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Virtual Roman Leicester (VRL): An interactive Computer Model of a Romano-British City

D. Cawthorne[1], G. Watson [2], A. Hugill[2]

[1] The Radford Group for Architectural Research, De Montfort University, UK
[2] The Institute of Creative Technologies (IOCT), De Montfort University, UK
{DCawthorne, gwatson, ahu}@dmu.ac.uk

1. Introduction

This paper describes the background, development and use of a new Virtual Reality (VR) model of the built fabric of Roman Leicester (Ratae Corieltauvorum) which has been based upon direct archaeological evidence, literary evidence and comparisons with the remains of similar Romano-British cities. It forms the conclusion of the first stage of a larger ongoing collaborative research project to create an inhabited virtual Romano-British world populated by interacting avatars programmed using a novel form of artificial intelligence (AI) to have a range of Romano-British morals and values for the purposes of examining resultant emergent behaviors and societal development. Virtual Roman Leicester (VRL) has been created in a popular games engine to allow real-time exploration by real world users and has a multiplatform capability to also examine issues surrounding the use of Virtual Reality for public outreach and the wider understanding of cultural heritage. Here we focus firstly upon issues surrounding the interpretation of the archaeological evidence and its extrapolation into full buildings (using a technique we call architectural forensics), secondly upon technical issues concerning importation of ancient land surface terrain and thirdly upon aspects of initial user experience following an extensive public exhibition of the model.

2. Interpreting the evidence

At the outset it should be stated that this is not a work of archaeology, it is an architectural interpretation of archaeological evidence. It attempts to synthesize particular archaeological observations into a broader architectural picture rather than describing a large number of archaeological finds in detail. Wilson-Jones has observed that: 'The study of ancient architecture has suffered from the tendency to view it as the domain of archaeology. However laudable they might otherwise be, archaeological publications often proffer an unexacting standard of architectural discussion, generally limiting themselves to issues of chronology, function and constructional technique' (WILSON-JONES 2000).

One of the aims of this project was to question these types of long standing archaeological assumptions about the built fabric of Roman Leicester and its forum in particular since they were without comparison to a specifically architectural interpretation of the evidence. It was recognized that such a comparison could bring to bear specific knowledge of planning, structure and the conventions of Roman architectural design and be applied to the development of the ground plans into a fully articulated schema. The value of doing so would be firstly to verify or refute these assumptions and secondly to offer putative but rationally derived architectural designs with auditable pedigrees which by critical examination may offer new insights within other disciplines.

Figure 1: ***Two columns on a 4.6m length their stylobate from the east wing of the forum, now in Jewry Wall Museum, Leicester***

Leicester has a rich Roman archaeological heritage which has been systematically recorded by archaeologists for some years with rather more material coming to light recently as a consequence of archaeological rescue operations ahead of major building works within the city. As with many Romano-British cities the overall proportion of extant building remains are very small, we estimate about 0.01% of the built fabric at best. While this is a commonplace in archaeology with consequent issues of uncertainty (SIFNIOTIS 2006, SIFNIOTIS 2007, VERHAGEN 2008) it is rarely encountered in architecture, and as such has required a significantly forensic approach to the selection and application of architectural methods of interpretation and authentication. This in itself is of interest in that it has opened up a range of questions of methodology for which at present there appear to be few exemplars for this kind of problem.

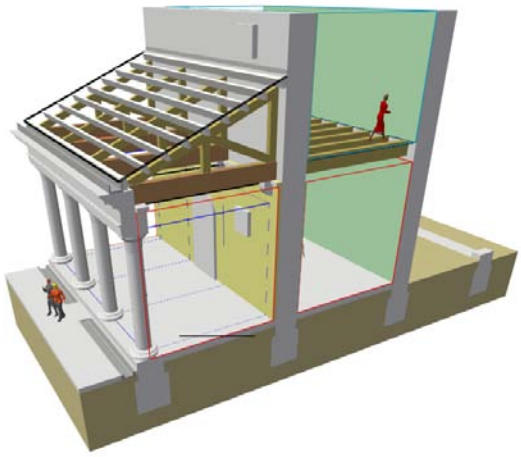

Figure 2: ***Typical constructional study, in this case of part of the forum examining the interrelationship between proportional norms of Roman design and architectural rationale in assembly .***

While this study does not attempt to provide a general method, it has employed three principles techniques; firstly the application of well known and understood methods of Roman geometrical and proportional design; secondly the use of a detailed architectural understanding of construction and assembly; thirdly the use of inductive logic to arrive at parsimonious architectural propositions in the spirit of *Entia non sunt multiplicanda praeter necessitatem*. The use of the first of these techniques (geometric and proportional system of design) was partially validated early on by clear evidence that major public buildings in Roman Leicester had been laid out using √2 (root 2) geometry. The second technique involved building detailed constructional models from the archeological foundation plan upwards to assess the constructional logical of previous interpretations. The third technique of parsimony combined with the second of constructional logic yielded some evidence from cross sectional studies and features in the plan form in the case of the forum that this building may possibly at one time been two storey's in height rather than one as had been previously thought. Further evidence is required to confirm this finding, as it would be an unusual feature within a Romano-British context.

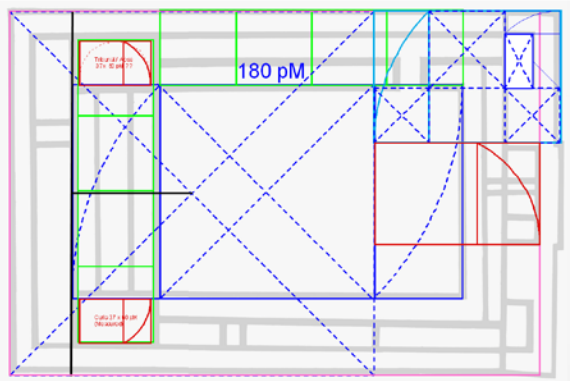

Figure 3: ***Typical geometric analysis of a foundation and ground floor wall plan, in this case of the forum, clearly showing its derivation from √2 geometry.***

Figure 4: ***Screen-shot of Virtual Roman Leicester***

2.1 The buildings

The archaeological evidence supplied by the University of Leicester Archaeological Services Unit (ULAS) included partial floor-plans of some of Leicester's major civic buildings including the Forum / basilica complex, Bath house, a Macellum or market hall, a potential Mithraeum and a large townhouse

complex known as the Vine Street Villa. In addition to this details of the town's road network and fortifications as well as a qualitative interpretation on the appearance of the town and its buildings were supplied. This information was instrumental as a starting point for the technique of architectural forensics that was used to deduce the form of the buildings.

3. Technical issues in developing the VRL model

The Virtual Romans project attempted to digitally model the whole of Roman Leicester – an extensive urban area of just under 1 square kilometer. The model also needed to be highly geometrically detailed so that it could be used for architectural and archaeological research. In addition to this, the ultimate aim of the project was to create an interactive and explorable environment and to this end the model needed to be importable into a commercially available games engine. Balancing these requirements was one of the most challenging aspects of this research.

3.1. Terrain modeling

Before the architecture could be modeled accurately, a terrain model of Roman Leicester was required. The topography of Leicester in the 3rd century was quite different from that of today. Years of human activity tend to obscure the land's natural topography, resulting in a general rise in the ground-level. To maintain the veracity of the model it was therefore necessary to investigate the ancient topography. Fortunately, the ULAS archaeologists had already gathered a great deal of information on Leicester's natural levels gleaned from surveys and digs, which they supplied as a GIS shapefile. Converting this spot height data into a format that was readily importable into a games engine was the first task undertaken.

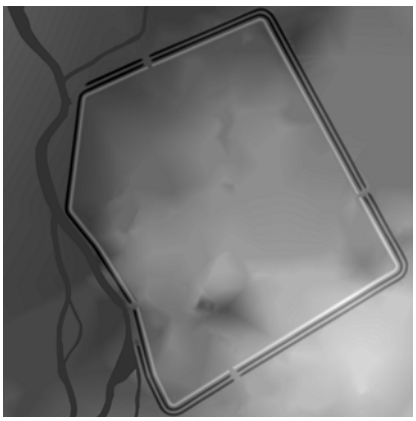

Figure 5: ***The terrain model as finally configured***

3.1. Natural landforms

The spot height data (elevations and grid references) was extracted from the shapefile and converted into a CSV file using MS Excel. This was imported into AutoDesk Revit, a Building Information Modeling (BIM) application which includes a terrain generator which can accommodate spot height data. The software uses various algorithms to interpolate between spot heights and produce a surface. This surface was then exported to 3DS Max for further refinement.

3.1. Artificial landforms

Having generated an accurate representation of the natural levels, the manmade topographical features could be added to the model. ULAS supplied a CAD town plan of Roman Leicester which was surrounded by fortifications, a double ditch system and banks. After superimposing and geo-referencing the town plan over the natural terrain model – a fairly complex task outside a true GIS - these features were added to the surface.

3.1. Games engine import

The Unity3D games engine we used generates terrain objects using a grey-scale height map so it was necessary to convert the topographic surface once again for this purpose. This was achieved using the Texporter 3ds Max plugin.

3.1. Architectural modeling

The architectural modeling process was an innovative three-fold procedure using high-end CAD, 3D Modeling and Games Engine software – namely AutoDesk AutoCAD, Revit, and 3DS Max and Unity3D. The buildings were primarily modeled using Revit, textured in 3DS Max and then imported, in the FBX format, into Unity.

4. Initial user experiences with the model

The Virtual Roman Leicester model was exhibited at the opening of the new Phoenix Square digital media centre in Leicester in November 2009. Approximately 2100 visitors viewed the model over the following 2 months. It was shown in three forms; firstly with as a real-time interactive tour within a cinema setting with a narrator to explain what was being seen; secondly as a continuous loop video with or without pre-recorded narration in a seated café area setting; and thirdly as a 'self-drive' installation where the user explores the model for themselves in a private computer suite but without narration.

4.1. User orientation and place recognition

The reaction of members of the public to the model and their interaction with it were extensively observed in all three settings. This revealed that the narration or other form of contextual guide was essential for the users to be able to understand what they were looking at and orientate themselves within the model in relation to the modern city of Leicester with which they are familiar. Without such contextual guides the initial interest in exploring the model quickly declines. The current absence of people within the model is an obvious omission which is currently being addressed and will potentially assist with user orientation and interest beyond the buildings.

4.1. Applications for public outreach

A further indication of potential from the exhibition of the model is its use for heritage interpretation as an informal learning tool that may beneficially influence people's social and cultural capital and behavior. In this regard one of the ancillary aims of creating the Virtual Roman Leicester model was to bring to a wider audience the city of Leicester's rich Roman heritage. Appreciation of the city's past may have a beneficial effect on the development of the city in the future and the VRL model is now being used as a vehicle for stimulating discussion at a civic level and also for discussing future developments in Museum interpretation and tourism within the city.

5. Conclusions

The development of the Virtual Roman Leicester (VRL) model over the past twelve months has indicated a potentially useful means of articulating archaeological and architectural information to lay audiences.

Figure 7: ***Interior of the entrance hall / palaestra of the larger of the two bath complexes within the city. Jewry wall is on the left.***

Further work is required in addressing issues of uncertainty in this kind of reconstruction and in providing navigational and information frameworks to enrich the user experience.

Figure 6: ***Overview of the VRL model looking down the Decamanus connecting the east and west gates.***

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