

Modelling and Simulation to Teach (Classical) Archaeology: Integrating New Media into the Curriculum

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Abstract

Digital modelling and simulation are increasingly becoming integral tools for historical research, making them relevant elements of any archaeological curriculum. In this chapter, we explore how creating reconstructions with these tools can be incorporated into programmes of study: modelling aids in critical analysis of source material, while simulations enable the critical integration of pragmatic, sensory aspects into interpretations. The use of each promotes specific forms of critical thinking that empower students to engage in historical interpretation and begin to ask their own questions.

Keywords

Modelling, Simulation, Digital Learning, Reconstruction, Virtual Environments

How to cite this book chapter:

Holter, E. and Schwesinger, S. 2020. Modelling and Simulation to Teach (Classical) Archaeology: Integrating New Media into the Curriculum. In: Hageneuer, S. (ed.) *Communicating the Past in the Digital Age: Proceedings of the International Conference on Digital Methods in Teaching and Learning in Archaeology (12–13 October 2018)*. Pp. 167–177. London: Ubiquity Press. DOI: <https://doi.org/10.5334/bch.m>. License: CC-BY 4.0

Introduction

With digital tools such as 3D modelling or virtual simulation becoming increasingly accessible to makers and users alike, more and more non-specialists are taking advantage of them. These new formats present the field of archaeology with fresh opportunities to communicate the past and engage students. Not only can they serve to pique interest in archaeological topics; not only do they provide a different medium with which to impart the subject matter; digital modelling and simulation can themselves be incredibly productive research tools, which gives them an enormous potential in terms of training students for research.¹ At its foundation, research involves the use of critical thinking skills, which are becoming a core component of the teaching of archaeology – and the humanities in general – in universities today.² In addition to concentrating on mastering a set subject matter, the archaeological curriculum today aims to teach students how to learn, understand and analyse content independently. In this chapter, we would like to address how digital tools in the classroom – specifically the use of digital modelling and simulations to create reconstructions – can foster students' critical thinking skills that can be applied to their own studies, to research and beyond. This chapter deals specifically with the use of digital reconstructions in modelling and simulation as a teaching tool; using the results in order to mediate and communicate archaeological research for a broader public is dealt with elsewhere in this volume.³

Modelling: critical thinking in practice

When it comes to the fragmentary remains of ancient life, the process of reconstructing a whole out of the disparate pieces is itself a method with which students and researchers can begin to think critically about how to analyse the sources that are available to archaeologists. Creating a reconstruction model is therefore not focused on a (realistic) final product but rather on the process of weighing and interpreting the sources at hand. As Joshua Epstein (2008)

¹ On the use of digital models and simulations for research, see for example Favro (2012); Bartz, Holter and Muth (2016); Holter, Schäfer and Schwesinger (2020).

² On the importance of critical thinking in the archaeological curriculum (and humanities in general), see for example Lipe (2000: 19); Hamilakis (2001: 9); OKell, Ljubojevic and MacMahon (2010: 152–155).

³ For example Quick or Hageneuer in this volume. Archaeological excavations also employ image-based digital 3D models in the field in order to aid in documentation (see for example Dell'Unto 2014). While this use of digital modelling requires greater scrutiny in a classroom setting to prepare students to understand its benefits and limitations, it is, however, not the focus in this chapter.

succinctly explained in his landmark article ‘Why model?’, the main goal for modelling is not, as commonly (mis)understood, prediction.⁴ He determined 16 alternative reasons for modelling, and it is worth reprinting his list here in full because it makes clear how useful it can be for training archaeologists (or, in general, those studying objects and sites that can be modelled and simulated, such as art historians etc.):

1. explain (very distinct from predict);
2. guide data collection;
3. illuminate core dynamics;
4. suggest dynamical analogies;
5. discover new questions;
6. promote a scientific habit of mind;
7. bound (bracket) outcomes to plausible ranges;
8. illuminate core uncertainties;
9. offer crisis options in near-real time;
10. demonstrate trade-offs/suggest efficiencies;
11. challenge the robustness of prevailing theory through perturbations;
12. expose prevailing wisdom as incompatible with available data;
13. train practitioners;
14. discipline the policy dialogue;
15. educate the general public;
16. reveal the apparently simple (complex) to be complex (simple) (Epstein 2008: 1.9).

The task of creating a model provides the students with a structure to begin ‘guiding data collection’ (2), on which basis they can explain the site and their reconstruction of it (1). Continued work on the reconstruction in turn ‘illuminate[s] core uncertainties’ (8) within previously ‘bracket[ed] ... plausible ranges’ (7), leading to the students’ questioning of prevailing theories (11) by ‘exposing prevailing wisdom as incompatible with available data’ (12).⁵

In order to illustrate how the process of modelling – specifically, the process of creating a digital reconstruction – can itself be a productive teaching tool, we would like to give a brief example of what this can look like in a classroom setting. These observations are based on seminars on digital reconstruction offered at the Winkelmann-Institut für Klassische Archäologie at Humboldt-Universität zu Berlin: one focused on the Forum in Rome and would go on to

⁴ E. Holter would like to thank X. Rubio-Campillo for leading her to this article.

⁵ An early example for the use of digital models (and CAD specifically) as teaching tools (in this case, in the field of art history) is Günther (2001), who mainly extols their benefits in training students to recognise and analyse elements of architecture. Further experiences with including the creation of digital models in archaeological or historical teaching have not to our knowledge been published.

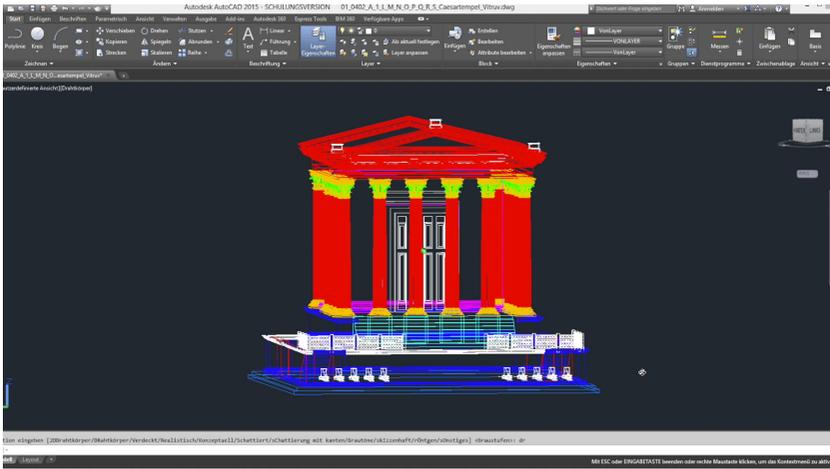


Figure 1: Screenshot of a reconstruction of the Temple of Caesar from AutoCAD.
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become the founding model of the *digitales forum romanum* project; the other built on the experience of the first and offered a course modelling the Athenian Agora.⁶ The first step was to teach the students how to use the software with which the reconstructions were to be created: in our example, in cooperation with an architect, we used the architectural modelling software AutoCAD (Figure 1).⁷ The students worked in teams, each team receiving a set of buildings that it was required to reconstruct in all of their building phases. For this, a documentation worksheet was developed with the class in order to structure the different evidence (archaeological, literary, comparative) on which the reconstruction was based as well as to explain each step.⁸

In addition to practical experience with gathering relevant material, the documentation of the sources – which is the first step of digital modelling – led to a clearer understanding of what information is available for a reconstruction –

⁶ This is based on the experience of E. Holter, who can describe the two courses from two different perspectives: in the first, she participated as a student under S. Muth; in the second she was a teacher. She is grateful to the architect A. Müller for his patience and help in teaching the students of both classes. For more on the *digitales forum romanum* project, headed by S. Muth, see the project website www.digitales-forum-romanum.de and Bartz, Holter and Muth (2016).

⁷ AutoCAD offers a free education licence for use in universities but it has a steep learning curve, which posed a significant barrier for some of the students in both classes. Other modelling software is possibly more suited to work with students.

⁸ The documentation for the class that would lead to the *digitales forum romanum* project was later moved to an online wiki to make collaboration easier: <https://wikis.hu-berlin.de/digiforo/Hauptseite>. Several examples can be viewed there.

and how conjectural different elements of the reconstructions would be. The questions that arose, often without clear answers in the academic literature, were the launch pad from which the students could begin to learn to form their own individual judgements based on the available evidence, training them in historical interpretation. In the class, students were specifically encouraged to reconstruct alternatives within the plausible ranges determined by the sources in order to underline this: the validity of the alternatives was then assessed as part of the learning process in discussion with the lecturer and the class. Understanding the nature of the sources on which reconstructions (and interpretations in general) are based also led to an increased awareness of other historical and social factors and assumptions that go into each, reinforcing critical thinking skills.

Creating digital architectural models, especially with students, therefore makes gaps in archaeological knowledge visible; the gaps themselves represent free spaces open to interpretations, in which new questions are made possible. Accordingly, modelling allows the students to become active participants in the process of knowledge acquisition, not only their own but for the discipline as a whole.⁹ Each free space represents a possible avenue of research that it is worthwhile to pursue. The creation of digital models can be integrated into departmental research projects for similar reasons, and serves as a means with which students can be directly included in the research process.¹⁰ Students of archaeology have to deal with a wide variety of disparate evidence, and it is the goal of teaching archaeology to give them the appropriate skills to weigh the evidence in terms of specific research questions, a skill with applications beyond the study of archaeology. Digital modelling in the classroom is one method by which these skills can be put into practice.¹¹

⁹ Active learning specifically in the context of the archaeology classroom is dealt with in Burke and Smith (2007) (a survey of the ideas behind active learning is given in their introduction, followed by a series of examples).

¹⁰ In addition to possible preparation for an academic career, see Ishiyama (2002) for the learning benefits to undergraduates who participate in faculty research. A prime example for this is the *digitales forum romanum* project (see above).

¹¹ The use of digital models created by others in the classroom is a question that needs to be dealt with in more detail elsewhere: reconstructions created by others are often especially difficult to analyse, as very few provide an extensive documentation detailing their research and design decisions. In addition, there is as of yet no widely accepted method for visualising uncertainties in digital models (Schäfer 2018). Integrating digital models into game engines could be a next step, as different models of the same building or space can be integrated into a single scene, thereby providing comparable alternatives and making the reconstruction itself dynamic. This underlines its uncertain elements and is a first step towards communicating the uncertainties to outside users, allowing digital reconstructions that have already been created to continue to be of use in communicating the past (on this, see Holter, Schäfer & Schwesinger 2020).

Simulation: engaging with the technology

The creation of various architectural models, while a research tool in its own right, leads to further uses with which to expand research questions, most notably through their integration into digital simulations. By creating the digital models themselves, students learned to critically analyse their sources – and any resulting reconstructions. In this section, we would like to turn to a further digital tool: digital simulations. Using simulations, we can expand what questions students can ask of the archaeological material: specifically, simulations enable the integration of sensory perception into historical interpretation.¹²

In a graduate course in which students developed and pursued their own research projects on ancient material public culture, we focused their attention on the Agora and the Pnyx in classical Athens.¹³ Digital architectural models of these spaces were provided, and the students were instructed to reconstruct historical scenarios in these ancient spaces using a game engine (in this case, Unity 3D).¹⁴ In addition to the ability to move freely through the reconstruction (from a first-person POV if desired), the use of a game engine allowed for the further embellishment of the virtual environment with textures, plants, people and equipment. In contrast to the rather sanitised aesthetic of architectural software, the game engine aesthetics enables a more ‘realistic’ look and feel. This impression is reinforced when using a head-mounted display for a VR set-up.

Especially the Pnyx as the location of the public assembly during the heyday of classical democracy proved to be a useful case study, and this scenario was reconstructed in the game engine (Figure 2). The Pnyx was renovated several times during this period, and, for the second building phase, there is no certain evidence for the location of the speaker’s platform. Knowing its exact location is highly relevant, as it would have had an influence on the visual and acoustic communication between the speaker and the audience, a primary purpose of

¹² Sensory studies in classical antiquity, itself a relatively new field, is subject to similar considerations as those we raised here regarding digital modelling. As E. Betts (2017: 195) puts it, ‘Interpretation (itself a “creative nonfiction”) begins during archaeological fieldwork, and partial evidence in any area of classical studies makes the search for Truth redundant. Instead, sensory studies enable us to extract new meaning from our evidence as we strive for better understandings of human individuals and societies.’

¹³ S. Schwesinger led this seminar in the Cultural History Department at Humboldt-Universität zu Berlin. He would like to thank the digital humanities scholar U. Schäfer for her inexhaustible patience while teaching rookies the principles and workings of a game engine.

¹⁴ On the possibilities of game engines for historical research, see Holter, Schäfer and Schwesinger (2020). On the intellectual history and epistemic potential of scenarios, see Wolfsteiner (2018).

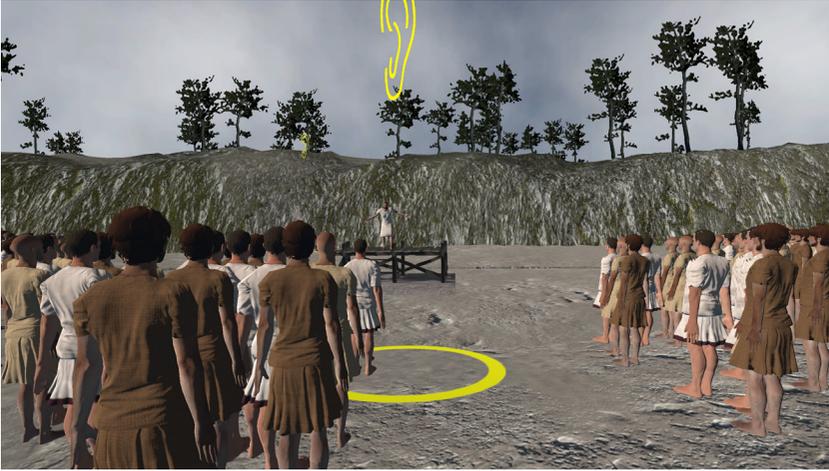


Figure 2: Screenshot from public assembly scenario on the Pnyx in Unity3D. © D. Mariaschk/U.U. Schäfer.

the assembly in this space. Consequently, we integrated an acoustic simulation of a speech signal for three different proposed locations of the speaker's platforms into the virtual environment in order to make the differences between these not only visible but also audible.¹⁵ In this way, digital simulation tools provide a chance for comparing different architectural reconstructions by placing them in an environment that can be experienced with different senses (seeing, hearing), thereby expanding the scope of possible interpretation. Multisensory experience is thus used as a kind of spatio-functional performance test: if spaces like the Pnyx were built to serve the function of political communication, then moments where they failed to serve their purpose – for example, where the speaker could be only poorly heard by the audience – might have triggered architectural or procedural changes. When, with the help of simulations, the reconstructions of ancient spaces stop being simply static architectural structures, students can start to examine the dynamic and sensory space the buildings were a part of. This opens up functional or pragmatic interpretations

¹⁵ In the research project Analog Storage Media – Auralization of Archaeological Spaces we developed this idea further into an interface within which it is possible to switch between the three different locations without exiting the play mode of the game engine. With this customizable interface, a user can toggle between variations not only for architectural but also for other uncertainties that concern, for example, the behaviour of the crowd or of the speaker, or the lighting due to the time of the day (Holter, Schäfer & Schwesinger 2020). For the application of acoustic simulations to archaeological research, see Holter, Muth and Schwesinger (2018) as well as Kassung and Muth (2019).

as opposed to symbolic or ideological ones.¹⁶ In this sense, virtual environments become a tool by which static reconstructions are made dynamic in order to include pragmatic considerations. Therefore, we can widen the scope of students to interpret the spatial implications of different reconstruction proposals, i.e. how well each of them performs its assumed function.

The role that digital models can and should play in research is, however, a matter of ongoing debate, and it is important to prepare students for this discussion as well. Considerations on the scientific applicability and research value of digital tools concentrate on a critical understanding of them as an epistemic medium, i.e. how the things and techniques we use to gain, store, express and convey knowledge inscribe themselves into that knowledge.¹⁷ This involves examining the means and formats of gathering and representing archaeological knowledge historically and contemporarily: one way to investigate the impact that digital modelling and simulation have on the way archaeologists work and think is to compare them to 2D line drawings and plaster models and consider how these might have done so as well. This perspective should help students to probe the limitations of simulations: what is their intended use? What aesthetics should they serve? Virtual environments, for example, often make use of a specific video game aesthetics that strives for a realistic impression in order to immerse users in a virtual world. But a virtual, computer game reality is not comparable to a historically perceived reality. While game engines today can accurately simulate the effects of many laws of physics (gravitation and optics are two examples that come to mind) – and future technology might come even closer to making virtual and physical reality indistinguishable – scholars and students will never be able to become a Greek or a Roman. Although the ancient spaces reconstructed should be interpreted within their cultural context, a critical position should always take the fact that we are evaluating it from a contemporary standpoint into consideration.

Coming back to the example of the Pnyx, the task for the listening student or scholar cannot be to use the audio-visual simulations in order to empathise with a Greek avatar but to determine and understand the important elements

¹⁶ A good example of this is given by S. Muth (2014: 304–310; see also Kassung & Muth 2019: 199–201) for the Forum in Rome: Caesar moved the location of the speaker's platform from its traditional, republican location. Instead of considering this architectural transformation solely in symbolic, ideological terms (Caesar is showing his disrespect for republican tradition), a pragmatic, functional view considers whether or not this renovation improved the conditions for the political communication that was the primary purpose of the speaker's platform. For university teaching, H. Günther already predicted that the advantage of self-created digital models and environments would lie in illuminating functional contexts (2001: 121).

¹⁷ For a media-critical perspective on cultural heritage, see Kassung and Schwesinger (2018).

of the historical scenario of the public assembly: how important was it to understand an orator word for word? How informed were participants of the public assembly about the content of the proposals? How interactive was the relationship between the speaker and the audience? What behaviour from the crowd was regarded as appropriate? Questions like these direct attention away from the simple textual content of the speeches that have survived to this day, instead focusing on the structural basis or situational components of the scene. In order to understand the function of architectural spaces students need to acknowledge the cultural foundations of the situation, which will come to their attention precisely through their experience of these historical spaces in digital simulations.

We believe that, in this way, virtual environments might serve as classroom tools for a sensory-based epistemology of archaeological reconstructions. Instead of trying to evaluate which simulated event and result is more 'true' than the other, students should be guided to experimentally investigate the conditions under which, for example in the case of political communication in classical Athens, such an auditory situation might have made sense to the people involved by bringing all possible resources together to study the structures, relations and sensory conditions that seem to have been important for political communication to function. This includes the (knowledge about the) role of architecture to acoustically support an orator as much as the different reception attitudes that may have guided a listener's understanding. Such findings can be used for listening trainings with students, helping them to reflect on their contemporary and mediated listening habits.¹⁸ This might also support a more extensive approach to virtual sensory spaces and counterbalance careless claims of 'realism'.

Conclusion

How can and should digital modelling and simulation be integrated into teaching? Most important is training the users of these digital tools in how to critically understand them. This includes learning to recognise the sources of the reconstructions and applying the sources themselves to the creation of digital models. Here, uncertainties in the reconstructions should be understood not as dead ends but as the starting point for new research questions. The experience in simulations can be used to consider the material and cultural conditions of sensory perception, so that users (in this case, students) can better understand the historical specificity of the experience and what questions we need to ask of the evidence in order to better analyse sensory conditions in antiquity. As we hope to have shown, digital reconstruction and simulation tools are not so

¹⁸ See Hamilakis (2001: 9–10), who also argues for more reflexivity in the classroom.

much for answering questions as they are for asking them. This is exactly the skill that we should want students of humanities to learn most of all, making the proper integration of digital tools into teaching a highly effective method.

Acknowledgements

The authors would like to thank the Image Knowledge Gestaltung Cluster of Excellence for their financial support, and all the colleagues in the Analog Storage Media – Auralization of Archaeological Spaces project for the rewarding collaboration that lies at the foundation of the views expressed here. E. Holter would also like to thank the Caroline von Humboldt Grant Program for a generous completion grant, which made further work on this chapter possible. She owes a debt to her teacher S. Muth, who provided to her as a student many of the opportunities discussed here.

References

- Bartz, J., Holter, E. and Muth, S. (2016). Digitales Forum Romanum: Chancen und Grenzen virtueller Rekonstruktion und Simulation. In: K.B. Zimmer, ed., *Von der Reproduktion zur Rekonstruktion – Umgang mit Antike(n) II*, Rahden: Marie Leidorf, pp. 193–208.
- Betts, E. (2017). Afterword: Towards a methodology for Roman sensory studies. In: E. Betts, ed., *Senses of Empire: Multisensory Approaches to Roman Culture*, London: Routledge, pp. 193–199.
- Burke, H. and Smith, C. (2007). *Archaeology to Delight and Instruct: Active Learning in the University Classroom*, Walnut Creek, CA: Left Coast Press.
- Dell’Unto, N. (2014). 3D models and archaeological investigation. In: I. Huvila, ed., *Perspectives to Archaeological Information in the Digital Society*, Uppsala: Institutionen för ABM, pp. 51–77.
- Epstein, J.M. (2008). Why model? *Journal of Artificial Societies and Social Simulation*, [online] JASSS. Available at: <http://jasss.soc.surrey.ac.uk/11/4/12.html> [Accessed 6 November 2018].
- Favro, D. (2012). Se non è vero, è ben trovato (If not true, it is well conceived): Digital immersive reconstructions of historical environments. *Journal of the Society of Architectural Historians*, 71: 273–277.
- Günther, H. (2001). Kritische Computer-Visualisierung in der kunsthistorischen Lehre. In: M. Frings, ed., *Der Modelle Tugend: CAD und die neuen Räume der Kunstgeschichte*, Weimar: VDG, pp. 111–122.
- Hamilakis, Y. (2001). Interrogating archaeological pedagogies. In: P. Rainbird and Y. Hamilakis, eds, *Interrogating Pedagogies: Archaeology in higher education*, Oxford: Archaeopress, pp. 5–12.

- Holter, E., Muth, S. and Schwesinger, S. (2018). Sounding out public space in late republican Rome. In: S. Butler and S. Nooter, eds, *Sound and the Ancient Senses*, Abingdon: Routledge, pp. 44–60.
- Holter, E., Schäfer U.U. and Schwesinger, S. (2020). Simulating the ancient world: Pitfalls and opportunities of using game engines for archaeological and historical research. In: C. Rollinger, ed., *Classical Antiquity in Video Games: Playing with the Ancient World*, London: Bloomsbury, pp. 217–231.
- Ishiyama, J. (2002). Does early participation in undergraduate research benefit social science and humanities students? *College Student Journal*, 36: 380–386.
- Kassung, C. and Schwesinger, S. (2018). Saxa Loquuntur. The function of (multi-) media for antique architecture. In: D. Singh, J. Sieck, H.N.-N. Muyingi, H. Winschiers-Theophilus, A. Peters and S. Nggada, eds, *Digitisation of Culture: Namibian and International Perspectives*, Singapore: Springer, pp. 171–185.
- Kassung, C. and Muth, S. (2019). Plausibilisieren. (Re-)Konstruktion als Experiment. Sehen und Hören in antiker Architektur. In: S. Marguin, H. Rabe, W. Schäffner and F. Schmidgall, eds, *Experimentieren. Einblicke in Praktiken und Versuchsaufbauten zwischen Wissenschaft und Gestaltung*, Bielefeld: transcript, pp. 189–204.
- Lipe, W.D. (2000). Archaeological education and renewing American archaeology. In: S.J. Bender and G.S. Smith, eds, *Teaching Archaeology in the Twenty-First Century*, Washington, DC: Society for American Archaeology, pp. 17–20.
- Muth, S. (2014). Historische Dimensionen des gebauten Raumes: Das Forum Romanum als Fallbeispiel. In: O. Dally, T. Hölscher, S. Muth and R. Schneider, eds, *Medien der Geschichte: Antikes Griechenland und Rom*, Berlin: de Gruyter, pp. 285–329.
- OKell, E., Ljubojevic, D. and MacMahon, C. (2010). Creating a generative learning object (GLO): Working in an ‘ill-structured’ environment and getting students to think. In: G. Bodard and S. Mahony, eds, *Digital Research in the Study of Classical Antiquity*. Farnham: Ashgate, pp. 151–170.
- Schäfer, U.U. (2018). Uncertainty visualization and digital 3D modeling in archaeology: A brief introduction. *Digital Art History*, 3: 87–106.
- Wolfsteiner, A. (2018). *Sichtbarkeitsmaschinen: Zum Umgang mit Szenarien*, Berlin: Kadmos.

