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Time.deltaTime: The Vicissitudes of Presence in Visualizing Roman Houses with Game Engine Technology

David Fredrick

University of Arkansas, USA
{dfredric@uark.edu}

Abstract

Game engines have continued to decrease in price and increase in accessibility; several popular engines have efficient web players and publish across a range of mobile devices. The actual use of game engines in heritage visualization, however, is far less than their feature set would suggest. Arguably, this is because the very power of game engines to create immersion and presence poses fundamental challenges to the assumptions of heritage visualization as a way of communicating history. These challenges can nonetheless prove heuristically fruitful if they are explicitly recognized and explored. This process is illustrated by a descriptive analysis of the recreation of the House of the Prince of Naples in Pompeii by an undergraduate humanities class, which concludes that the immersive effects of engine-based visualizations are as much to be found in their creation as in their "playing."

Keywords---**Visualization, Game Engines, Rome, Education, Presence theory**

1. Introduction

Over the past two decades, three-dimensional models have become widely popular for the visualization of archaeological sites and historic buildings, as tools for academic research and for sharing these environments with the public. So popular, in fact, that an international set of guidelines, the London Charter, has been established to define "principles for the use of computer-based visualisation methods in relation to intellectual integrity, reliability, documentation, sustainability and access" [1]. At the same time, game engines have emerged as increasingly robust vehicles for archaeological visualization. The maturation of the game industry has led to an increase in the choice of engines and a decrease in their cost, and several leading-edge engines (Unreal, Shiva, Trinigy, Unity) are now available for free for non-commercial or academic users [2] [3]. The accessibility of these engines has also improved dramatically, with user interfaces that make it possible to create polished 3D environments with only limited knowledge of scripting. The combination of lowered cost and improved accessibility means that, for small academic teams, game engines can be a realistic choice.

While game engines have become less expensive and more accessible, recognition is growing within the academy that commercial games are teaching platforms of enviable power and market penetration. To pick a notable example, I suspect that it is only a matter of time before one of my students leads me through Venice (or Rome) based on her or his 40-60 hours of serious engagement with *Assassin's Creed.* There are many anachronisms and errors in *Assassin's Creed,* and it is evident that the designers at Ubisoft did not read the London Charter.

Figure 1 Screenshot from *Assassin's Creed*

But for all its inaccuracies, *Assassin's Creed* absolutely dwarfs, in scope and number of users, any academic heritage visualization. Recognition of the teaching effectiveness of games has led to initiatives to replace the "tell and test" methodology of traditional classroom teaching with games- based curricula, a goal to which historical visualizations with game engine technology lend themselves [4]. Indeed, game engines appear to promise heritage visualizers something that

Second Life, SketchUp, Google Earth, 3D pdfs, textured point clouds, rotating OBJs, 3DS Max, Maya, SoftImage, Vue, ArcGIS maps, and QuickTime flythroughs cannot match: realtime, interactive immersion in finely modeled, lit, and textured environments.

However, the potential use of game engine technology in heritage visualization raises profound challenges on both sides of the equation. What are classicists, medievalists, anthropologists, archaeologists, and other cultural heritage professionals supposed to say about the past with this new vehicle, given its unprecedented ability for immersion in "other" worlds, when so many of the rules of our publication game are premised on objective and critical (i.e. not- immersive) analysis? At the same time, what becomes of the game engine when its immersive agenda is turned toward something like a "factual" recreation of the past?

On the one hand, the freedom of movement a game engine provides--in fact, practically mandates--means that the visualizer is faced with a daunting sense of responsibility for *everything.* What were all those bits of Roman life like (doors, windows, beds, lamps, coins, fountains, plants...) ? These must be represented, because the user can approach them all, hopefully with curiosity. On the other hand, the game engine seems to find itself, at least in one key respect, responsible for *nothing.* That is, the construction of environments for historical visualization does not seem to encourage game mechanics as they are usually understood. In historical visualizations, the central concern of game mechanics ("is it fun?") has been replaced by a quite different set of questions ("is it true, and how do we know? Does it produce a sense of cultural presence?").

The difficulty of these latter questions, when it comes to including many non-player characters (NPC)s and scripting their interaction, has produced silence. Or, rather, emptiness, the emptiness of the Forum in *Rome Reborn* [5], of Procedural's Pompeian streets [6], of Birmingham's Stonehenge [7], and (as yet) the author's own Pompeian houses [8]. Most historical visualizations using game engines do not have much in the way of mechanics because producing them would be both technically challenging and historically fraught. The visualization lab would have to pretend to know a lot of things that it doesn't, and perhaps embrace a more elastic definition of "heritage." The team would require the skills to code a huge amount of AI, a subset of game design that evolves every year. Socio- cultural issues are even more important than this technological challenge. How *did* Romans walk [9]? How did Roman constructions of gender and sexuality inform their *habitus,* their

presentation of body and self [10]? What types of spaces and behaviors do our upper-class Roman literary sources find disgusting [11]? Should we include these in the NPCs of our cultural heritage project? The difficulty of questions like these means that one of the most powerful aspects of game engine technology, the scripted interaction of avatars and NPCs with AI, has almost never been called upon in historical visualization.

The strong form of this argument would be: game engines are not being used, or are being underused, precisely because they raise the issue of cultural presence at least as much as spectre as goal. Tost and Champion have suggested, "A VE (virtual environment) is expected to be populated as the real world, with virtual and real inhabitants who contribute to the learning process and the sensation of presence" [12]. If we could ask the game engine, how might it respond? "Ok, let's do that! Which part of that population's behavior and experience would you like to omit? Are you saying that to omit any part would sacrifice intellectual integrity? Wow...that's, umm, going to be a challenge to code...." Had the designers at Ubisoft read the London Charter, they would have found themselves on a collision course.

All of which is to say that the use of game engines in historical visualization reorients the questions of presence. Much of the research on presence in videogames has focused on how the effect of presence is produced and sustained [13], and how this can be measured [14]. However, the attempt to reconstruct Roman houses "realistically" using a game engine has shown us that presence is at once a double- edged sword, and an uniquely rich opportunity to deconstruct the practice of history itself. This can take place directly on the grounds put forward by the London Charter (intellectual rigor, accuracy, authority) [1], and in a way that is tangible for undergraduate students. In the distance between what the London Charter prescribes and what a game engine "wants" to do lies a powerful teaching opportunity.

2. Project Overview

The ultimate goal of the Digital Pompeii project is the creation of a searchable, 3D database of wall paintings and mosaics in Pompeii. The core of the database is the collection of images found in the multivolume Italian encyclopedia, *Pompei: pitture e mosaici* (PPM); the images from this encyclopedia are in the process of being digitized and entered in a database that tracks art-historically relevant features like color, motif, characters, and style [15]. The images themselves are mostly black-and-white, and many date from the 1960s or before, which

is to say they are completely useless for digital texturing. At the same time, the are invaluable for the history of wall painting and mosaics in Pompeii, because so many of these have been damaged or lost since the photos were taken. The database is in turn linked to 3D models of houses in Pompeii, so that users moving through the space can follow links to the photographs in the database, and quickly see the results of searches for different themes/characters/styles rendered in a 3D spatial context. By necessity, most of city blocks in Pompeii will be modeled quite schematically, only to a height of ca. 5 meters, with quite simplified textures and lighting. This is because the level of preservation in Pompeii is extremely uneven. For many houses, a room or two may be fairly intact while frescoes from the rest are largely gone; with a few exceptions, second stories throughout Pompeii have not been preserved [16].

Some houses, however, have a much higher level of preservation, and these lend themselves to much fuller realization, using many of the resources and techniques for presence offered by a next generation game engine. Our project uses Unity, for the reasons of cost and accessibility mentioned above. We use the Pro version because it provides features like sophisticated water and glass shaders, realtime soft shadows, efficient baking of lights, occlusion culling, and normal map generation. These features speak directly to the creation of presence: the water, glass, and shadows "look real," while the normal maps make rough surfaces appear to react to light as the user moves through the space; occusion culling allows for a high framerate and smooth play even in a large environment with 100,000+ efficient scripting of the connection to the database, so that colliders set in the model can trigger the presentation of information about a given wall or floor, within the Unity webplayer itself or in the webpage that contains it.

We chose Unity because of its balance of cost and features (especially the webplayer), and its availability on the Mac platform. However, most current game engines
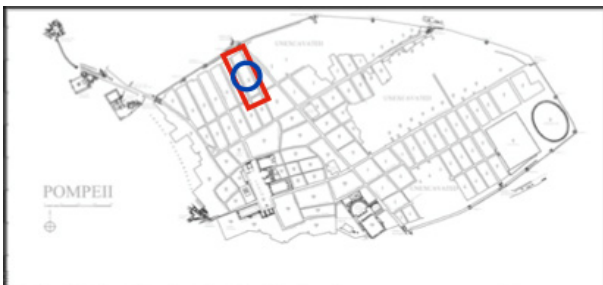
would provide these features, so the issues of presence raised here are certainly not specific to using Unity, but rather bear widely upon the use of any next generation game engine for historical visualization. A further, and perhaps more unique, aspect of the Digital Pompeii project is its involvement of undergraduate students. A course is offered every semester to 5-10 students, who take responsibility for modeling a section of Pompeii (usually several rooms from a given house), and putting the surviving decoration in place. While this gives them valuable training in Photoshop, 3D modeling software (Cinema 4D), and a game engine, it also gives them direct, hands-on experience with the complex issues of presence raised by the attempt to create an immersive model of a past environment.

3. Specific Example: The House of the Prince of Naples

The House of the Prince of Naples is located in Regio 6, insula 15, in the north-central part of the city. There are two doorways into the house (7 and 8); the house itself is fairly small by Pompeian standards, approximately 15 x 16 meters.

As often in Pompeii, the name of the house has nothing to do with the original Roman inhabitants, but rather commemorates the excavation of the house in the late 19th century in honor of Vittorio Emanuele III, the then Prince of Naples and future king of Italy. The virtual house was modeled and textured in the fall semester, 2010, by a group of six undergraduate students, using plans, drawings, and photographs from PPM, the volume in the German *Hauser in Pompeji* (HIP) series [17],
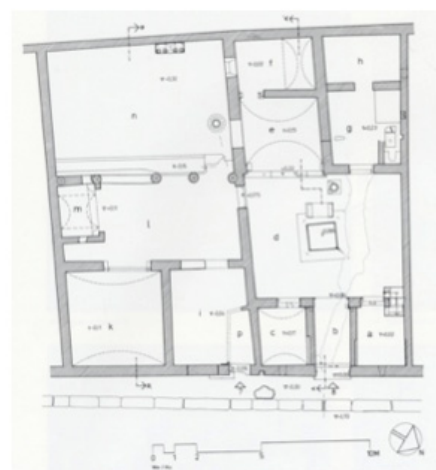

Figure 2 Location of the House of the Prince of Naples in Pompeii

Figure 3 Plan of the House of the Prince of Naples

photographs from other University of Arkansas students who had visited the house, and photographs from the website "Pompeii in Pictures" [18].

Since this house is fairly well preserved and documented, the goal of this semester was to create a model of the house at the time of the eruption of Vesuvius, not a simplified schematic model. This decision was debated in some detail with the students, because it raises crucial issues of presence. If a house is only modeled up to 5 meters, without roofs, then there can be no attempt to explore the lighting conditions of the Roman period (when there were second stories and roofs), which obviously impacts the visibility of decorations within and between rooms. More subtly, the presence of roofs speaks directly to the collection and circulation of water in the house, which is in turn connected to the location of the kitchen and latrine. Still more subtly, the presence of a second story and roofs affects the behavior of sound. Once the decision was made to model the entire house, more or less "realistically," the students found themselves confronting an increasingly thorny series of questions regarding presence in historical visualization.

3.1. What to Do with the Walls?

The wall painting is reasonably intact in only one room (m). In other rooms, there are well preserved portions of fresco, sometimes an entire wall, sometimes just pieces. In practical terms, this means one is faced with the choice of what to do: use only photographic evidence of existing decoration, or restore digitally? Again in discussion with the students, it was decided to work toward the goal of immersion and restore the walls as they looked in Roman antiquity. This meant that what remained of the wall decoration would need to be sampled and extended to cover the entire room.

This required considerable investment in Photoshop

Figure 4 View of Portico l in the Model

Figure 5 Corresponding Photograph of Portico l

technique, and careful study of techniques for sampling and tiling in the game industry. The students were not able to get through this process for all the rooms in a single semester, but the were able to get far enough along to find themselves confronting another problem: likely wear and damage. Having removed from the paintings most or all of the ravages of the eruption, excavation, and exposure, they found themselves looking at that frigid antidote to immersion, the Perfect Monument. *Rome Reborn,* the Villa Oplontis Project, and the digital reconstruction of the Forum of Trajan by James Packer are all extremely useful, but as we evaluated them in class, one student observed, "There appears to have been no birdshit in ancient Rome" [5] [19] [20]. Or rust, fire, flooding, garbage--an absence of grunge no game design artistic director would stand. This led to further consideration that the brushes, line, and pen tools of Photoshop were distractingly inorganic compared to the "real" Roman painting. Serious exploration of filters, scatter, torn edges, and jitter ensued.

Grime, cracks, and streaks are essential tools in the arsenal of presence in games, and so the students adapted techniques for these for their Roman walls. This led them still further away from the direct use of photographs. A workflow emerged of sampling the background color of a given wall and using that as a base, then adding decorative frames and borders using line drawings of these turned into Photoshop brushes, and then relying on photographic referent only for central paintings and other features that would be very difficult to create entirely in Photoshop. This made it much easier to balance color through the room, so that the lighting and color conditions would emerge from the lighting in the game engine, rather than the original lighting in the photographs, which varied widely and was very difficult to match. It also made it

Figure 6 Atrium d with Water and Cocciopesto Floor

easier to add grime, pits, and cracks at specific layers in the process [21].

3.2. What to Do with the Floors?

This house does not contain well preserved geometric or figural mosaics, and there is not a single photograph of its floors in PPM or the HIP volume. Occasional slices of the floors did show up in photographs of the walls, and there are brief verbal descriptions (e.g. "The pavement was in cocciopesto decorated with rows of white tesserae") [22]. This led to careful scouring of the web for photographs of cocciopesto (a floor material composed of crushed terracotta, reddish-brown in color). The best candidate actually came from Roman Spain, and so photographs of this were edited to produce the necessary floor patterns (regular lines of white marble chips, or irregular patterns of large pieces of terracotta plus white marble chips). Other floors were of beaten earth, or grey cocciopesto; these were created from Unity's default textures, and by adjusting the color balance and hue of the cocciopesto photographs we already had. As a result, none of the floors in the model rely on photographs from the House of the Prince of Naples itself. Nonetheless, careful handling of the floors was necessary to pursue the goal of immersion, since much of the overall feel and color tonality of a room comes from its floor.

3.3. What to Do with the Ceilings?

All of the ceilings in the House of the Prince of Naples are modern reconstructions. However, several rooms (c, e, f, and m) contained patterns of holes indicating that the room originally had a barrel-vaulted ceiling. It was decided to reconstruct these, since they were crucial to the play of light and sound in the rooms,

and also functioned as a marker of room status. This immediately raised the question of their decoration. In the absence of evidence for stucco coffers we chose fresco, for which we had no photographic referent. Comparison with surviving barrel vaults in Pompeii suggested that framework and motifs were often adapted from the walls to these ceilings, and so this is what was done for the barrel-vaulted ceilings in the model.

3.4. And the Garden?

There is no evidence for the plantings in the garden, but simply covering the "floor" of the garden with a bare patch of grass texture was also not an option. The most well decorated rooms in the house (m, e, and f) flank the garden. They contain windows designed to exploit the garden view, and decorative motifs which stress the interconnection of interior and exterior space [23]. The student responsible for the garden therefore decided to adapt default plant assets in Unity, using wall paintings of Roman gardens to get a sense of plausible sizes and arrangements. Beyond their visual effect, the plants are also important because they can respond to wind, and provide an environment for animals, whose movements and sounds would reinforce the sense of immersion in the model.

3.5. The Kitchen, Latrine, and Second Story

The kitchen and latrine area (g) proved to be one of the more interesting in terms of the creation of presence, partly because the decoration of this area is so poorly preserved, and partly because of its likely traffic and use. In the corner of the north and east walls lies a large masonry base, which most scholars believe was used as a hearth for cooking. This is consistent with the presence of

Figure 7 Tablinum e with Recreation of Barrel-vaulted Ceiling

Figure 8 View from Exedra m into Garden n

Figure 9 Kitchen g with View of Stairs and Hearth

a small niche for household gods toward the center of the east wall; these *lararia* are frequently associated with cooking in Roman houses. And yet, immediately to the south of this niche, in the southeast corner of g, is a latrine--again, a combination which is not surprising in Pompeii because both cooking and the latrine benefit from a ready source of water and drainage. The latrine was screened from the rest of the room by a thin partition wall constructed of *opus vittatum,* plastered rubble in a light wooden frame.

Interestingly enough, across from the latrine, along the west wall of g, a steep wooden staircase led up to the second story. This led us to some hypotheses about the layout of the second story. The portion of the second story above e and f very likely had windows enjoying the view out into the garden (like e and f below). This would make these upper rooms very desirable, in terms of light, air, and sound. At the same time, if these upper rooms also had windows opening out over g, that would be different, since then they would be open to all the associated sights, sounds, and smells of the kitchen and latrine (Roman literary sources are repetitive on the displeasure caused by hearing and smelling slaves at work in the kitchen). This in turn suggested a corridor along the east wall of the upper rooms, which would be lit by windows out into g, but at the same time would buffer the high-status upper rooms from disagreeable contact with g. Meanwhile, it seemed likely that the room above the storeroom h would have windows out to the east, only over g, suggesting that this room was used for slave quarters; the corridor along the east wall of the rooms over e and f would therefore provide access for slaves to their quarters in h, and also a means for them to provide service to much more desirable, high-status rooms over e and f [23].

This meant that the steep wooden staircase in g was the single means for the owner and family members to reach the rooms over e and f, and yet also brought them

into the smoky, smelly, sweaty domain of the slaves in the kitchen. At the same time, that wooden staircase would be the only means for slaves to reach the room above h, and so would provide the setting for an ongoing drama of close personal contact between owner and slaves, who would seem in this instance to share the same circulation space. For this reason, considerable effort was spent adding wear and tear to the walls of g, even though very little of their original decoration has survived. Similar effort also went into the beaten earth floor, which was textured with sampled photographs of the imprint of Roman sandals lifted from where they have been preserved in other contexts.
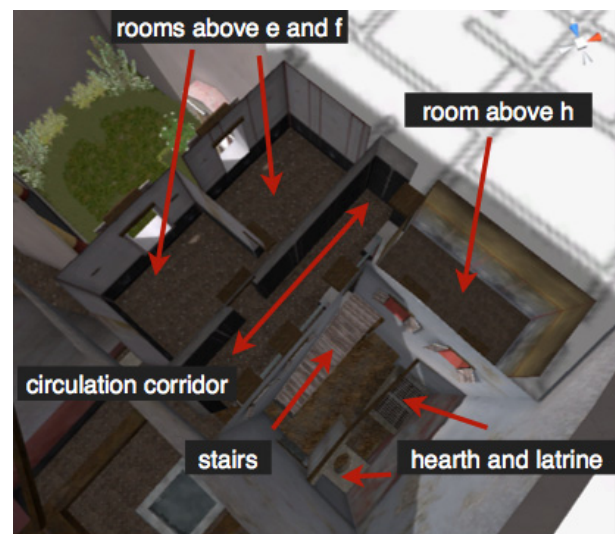

Figure 10 Hypothetical Layout of Second Story

4. Time.deltaTime: Presence and Telling History through a Game Engine

What we discovered through the process of creating the Unity model of the House of the Prince of Naples was that almost every step toward immersive presence was a step away from the "real" evidence. This is true in part because a game engine model achieves presence by allowing the user to explore at will. As modelers, we then have nowhere to hide when the evidence is bad or missing, since a flythrough of just the well preserved parts would defeat the purpose of using the game engine in the first place. In order to create wall textures that would respond appropriately to light and shadow within the game environment, it was necessary both to use photographic evidence as little as possible and (paradoxically) to sample, flip, and tile what we did have as cleverly as possible to cover the space. In order to have textured floors at all, we relied on remixed photographs of Roman floors in Spain. In order to have ceilings, it was necessary to build them and then make plausible guesses about how they might have been decorated. The garden likewise could only be reconstructed through guesswork, and yet it is the central decorative feature of the house, its primary source of light, air, and sound. The layout of the second story depends on hypotheses developed around the location of the stairs, the function of room g, and the likely positions of windows, and yet without it an immersive experience of the space is not possible.

When used for historical visualization, the game engine's capacity for immersive presence can become something of an imperative. Once you move toward it, it is difficult not to keep moving in that direction, and efforts to call attention to the mediating presence of the computer or the limitations of the evidence can easily appear awkward or contradictory. This means that a game engine is not just one choice among many when it comes to historical visualization (could have been a QT flythrough, could have been a 3D pdf, could have been Google Earth, but it's a FPS-style Unity "game"). One of the guiding tenets of cultural heritage visualizations is that they be "scientific" and "accurate," securely and explicitly based on the evidence [1]. And yet games could never produce their immersive effects if they could not lie. History, after all, does not come with normal maps, ambient occlusion, and glass shaders. This does not make a game engine a bad choice for historical visualization, but rather an instructive one precisely because realizing presence through the engine cannot be the end of the game.

In Unity's version of Javascript, Time.deltaTime is an expression that refers to the time it took in seconds to complete the last frame. It is frequently used as a multiplier to provide an absolute rather than frame-rate dependent measure of time. This reference is perhaps useful here because in as much as it seems the job of game engines to immerse us in virtual worlds, it is not their job to pretend to erase our temporal separation from the past. Next generation game engines are arguably the most efficient means of creating an immersive historical visualization, yet the immersive quality of an engine-based visualization arguably constitutes a fairly accurate measure of how far it is from the evidence. Further, most videogames don't need or want to break the spell of presence, and their players don't want that either. An engine-based historical visualization, on the other hand, has something like a professional imperative to do so. And to the extent that the visualization has managed to immerse the user in its world, the loss of this world *should hurt.*

Which is to say that game engines have a new and perhaps unmatched capacity to make a crucial problem in history telling tangibly, almost corporeally evident: intellectual rigor, standards, and authority *do* matter, but history is nonetheless always discursive, provisional, and unfinished. It is also always political. In constructing the the model of the House of the Prince of Naples, the students were forced to confront the lack of evidence for servile spaces, an issue throughout Pompeii. It's not that these spaces were not decorated originally, but rather that their decoration was usually not recorded and preserved during excavation. Lower-class Roman lives (as the name "House of the Prince of Naples" suggests) were not an object of interest for the aristocratic money that funded excavations well into the 20th century [24]. But in an immersive, engine-based model, there's nothing to prevent the user from heading toward these spaces, and so one must either decorate them "inaccurately" based on the very limited pool of surviving evidence, or "accurately" reproduce the empty space left in the surviving fabric of Pompeii by the biases of the original excavators. One premise of the Digital Pompeii project is that lessons like these are indeed valuable, and should not be the exclusive province of research visualization labs or hired architects. These are usually chosen to lend professional cachet to a project, but in fact they often have little experience with modeling, texturing, or lighting specifically for games. Moreover, this choice means that the conflict between presence and truth can only be experienced by students when they "play" the game, if at all. Yet a considerable power for immersion or presence (and consequently for

the power of its breaking) lies in the building of the model itself, and this experience belongs directly in the hands of our students.

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