Current Productions
Carnuntum, German Limes and Radiopast

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Resumen

Presento tres proyectos elegidos que delimitan técnicas diferentes de la producción y su transmisión de contenido. El impacto diferenciado en la absorción pública del contenido es descrito dependiente a experiencias con ello en exposiciones y publicaciones, y puede ser usado para rectificar futuros acercamientos de temas similares. En la mayor parte de estas producciones, las dificultades técnicas fueron estudiadas y solucionadas por el uso extenso de instrumentos diferentes y técnicas para conseguir una salida razonable y representar nuestro estado del conocimiento que nos gustaría compartir. La documentación de la producción así como la comunicación entre la producción y grupo de investigación es indispensable en estos formatos multimedia.

Palabras Clave: *RECONSTRUCCION, ROMANO, CARNUNTUM, LIMES, RADIO-PAST*

Abstract

The here presented three chosen projects mark out different techniques of production and their transmission of content. The differentiated impact on the public absorption of the transported content are described dependent to experiences with it in exhibitions and publications, and can be used to rectify future approaches of similar topics. In most of these productions, technical difficulties were observed and solved through extensive use of different tools and techniques to achieve a reasonable output and represent our current state of knowledge which we would like to share. The documentation of the production as well as the communication between the production and research team is indispensable to the sucess of these media formats.

Key words: *RECONSTRUCTION, ROMAN, CARNUNTUM, LIMES, RADIO-PAST*

1. CARNUNTUM 2009-2011

1.1. Assignment

Marking the 2000 year anniversary of the former Roman capital of Pannonia superior, Carnuntum, we had the chance to start a long-term project, aiming for a total reconstruction of the city, the legionary fortress and its canabae, including the surrounding landscape. This will result in a 1:300 scale model measuring over 20 x7 meters as well as a series of other media including Film and interactive Applications.

The Scale Model will inherit approx. 5600 buildings and will be processed through virtual models which will then be plotted on a 3d printer, either as a single instance or in negative-form in order to duplicate certain smaller buildings by cast moulting. The generated computer models will also be used for the film scenes and have to be prepared accordingly. The final result will be presented in spring 2011. We will present a short overview of the used techniques and show the current state of this project.

Figure 1.1 Scene of the reconstructed Forum

1.2. Technical realisation

One of the tasks of the project was the construction of a haptic scale model of the ancient city including its surrounding area. The model displays a section measuring 6,750 m x 4,500 m in a ratio of 1:300 and thus being 22,5m x 15m in size and including over 5000 visible Structures. Therefore extensive planning was necessary for the implementation of this model.
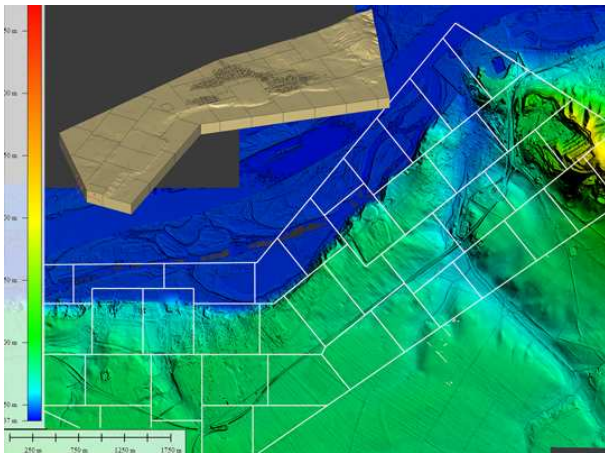

Figure 1.2 Lidar and STL Model of Carnuntum

Unlike traditional model building the scene was entirely built in 3-D programmes and then printed in a 3-D format. For this process a Stereolithographic machine (STL) was used which utilises laser technology to build up the layers of a structure in a matter of hours. For certain repeating buildings a vacuum moulding technique could be used to lower costs since this allowed the replication of existing prototypes. Hence the 3-D Objects had to be made especially to meet the requirements of 3-D printing.

Due to technical limitations the Terrain had to be divided into 38 terrain tiles that would have to fit perfectly together with a very low error tolerance (<0,5mm). It was decided that instead of placing single houses across this model, a set of structure tiles were used approx 7cm in size. This would ease the production process of the model as well as set further requirements. The base of these Structure tiles had to be subtracted from the Terrain tiles so that these would fit exactly into the indentation afterwards.

1.3. Object creation

The creation of the virtual models involved in this project had to fulfil certain requirements. They would have to be able to be produced by a 3-D Plotter and therefore had to be constructed as STL files. This would mean that the individual models consisted of a single mesh with no holes or vertical elements that were hanging over. Roofs and Structures were separated in the process for alternate coloring and reassembly afterwards.
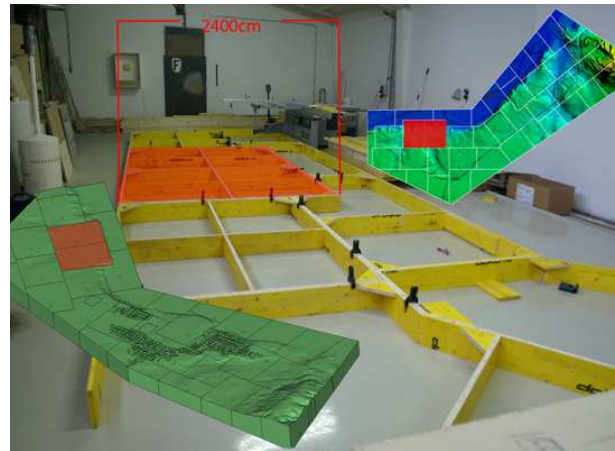

Figure 1.3 Set-up of the framework for the Scale Model

Figure 1.4 Virtual and Scale Model of the Great Baths of Carnuntum

1.4. Artefact Database

Currently a virtual web based database is being established containing numerous findings of roman artefacts from the carnuntum area. The artefacts are scanned with a professional scanner and then processed to be able to present a low-resolution poly model containing detail information of the high poly model in an interactive flash application alongside photos of the artefact. The original texture however is not shown in these objects as other information regarding the surface properties is more abundant that way.

The Database is available online to the public whilst professionals can access additional metadata.

2. VIRTUAL LIMES OF RAETIA AND GERMANIA SUPERIOR

2.1. Assignment

In autumn 2009, a consortium of regional municipal and federal state authorities in Baden -Württemberg, Germany, requested a

proposal for the visualisation of a approx. 90 km long part of the former roman Limes, inheriting 11 military bases and their civil settlements. The output should result in a virtual 3d real-time environment allowing the user to interactively navigate through these settlements while receiving the necessary information about the regions, buildings and local finds, on the fly. Two short films should explain the historical background of this segment of the German Limes, giving an insight view to the daily life of a roman solider, explaining their duties, equipment and architectural environments. All media was to be presented in a stereoscopic format. In addition, a GIS -like application should allow the user to stroll along the former Roman Limes section while gathering information through marked areas and points of interest but also giving him the opportunity to change the appearing maps from the present to the reconstructed state. The great task in this project was to find a solution for deducing the data size to a suitable dimension while still conserving most of its visual quality.

2.2. Resources

The research team consisted of five archaeologists assigned to different duties. The content of this Project was broken down to the individual scenes, giving us time to process the given information and present it for correction and validation. Finally, a 130 page manuscript documented all decisions through interpretation of the gathered source material.

A coarse DHM together with topographic maps and orthogonal photos of the region was supported by the federal authorities, while a detailed LIDAR (light detection and ranging scan) was produced and processed by our partner (ARCTRON), which presented the base for the used Geographical Information System, where all archaeological and topographical information could be hosted.
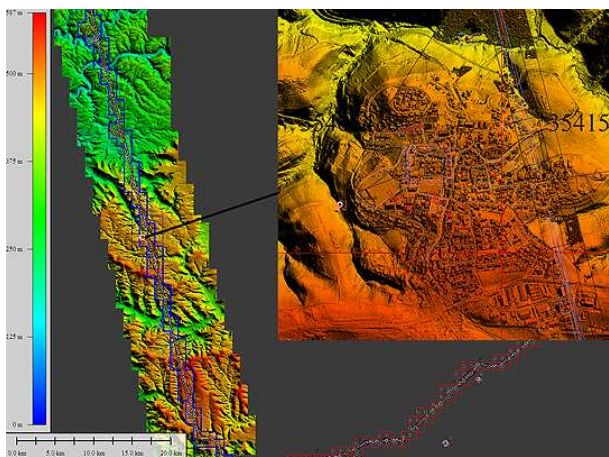

Figure 2.1. Digital Elevation Model and Lidar Scan inside the Infosys GIS Application

2.3. Communication

To assure a good communication between the production and research teams, an internet blog was installed to update all production progresses. Through this we were able to illustrate ideas for reconstructions and obtain crucial information and various suggestions from all participants. The approval of

realized scenes and objects were also published within this blog and could therefore be documented.

2.4. Technical realisation

In a first attempt, a query of existing 3d real-time engines was done, to assure that the large amount of data could be presented fluently in a high quality. Our requirements to the 3d real-time editor where focused on interchangeable data formats, interactive implementation through simple scripting languages, good stability and a comprehensive asset management. After a few weeks of trials we decided that the UNITY3d engine suited these requirements best, and would also be a good option to publish on various operating systems and hardware devices (mobile, web, standalone, consoles, etc..) The output of a stereoscopic format could be assured, since the compiled version of the application allowed to write to its camera buffer and was therefore suitable for both DLP and active stereoscopic devices like 3dVision from Nvidia.

2.5. Object creation

In order to obtain fluid frame rates for the end -product, we where aiming to keep the polygon count as low as possible while keeping as much visual quality as possible. The base reconstructions where made in high to medium resolution and served as a pattern of textures, which where then applied to low resolution models.

A standardisation of objects had to be achieved to meet the large amount of buildings and structures used within these scenes. The various military complexes where constructed of a modular set of parts which could be assembled to fit the archaeological constituent and its interpretations. In case of anomalies, adoptions of the pre modelled objects had to be made. The templates where delivered from standing structures and well known regional reference sites as well as literal sources of antique authors and illustrated examples. A similar approach defined the illustration of the civil architecture. A typology of certain houses was created, using the nearby reference sites of "Wimpfen" and "Wahlheim" which are well documented and assembled to the results of excavation or prospection. To achieve a variety of buildings, the existing models where differentiated through texture, scale and modular compilation.

2.6. Scene creation

Through the use of the prepared research data, existing digital elevation models and Lidar scans, a presumption of the former roman terrain was made and illustrated in various maps to discuss the placement of vegetation and settlements. A GIS application was used to gather most of the information and extract certain areas of interest to suitable formats.

In the real-time editor, scripts where created to allow the placement of textures and objects using these prepared maps as masks. Through this we could achieve a flexible way of modelling the landscape communicating its results through 2d information (maps) which could easily be changed and corrected.

The terrain geometry in unity-3d was created through extrusion of 32-bit grayscale images taken from the GIS data which were manipulated by applying fluvial and erosion simulations. The

surface of this terrain was textured using so called "splat maps", which allowed the placement of different surface features on certain parts of the DHM, depending on slope steepness, height -value and regions defined by the splat maps in their RGB value. Through this, a large area of the landscape could be covered using textures of fairly small sizes and therefore economize the computation costs during runtime. The geometric density of the terrain is dependent to the distance of the viewer's camera and can therefore adjust its detail which was crucial for the performance of the compiled application.
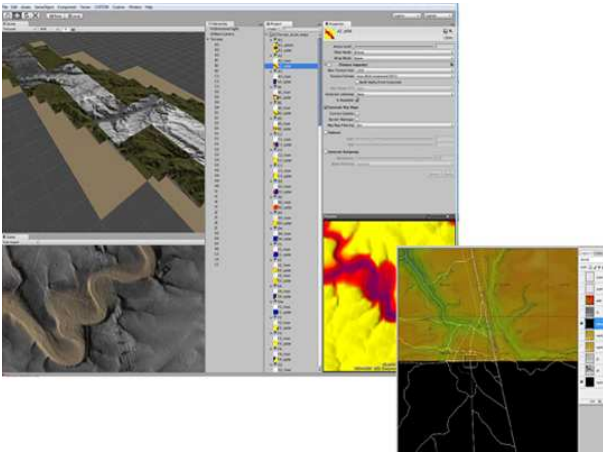

Figure 2.2. Example of a splat map

Figure 2.3. Scene in the runtime environment

A similar feature had to be applied to the vegetation of the landscape, using pre-made plant species with three instances of detail, ranging from 3d models of approx. 5000 polygons to simple billboards with only 4 polygons, dynamically switching on and off dependant on the viewers distance.

Although the terrain texture, street networks and some of the vegetation could be placed by the use of splat or overlay maps, architectural elements, objects and further vegetation had to be placed by hand, which consumed a great amount of time. The reason for not automating this process, was the detailed placement according to plans of excavation and prospection results which demanded individual decisions for all parts of a

fortress, its canabae and other building structures. Although an individual modelling approach for each of the settlements could not be realized, due to deadlines and budget reasons, the modular setup of the scenes turned out to be satisfying to the artistic and scientific demands.

At the end, we could present 11 reconstructed landscapes of that period (233 a.d.) inheriting approx. 2600 buildings with a fairly high degree of quality, still maintaining the necessary performance for the runtime of the stereoscopic, 3d –real-time environment.

2.7. Character creation and animation

The 3d Characters used within the short film and the real-time environment where first modelled in high detail and afterwards reduced through re-topologisation of their surface, while retaining most of their visual details through a process of so called "texture baking", where the surface appearance of the highly detailed model is being transferred to the model of lower detail through projected texture maps. This was especially necessary for the use inside the real-time environment, but also turned out to deliver almost the same quality for the film scenes with the advantage of faster computation in the animation and rendering processes. Different head or body models and textures where used to diverse the characters and generate small crowds of actors.

Most of the humanoid characters where animated through our in-house motion capture system, which is driven by magnetic sensors, placed on the actors body on a whole-body suit.

The resulting motions are convincing, but still demand more post correction and cleaning than the optical motion capture systems.

Figure 2.4. Topology of a characters Mesh

2.8. Content assembly and storytelling

The four components of this production work as a composite and complement the ported information in different ways.

The first short film explains the origin and morphology of the Roman boarder producing a clamp of information around the Period of the Roman occupation of the German territory west of the Rhine and south of the Danube.

The second film aims to give an insight into the daily life of the soldiers at this frontier, explaining their duties, aspects of warfare and border control as well as the facilities of the military bases.

The real-time application lets the viewer explore the 11 settlements with their surrounding landscape while delivering information via text, narration and pictures as the user flies by areas of interest. A mini-game, in each of the main scenes, puts the user's skills to a test and interrupts the otherwise, more linear approach of information transfer. The flight-height in the scenes is approximately 50m above ground but for some scenes presenting walkthroughs of buildings and castles a first person perspective was used to show the inside of these facilities from a closer range.

A map-based information system informs the audience in more depth about areas of finds along the 90 km part of the limes. Information is presented through hotspots, which call up a pop up window, delivering text and pictures concerning the current area. The maps can be changed to compare modern state topographic information, orthogonal photos, lidar scans and the reconstructed terrain and settlements.

2.9. Resume

I am quite confident that the output of this production is on a high level of quality, considering the large scale of scenes and the huge amount of modelling and animation tasks in comparison to the relative short production time. The reaction of the public in various presentations of these media is good and the fact that the younger audience showed a high interest, due to the 3D-realtime content, was a valuable experience. Some critical comments, concerning the usability of the real-time application for the elder audience, had to be taken into account and corrected.

In difference to a rendered 3D scene, changes in the real-time application can be altered more easily. This makes the production process more flexible, but can also be of advantage to later changes or follow-up productions.

Figure 2.5. Scene detail in the runtime environment

I am convinced, that within the near future, picture and animation quality of midlevel game engines will be competitive with rendered pictures or films and could therefore substitute these, giving the producer more interactivity and flexibility while delivering more excitement to the user, thus transporting the content in a more ludic and enjoyable form.

3. RADIOGRAPHY OF THE PAST

3.1. Assignment

In April 2009 a European project, called "RADIO-PAST", was launched within the Marie Curie framework "Industry-Academia Partnerships and Pathways". The project aims to join resources and very different skills to tackle each possible aspect connected with "non-destructive" approaches to complex archaeological sites. The consortium of 7 partners has chosen an "open laboratory for research and experimentation" in and around the abandoned Roman site of Ammaia in central Portugal, but some research activities are carried out by the partner institutions in different areas of the Mediterranean.

3.2. Introduction

Ammaia is a Roman town whose foundation should predate the inscription mentioning the Civitas Ammaiensis during the reign of Claudius (44 o 45 AD; IRPC, 615: Mantas 2000, 392-393.). It was converted in municipium at the latest in the age of Vespasian, as is witnessed by another inscription conserved in Portalegre (CIL, II, 158 = IRCP, 616).

The ruins of the Roman town of *Ammaia* are located in the heart of the Natural Park of the Serra de São Mamede, a mountainous area of east central Portugal extending into Spanish territory. The site is part of the fertile valley of the river Sever (Marvão). At this stage of research, no traces of settlements preceding the Roman foundation have been detected.
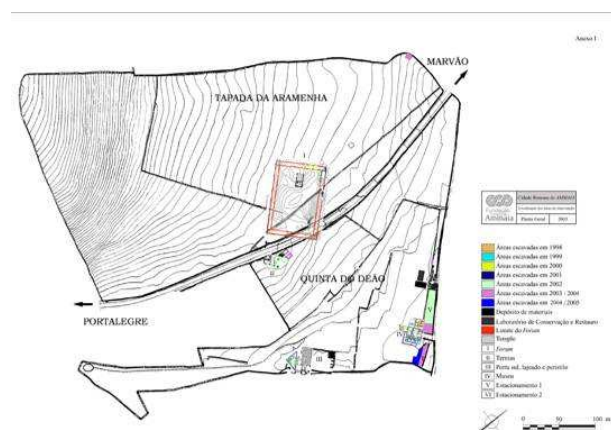

Figure 3.1. Sitemap of Ammaia

3.3. Methodologies

We are elaborating an integrated methodology which involves a wide range of field survey techniques (geomorphologic and topographical survey (CORSI, DE DAPPER, DE PREZ, VERMEULEN 2005; DEPREZ, DE DAPPER, DE JAEGER 2006), surface artefacts collection, the main types of geophysical prospection, vertical aerial photography interpretations (CORSI, VERMEULEN 2007), high resolution LIDAR scanning, innovative

low altitude aerial photography, ...) as well as new avenues for data processing, modelling, 3D visualisation and site presentation.

The first campaign of geophysical survey has been carried out in 2008 by Ugent (L. Verdonck), mainly with GPR, while the second campaign in 2009, carried out in the framework of the project in collaboration with the University of Southampton (APSS-team), was focussed on the magnetometry and covered an area of almost 5 hectare.

3.4. Results

Archaeological data collected until now proves that most urban structures were developed during the 1st c. AD, and the wealth of the town is probably mainly due to its position at the centre of a vast communication network in *Lusitania* (especially along the road connecting the capital *Emerita Augusta* (Merida) with the Atlantic harbour *Olisipo*-Lisboa: *It.Ant.*, 419,7-420,7) and to the exploitation of a wide range of natural resources (metals, stone and rock crystal, pastoral and agricultural activities...).

The urban centre of *Ammaia* was delimited by a wall circuit enclosing some 22 h, and the town had a regular layout, with main axis connecting the gates and a system of terraces regulating the most sloping part of the *intra-muros* area. The first attempt to produce a 3D reconstruction has chosen the well preserved Porta Sul.

The results of the "time slicing" of the GPR data processing allow to prepare the ground for elaborating a digital reconstruction of the *Forum*. All elements visible on the geophysics results, such as the large basilica, the symmetrically positioned 20 shops, the axial temple and a series of monumental structures on the central square can be well reconstructed, combining the survey data with punctual in situ information and examples from elsewhere.

Here an excavation campaign planned for the summer 2010 will perform the ground truthing tests and will supply more elements for the chronological definition of the different architectural phases.

The magnetometer survey produced a fine map of regular town structures, based on a regular grid of city streets, delimiting housing blocks, public spaces (such as the bath complex and a market), workshops and water infrastructures. The results obtained so far give reason to believe that the full intra mural town plan can be revealed, limiting the necessity for grand scale and costly excavation procedures, but at the same time allowing a 3D view of the townscape and opening perspectives on a sustainable touristic exploitation and cultural valorization of the site.

3.5. 3D Reconstructions

The visualization of the geophysical results are approached by referencing the existing data with better preserved sites of the region comparing similar structures and dimensions, aiming to preserve architectural local features and details of decoration.

Digital Elevation models, geophysical results, 3D Laser and Lidar -scans are taken into account to build the ancient terrain, where the results of the architectural 3D reconstruction will reside.
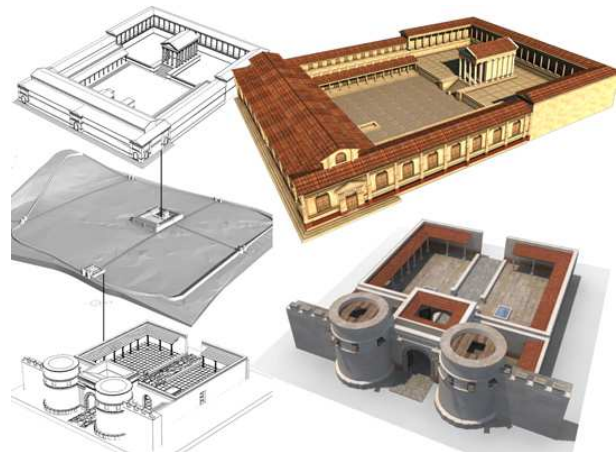

Figure 3.2. Visualisation of the Forum and the eastern Gate of Ammaia

Special programs are used to achieve realistic results and breathe life into the scenes. A motion-capture system is used to drive the animation of computer generated people to ensure correct movements while keeping the production costs feasible. Sophisticated render algorithms will enable the creation of thousands of terrain features, like plants, stones and boulders as well as populating the scenes with animated characters.

3.6. Resume

The output will result in a short movie clip (approx. 15Min) which can be also used for ongoing productions for television (documentaries) and print publications, with the option to re/use the produced data for other medias like installations for augmented reality, 3d real-time applications (educational games) and VR environments (Dome or Cave -Projections).

Figure 3.3 Reconstructed City of Ammaia

ACKNOWLEDGEMENTS

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