3D model is not displayable, any dialogue between the specialists is delicate with each scientist having their own view of the volumes. As soon as a first three-dimensional sketch is created it then becomes possible for two researchers from different branches of learning to speak together with precision over the lost “volumes” (Brommelaer 1997). The argumentation can be established with exactitude. Each specialist uses their own knowledge regarding the details of the 3D reconstruction which everyone may visualize. The very first indispensable step of scientific projects of 3D reconstruction is therefore the creation of this first 3D sketch of the site studied, which takes into account any previous hypotheses, if there are any.

Although at this stage the model is clearly not yet scientifically validated it is essential to get all the scientific partners to communicate with each other. This version level is called V1. It corresponds to the first 3D approach of the reconstruction potential of the site. It allows us to evaluate the reconstruction difficulties and to anticipate them via complementary research adapted to the scientific objectives.

2) Building a 3D terminology.

In order to create a synergy throughout the whole of the archaeological and historical documentation associated with the 3D model, it is essential to have a system of 3D identification brought into effect by setting up a terminology. It is composed of a common vocabulary describing the “volumic” hierarchy of the archaeological site studied. The aim of this sort of 3D thesaurus is to make it possible to link any element of the 3D digital model with all the associated documents. The terminology is built after studying the identification systems that may be used by the archaeologists on the archaeological site in question. If such a system already exists, it generally corresponds to plane identification but rarely to that of volume, it must therefore be completed. If it

does not exist it must be created. This step can only be accomplished with the participation of the specialist archaeologists of the site.

For all the projects this work is compulsory. After validation by the members of the team, the 3D terminology constitutes the backbone of the project. It makes it possible to “name” the 3D parts and to assign, as an attribute, all the relative documents to them.



Le tabloïde

Interface web de manipulation des données iconographiques et textuelles utilisées dans le cadre des projets de restitution des édifices antiques. Vue partielle du dossier sur le projet du Circus maximus.

The tabloid

Web interface for the manipulation of iconographic and textual documents used in reconstruction projects of ancient edifices. Partial view of the file on the Circus Maximus project.

3) The organisation of the documentation necessary for 3D reconstruction

In parallel to this first creation it is necessary to bring together the documentary base of sources required for the 3D reconstruction operation. They are classified for each site studied according to the following categories:

- Old and recent records (planes, sections, scatters of points, contour lines, etc.)
- In situ photographic views (from the beginnings of photography to present day)
 - Scattered vestiges
- Earlier reconstruction hypotheses (physical models, drawings, digital models)
- Texts (textual data providing information of the lost volumes)
- Complementary documents (parallel documents from other buildings)
- Iconographical sources (graphical representation, from every era)

Within the framework of the PFT3D we have developed a special interface for handling this data, a kind of virtual luminous table (tabloid) accessible to the researchers through the computer network. The “factual” part of this data is therefore pooled. Every researcher may add their own information and comments if they so wish. The tabloid also uses a special structure of “unicos” and of “unitext”. These are fragments of image or text issued from a document authorising a semantic manipulation of the 3D contents (Vergnieux 1999).

4) *Setting up seminars*

For every 3D reconstruction project, seminars are organised around a precise agenda and linked to the reconstruction of the buildings. Those attending these seminars have a “3D scene” at their disposal which can be manipulated in real time so making it possible to collectively visualize any 3D sector and detail of the site in progress of study. Those present also have access, during the seminar, to all the sources linked to the research project. Researchers or specialists with specific skills in line with the agenda are occasionally invited to join a seminar session. For example for the *Circus Maximus* project : the agenda of a session put forward the study of the physical liaison between the imperial lodge of the *Circus Maximus* and the imperial residence of the Palatine.

Several researchers specializing in the Palatine were invited to participate. The group reflective analysis which was conducted during this session, thanks to the use of aerial photographs of the sector and to the 3D digital model in which the imperial lodge had been accurately positioned, made it possible to demonstrate that in the 4th century, an architectural connection between the imperial lodge and the Palatine was not conceivable.

5) *From model V1 to models V3*

Each seminar strives to result in furthering the knowledge and hypotheses of 3D reconstruction. After each seminar, it is therefore necessary to update the 3D digital model. The different versions are qualified as second level (versions $V2_x$). The seminars are held as often as necessary so taking the models from a version $V2_x$ to a version $V2_{(x+1)}$. During these seminars, it is also possible that we identify new documents which are then added to the documentary base which regularly grows both in quantity and in quality. Finally the link between the 3D digital model and the documentary sources rests on the 3D terminology.

The total sum of work carried out according to the method indicated progressively leads to the creation of a digital model in version V3. The members of the seminar come to an agreement stating that this version is consistent with current scientific hypotheses. The version V3 models are also intended to advance according to new progress made in research. They are nevertheless at a sufficiently advanced level to be used as aids for scientific communication as well as communication to the public for the valorisation of research programmes.

B) An urgent call to set up a National Conservatory of 3D Archaeological Reconstructions

The simplification of C.A.D. tools and the reduction of production costs of 3D images mean that a large number of models appear in the field of archaeology. It can be observed that in the main these models are of type V1 (version V1) or V2 when scientists have actually taken part in the validation process. In general they are the result of development operations arising from the initiative of local authorities, museums, television production companies or publishers. These reconstructions are created by 3D computer graphics companies then validated by a specialist (archaeologist, historian, etc.). Once the event is over, we have noticed that the sponsor generally has neither the human resources nor the material resources, nor the skills to act as depositary for the 3D model used. This is the case, for example, of the well undertaken 3D models of the fiftieth anniversary of the Ecole Française d’Athènes (Brommelaer 1997). This establishment the neither has industrial software, nor the human resources necessary to maintain the models that have now become inaccessible. In more serious cases, the 3D files are no longer consultable since the range of software used for their creation no longer exists. Thereon scientists implicated in the project only have at best a few images or an animation sequence at their disposal which they may use for seminars in which they partake. Occasionally, they may even find themselves in the farcical situation of having to buy back the images which without them would not have existed.

As for laboratories producing the 3D data themselves, they are also faced with the problem of filing and the perpetuation of the data. It is worth noting here the fact that new technology is considered to age very quickly. However, it is not technology that ages but the perception that we have of it that changes (Ellule 1976). A 3D digital model visualized on a computer will always work in exactly the same way in one year from now as in twenty years’ time, provided that we maintain the computer in good working condition. It is the apparition of newer technology which makes us see existing technology as archaic, but it must be understood that from the moment it was created in no way does the technology degenerate. This imposes the necessity to protect and conserve all this information which, for virtually the last twenty years now has been disappearing as quickly as it has been created. It’s a matter of urgency. A large number of files have already been lost, yet a great many files are created each year often involving public finance.

1) Nature of the research tool built from the corpus of 3D archaeological reconstructions

First we aim to favour the inventorying of scientific projects in the creation of this corpus. All archaeological reconstruction projects having created a 3D digital model will be the object of an identification record. The information registered will be of two types, one about the scientific operation (who, what, where, how?), the other about the technical aspect of the 3D model (who, what, where, how?)

Any existing bibliographical information will naturally be checked.

To illustrate the record we shall use a “view” of the 3D model. If the authors of the model can be contacted, we shall approach them so we may hold a copy of the 3D files in trust. For this purpose, we have provided a repository card specifying the conditions of conservation of the copy; the Plate-forme Technologique 3D of the CNRS undertakes to maintain a backup of the data deposited. The level of confidentiality of the files will also be specified at each deposit. As for the 3D model, it will not be manipulable on-line during the first phase of the project. A number of format problems must be resolved beforehand.

This first core of information accessible on the web will make it possible for anybody to immediately identify past 3D reconstruction experiments of archaeological sites. The authors’ references will be indicated so enabling people to get in touch with them. The researchers may get in touch with teams having already conducted studies on a particular 3D reconstruction. In the same way a documentary film maker wishing to use computer-generated images to illustrate the subject matter on an archaeological site may find out about existing 3D models and maybe ask permission to use them.

Finally, every individual will be able to ascertain the state of advancement of archaeological research of the 3D understanding of a given site.

Moreover for each 3D file identified, we shall make every effort to complete the corresponding document file. In this

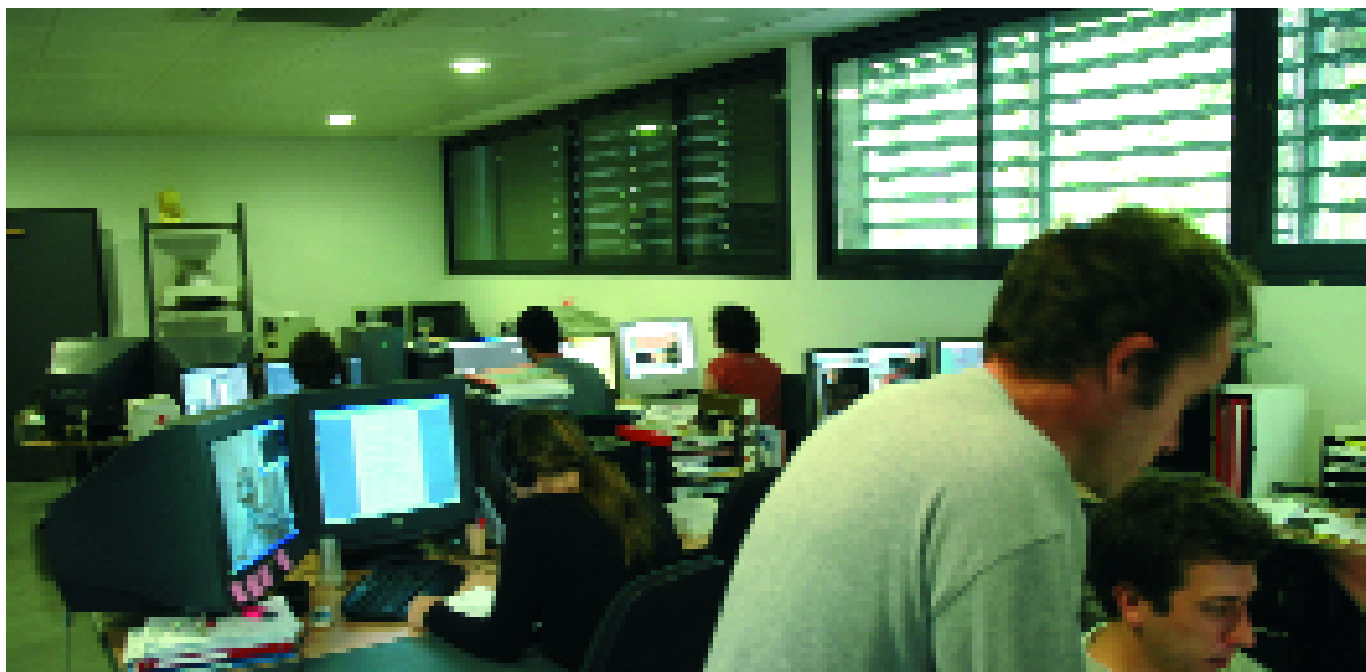
way the factual information made available on 3D reconstruction projects will be as complete as possible. Throughout our many collaborations and contacts with the forces behind the creation of archaeological 3D models, we already have around 300 projects set to be integrated into the corpus and we estimate the quantity of 3D models immediately available to be at several thousand.

The conservatory has begun a sustained communication and information campaign aimed at producers of 3D information in archaeology to incite these protagonists to carry out voluntary deposits of their data with the two-fold perspective of saving and indexing the 3D model in our corpus.

At a later stage propositions of less scientifically accomplished 3D reconstructions will also be included. These entries will also been given to an identification card. Any person consulting the database will quite easily be able to identify the level of scientific validation of the reconstructions.

2) *Developments conducted on the technical aspects of 3D data (GIS)*

The future of making the 3D files available (geometry + texture) is complex and poses the problem of the diversity of formats. How do we perpetuate the consultation of such documents in their dynamic three-dimensional form? The Conservatory is turning towards the creation of a storage format specific to 3D data in archaeology (format “archo3D”).



La PFT 3D :

la plate forme technologique 3D est au service des équipes scientifiques souhaitant explorer les usages de la 3D dans la recherche en archéologie.

The PFT 3D :

The 3D Technological Platform is at the service of scientific teams wishing to explore the usages of 3D in archaeological research.

The idea of this process is to considerably simplify the problem of data perpetuation. On inputting the 3D files into the corpus a version in the archeo3D format will be automatically created. In future, to visualize the 3D files in the corpus then, we shall only have to convert from the archeo3D format to the new standards. Although the development of such a storage format falls within the competence of computer engineers, it should be high on the list of the scientific concerns of archaeologists. It is for this reason that a SIG bringing together the PFT3D, Laboratoire d'Informatique de Bordeaux (LABRI) and the two companies, Mad Monkey and Immersion, is in the process of being set up. This group is not only devoted to setting up a storage format, but also to considering the files direct portability in terms of large screen display or immersion. In its concerned to reach an ever widening public, the SIG also explores the potential of this format for interactive visualisations through the medium of iDVD.

3) Infrastructure of the National Conservatory of 3D Archaeological Reconstructions

The Conservatory is set up on the premises of the PFT3D of the Ausonius Institute. Situated in the Archéopôle d'Aquitaine on the Campus of Pessac, the PFT3D has a production platform equipped with seven 3D development workplaces and a virtual reality centre where research seminars on the validation of 3D reconstructions are organised. This room called "the Odeon" enables us to open to the public who come to discover the 3D digital models created within the framework of research programmes. It is planned to also use the Odeon as a preferential point for the consultation of the 3D archives of the corpus (this consultation concerns the 3D files whose authors gave their authorisation on depositing their data.).

4) 3D data producers

A few research centres are currently producers 3D data for archaeological reconstructions. For example: the research centre of Caen (Map of Rome Team) (see above p.87); the MAP GAMSAU, more turned towards the digital acquisition of architectural heritage than the archaeological reconstruction of lost sites (see above p.31), French schools abroad, the Ministry of Culture which assists in the digital acquisition of prehistoric sites. Numerous local authorities also invest in 3D models that set off their archaeological heritage. In this way, private companies create numerous 3D models corresponding mostly to version V1 of the edifices.

The Archeogrid conservatory therefore offers all these state and private entities a backup service for their 3D data. Each file received gives leads to an entry to the corpus. The goal is to draw up as comprehensive a list as possible of 3D files of archaeological reconstructions, to keep a trace and to perpetuate them. In fact the project aims to create a tool serving not only as a catalogue of 3D reconstructions in archaeology, but also centralising this type of information to make them available to archaeological research teams. Many

researchers already use our interfaces to consult this data.

C) Conclusion

Though 3D models of archaeological reconstructions have become relatively commonplace, it would seem they have been left out of digital filing and perpetuation projects. The European internet portals on the digitization of cultural heritage ignore the 3D archaeological reconstructions (portal Michael :

<http://www.numerique.culture.fr/mpf/pub-fr/index.html>). The issues of the access to digital resources, such as the knowledge bank, do not generally take into account 3D digital data. Undoubtedly, laboratories, private companies, film production companies, as well as some publishers produce 3D digital models, yet none have embarked on an operation of filing and making all this information available to the scientific community. Parallel to the urgency of saving this information, it is necessary to point out the importance of the iconographical and written documents that accompany the research on archaeological reconstruction. It is essential to make an effort of structuring this data to be able to convey all its value to reconstruction projects. The reconstruction propositions that come to our notice do not always have the minimum scientific quality required. Although this state of affairs is often due to a lack of time, it also stems from an under-exploitation of the useful scientific documentation. The originality of the conservatory is to make this documentation available.

Concerning the validation methods of 3D reconstruction, the biennial international seminar, Virtual Retrospect, is the only one exclusively dedicated to the use of 3D in the study and reconstruction of archaeological sites. There are other conferences and events on the valorisation of the digitization of cultural heritage, but they do not expand upon the scientific problems of reconstruction. One team whose work is more in phase with these aspects of the future of 3D data and its conditions of use is that of the Ename Centre which is at the third version of a charter on the role that the projects of rendering archaeological heritage sites must occupy. The Archeogrid conservatory grants an important place for the reflective analysis that has been conducted as much by the archaeologists on the sites as by professionals of museums on the relationship between the rendering and the site itself. This relationship is fundamental if we are to develop a large-scale and long-term operation for the stabilization of the very volatile 3D digital data of archaeological heritage...

Bibliography : See above p. 162.