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Philippe Fleury, Sophie Madeleine

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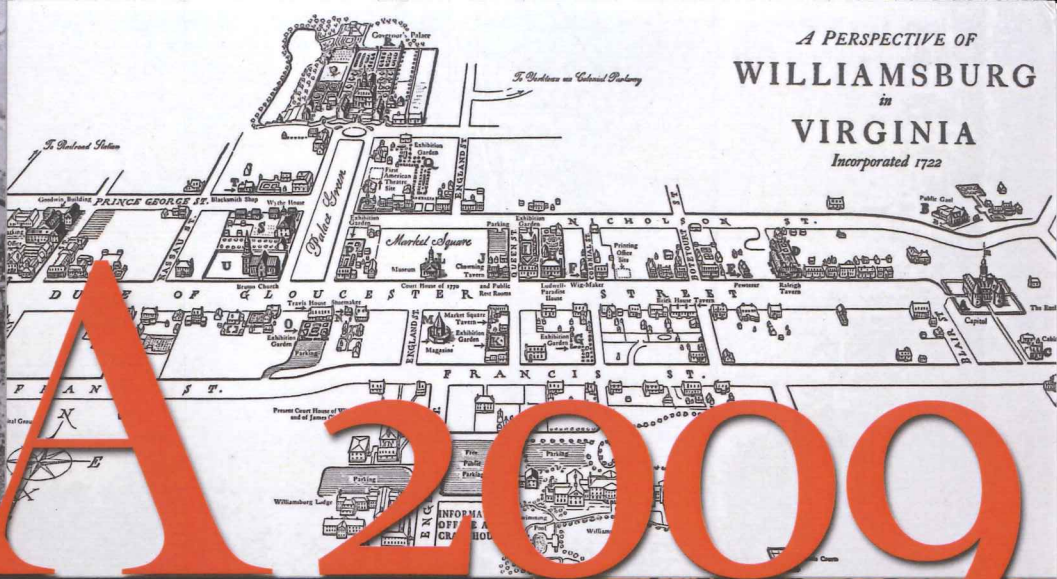
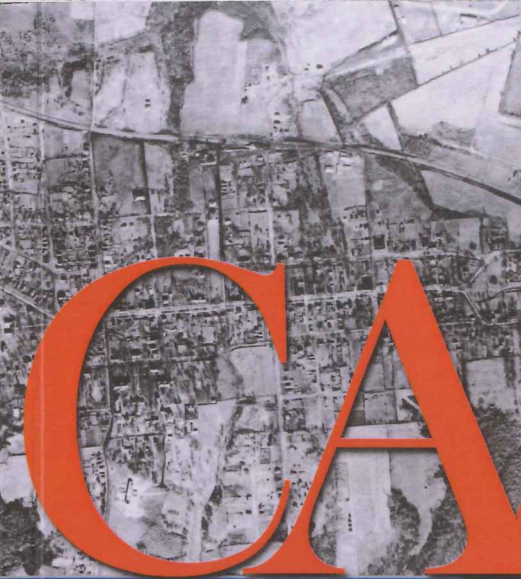
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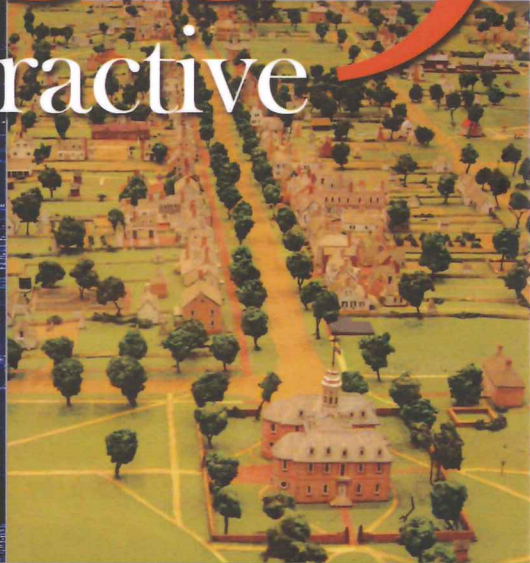
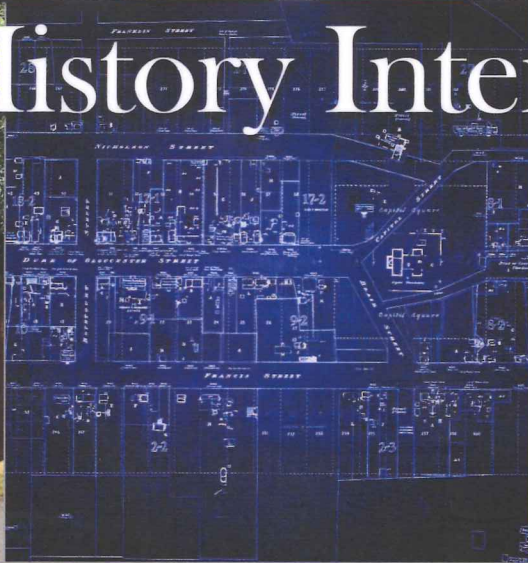
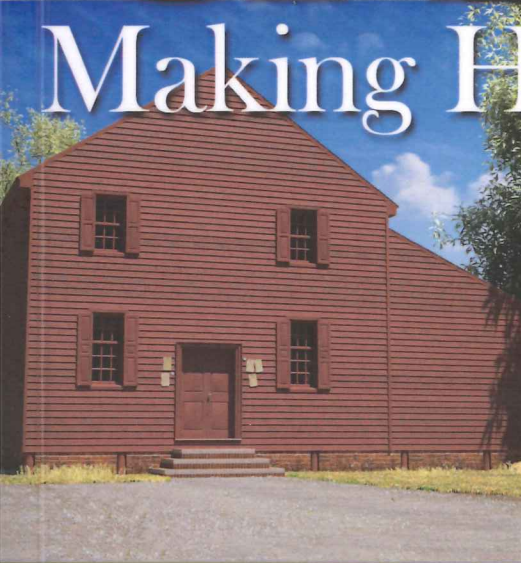
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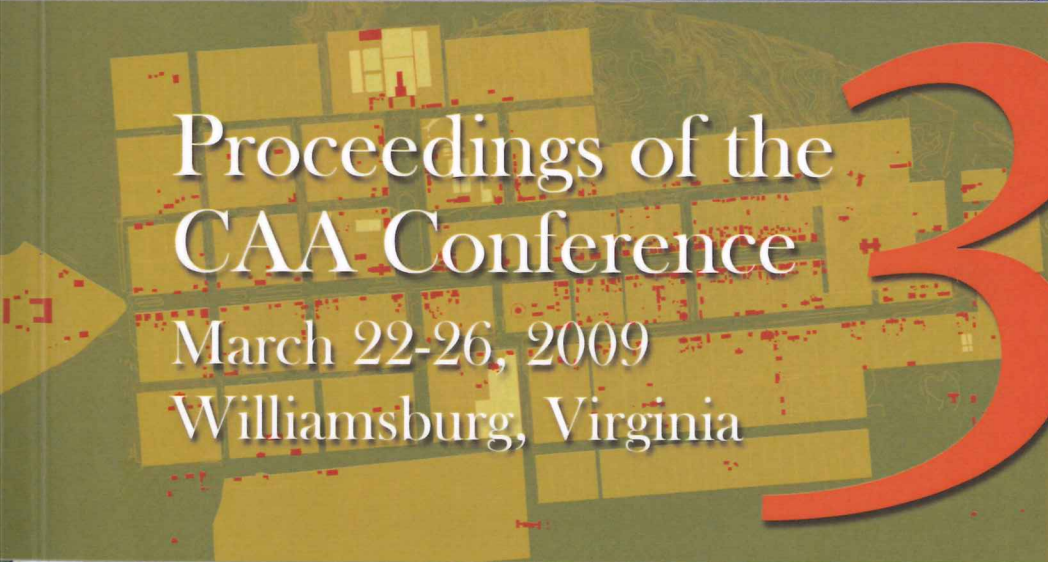
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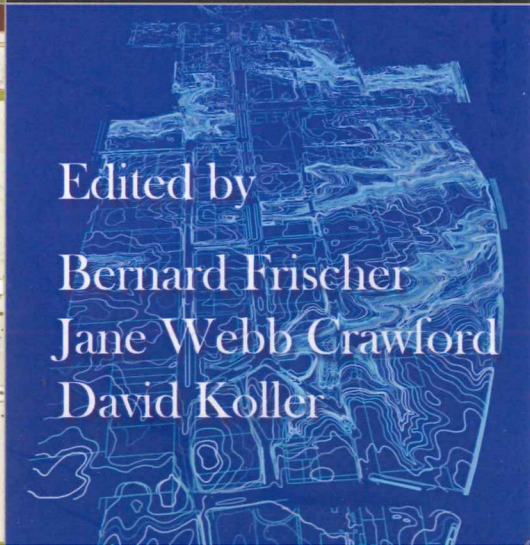
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Making History Interactive



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March 22-26, 2009
Williamsburg, Virginia



Edited by
Bernard Frischer
Jane Webb Crawford
David Koller

Digital History Center, The Colonial Williamsburg Foundation
The Virtual World Heritage Laboratory, University of Virginia

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Computer Applications and Quantitative Methods in Archaeology (CAA)
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Bernard Frischer, Jane Webb Crawford, and David Koller

An Interactive Visit to the City of Rome in the Fourth Century A.D.

Philippe Fleury¹ and Sophie Madeleine¹

¹ Equipe de Recherche Technologique éducation "Sources Anciennes, Multimédias et publics pluriels" (ERSAM), University of Caen. France.

Abstract

A project to develop a virtual model of the city of Rome in the fourth century A.D. was initiated in Caen in 1994. The project is based on a 70-square meter physical model of ancient Rome created by the architect P. Bigot at the beginning of the twentieth century, known in French as the "Plan de Rome." The Plan de Rome is an exceptional example of our cultural heritage whose only equivalents are its twin, which is in Brussels, and the model made by I. Gismondi, which is in the Museum of Roman Civilization in Rome. A new research structure—the Interdisciplinary Virtual Reality Center (Centre Interdisciplinaire de Réalité Virtuelle or CIREVE)—has since been added to support the work of building the virtual model of the ancient city of Rome. The CIREVE is a University of Caen shared resource that makes it possible to pool the staff and equipment for the application of virtual reality techniques for research purposes.

The project involves the development of a fully interactive digital model of ancient Rome that includes both its architecture and mechanical technologies. In reconstituting the past, the digital model makes it possible for scholars to test their hypotheses regarding the city's architecture and topography and to study the functionality of Roman technologies. The visitor to the virtual site will be able to wander through a full-scale city and enter most of its large public monuments and a few residences. The work preliminary to the reconstruction itself involves the analysis of ancient source materials, which is currently being performed by the project team's members who have recourse to outside experts for help with specific points. The body of source material is directly accessible via the interactive model.

The aim of this paper is to provide an overview of the methodology in the introduction and to present two kinds of virtual reconstruction: reconstructions of ancient architecture (imperial fora of Vespasian, Nerva and Augustus) and reconstructions of ancient machinery (the force pump).

Keywords: *Ancient Rome, virtual reality, interactivity, archaeology, ancient technology*

INTRODUCTION

Since 1994, the team "Plan de Rome" of the University of Caen has been developing a virtual model of the city of Rome in the fourth century A.D.

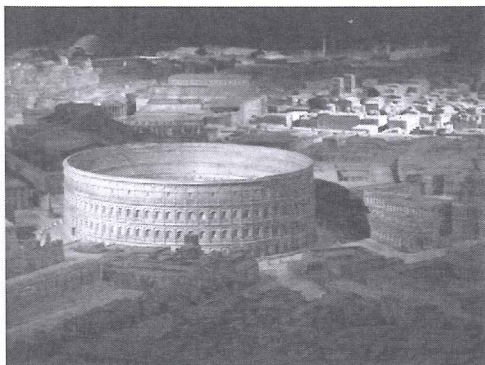


Figure 1. Detail of the Plan de Rome (www.unicaen.fr/rome).

The point of departure of the work is a 70-square-meter model of ancient Rome made by the architect P. Bigot at the beginning of the twentieth century, and known in

French as the "Plan de Rome" (fig. 1).¹ The Plan de Rome is an exceptional part of our cultural heritage whose only equivalents are its twin, which is on exhibit in Brussels, and the model made by I. Gismondi in Rome.² Each year three thousand students visit the model in Caen, and the website developed by the project team receives frequent visits, testimony to the interest it inspires throughout the world.

The final objective is creation of a virtual model of the entire site, embedding metadata and including not only the presentation of buildings and town planning, but also the reconstruction of the main mechanical systems used in Roman antiquity. A joint venture agreement signed in 2008 links both teams: "Plan de Rome" and

¹Manuel Royo, *Rome et l'architecte: conception et esthétique du plan-relief de Paul Bigot* (Caen: PUC, 2006).

²Anna-Maria Liberati, "La rappresentazione di Roma antica nel plastico di Gismondi del Museo della civiltà romana a Roma," *Les Cahiers de la M.R.S.H.* 33 (2003): 243–252; Carlo Pavia, "La ricostruzione dell'antica Roma. Breve storia del platicismo romano," *Forma Urbis* 13 (5) (2008): 30–39.

Rome Reborn.¹ The objective of the joint venture is to enhance the content of both reconstructions by the mutual agreement to exchange relevant data, viz: that “Plan de Rome” is granted permission to use the Rome Reborn model of the city of Rome as a medium for its reproduction of individual sites in Rome and that Rome Reborn is granted permission to incorporate the “Plan de Rome” reconstructions of individual sites in Rome into their model of the city of Rome.

Why create a virtual model near the real model? There are two main reasons: scientific and educational. The scientific objectives are:

- to update Paul Bigot’s model by taking into account the evolution of archaeological and historical knowledge about ancient Rome since his death in 1943;
- to provide a tool for researchers to test the architectural and topographical assumptions and to test the functionality of Roman machinery (fig. 2).²

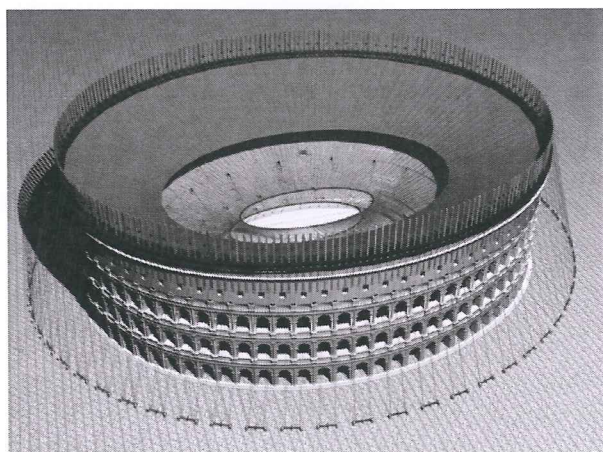


Figure 2. Model showing velum of the Colosseum.

The educational objective is to provide university and secondary school students, and also the public at large, with a vivid illustration of ancient Rome and an example of the ancient urban reality that is not available through traditional archaeological publications.

The work produced by the project can be accessed via scientific papers (see Bibliography), via the website,³ and through a stereoscopic display at the University of Caen (fig. 3). We cannot go into the full details of the methodology here, but the diagram in figure 4 gives a general view.⁴ There is continuous collaboration

between specialists of the science of antiquity and computer scientists. The main software used is 3D Studio Max for modeling, rendering, and passive animation, Poser for modeling the sculptures, Photoshop for creating some textures, and Virtools for the interactive visit.

We now describe some examples of reconstructions: the imperial fora and a machine in the theater of Pompey.

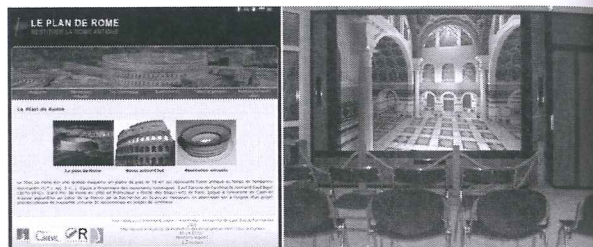


Figure 3. Access to the work produced.

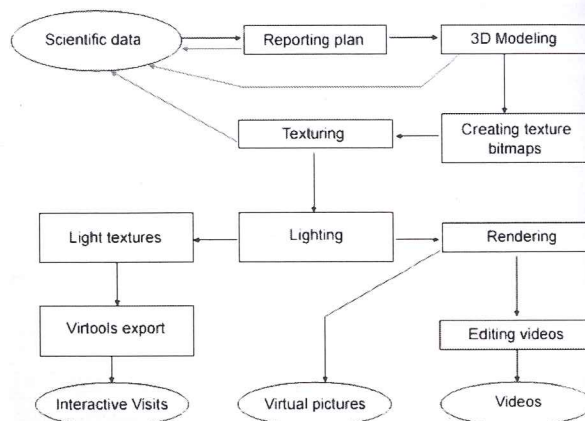


Figure 4. Methodology.

1 FORUM OF VESPASIAN

As 2009 is the “Year of Vespasian” (Vespasian was born in 9 A.D.), we will start with Vespasian’s forum, which was also called “the Forum of Peace” and that was inaugurated in 75 A.D. It is an innovative space,⁵ with ponds surrounded by rose bushes (fig. 5). It is also an open air museum with sculptures and paintings

¹ www.romereborn.virginia.edu/rome_2.0.php.

² www.unicaen.fr/ersam.

³ www.unicaen.fr/rome.

⁴ For a more developed description of the methodology, see Philippe Fleury and Sophie Madeleine, “Réalité virtuelle et

restitution de la Rome antique au IV^e siècle p.C.,” *Histoire urbaine* 18 (2007): 161–169.

⁵ There may be a Jewish influence on the architecture of this forum; see Marcello Gaggiotti, “Templum Pacis: una nuova lettura,” in *Divus Vespasianus, il bimillenario dei Flavi*, ed. Filippo Coarelli (Rome: Electa, 2009) 168–175.

under the porticoes,¹ and a place for the administration of the city. In the middle of the south-east portico there is the temple of Peace (fig. 5). Indoors were probably the spoils of the temple of Jerusalem (the golden candlestick with seven branches, Moses' tables of the law and the trumpets of silver which are depicted on the arch of Titus).²

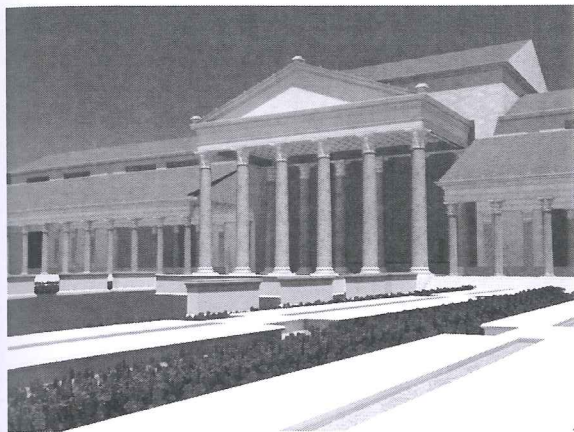


Figure 5. Forum of Vespasian. General view of model.

During an interactive visit, we can use "Marcus" who provides a scale (he is 1.70 meters tall; see fig. 6). Marcus walks and runs like a real human. He is subject to the law of gravity. He cannot walk across an obstacle. We can also see the virtual environment with Marcus's eyes (fig. 7).

The model is progressive. We constantly try to integrate the latest archaeological publications. For example, the low wall of *cipollino* marble in the middle of the porticoes (fig. 6) was based on archaeological research published in 2007.³ This low wall may protect ancient Greek statues located in the porticoes (see the archaeological remains and their reconstruction in fig. A; *N.B.*: figures A and B are at the end of this paper).⁴ The metadata are always accessible by a mouse click. Figure A shows an example of metadata available by clicking on the bases of statues in the portico. The bases of the statues are a recent discovery, too; they were found in 1999.

¹About the museum context see Alessandra Bravi, "Immagini adeguate: opere d'arte greche nel *templum Pacis*" in *Divus Vespasianus, il bimillenario dei Flavi*, ed. Filippo Coarelli (Rome: Electa, 2009) 176–183.

²Flavius Josephus, *War of the Jews* 7, 5, 7.

³Roberto Meneghini and Riccardo Santangeli Valenzani. *I fori imperiali. Gli scavi del Comune di Roma (1991–2007)* (Rome: Viviani Editore, 2007) 64.

⁴Roberto Meneghini, Antonella Corsaron, and Beatrice Pinna Caboni, "Il *templum Pacis* alla luce dei recenti scavi," in *Divus Vespasianus, il bimillenario dei Flavi*, ed. Filippo Coarelli (Rome: Electa, 2009) 193.

The water basins (fig. 7) are an innovation of the Forum of Peace. The rose bushes have been depicted from remains found in the floor along the basins, and we know that they were red rose bushes from Gaul. With the presence of water, this forum is not only a civic or a cult center, but it is also a public park where Romans could find a little greenery in the center of their city.

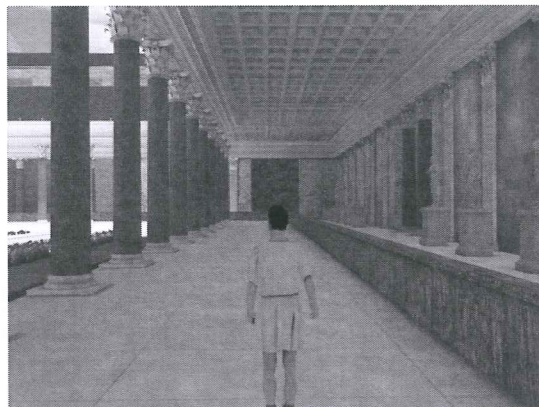


Figure 6. "Marcus" in the portico of the model of the Forum of Vespasian. Note low wall of *cipollino* marble on the right.



Figure 7. View of the plaza of the model of the Forum of Vespasian. Note the rose beds, between which are the shallow ponds.

The Temple of Peace is incorporated into the colonnade of the forum: it was not otherwise separated from the portico like the temple of Mars Ultor in the forum of Augustus (fig. 12) or like the temple of Minerva in the forum of Nerva (fig. 10). Nevertheless, it is easy to spot it because the six columns screening the cella were taller than those of the portico. The colors of the temple floor come from recent excavations (fig. B).⁵

⁵Stefania Fogagnolo and Claudio Mocchegiani Carpano, "Nuove acquisizioni et ritrovamenti nell'aula di culto del *Templum Pacis*," in *Divus Vespasianus, il bimillenario dei Flavi*, ed. Filippo Coarelli (Rome: Electa, 2009) 184–189.

The room in the southwest of the temple contained the *Forma Urbis Romae*, a great marble map of the city of Rome executed at a scale of 1:240 in the time of Emperor Septimius Severus (fig. 8). Although only a very small part of it has been preserved, it constitutes a very important document for the knowledge of the topography of the city.¹ In order to reconstruct the total marble plan, we have used an overlaid 2D plan derived from Bigot's model. The plan was oriented in its original mounting to the southeast, and we have colored red the engraved lines because red pigment has been found in some ancient fragments.

A visit to this room gives rise to the problem of lighting. All models are lit by a virtual sun. The sun's position is calculated as if we were in Rome on the 21st of June at 3 pm. As a rule, we do not use artificial light projections, so some spaces can be dark, but this corresponds to the ancient reality. However, when a room has no windows, we have to use artificial light, but this light always corresponds to an ancient system, as we will see in the Forum of Nerva (fig. 10).

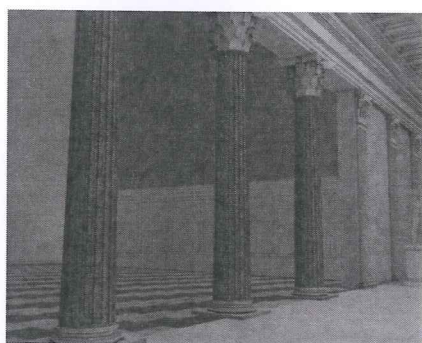


Figure 8. Detail of model showing the *Forma Urbis Romae* ("Severan Marble Plan") incised on the right wall of a room in the Forum of Vespasian.

2 FORUM OF NERVA

Work on the Forum of Nerva was initiated by the Emperor Domitian. It occupies the space left vacant between the previous fora, and for this reason it was sometimes called the Forum Transitorium. It formed the physical link between the Forum of Vespasian and the Forum of Augustus. This civic space did not bear the name of its founder, Domitian, whose memory had been condemned by the senate, but that of Nerva, who was made responsible for finishing its construction and for inaugurating it in 97 A.D. The Forum of Nerva is

narrow and rectangular in plan. In the center was a plaza. At the eastern end was the Temple of Minerva, a goddess dear to Domitian.² It was of the Corinthian order, hexastyle prostyle in architectural design. As there is not a lot of space (its length was about 120 meters with a width of 40 meters), the plaza is surrounded by a false portico (fig. 9). However, through the virtual reconstruction, we have a good perception of its architectural monumentality, which on 2D plans seems "crushed" by the fora of Vespasian and of Augustus. Even though a part of the wall at the north-east end of the portico is still standing (with the beautiful relief of Minerva on the attic, the famous "colonnacce"), the scanty remains do not help to give a good idea of this forum.



Figure 9. Forum of Nerva. General view of model.

In the cella of the temple, we have had to use artificial light (fig. 10). The virtual light of the sun is insufficient to see details, just as the real light of the sun was not sufficient to see details in the fourth century A.D. We also added reconstructions of ancient candelabras. For the moment, the intensity of light given by the candelabras is calculated approximately, but we are working in order to have the exact quantity of lumens provided by the ancient systems of lighting.



Figure 10. The cella of the temple of Minerva in the Forum of Nerva.

¹Rodolfo Lanciani, *Forma Urbis Romae* (Rome: Quasar, 1988 (1893–1901)); Emilio Rodriguez-Almeida, *Forma Urbis marmorea: aggiornamento generale* (Rome: Quasar, 1981); Gianfilippo Carettoni et al., *La pianta marmorea di Roma antica* (Roma: 1960); Emilio Rodriguez-Almeida, *Forma Urbis antiquae. Le mappe marmoree di Roma tra la repubblica e Settimio Severo* (Rome: De Boccard, 2002); Stanford Digital Forma Urbis Romae Project, <http://formaurbis.stanford.edu/> (accessed September 7, 2009).

²Sextus Aurelius Victor, *De Caesaribus* 12.2: "...dedicato prius foro...quo aedes Mineruae eminentior consurgit et magnificentior," P. Dufraigne, ed. Paris: Les Belles Lettres, 1975.

3 FORUM OF AUGUSTUS

The Forum of Augustus was dedicated in 2 B.C. The temple of Mars Ultor takes up a large portion of the space (fig. 11). Mars Ultor alludes to Augustus' revenge for the murder of Caesar. Behind the temple, there is a high wall to protect this civic area from fire, which might spread from the populous neighborhood of Subura.¹ In figure 12, we can see the pediment of the temple with its decoration. It has been reconstructed on the basis of the bas relief known as the Ara Pietatis which is now in the Villa Medici (Rome) and that is thought to have illustrated the façade of the temple. In the center of the pediment, Mars Ultor is depicted.



Figure 11. Forum of Augustus. General view of the model.

One other thing that may be noted in this forum is the bronze equestrian statue of Augustus in the middle of the plaza (cf. figs. 11, 12). The phrase *Pater Patriae* is inscribed on the base of the statue. After Augustus, most emperors will have this title, which he was the first to receive. From the center of the forum, there is a good view of the Temple of Mars Ultor, one of the biggest temples of Rome. The avatar, which is placed between the second and third columns on the left in fig. 12, gives a sense of its scale. Its columns are 17 meters high; the capitals measure 2 meters in height (fig. 12). In figure 13, we look out at the forum from the top of the stairs of the temple podium where we have a good perspective on the decoration of marble colonnades flanking both sides of the central area. Decorating the attic level are Caryatids and shields with Jupiter Ammon. The porticoes included columns, pavements of colored marble, statues, and two exedras. The colonnades were used for educational purposes by teachers who met with students here. With the pavement now preserved, we have enough information to reconstruct the marble of the portico and of the exedra. At the northwest end of the portico is the hall of the Colossus, where a statue of Augustus stood 12

¹Roberto Meneghini, "I fori imperiali nell'antichità," in Roberto Meneghini and Riccardo Santangeli Valenzani, *I fori imperiali. Gli scavi del Comune di Roma (1991-2007)* (Rome: Viviani Editore, 2007) 43-60.

meters high (fig. 14). We know the size of this statue because archaeologists have found the imprint of its foot in its base and have also found a part of its hand (now in the museum of the imperial fora).²



Figure 12. View of the face of the Temple of Mars Ultor from the middle of the Forum of Augustus.



Figure 13. View of the model from the pronaos of the Temple of Mars Ultor looking toward one of the colonnades flanking the plaza of the Forum of Augustus.

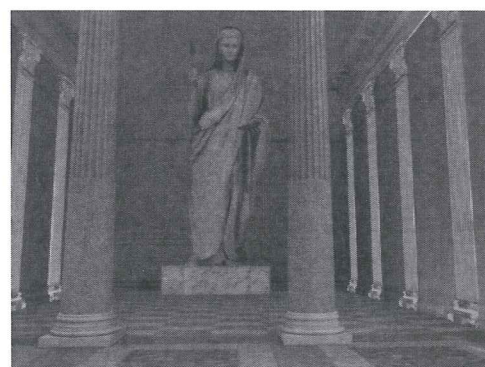


Figure 14. Colossal statue of Augustus in the model of the Forum of Augustus.

²Lucrezia Ungaro, "La memoria dell'antico," *Il museo dei Fori imperiali nei Mercati i Traiano* (Rome: Electa, 2007) 130-169.

5 PUMPS IN THE THEATER OF POMPEY

Another aspect of the project is to integrate into the virtual reconstruction of the city the mechanical devices used in the Roman world: hoisting machines, machines to lift water, *uela*, stage curtains, hydraulic organs, odometers, artillery, siege engines, etc.¹ An example is the force pump used in the theatre and in the arenas for *sparsiones*.² Pompey's Theater in the Campus Martius, completed in 55 B.C., is Rome's first stone theater. The complex also includes a Temple of Venus, a meeting hall of the Senate (*curia*), and a quadriporticus with the city's first public garden (fig. 15). The virtual reconstruction of the entire complex,³ includes simulations to illustrate and test different mechanical systems, including the pumps for *sparsiones*, or the machine for raising the stage curtain.

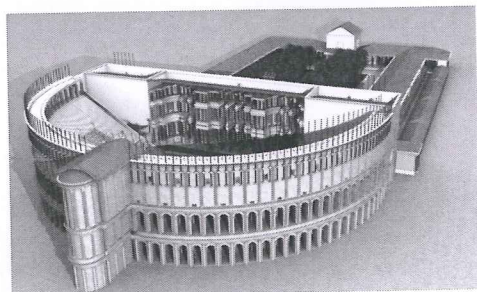


Figure 15. Theater of Pompey. General view of the model.

In figure 16, we are situated at top of the theater, in front of the temple. There is an actor on the stage, and we see that people sitting this far back could not see him very well. This explains why actors wore clothes of a special color according to their role. It is possible to see the curtain on the stage (*pulpitum*), and we see that its effectiveness in blocking the spectators' view is good, even though it is only five meters high (fig. 17). The height is based on the curtain used in the theater in Lyon. In the *orchestra*, three mechanical systems were installed (fig. 18). These were pumps used to spray saffron-perfumed water in small droplets on the spectators and on the stage. For spectators, it served as a kind of air conditioning, and probably only the first rows benefited from it. When it was used on the stage,

¹ www.unicaen.fr/ersam.

² Philippe Fleury, "Les *sparsiones* liquides dans les spectacles romains," *Revue des études latines* 86 (2008): 97–112. "Sparsiones" refers to spraying perfumed water in small droplets on the stage or on the spectators.

³ This is the subject of the thesis by S. Madeleine, *Le complexe pompéien du Champ de Mars, une ville dans la Ville. Restitution virtuelle d'un théâtre à arcades et à portique au IV^e siècle p.C.* (Ph.D. diss., Caen Basse-Normandie University 2005), publication in progress.

it produced a colored and perfumed haze that could be used during the play. Vitruvius's *De architectura*⁴ helped us to reconstruct the pump (see fig. 19). It is also possible to view an educational video on the project website to understand how the mechanical system worked. The pump was immersed in water and was operated by two men. The virtual environment allows us to propose two possible ways of reconstructing the pump: a pump without air in the central reservoir; and a pump with air. In both systems, water is sucked up into the central reservoir and a system of valves prevents it from draining back. The problem with the system without air is that between two cycles of the reciprocated motion, the water is not under pressure during a split second, so the water jet is discontinuous.

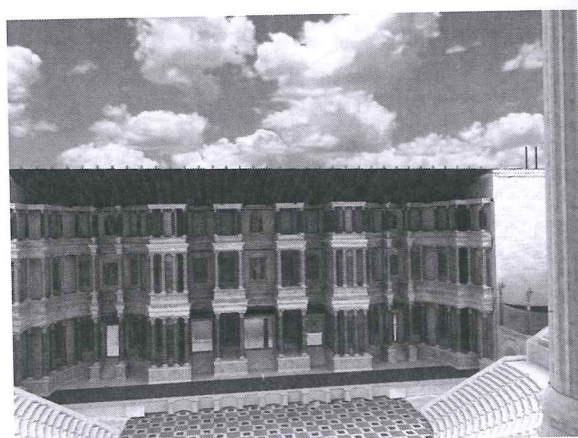


Figure 16. Scenae frons of the model of the Theater of Pompey.

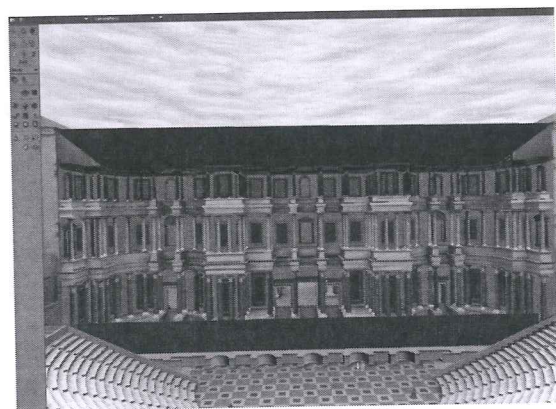


Figure 17. View from the top of the seating area of the Theater of Pompey showing the effectiveness of the curtain.

In the other system, there is air in the central reservoir and this air can be compressed when the workers pump. Between two cycles of the reciprocated motion, air is the source of power to push water through the pipe. With this system, the spray is continuous and it

⁴ Vitruvius, *De architectura*, 10.7.1–3.

was probably more pleasant than the alternative solution. It can be turned from right to left and from top to bottom. This same pump was used by the firemen in ancient Rome.



Figure 18. View from the pulpitum.

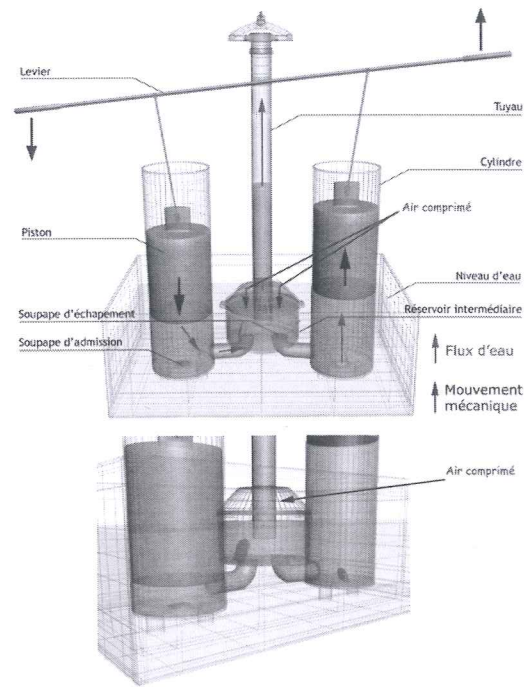


Figure 19. Digital model of a Roman force pump.

CONCLUSION

The project is a work in progress. The model is constantly being updated. The top priorities for enhancing the model currently include:

- Exchanging models and cooperating with the Rome Reborn Project (www.romereborn.virginia.edu).
- Extension of the model with new buildings and new machines. Currently, ca. twenty per cent of the city is modeled.

ACKNOWLEDGEMENTS

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