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# Across Space and Time

Papers from the 41st Conference  
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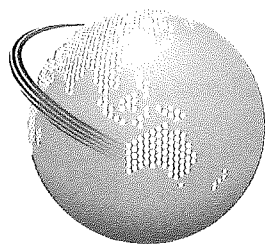
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**CAA**  
Computer Applications &  
Quantitative Methods in Archaeology

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# A Roman Street at the Time of Constantine: Interactive Visit with Access to Ancient Source Materials

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## Abstract:

*The virtual model of ancient Rome created in Caen (France) is a digital model built from the available textual, archaeological and iconographic sources. It is also as realistic a model as possible. Finally, it is a model that makes available the sources used in its creation. Whereas the specialists see an hypothesis of justified reconstruction, the non-specialists find simply the display of a reality which they would otherwise have difficulty imagining. The objective of the team is to contribute to the scholarly knowledge of a city that marked the Western world in an indelible way by its architecture and its technology. This paper will focus on a particular example: the condition of a Roman street in the 4th century CE.*

## Keywords:

*Virtual Reality, Ancient Rome, Streets*

## 1. Introduction

Ancient Rome has always especially fascinated people in the western world. Reconstructions have been increasing since the Renaissance: literary reconstructions, drawings and watercolours, physical models (e.g. P. Bigot's and I. Gismondi's 20th century monumental models: Liberati 2003; Royo 2006). Today digital techniques offer new possibilities for reconstructing the past (among recent writings, see Frischer and Dakouri-Hild 2008; Vergnieux 2006; see also the international colloquiums of the *Computer Applications and Quantitative Methods in Archaeology* (CAA) in CAA 2014, and, since 2003, the biennial colloquium "Virtual Retrospect" organised in Bordeaux by R. Vergnieux). Many scholars around the world are working on ancient Rome (e.g. the project "Virtual Rome" in Italy: Pescarin 2008), but only two teams are rebuilding the entire city in its condition as of the 4th century CE: the team "Rome Reborn" at Indiana University (USA) (Frischer and Dakouri-Hild 2008) and the team "Plan de Rome" at the University of Caen, France (Fleury and Madeleine 2008). The two teams signed a joint venture agreement in 2008. The objective of the "Plan de Rome" research team is to reconstruct ancient Rome in the 4th century CE, not only with its main monuments but also with its hills, streets (Gruet and Pitte 2006), and houses. This

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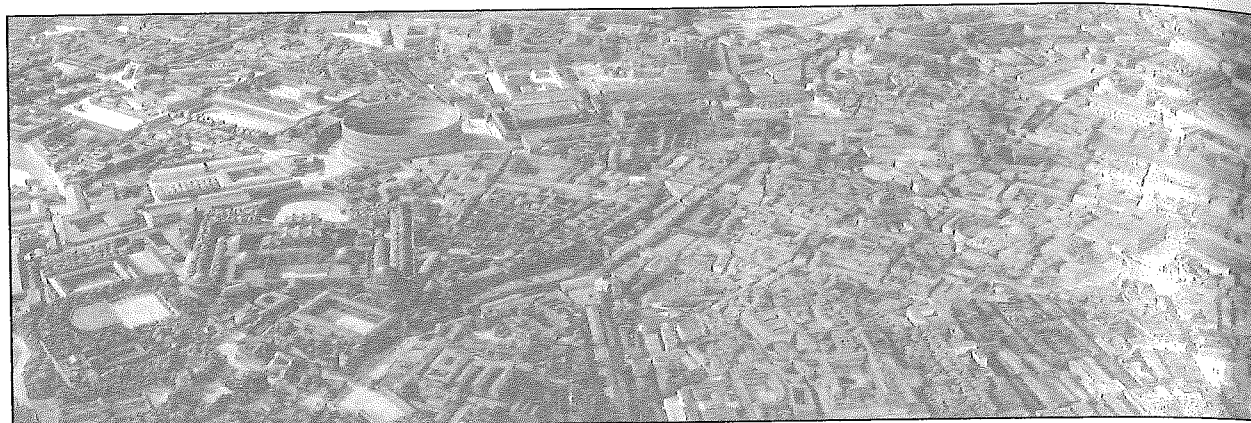
article will show two different aspects of the virtual model: the traditional reconstruction of public monuments and the reconstruction of the daily activities buildings, with the specific problematics of reconstructing streets with private dwellings and shops. The analysis of data is not the same in the two cases.

## 2. Reconstructing Virtual Ancient Rome in Caen (France)

### 2.1 Paul Bigot's model

The University of Caen owns the "Plan de Rome", an exceptional example of European cultural heritage (Fig. 1). It is a large plaster model of nearly 70 square metres which represents ancient Rome in the 4th century CE. It is the work of the architect P. Bigot (1870-1942), winner of the Grand Prix of Rome and professor at the Ecole des Beaux-Arts in Paris. Its only equivalents are its twin in Brussels (Belgium) and the model made by I. Gismondi in Rome (Pavia 2008).

Paul Bigot's model arrived in Caen by chance; Bigot had bequeathed his work to one of his pupils, Henry Bernard. Bernard was chosen as architect for the reconstruction of the University of Caen after the destruction of the Second World War and he gave the Bigot model to this institution.



*Figure 1. The physical model of Paul Bigot.*

This physical model is a scientific and pedagogic object. It is used for research and for teaching, but it has its limits. The first limit is the date of its creation. Bigot's model was completed in 1913, with some corrections made between the two world wars. Since the 1950s, there have been new discoveries while earlier data have been reinterpreted. Updating cannot be carried out on the physical model because it is classified as a historic monument. The second limit is the way it can be used. A physical model on a scale of 1:400 can only be visited from an external viewpoint, making indoor spaces inaccessible and details not visible.

The creation of a new model using 3D technologies has proven successful. Nevertheless this model cannot be a duplicate of the physical model (a scan, for example). It had to be a new creation. Three main reasons explain why we preferred modelling Rome by hand. Firstly, the physical model scale was 1/400 and if we had carried out a 3D scan, there would have been significant distortion of measurements. Second, as we have mentioned, Bigot's model cannot be updated. Third, we cannot use the terrain of the physical model, because it is a "Plan relief" where the elevations have been deliberately erased to make all buildings visible from the edge of the model.

We therefore sought to create the new model in a scientific environment to make it more suitable for research and educational purposes. The work we are presenting is being carried out by the research team "Littératures, Imaginaires et Sociétés" (ERLIS, groupe "Plan de Rome") (Université de Caen 2014a) with the support of the CIREVE at the University of

Caen Basse-Normandie. The aims of this technical platform is to promote the use of virtual reality in all the areas possible, in particular in the field of archaeological reconstitution.

#### *2.2 A new reconstruction of ancient Rome in Caen: for what and for whom?*

Our objective is to provide tools for a better understanding of ancient Rome. The work involves the development of a fully interactive model of ancient Rome that includes both its architecture and the machinery in use. The visitor of the virtual model is able to wander through a full-scale city and enter most of its large public monuments and a number of private residences. The expected project results are: firstly a digital 3D model of Rome as it was in the 4th century CE; secondly a digital 3D model of the principal machinery used in the Roman world; and thirdly links for each digital model to the body of sources (documentary, archaeological, and iconographic) used in their development. The body of source material is directly accessible via the interactive model (Fig. 5). The scientific objective is to provide a tool for researchers to test their architectural and topographical assumptions, to test the machines' functionalities, and to illustrate the assumptions developed regarding the reconstruction of the city. The virtual model is inseparable from research on the history of the real model, and furthermore, the updating of Bigot's work highlights the evolution of archaeological and historical knowledge of ancient Rome. The educational objective is to provide students and secondary school pupils, but also the public at large, with a vivid illustration of ancient Rome and an example of

the ancient urban reality that is easily visualised on screen. Each year, three thousand school children visit the model in Caen and each month a hundred and fifty people attend "The Nocturnes du Plan de Rome", an interactive visit of a part of virtual Rome (Université de Caen 2014b).

### *2.3 Selecting a time slice for the reconstruction*

The first step in our work was the choice of a particular date for the reconstruction because, in the realm of visual representation, only a synchronic approach has scientific value. The reconstruction of Rome is a snapshot of the city at a given point in time; in order to be scientifically credible, the reconstruction must not mix elements from different periods. The team chose the period of Constantine, more specifically the beginning of his reign, between 310 and 320 CE. Several factors account for this choice. Firstly, it seemed of interest for the visitor to be able to compare the virtual model with Bigot's physical model (he also chose this period) and the ruins that can still be seen in Rome (which are generally the most recent antique buildings, i.e. in their state as in the 4th or 5th century CE). Secondly, the reign of Constantine brought about an architectural climax when Rome seems to be at the height of its urban development. Thirdly, Late Antiquity is the best documented period from the archaeological point of view. Finally, since we plan to show different stages of urbanisation of ancient Rome, and, since in archaeology the last layer is the first layer excavated, it seemed normal to proceed in the same order.

## **3. Reconstructing a Street: Specific Problems**

### *3.1 Reconstructing the town: the traditional approach*

The work preliminary to the reconstruction itself involves the analysis of data sources, which is currently being performed by the members of the research team who have recourse to outside experts for help with specific issues (Fleury and Madeleine 2007). Before modelling a building, the team's researchers collect all the source materials (textual, iconographical, and archaeological data) which make it possible to understand its history and draw plans in 3D. They first attempt to collect

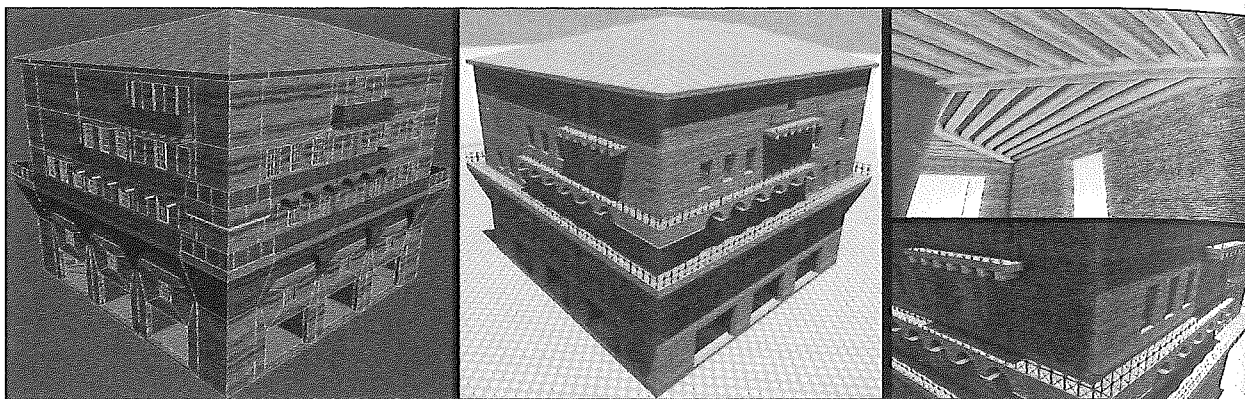


*Figure 2. Streets of ancient Rome.*

all the Latin and Greek texts on the subject. They are responsible for finding texts, translating them if needed, and extracting the data necessary for the virtual reconstruction. The analysis of the iconographic and archaeological sources comes next. The study of the archaeological reports must be conducted using a rigorous historical method; it is the conditions of the 4th century that are being reconstructed and these conditions must be isolated from all the available information. When all the data concerning a 4th century building have been collected and relevant information is still missing, we use what can be extracted from previous and subsequent periods or we work by analogy by further studying still standing buildings that have the same function as the one which is to be reconstructed. The virtual reconstruction is made only when all the data have been studied and synthesised by the team of researchers, but their work does not stop here. Daily collaboration with the modellers is necessary not only to answer questions concerning the creation of the model (measurements, materials used) but also to help them to understand the historical, functional and social context of the monument which is modelled.

### *3.2 Reconstructing streets: particularities and difficulties*

Reconstructing a specific building is easier than reconstructing a street network with dwellings and shops that have not been so well documented. However, a digital reconstruction of Rome in the 4th century CE is not only a reconstruction of monumental Rome. It is also a reconstruction of



**Figure 3.** *An insula created with the automatic process.*

Rome in its daily life. The street network is necessary to give meaning to the public buildings (Fig. 2).

The first difficulty is the lack of the sources in a city which has been continuously inhabited and constantly rebuilt and reshaped, as Rome is. Therefore, in order to reconstruct houses and shops we had to work by analogy and used examples from Ostia, the port city of ancient Rome (Stöger 2011). This archaeological site is about 30 km west of Rome, and boasts well-preserved Roman urban architecture, in particular apartment buildings – *insulae* – which were typical of Rome, but were not present, for example, in the two well-preserved archaeological sites of Pompeii and Herculaneum (Monteix 2010). Apartment buildings housed most of the urban citizen population of ancient Rome, which could have numbered about one million people. The solution was thus to construct multi-storey blocks of flats which were sometimes as high as seven storeys.

The second difficulty concerns the relief. A modern digital elevation model is used as a first step. But as the current terrain of Rome has changed drastically in places over the past 2000 years, the digital elevation model is manually corrected in a second step so as to create a model that approximates the historical terrain.

#### **4. Methodological Choices at the University of Caen**

##### *4.1 Interdisciplinary co-operation*

The virtual reconstruction of Rome in Caen involves interdisciplinary efforts across several

fields of study. First there is philology. Ancient texts are the primary source for studying the topography of ancient Rome. How does one interpret the distinction between *domus* and *insula*? Texts have to be set against archaeological remains and iconographical data. The ruins of Ostia are essential for authentic representation of the form of the Roman streets. A precise study of some signs on the *Forma Urbis Romae* has been necessary for estimating the height of the buildings in Rome. Historians must locate the elements in a chronology and in a social and economic context. We also call upon urban geography and physical geography (the natural terrain of Rome). Of course, computer graphics (for representation) and computer science (for programming interactivity) are essential.

##### *4.2 Software*

The software used included: 3DS Max for modelling, texturing, rendering and motion; Daz Studio and MudBox for modelling sculptures; Photoshop for creating textures files; and CryEngine for real time navigation. We also used Flash for the graphical user interface and XML to store metadata.

The construction of street requires a particular workflow. We developed a shape-based modelling process to help us in the modelling, texturing, and exporting of data into CryEngine. Roman streets cannot be mapped quickly without an automatic process. Our process keeps each apartment building creation to under 1 minute if done with the automatic method, adopting optimum game development methods to keep real time cycles as fast as possible, and under 5 minutes with hand tweaking if needed (Fig. 3).



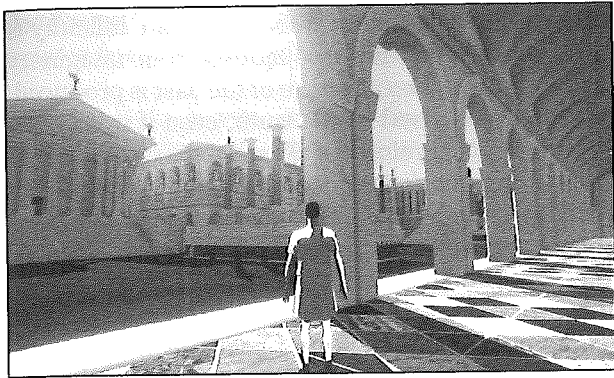


Figure 4. The interactive model of the Forum Romanum.

#### 4.3 Interactivity

The “Plan de Rome” team is reconstructing ancient Rome in order to access the model in real time (Fig. 4). There are many advantages in undertaking an interactive tour. Foremost, people using the virtual model are no longer spectators, but actors. Whereas with a pre-calculated video, the visitor follows a precise script, the interactive world gives them the freedom to move where they want, when they want. The researcher can thus go precisely to the details which they want to verify and they can make a personal critique of the model. Since motion is calculated in real time, the exploration of the model can be an experiment on movement time in ancient Rome, which is an important issue for the understanding of daily life in Antiquity. How much time did it take to go from the Campus Martius to the Coliseum? How much time was necessary to reach the highest seat in the Theatre of Pompey? Understanding movement time is important for the understanding of events and ways of thinking. Visualisation in real time allows for a better appreciation of the effects of shadow



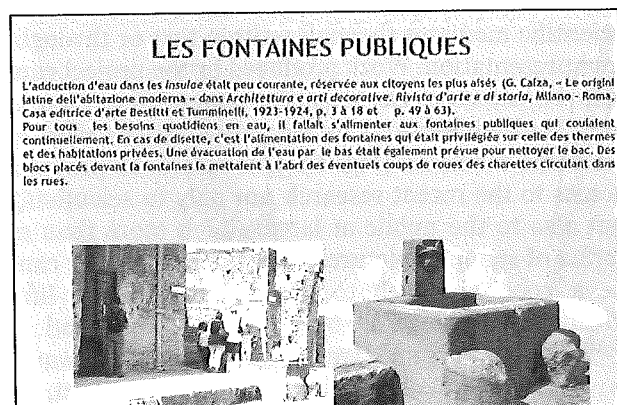
Figure 5. A relevant picture.

and light, with respect to the period of the year or the time of the day, the height of the buildings, the distribution between dwellings and shops, traffic problems, and the necessary network for water supply and evacuation.

#### 4.4 A relevant picture and a scientific model

The methodology developed by the “Plan de Rome” team is inspired by the principles defined by J.-C. Golvin (Golvin 2003) with whom we have worked for a long time. Golvin is well known for his reconstructions of classical antiquity in watercolours (all these drawings are now exhibited in the Museum of Arles Antique, France), but many principles are common to reconstructions in watercolours and reconstructions in virtual reality, in particular the fundamental principle of pertinence. A relevant virtual picture is the most likely picture given the data we have. It means that the pictures must be complete. It is our belief that reconstructing only what is certain is a limited approach. We have found that pictures adopting different expedients to differentiate what is verified from what is not (transparency effects, different colours, models without texturing or with modern textures) are unsatisfactory. Nevertheless, the models must be based on valid data sources and it is important that the visitors of the interactive model know what is proven and what is not, with all the nuances between these two possibilities.

To solve this problem we worked with an interactive model in five dimensions (Golvin 2012). We have the three dimensions of all models: height, width, and depth. However a virtual model is more thorough than a physical model since we can walk inside it. Time is our fourth dimension. The fifth



#### LES FONTAINES PUBLIQUES

L'adduction d'eau dans les *insulae* était peu courante, réservée aux citoyens les plus aisés (G. Calza, - Le origini latine dell'abitazione moderna - dans *Architettura e arti decorative. Rivista d'arte e di storia*, Milano - Roma, Casa editrice d'arte Bestetti et Tumminelli, 1923-1924, p. 3 à 18 et p. 49 à 63). Pour tous les besoins quotidiens en eau, il fallait s'alimenter aux fontaines publiques qui coulaient continuellement. En cas de disette, c'est l'alimentation des fontaines qui était privilégiée sur celle des thermes et des habitations privées. Une évacuation de l'eau par le bas était également prévue pour nettoyer le soc. Des blocs placés devant la fontaines fa mettaient à l'abri des éventuels coups de roues des charrettes circulant dans les rues.





**Figure 6.** The stereoscopic display used for the interactive visits.

dimension is the interactive access to sources of data. Linked to the virtual model, there is a database with ancient texts, didactic, 2D pictures and a bibliography. With this documentation, we provide the visitor the possibility of consulting the research data. In reading the interactive documentation, visitors are able to obtain a good idea of the degree of reliability of the model (Fig. 5). When the visitor approaches a sign ("I" for Information), they can read the relevant documentation. They can see the amount of data we have, its nature and how the data have been used. Such thoroughness is an enormous undertaking, but it is the best means for demonstrating the degree of reliability of the reconstructions. Interactivity makes it possible, at the same time, to provide a complete picture and to educate the visitor about questions of authenticity.

## 5. Conclusions

The virtual model is a tool among others. It cannot exclude scientific commentary. The researcher must participate in the input stage and in the output stage of the model. The model needs a scientific mediator through written text or through oral presentation. Work produced by the project can also be accessed via scientific papers (e.g. Fleury and Madeleine 2007) or via presentations with a scientific mediator (Fig. 6). Our aim is to provide access to the recent research not only to scientists, but also to the public at large. Much more than a series of synoptic pictures, the interactive tour can be a good approach to understanding daily life in ancient Rome. The best way to understand a civilisation is through travel, but this is not always possible. The possibility of consulting an interactive

visit can provide another way. The main difficulty is to separate scientific productions from imaginary ones because, when a picture of the past is produced, it is often perceived as the truth, even if it is only a hypothesis. Therefore B. Frischer has established *Digital Applications in Archaeology and Cultural Heritage*, the world's first on-line, peer-reviewed journal specifically dedicated to publication of 3D digital models of the world's cultural heritage sites, accompanied by related academic articles. As members of the editorial board of this journal, it is important to us to discuss our methods, our objectives, and our principles of research using all that is available to us in today's world of technology and science.

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