

**Hertziana Studies**  
in Art History



**BIBLIOTHECA HERTZIANA**  
MAX PLANCK INSTITUTE  
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# Visualizing Complexities

Practices and Heuristics of Digital Models in Art History

Edited by Nicola Camerlenghi, Tanja Michalsky & Elisabetta Scirocco



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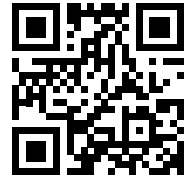
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# Abstract

Nicola Camerlenghi

Virtual St. Paul's Basilica 2.0. Developing an Open Educational Resource

keywords – Rome, Open Education Resource, Virtual Reality, Digital Modeling, St. Paul's Basilica



Rome's fourth-century Basilica of St. Paul's Outside the Walls, which burned down in 1823 and was then rebuilt, is the principal cult center of the Apostle Paul. Despite its travails, the building is well documented in graphic, written and archeological sources, which together provide sufficient data to build digital models of the building over time. These models were the backbone to a published monograph and associated website. My current aim is to develop a diachronic, virtual reality experience available to a broad audience of students and scholars—an endeavor that presents an opportunity to focus on issues critical to both our discipline and its pedagogy. Digital reconstructions seldom address the importance of scientific transparency to the evaluation of the work in a structured, documented, and peer-reviewed manner. Regarding pedagogy, a major challenge is the creation of an experience that can be easily and reliably employed in diverse learning environments. I aim to address both shortcomings, by augmenting my digital model of St. Paul's with interactive annotations that permit users to select features in the model to (1) learn about them; (2) call up primary sources used in their reconstruction; (3) understand the process by which data were interpreted; and (4) verify accuracy. In sum, the project is a testing ground to formulate best practices for content delivery that will enhance embodied experiences, exploratory learning, and architectural education within virtual spaces.

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# Virtual St. Paul's Basilica 2.0. Developing an Open Educational Resource

Nicola Camerlenghi

## The Basilica and the History of the Virtual Basilica Project

The Basilica of St. Paul in Rome, originally constructed in the fourth century, was one of the oldest standing churches in the world until a fateful fire reduced it to rubble in 1823. Lost in that conflagration was the last imperial basilica built in Rome, the city's second largest church, and the global epicenter for the veneration of St. Paul. Through the centuries, the building—like its namesake—had become a protagonist in the development of Christianity and, thus, serves as an exemplary case for the study of ecclesiastical architecture, writ large. Also lost to—or at least greatly compromised by—the fire was our ability to know and study the building's complex evolution. A similar fate befell countless works of art housed within, while those that survived lost their original context. Today, following its nineteenth-century reconstruction, the basilica stands as a UNESCO World Heritage Monument and continues to attract many pilgrims, tourists, and scholars.

Yet another kind of reconstruction of St. Paul's is possible and currently underway. Since 2012, I have been engaged in the digital modeling of the basilica across its long history. Initially, the model allowed me to make sense of the various transformations that took place there. The ability to conduct the necessary back-and-forth between visualization and analysis is taken for granted with buildings that still stand; but that operation is considerably more challenging for buildings, like St. Paul's, that are no longer extant. The digital model allowed me to understand the complexities of the building that perished in the flames. That initial phase of work culminated in a book—*St. Paul's Outside*

*the Walls: A Roman Basilica, from Antiquity to the Modern Era* (2018)—and a website that hosts, among other assets, a proof of concept Virtual Reality walkthrough experience (version 1.0) of the building on the eve of the fire.<sup>1</sup> Since its commencement over ten years ago, the Virtual Basilica Project has undergone various changes with respect to technology, output, and even purpose. This short contribution treats the new goals and opportunities inherent to broadening the focus and reach of the project's second iteration.

Now, with funding from an NEH–Mellon Digital Publications grant and support from Dartmouth College's Data Experiences and Visualizations Studio and collaboration from Smith College's Imaging Center, the project is becoming an intuitive, interactive, annotated, diachronic, Virtual Reality (VR) model of St. Paul's Basilica for students, scholars, teachers, tourists, and others interested in the history of Rome and of Christianity. Through three basic modes (“tour”, “exhibition”, and “exploration”—outlined below) users will be able to tailor their experience of the virtual building. Users are able to move through space—a handy plan is provided—and through time—seven periods are selectable through an interactive timeline (see video <https://doi.org/10.17617/3.N7FNCA>). From our perspective as developers, the project is an opportunity to create and share knowledge through a custom-built user interface. Along the way, learning opportunities abound for myself and the rest of the development team. If this present written contribution reads like a proposal that is because the project is not yet complete. But even in its incomplete state, it presents the chance to address the nature and value of Virtual Reality.

<sup>1</sup> Camerlenghi 2018. For the website:  
<https://rcweb.dartmouth.edu/CamerlenghiN/>

[VirtualBasilica/index.php](http://VirtualBasilica/index.php) or also <http://dartgo.org/virtualbasilica>.

## The Digital Model in Virtual Reality

In academia and heritage conservation, the role of digital models—particularly those experienced through VR—is being constantly redefined. A key reason why VR has yet to claim a pivotal place in the humanities (and elsewhere), in part due to equipment and production costs. But dropping prices and enthusiastic developers suggest that in a handful of years those challenges could be overcome. Now is the time to shape the medium into a useful and intuitive supplement to conventional modes of visualization and analysis for humanistic study. As I write, big tech has launched an overt effort (to wit, the “metaverse”) to direct the future of the medium. In academic circles, VR projects are still rather niche and find outlets in books and journals often as still frames, but increasingly they are being shared with more of their complexity intact thanks to electronic publications such as this one. In conservation and cultural heritage circles, VR models play a role in documentation, conservation, and valorization. Often, actual usage of the models (through VR headsets or through AR-enabled hand-held devices) is limited to the site in question. One thinks of the projections that are part of tours at the Palazzo Valentini or the augmentations of the Domus Aurea, to mention just two examples in Rome.<sup>2</sup> The Virtual Basilica Project, 2.0 hopes to encompass a variety of circles—from academic and heritage, to religious and cultural ones—and it does not require one to be physically present on site.

The project builds upon and expands the features present in several existing digital reconstruction projects related to other buildings. In the classroom, an instructor will be able to impart lessons as if on site. The recent pandemic has reminded even the most fortunate not to take travel for granted, an opportunity the less fortunate are seldom able to have. All this is more reason to foster virtual experiences, not as

*substitutes for*, but as *complements* to the physical world. The simulation of being “on-site” is an aim shared by other VR evocations of cultural spaces such as the Sistine Chapel; but, unlike that project, focused on celebrated surface decorations, the virtual basilica presents decorative, architectural, and archaeological details across time.<sup>3</sup> Like another groundbreaking project, Rome Reborn, users will be able to juxtapose historical reconstructions with a representation of the current site.<sup>4</sup> The project will contrast not just antiquity and the present, but select moments from across the history of the basilica. My reconstructions have been based on a careful study of archaeological reports, written descriptions, and over 1,700 images including detailed survey drawings. Such dependence on and respect for primary sources is modeled on projects like Visualizing Venice, a pioneering research platform, which presently lacks a VR component.<sup>5</sup> In order to share both the primary evidence and its interpretation, a system of annotations—inspired by commercial pedagogic softwares like Organon’s VR Anatomy—can be activated by clicking hotspots located at key points around the virtual building (see fig. 1).<sup>6</sup> These annotations will be important features of the project and include didactic text, images, audio, and/or video.

## Movement and its Challenges

The ability to move in (and to interact with) a model like the Virtual Basilica Project unleashes important affordances. Decisions about what movement to invite revolved around two factors. The first approach aimed to convey the experience of the space. In this case, the observer of the model—often called the “user” in digital parlance—needs phenomenological veracity, which includes a relatable speed of movement, eye-level perspective, and lack of distortion in the rendering of the space. The second approach to movement in virtual space aims to enable analyses impossible in the physical world. In this case, the user, no

2 For Palazzo Valentini, see: <https://www.palazzovalentini.it/domus-romane/index-en.html#visita>. For the Domus Aurea, see: <https://parcocolosseo.it/en/guided-tours/domus-aurea-experience/>.

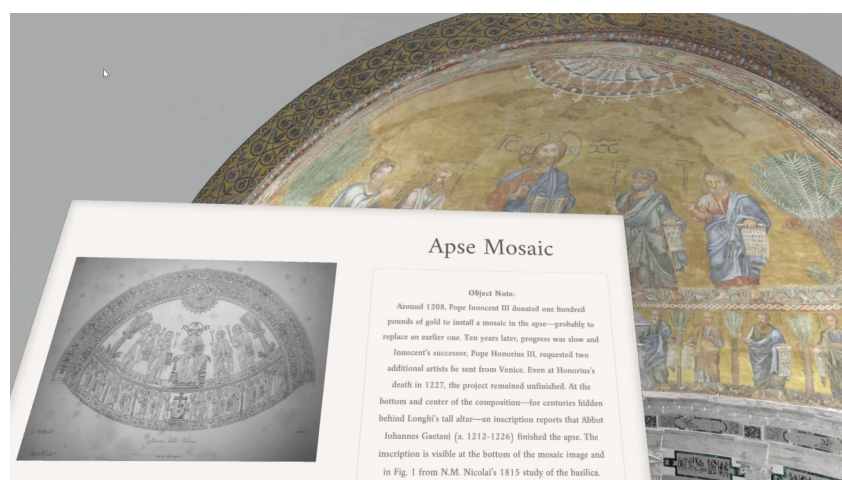
3 [https://store.steampowered.com/app/1165850/IL\\_DIVINO\\_Michelangelos\\_Sistine\\_Ceiling\\_in\\_VR/](https://store.steampowered.com/app/1165850/IL_DIVINO_Michelangelos_Sistine_Ceiling_in_VR/).

4 <https://romereborn.org/>.

5 <http://www.visualizingvenice.org/visu/>.

6 [https://store.steampowered.com/app/548010/3D\\_Organon\\_VR\\_Anatomy\\_2018/](https://store.steampowered.com/app/548010/3D_Organon_VR_Anatomy_2018/).

Figure 1  
The apse with annotations.  
Image by the Author.



longer gravity-bound can “fly” around to access hard to reach areas or details, to see through or within walls or floors to explore hidden features and their relation to visible ones. This movement lacks a phenomenological counterpart in the physical world; indeed, it is a hyper-physical, extra-corporeal sort of experience.

For each of these movement types, we envisioned an over-arching category of user. The gravity-bound mode that demands phenomenological veracity might best apply to the history buff, amateur, pilgrim, or tourist. After all, such movements are generally not jarring and yield easily conveyed takeaways. The second category of user might be the scholar, who wishes to test hypotheses, see through surfaces, even measure, or vet dimensions with our virtual measuring tape. The freedom inherent to hyper-physical movements within a model is less compelling to a broader public. In the end, both options needed to be offered to accommodate the breadth of possible users.<sup>7</sup>

In theory, the ideal manner to experience a digital model would be through unrestrained movements, where the user is allowed to explore from any angle or position. In practice, however, this sort of freedom comes at a cost. Simulator sickness (a form of motion sickness) increases hand in hand with such unrestrained forms of navigation, especially when the model is viewed with virtual reality visors. Indeed, both gender and generational challenges exist to the

experience of a model through VR navigation. Studies have shown variances in interpupillary distance (IPD) to be the major (preventable) factor, alongside the (less preventable) propensity for simulator sickness among females.<sup>8</sup> And in terms of generational challenges, it has been shown that people with extensive (video) gaming experience can “train away” the motion sickness, but gaming remains a practice more common to younger generations. In terms of interface design, constrained visualizations that use “blindings” while in motion (see fig. 2) and forcing motion along pre-defined paths—a bit like visiting a museum exhibit, where one moves sequentially from room to room—are solutions that lessen simulator sickness.

The project is touted primarily as a VR experience but given the challenges to the medium we are developing an interface that functions with a regular monitor and through keyboard-controlled movements. Of course, the desktop screen sacrifices the phenomenological veracity and full immersion potential of virtual reality. With both interfaces, users will be able to walk among the rafters on the eve of the fire, fly by fifth-century frescoes, stand at the altars where popes celebrated Mass, examine the numerous sarcophagi beneath the floor, and crawl into the tomb believed to belong to Paul.

Unrestrained movement has another shortcoming. For the sorts of structures being modeled by historians, scholars, and those concerned with

<sup>7</sup> Though still limited in its rendering capacity, a platform like Mozilla Hubs,

permits users to conduct a class or seminar in a virtually modeled space.

<sup>8</sup> Stanney/Fidopiastis/Foster 2020; Grassini/Laumann 2020.

Figure 2  
Screenshot of activated “blind-ers” to lessen  
simulator sickness.  
Image by the Author.



cultural heritage, it is often not enough to merely convey a sense of space. It is desirable to also convey a sense of historical space. Perhaps counterintuitively, a user can acquire a more profound appreciation for the historical use of space, by being restricted in her or his movements. Freedoms and restraints to movement were—and in many cases still are—based on status. To reflect this principle within a digital model is to open interesting aspects to the study of historical space and historical movement. Consider that the presbyterial enclosure around the tomb of St. Paul was a space reserved solely for clergy. Our simulations of movement along with being phenomenologically accurate, are pitched to a user, who might virtually embody a pope, priest, prince, or pilgrim. The challenge became to design an interface that could negotiate the user experience in a compelling and intuitive manner. Intuitive interfaces have historically been the purview of the commercial gaming industry, from which scholars have much to learn.

## Features of the Open Educational Resource

Thanks to these capabilities, the project is veering toward another category of digital media known as Open Education Resource (OER).<sup>9</sup> OERS have yet to acquire the status of other digital outputs. In promotion and tenure terms, at least in American universities, with which

this author is familiar, they are demoted to the category of teaching, rather than recognized as potential instances of research.<sup>10</sup> Indeed, most OERS combine both facets of an academic's job description. OERs need not be mere teaching tools showcased by an enterprising teacher, presented to a flipped classroom, or offered as an instance of experiential learning. Indeed, they can be as densely annotated as an article, as copiously illustrated as a lavish book, and as chalk-full of information and interpretation as any conventional form of academic publication. Having already produced a research-centered digital model that helped develop new visualizations, analyses, and hypotheses, I opted to transform it into a Virtual Reality and regular screen interface OER.

At the start of the experience, users will be introduced to the digital interface and to the building with audio and written explanations. They will be asked to choose between “tour”, “exhibition”, and “exploration” modes. In “tour” mode, one is guided through the building along a choice of pre-selected paths, each dedicated to a specific theme such as “Paul's Tomb through the Ages,” “Artworks within the Basilica,” “The Pilgrim's Basilica,” and “The Popes' Basilica.” The last two tours encourage users to learn through simulation (and virtual embodiment) about the distinct spatial experiences available to pilgrims and prelates at St. Paul's.

<sup>9</sup> <https://www.oercommons.org/>.

<sup>10</sup> <https://www.doers3.org/tenure-and-promotion.html>.

“Exhibition” mode assumes the user has become familiar with the interface and the building, which should occur upon completion of one or more guided tours. In this mode, one can travel to any of the tour stops and interrogate the building through 150+ interactive annotations accessed by directing a simulated laser pointer onto features in the virtual building. These annotations illustrate the basilica’s features and the process of their digital facture by engaging assets not available in “tour” mode, including a database of historic images. The ability to call upon digitized primary sources makes the project as much an interpretation of sources as a repository for them.

The final way to experience the building is in “exploration” mode, which enables free-range movement in space and time, while still providing access to the annotations. Additionally, by toggling a feature called “certainty vision,” which pinpoints objects whose location, material, or both remain uncertain, one can parse through vexed or unresolved aspects. In “exploration” mode, a user can question the benefits and limitations of the reconstruction by critically engaging, measuring, and verifying the model’s accuracy against the primary sources—an aspect essential to peer-review. The three interactive modes (“tour,” “exhibition,” and “exploration”) organize the digital experience for the viewer to best achieve the VR model’s potential as a broad-reaching, pedagogic, and scholarly tool.

Perhaps the most pedagogically innovative aspect is the fourth mode called “tour creation.” Here, a student or teacher is invited to design, assemble, and export their own tour set at a specific time in the basilica’s history, located in a specific place, and enlivened with an original audio component recorded by the user. The very tools that I, as developer, use to devise the stops of the “tour” mode, are the tools that a user can deploy to develop their own narrative or interpretation. The tours can then be saved and shared with peers, in a classroom setting, or even evaluated by a teacher or professor.

## Output and Future Potential

Developed by importing 3Ds Max models into Unity, the Virtual Basilica Project will be made available through SteamVR and OER Commons and through the Basilica website mentioned above. Future funding could transform the VR model into an Augmented Reality (AR) experience, whereby visitors to the actual building could use their hand-held devices to call up reconstructions of earlier phases, view archaeological finds below the floor, and learn about these through annotations.

And beyond the current aims of the project, the digital models—those adopted to generate the OER—remain controlled environment through which to ask and test research questions about a range of subjects, such as acoustics, lighting, celestial alignment, etc. It is possible for a variety of scholars to ask different questions from these controlled environments. In other words, there is opportunity to embrace interdisciplinary themes that broaden the scope, applicability, and the affordances of the models. For this to work effectively, it is essential for the models to be placed in an open-share environment (in our case GitHub) and not to be siloed away. In this manner it can function as an open-ended and interoperable research tool, rather than a single-use product. The model of St. Paul’s, for example, can serve one scholar’s needs to study the circulation of people, and another scholar’s desire to consider how sunlight moves through that building, while a third scholar might examine that building’s relation to the broader urban or topographic setting. The same open-share environment will be adopted for the custom-made user interface. Its time travel capability, map interface, uncertainty mode, and annotations can easily be adopted by a third party interested in sharing their own digital reconstructions of another site. This represents a paradigm shift, because a model or user interface treated in this fashion becomes a non-linear, open and unfinished entity, unlike the journal article or monographs that scholars are generally trained to produce.<sup>11</sup>

<sup>11</sup> See for example, Stabel 2014, especially p. 32.

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