Interdisciplinary Workflow for Virtual Archaeology

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Abstract— **There is an increasing trend to present cultural heritage with the help of virtual visualisation. It offers a unique level of understanding of the heritage in question. Moreover, depending on the precision of the virtual model, it can be used for scientific research, and it can inspire new ideas and conclusions about the actual looks of the visualised objects. Over the years, companies and institutions have specialized in this field of work, creating new demands on the CG artists of the involved teams, as well as establishing a new kind of archaeological methodology that seeks to research and develop ways of using computer-based visualisation for the comprehensive management of archaeological heritage. However, the interpretation of archaeological datasets and their subsequent transformation into 3D representations of the interpretation usually requires a time-consuming process of re-evaluation and discussion. Very often, a discrepancy between scientific architectural interpretation that is normally presented in a 2D plane and its realisation in a 3D space occurs, because the 2D representation is not able to show the physical laws of the third dimension. To overcome these difficulties, we propose alternative solutions that lessen the disconnection between the parties. Our software solution enables the archaeologist to perform an interpretative work-flow that places ideas within a customizable 3D environment, therefore resulting in a more direct involvement throughout the reconstructive or representative process. On a broader scale, CGI artists would benefit greatly if they could follow the project evolving and gain a deeper understanding of the specific cultural heritage.**

Index Terms—**Virtual Archaeology, Interdisciplinarity, Communication Gap and Visualisation Workflow.**

I. Introduction

There is an increasing trend to present artefacts, monuments and whole sites, tangible and intangible heritage, with the help of virtual visualisation. Virtual visualisation offers a unique level of understanding of the heritage in

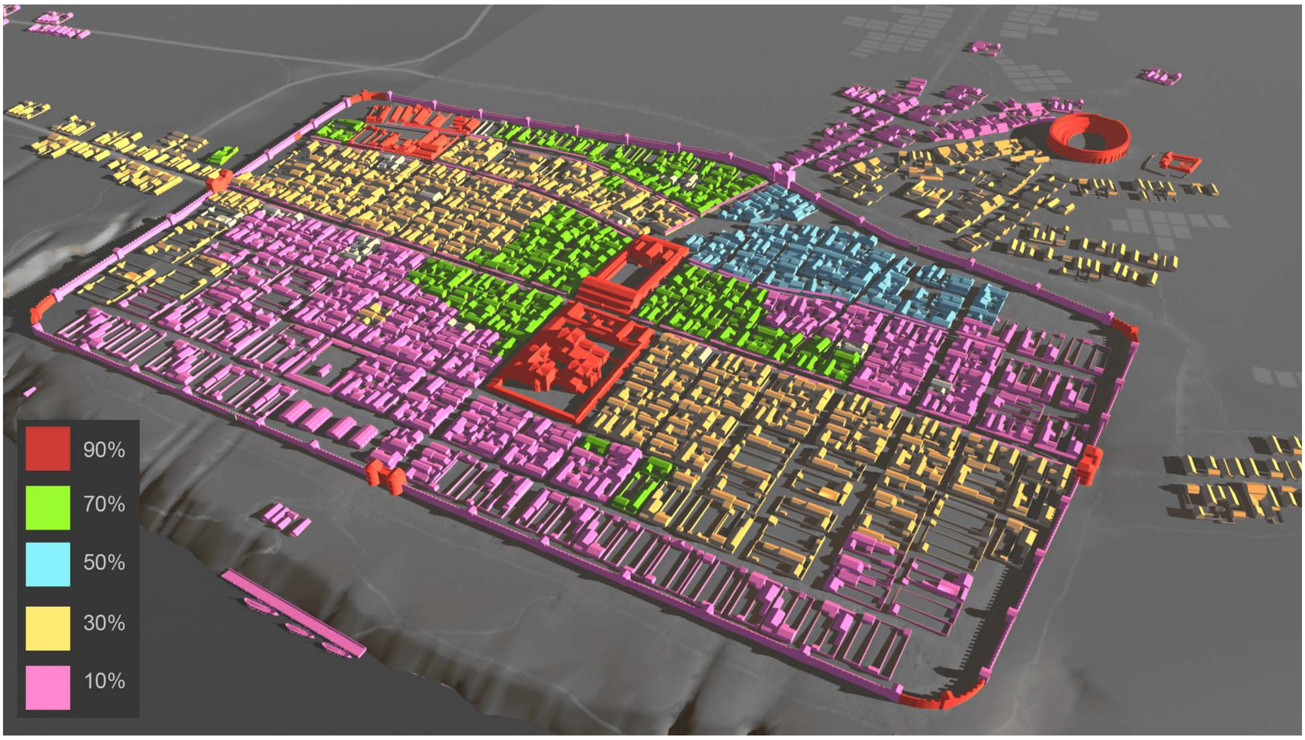

Fig. 1. Colour coded visualisation of the city of Carnuntum/Lower Austria showing the archaeological certainty of the reconstructions.

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question. It transcends place and time, offering a window into the past using either photorealistic techniques to mimic the past to the smallest detail, or non-photorealism to accentuate selected features of the model. What distinguishes virtual visualisation from other forms of presentation like drawings and maquettes is the fact that the made model can easily be adjusted to new interpretations, and that it provides interactivity. Depending on the precision of the virtual model, it can also be used for scientific research, and it can inspire new ideas and conclusions about the actual looks of the visualised objects.

Since the beginning of the nineties of the twentieth century, computer graphics have been used to visualise heritage presentations through still images and animations to support publications and exhibitions [1, 2, 3]. The on-going hardware and software development over the last three decades has resulted in a qualitative and quantitative increase of 3D computer-aided visualisation, which has become a standard form of presentation for cultural heritage service providers as well as research institutions. Over the years, companies and institutions have specialized in this field of work, creating new demands on the CG artists of the involved teams, as well as establishing a new kind of archaeological methodology that seeks to research and develop ways of using computer-based visualisation for the comprehensive management of archaeological heritage. It includes virtual reconstruction, recreation, anastylosis and restoration of archaeological finds, aiming to produce highly detailed images of the past – the so-called "Virtual Archaeology" [4, 5, 6].

Results of Virtual Archaeology can serve both as a scientific tool, as well as a communication tool. From the scientific point of view, computer-aided visualisations provide a new aspect of the objects' understanding, allowing different hypotheses to be tested out and reflecting various interpretations. The established model follows rules of scientific transparency and re-traceability (Fig. 1).

In a digital workflow, an interpretation of the features and the relationships between them must be undertaken after the actual data-collection process. This quite often takes the form of describing the spaces of the mapped survey data with two-dimensional lines, two-dimensional polygons and some guidelines as to a proposed elevation. The classified overlay derived from this process is then passed to a 3D graphic artist, who is given the task of visualizing and creating a 3D model and adding detail to the interpreted structures (Fig. 2).

However, the interpretation of archaeological datasets from complex urban environments and their subsequent transformation into 3D representations usually requires a time consuming process of re-evaluation and discussion.

Cultural landscapes, buildings and artefacts are either digitally recreated, or their scan is incorporated into virtual environments to present them in their presumed original context. Through constant consultation and discussion with scientists, authenticity and correctness of the models is ensured. With the help of excavation plans, building remains and unearthed artefacts, the development of comprehensive models of ancient life is sought. For the presentation of towns or smaller settlements and the use of surrounding environment by their inhabitants, the building typology is recreated for representative buildings as well as for vernacular architecture. To increase the detail of singular buildings and complexes, and to show functionality of interior space, finds of the site are displayed at their presumed position. Very often the finds of one particular archaeological site are not sufficient to allow for a comprehensive reconstruction. In this case, data has to be obtained by comparative research, by using information from sites of the same time, geographical region and importance. What kind of comparative data can be used is determined in

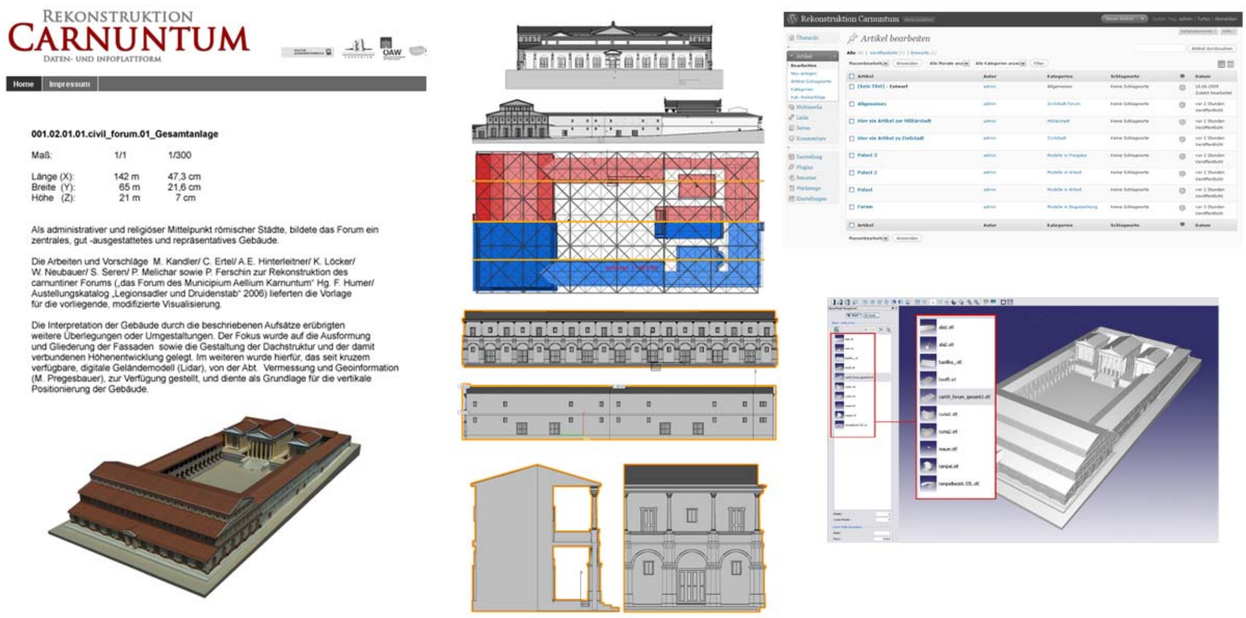

Fig. 2. Documentation of the visualisation process of the forum of Carnuntum.

discussions with the scientific consultants. To understand questions of operating cycles, effectiveness and ergology of ancient tools, as well as machinery and their use, functional presentations are devised and simulations are carried out. From ergological studies concerning Iron Age salt mining procedures and transportation (wagons and chariots), to Roman water supply systems, pumps, lifting devices and building machinery, different issues were examined. These functional studies are indispensable for correct interpretation and validation of archaeological documentation for visualisation.

II. BRIDGING THE GAP

Usually the team of CGI (Computer Aided Imagery) artists is included in the project as the final step in the pipeline of the heritage project execution, when the results are supposed to be presented to the scientific or general public. Very often, a discrepancy between scientific architectural interpretation that is normally presented in a 2D plane and its realisation in a 3D space occurs, because the 2D representation is not able to show the physical laws of the third dimension.

An attempt at bridging the gap was made during the long-term project *Radiography of the Past* (RadioPast), where a cityscape was reconstructed based on excavation and geophysical results [7]. During that time, an alternative solution was sought that lessens the disconnection between the producers of the archaeological interpretations of features. A tool was developed that enables the *archaeologist* to follow an interpretative work-flow that places ideas within a customizable 3D environment. This results in a more direct involvement throughout the reconstructive or representative process (Fig. 3).

The software platform chosen for this purpose is the freely available Unity 3D© game-engine, enhanced by a customized interface. This provides the archaeologist with a highly intuitive, specialized and easy-to-use 3D environment. Within this environment, a series of datasets can be incorporated, including a terrain model, generated maps from aerial photographs, geophysical survey plans and their digitized interpretations. These layers provide the basis for a simple geometric representation of the interpretation in three dimensions. Through a rapid process that permits collaborative discussion and iterative refinement of the interpretation, a 3D block-representation of the full extent of the studied area (in this case the town) is created. Input from a number of operators can be accounted for. The block-model can then easily be modified to provide the basis for a more fully detailed 3D model. Such a detailed model can incorporate various building elements that have been fully documented through excavation (where available), and can be used in other presentations like film, real time and augmented reality productions. The whole procedure, however, may encounter difficulties due to the large amount of single modules that have to be set in order to construct the individual houses. One option is therefore to produce larger units of these modules to speed up the process.

Fig. 3 Screenshot of the 3D Realtime Editor.

Nonetheless, this modular approach turned out to be very effective even for operators who are not trained in computer-aided 3D drawing.

From the other point of view, *CGI artists* need a deeper understanding of the site to produce better reconstructions. While presented finds and made interpretations are clearly prerequisites for CGI artists to create visualisations, recent closed-loop projects like the Çukuriçi Höyük excavation [8] demonstrate that even better results can be obtained if the CGI artists can follow the project evolving. In this way, they can observe the documentation process, assess already at an early stage to which extent the documentation is helpful for a later visualisation, and if needed, improvements can be suggested. Sometimes even only small adjustments, like taking care of more suitable light conditions for photos, can make a substantial difference in constructing, *e.g.*, a Structure From Motion (SFM) model.

In this sense, it is important not only to provide better software support to archaeologists (*e.g.*, in the form of the tool mentioned above), but concrete attempts must also be made to better embed CGI artists in research projects. This requires, to some extent, to rethink the way such projects are organized. Specifically, it is important for an intermediate person to be present in the team – a cultural heritage researcher with adequate skills in 3D graphics and an understanding of 3D reconstruction as well as its limitations and prerequisites. In this way, such a person can oversee the way the documentation is prepared and continuously convey relevant data and archaeological interpretations to the team of CGI artists.

III. CONCLUSION

This is an initiative to motivate researchers – both archaeologists and CGI artists – to think about the visualisation of a project right from the beginning. In this way, data can be collected accordingly, and information and interpretations can be provided to the CGI artists in a closed loop. Mid-project visualisations can then provoke new insights about the site and in this way enable different interpretations. Consequently, the visualisations can even affect the course of action on the field. For this reason, 3D presentations are becoming a crucial part of heritage projects, and more concise solutions are of considerable interest. It is hoped that the proposed initiative could be one among many steps leading to such a solution.

REFERENCES

[1] P. Reilly, “Towards a virtual archaeology,” Computer Applications and Quantitative Methods in Archaeology 1990 (BAR International Series 565), pp. 133-139, 1990.

[2] A.C. Addison, “Emerging Trends In Virtual Heritage,” IEEE Multimedia, 7/2, pp. 22-25, 2000.

[3] E. Berndt, and J. Carlos, “Cultural Heritage In The Mature Era Of Computer Graphic,” IEEE Computer Graphics And Applications, 20/1, pp. 36-37, 2000.

[4] The Principles of Seville - International Principle of Virtual Archaeology, International Forum of Virtual Archaeology, 2011. Web.
http://www.arqueologiavirtual.com/carta/wpcontent/uploads/2012/03/BORRADOR-FINAL-FINAL-DRAFT.pdf (2 Jul. 2015).

[5] The London Charter, 2009. Web. http://www.londoncharter.org/ (2 Jul. 2015).

[6] The ICOMOS Charter For The Interpretation And Presentation Of Cultural Heritage Sites, ICOMOS, 2008.Web.
http://icip.icomos.org/downloads/ICOMOS_Interpretation_Charter_ENG_04_10_08.pdf (2 Jul. 2015).

[7] M. Klein, F. Vermeulen, and C. Corsi, "Radiography of the Past-Three Dimensional, Virtual Reconstruction of a Roman Town in Lusitania." International Journal of Heritage in the Digital Era 1, Supplement 1, pp. 131-136, 2012.

[8] B. Horejs, "Çukuriçi Höyük. A New Excavation Project in the Eastern Aegean." in: Aegean and Balkan Prehistory. B. Horejs and P. Pavúk, Eds. 4 Feb. 2008.
http://www.aegeobalkanprehistory.net/article.php?id_art=9
(2 Jul. 2015).