VIRTUAL INTRODUCTION TO DIGITAL AND CYBER ARCHAEOLOGY

ONLINE ONLY

Course ID: ARCH 310B

May 1 – May 19, 2023

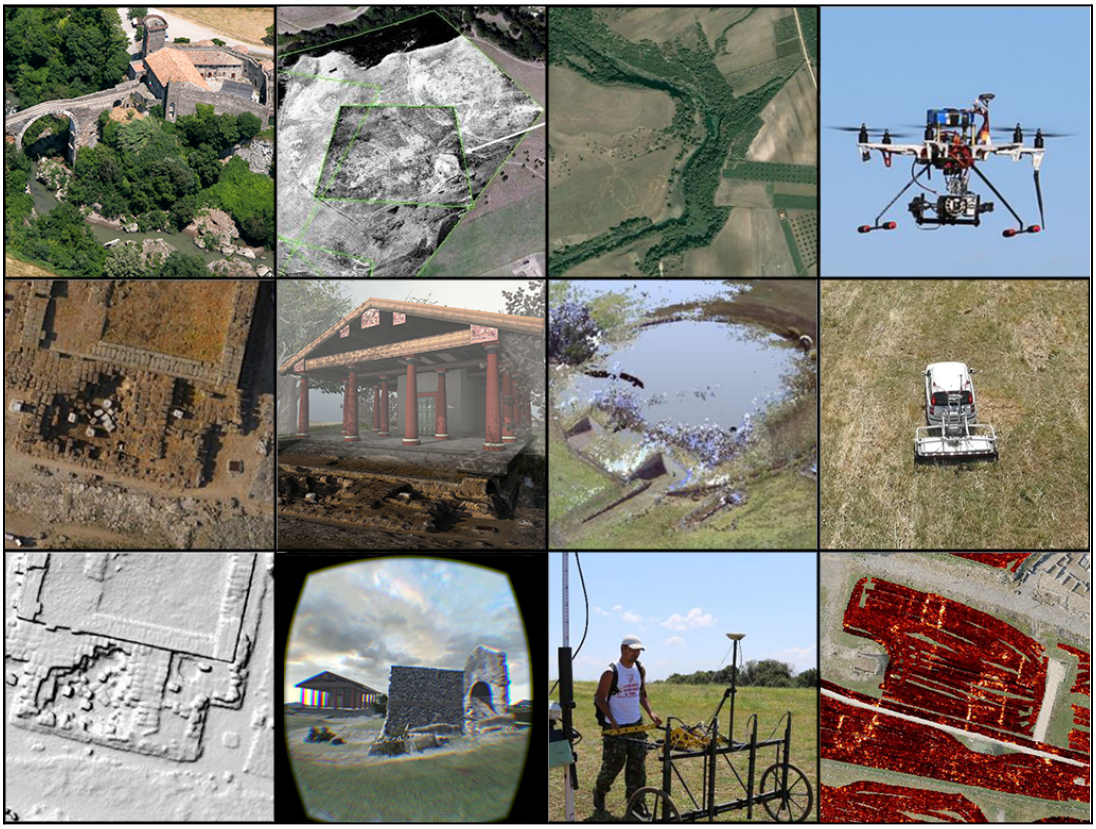
Academic Credits: 2 Semester Credit Units (Equivalent to 3 Quarter Credit Units)

COURSE INSTRUCTORS:

Maurizio Forte, Director of the Dig@Lab, Distinguished professor of Classical Studies, Art, Art History and Visual Studies (maurizio.forte@duke.edu)

Nevio Danelon, PhD, Researcher, Dig@Lab (nevio.danelon@duke.edu)

Antonio LoPiano, PhD candidate, Duke University, Dig@Lab (antonio.lopiano@duke.edu



COURSE DESCRIPTION

Archaeology in the third millennium is strongly digital: from data recording to post-processing and immersive virtual reality, archaeologists produce large amounts of digital data in different formats and platforms. It is a highly multidisciplinary activity, which requires advanced skills in information and spatial technologies, but it opens new research perspectives and creates new job profiles at international level. This **three-week online** course will provide the students a comprehensive understanding of the digital workflows and methods in archaeology implemented by the most recent technologies. Participants will also acquire practical skills which will be useful in both archaeological fieldwork and cultural heritage management.

The Dig@Lab

The name Dig@Lab (Digital Digging Laboratory) recalls the main goal of this research unit, which is "digging for information", looking for new interpretations at the intersection of archaeology, cybernetics, heritage, computer science, neuroscience, cognitive science, art and history. More specifically, we are interested in investigating how the information is shaped, elaborated, stored and then culturally transmitted by different societies, with a focus on ancient civilizations. We like to say that the past cannot be "reconstructed" but "simulated", then performed by digital simulations. The Dig@Lab has its home at the Department of Art, Art History & Visual Studies but it collaborates with several different departments at Duke such as Classical Studies, Nicholas School, Computer Science and Institute for Brain Science.

Case studies

Students will be engaged in the use of real archaeological data coming from some of the Dig@Lab archaeological projects such as the Etruscan city of Vulci (Italy), the Neolithic site of Çatalhöyük (Turkey), the sites of Akrotiri and Knossos in Greece.

ACADEMIC CREDIT UNITS & TRANSCRIPTS

Credit Units: Attending students will be awarded 2 semester credit units (equivalent to 3 quarter credit units) through our academic partner, Connecticut College. Connecticut College is a private, highly ranked liberal arts institution with a deep commitment to undergraduate education. Students will receive a letter grade for attending this field school (see grading assessment and matrix). This field school provides a minimum of 90 instructional hours. Students are encouraged to discuss the transferability of credit units with faculty and registrars at their home institution prior to attending this field school.

Transcripts: An official copy of transcripts will be mailed to the permanent address listed by students on their online application. One more transcript may be sent to the student home institution at no cost. Additional transcripts may be ordered at any time through the National Student Clearinghouse: http://bit.ly/2hvurkl.

COURSE OUTCOMES

Upon the successful completion of the course requirements, students will acquire theoretical knowledge and practical skills of digital archaeological research methods including:

- Non-destructive methods in archaeological investigation and remote sensing such as LIDAR and Ground Penetrating Radar
- Airborne and satellite imaging interpretation
- Geographical Information Systems (GIS) for the management of spatial data
- Set up and use a Total Station to record target points
- Create 3D models of excavation trenches and buildings through SfM photogrammetry
- Generate orthophotos and DEMs from photogrammetry
- Create 3D models of archaeological artifacts
- Operate a drone to take aerial photos
- Archaeological databases and data management
- Create Virtual Museum applications using game engine platforms such as Unity or Blender

CLASS FORMAT

The course is split into 4 main types of activities. ***Lectures*** will consist of the instructors teaching the students about a given subject. ***Seminars*** are discussion based and will cover material from the readings assigned to students, lectures, and labs. During ***Workshops***, the instructors will guide students through the practical functions of the various technologies covered by this course. ***Labs*** are when the students will apply the skills learned in the workshops on their own to a pre-designed assignment. Generally speaking, the mornings will be allotted to lectures, seminars, and workshops whereas afternoons will be given over to independent study of the readings and the completion of labs. However, instructors will be available to answer student questions and provide guidance during the afternoon upon student request.

FINAL ASSIGNMENT

Students can choose between two possible project structures:

1500-word archaeological project proposal: Students will design an archaeological project plan for a hypothetical excavation incorporating digital technologies across all phases of the archaeological project: survey, excavation, and lab analysis. Students will first need to select a culture and site to study. They will conduct background research into the culture of their choosing and incorporate that research into their plan. The plan should give thoughtful consideration to what technologies will best suit the practical concerns of their proposed site (environment, extent of territory, material type etc.) and theoretical concerns (desired data output, cultural resource management, data management and preservation, etc.) during each phase of their proposed project

Digital Project: Students will choose one or two of technologies we have reviewed in class and execute a brief project utilizing that technology. Examples could be producing a 3D model of a temple and

incorporating it into a 3D GIS environment or using photogrammetry to produce a repository of "artifacts."

GRADING AND REQUIREMENTS

Student grades are based primarily on their mastery of the material presented in lectures, readings, as well as in the final assignment. The final grade will be based on the average of grades earned during the course. Specifically:

Regular participation (15%): Students should have the readings prepared before the Seminars, provide meaningful contribution to discussions, and speak thoughtfully and on topic.

Lab activity (15%):

Final assignment (70%):

HARDWARE REQUIREMENTS

Students will need regular access to a laptop or desktop computer with a web browser and video conferencing capabilities (i.e., a microphone, speakers, and a camera). The software used during this course does have certain hardware requirements. However, they are not overly demanding, and any reasonably modern computer should manage just fine. Generally speaking, a laptop with at least a quad core CPU should be the minimum necessary to handle the basic functions of the software covered in this class. All the software is platform agnostic, meaning they are compatible with both windows and mac operating systems. If you have any questions about hardware compatibility, please get in contact with one of the instructors.

SOFTWARE

Software provided to students: Metashape*, QGIS, Blender, Unity
Software introduced or discussed by the instructors: Autocad, 3D Studio Max, Pix4D, ArcGIS, Meshlab, Altspace VR, Mozzilla Hub.

CALENDAR (All times in EDT)

Mon. May 1: ***Introduction to Digital Archaeology***

9:00 - 10:30	***Lecture 1***: Fundamental concepts of archaeology and stratigraphy
10:30-11:00	***Break***
11:00- 12:30	***Lecture 2***: Fieldwork methodology and digital archaeology
12:30- 2:00	***Lunch***
2:00 - 5:00	***Independent Study - Readings***: Archaeology 101; Zubrow and Evans (2006), "Digital Archaeology"; Interactive Dig, Zominthos.

Tues. May 2: ***Principles of Photogrammetry***

9:00 - 10:00	***Seminar 1***: Students and instructors will discuss readings from the previous day. Students should be prepared to discuss how digital methods are incorporated into field methodology and how digital methods can contribute to the archaeological process.
10:00-11:00	***Lecture 3***: What is photogrammetry, why is it useful, and how do we use it?

11:00-12:30 ***Lunch***

12:30-4:00 ***Independent study - Readings:*** Štuhec (2017), "3D Digital Recording: Basics"; Campana (2014), "3D Modeling in Archaeology and Cultural Heritage – Theory and best practice"; Remondino (2014), "Photogrammetry: Theory."

4:00-5:00 ***Seminar 2***: Discussion of readings and review of terms. Students should be prepared to discuss practical and theoretical concerns around the use of photogrammetry in archaeological research.

Wed. May 3: ***Artifactual Photogrammetry***

9:00 - 10:30 ***Workshop 1***: Photogrammetry basics - Data capture

10:30-11:00 ***Break***

11:00-12:30 ***Workshop 2***: Photogrammetry basics - Alignment w/ Metashape

12:30-2:00 ***Lunch***

2:00 - 5:00 ***Independent study - Reading***: Štuhec and Zachar (2017), "Digital Photogrammetry" (38-52 only) **-** ***Lab 1***: Photogrammetry - modeling an object

Thurs. May 4: ***Architectural Photogrammetry***

9:00 - 10:00 ***Seminar 3***: Reviewing results of Lab 1

10:00-10:30 ***Break***

10:30-11:30 ***Workshop 3***: Photogrammetry for architecture

11:30-12:30 ***Independent study - Lab 2***: Photogrammetry - modeling architecture

12:30-2:00 ***Lunch***

2:00 - 5:00 ***Independent study - Readings:*** Jončić and Zachar (2017), "3D Scanning"*;* Lecari (2017), "Terrestrial Laser Scanning in the Age of Sensing"; Optiz (2016), "Airborne Laser scanning in Archaeology: Maturing Methods and Democratizing Applications"

Fri. May 5: ***Laser and Structured Light Scanners***

9:00 - 10:00 ***Seminar 3***: Reviewing results of Lab 2.

10:00-10:30 ***Break***

10:30-11:30 ***Lecture 4***: Laser and structured light scanner - terms and technology

11:30-12:30 ***Seminar 4:*** Discussion of previous afternoon's readings. Students should be prepared to discuss practical and theoretical concerns around the use of laser and structured light scanning in archaeological research.

12:30-2:00 ***Lunch***

2:00-3:00 ***Workshop 5***: Visualizing and processing point clouds.

3:00-5:00 ***Independent study - Reading*****:** F. Remondino (2014)**,** "Geomatic and Cultural Heritage"; Cowley (2017), "What Do the Patterns Mean? Archaeological Distributions and Bias in Survey Data"; Triplet (2017), "Visualizing Medieval Iberia's Contested Space Through Multiple Scales of Visibility Analysis."

Mon. May 8: ***Intro to GIS and Spatial Recording in Archaeology***

9:00-10:00 ***Lecture 5***: Fundamental concepts of GIS: projections, coordinates, and precision

10:00-10:30 **Break**

10:30-11:30 ***Lecture 6***: Topographical measurements with the Total Station and Satellite Positioning Systems (GPS, Differential GPS and GNSS).

11:30-12:30 ***Workshop 6***: Adding control points in Metashape.

12:30-2:00 ***Lunch***

2:00 - 5:00 ***Independent study - Reading:*** Zachar and Horňák (2017), "3D Recording in Archaeological Practice"; Orengo, H. A. (2013), "Combining terrestrial stereophotogrammetry, DGPS and GIS-based 3D voxel modelling in the volumetric recording of archaeological features".

Lab 3: Photogrammetry - generating georeferenced orthophotos and DEMs from an excavation photo set in Metashape.

Tues. May 9: GIS

9:00 - 10:00 ***Seminar 5***: Reviewing results of Lab 3 and discussion of role of GIS and photogrammetry in the recording of archaeological contexts.

10:00-10:30 ***Break***

10:30-11:30 ***Workshop 7***: Managing spatial data in QGIS.

11:30-12:30 ***Workshop 8:*** Adding and georeferencing raster data in QGIS.

12:30-2:00 ***Lunch***

2:00-5:00 ***Independent study - Lab 4***: Importing an orthophoto from Metashape to QGIS.

Readings: Vermeulen (2017), "Towards a Holistic Archaeological Survey Approach for Ancient Cityscapes"; Campana (2017), "Sensing Ruralscapes. Third-Wave Archaeological Survey in the Mediterranean Area"; Dell'Unto (2016), "Using 3D GIS Platforms to Analyse and Interpret the Past"; Agugiaro (2014), "2D GIS vs. 3D GIS Theory."

Wed. May 10: ***Remote Sensing and Drones***

9:00-10:00 ***Lecture 7***: Drone types (fixed and rotating wing UAVs), multispectral cameras

10:00-10:30 **Break**

10:30-11:30 ***Workshop 7***: Multispectral image processing in QGIS Raster Calculator

11:30-12:30 ***Lecture 8***: The Use of Satellite Imagery in Archaeology

12:30-2:00 ***Lunch***

2:00-5:00 ***Independent study - Readings***: N. Galiatzatos (2014), "Exploring archaeological landscapes with satellite imagery"; Verdonck *et al.* (2020), "Ground-penetrating Radar Survey at Falerii Novi: A new approach to the study of Roman cities";

Thurs. May 11: ***Geophysical Prospecting and LiDAR in Archaeology***

9:00 - 10:00 ***Seminar 6***: Discussion of readings. Students should be prepared to discuss the role of remote sensing in archaeological surveys.

10:00-10:30 **Break**

10:30-11:30 ***Lecture 9***: Prospecting methods (Magnetometry, Resistivity, GPR, LiDAR)

11:30-12:30 ***Workshop 8***: DEMs and GPR data visualization in QGIS

12:30-2:00 ***Lunch***

2:00-5:00 ***Independent study - Readings***: Mozzi *et al*. (2015), "The Roman City of Altinum, Venice Lagoon, from Remote Sensing and Geophysical Prospection"; Evans (2016), "Airborne

laser scanning as a method for exploring long-term socio-ecological dynamics in Cambodia" - ***Lab 5*****:** Interpreting and vectorizing GPR data

Fri. May 12: ***Digital Repositories and Virtual Museums***

9:00-10:00 ***Seminar 10***: Discussion of readings and reviewing results of Lab 6
10:00-10:30 ***Break***
10:30-11:30 ***Lecture 10***: Virtual Museum platforms
11:30-12:30 ***Workshop 11***: Morphosource
12:30-2:00 ***Lunch***
2:00-5:00 ***Independent study - Readings***: Gabellone *et al.* (2015). "What communication for museums? Experiences and reflections in a virtualization project for the Museo Egizio in Turin"; B. Frischer (2014), "3D Data Capture, Restoration and Online Publication of Sculpture"; Pietroni (2017), "From Remote to Embodied Sensing: New Perspectives for Virtual Museums and Archaeological Landscape Communication."

Mon. May 15: ***Introduction to Virtual and Cyber Archaeology***

9:00-10:00 ***Seminar 11***: Discussion of readings
10:00-10:30 ***Break***
10:30-11:00 ***Lecture 11***: Virtual and Cyber Archaeology, terms and approaches
11:30-12:30 ***Workshop 12***: CAD and 3D modeling in archaeology
12:30-2:00 ***Lunch***
2:00-5:00 ***Independent study - Readings***: J.A. Barceló (2014), "3D Modelling and Shape Analysis in Archaeology"; Forte (2017), "Cyber Archaeology: 3D Sensing and Digital Embodiment."
Lab 7: Modeling a basic structure

Tues. May 16: ***Archaeological reconstructions and 3D modeling***

9:00-10:00 ***Seminar 12***: Discussion of readings
10:00-10:30 ***Break***
10:30-12:00 ***Workshop 13***: Creating a simple scene in Unity
12:00-1:00 ***Lecture 12***: Future prospects: Social VR
11:00-2:00 ***Lunch***
2:00 - 5:00 ***Independent study - Lab 8***: Creating a simple scene in Unity

Wed. May 17: ***Beginning Student Projects***

9:00-10:00 ***Seminar 13***: Reviewing results of Lab 7 and course conclusions.
10:00-10:30 ***Break***
10:30-11:00 Discussing projects and choosing topics
11:00 -12:30 ***Independent study*** - Supervised Independent work period where students can engage with instructors about directions of research, ask practical questions concerning their projects, and make initial inroads along their chosen subjects.
12:30-2:00 ***Lunch***

2:00-5:00 ***Independent Study*** **-** *S*tudents will work on their chosen projects. Instructors are available to meet with students for practical, methodological, and theoretical concerns related to their projects.

Thurs. May 18: ***Student Projects***

9:00-5:00 ***Independent Study*** **-** *S*tudents will work on their chosen projects. Instructors are available to meet with students for practical, methodological, and theoretical concerns related to their projects.

Fri. May 19: ***Student Project Presentations***

9:00-12:00 ***Independent Study*** **-** *S*tudents will finish projects
12:00-1:00 ***Lunch***
1:00-5:00 **Student presentation of projects and course evaluations**

COURSE RESOURCES

https://diglab.duke.edu/papers

READINGS

Archaeological Institute of America. "Archaeology 101."
https://www.archaeological.org/pdfs/education/Arch101.2.pdf

Archaeological Institute of America. "Interactive Dig, Zominthos."
https://www.archaeological.org/interactive-dig/zominthos-crete/

Agugiaro, G. (2014), "2D GIS vs. 3D GIS Theory." In *3D Recording and Modelling in Archaeology and Cultural Heritage,* eds. Remondino, F., & Campana, S.: 7-12. *BAR International Series*, *2598*.

Barceló, J.A. (2014), "3D Modelling and Shape Analysis in Archaeology." In *3D Recording and Modelling in Archaeology and Cultural Heritage,* eds. Remondino, F., & Campana, S.: 15-26. *BAR International Series*, *2598*.

Campana, S. (2014). "3D Modeling in Archaeology and Cultural Heritage – Theory and best practice." In *3D Recording and Modelling in Archaeology and Cultural Heritage,* eds. Remondino, F., & Campana, S.: 7-12. *BAR International Series*, *2598*.

Campana, S. (2017), "Sensing Ruralscapes. Third-Wave Archaeological Survey in the Mediterranean Area." In *Digital Methods and Remote Sensing in Archaeology. Quantitative Methods in the Humanities and Social Sciences*, eds. Forte, M. and Campana, S.: 147-170. Springer: Cham.

Forte, M., Murteira H. eds. (2020), Digital Cities, Oxford University Press, 2020.

Cowley, D. (2017), "What Do the Patterns Mean? Archaeological Distributions and Bias in Survey Data." In *Digital Methods and Remote Sensing in Archaeology. Quantitative Methods in the Humanities and Social Sciences*, eds. Forte, M. and Campana, S.: 113-145. Springer: Cham.

Dell'Unto, N. (2016), "Using 3D GIS Platforms to Analyse and Interpret the Past." In *Digital Methods and Remote Sensing in Archaeology. Quantitative Methods in the Humanities and Social Sciences*, eds. Forte, M. and Campana, S.: 305-322. Springer: Cham.

Forte (2017), "Cyber Archaeology: 3D Sensing and Digital Embodiment." In *Digital Methods and Remote Sensing in Archaeology. Quantitative Methods in the Humanities and Social Sciences*, eds. Forte, M. and Campana, S.: 271-289. Springer: Cham.

Maurizio Forte, Immo Trinks, Alois Hinterleitner, Michael Klein, Antonio LoPiano, Katherine McCusker, Hannes Schiel, Ingrid Schlögel, Tanja Trausmuth, Alexandra Vonkilch, Mario Wallner & Wolfgang Neubauer (2022) Multimodal Remote Sensing Applications in the Etruscan-Roman City of Vulci, Journal of Field Archaeology, DOI: 10.1080/00934690.2022.2126920

Frischer, B. (2014), "3D Data Capture, Restoration and Online Publication of Sculpture." In *3D Recording and Modelling in Archaeology and Cultural Heritage,* eds. Remondino, F., & Campana, S.: 137-144. *BAR International Series*, *2598*.

Evans, D. (2016), "Airborne laser scanning as a method for exploring long-term socio-ecological dynamics in Cambodia", *Journal of Archaeological Science* 74, 164-175. [https://doi.org/10.1016/j.jas.2016.05.009]

Gabellone, F., F. Giuri, I. Ferrari, M. Chiffi, (2015). "What communication for museums? Experiences and reflections in a virtualization project for the Museo Egizio in Turin" in *Proceedings of the 20th International Conference on Cultural Heritage and New Technologies 2015, Vienna 2016*. Available from: https://www.researchgate.net/publication/309210920_What_communication_for_museums_Experiences_and_reflections_in_a_virtualization_project_for_the_Museo_Egizio_in_Turin [accessed Jan 27 2021].

Galiatzatos, N. (2014), "Exploring archaeological landscapes with satellite imagery." In *3D Recording and Modelling in Archaeology and Cultural Heritage,* eds. Remondino, F., & Campana, S.: 91-102. *BAR International Series*, *2598*.

Jončić, N. and Zachar, J. (2017), "3D Scanning." In *3D Digital Recording of Archaeological, Architectural and Artistic Heritage,* eds. Novaković, P., M. Hornak, M. Zachar, and N. Joncic: 23-32. University of Ljubljana Press: Ljubljana.

Lercari, N. (2016), “Terrestrial Laser Scanning in the Age of Sensing”. In *Digital Methods and Remote Sensing in Archaeology. Quantitative Methods in the Humanities and Social Sciences*, eds. Forte, M. and Campana, S.: 3-33. Springer: Cham.

Mozzi, P., A. Fontana, F. Ferrarese, A. Ninfo, S. Campana, R. Francese (2015). “The Roman City of Altinum, Venice Lagoon, from Remote Sensing and Geophysical Prospection” in *Archaeological Prospection*. 23. 10.1002/arp.1520.

Opitz, R. (2016), “Airborne Laser scanning in Archaeology: Maturing Methods and Democratizing Applications.” In *Digital Methods and Remote Sensing in Archaeology. Quantitative Methods in the Humanities and Social Sciences*, eds. Forte, M. and Campana, S.: 3-33. Springer: Cham.

Orengo, H. A. (2013), "Combining terrestrial stereophotogrammetry, DGPS and GIS-based 3D voxel modelling in the volumetric recording of archaeological features", *ISPRS Journal of Photogrammetry and Remote Sensing*, 76: 49-55.
Available at: http://www.sciencedirect.com/science/article/pii/S0924271612001542

Pietroni (2017), “From Remote to Embodied Sensing: New Perspectives for Virtual Museums and Archaeological Landscape Communication.” In *Digital Methods and Remote Sensing in Archaeology. Quantitative Methods in the Humanities and Social Sciences*, eds. Forte, M. and Campana, S.: 437-474. Springer: Cham.

Remondino. F. (2014), “Photogrammetry: Theory.” In *3D Recording and Modelling in Archaeology and Cultural Heritage,* eds. Remondino, F., & Campana, S.: 65-73. *BAR International Series*, *2598*.

Remondino, F. (2014), “Geomatic and Cultural Heritage.” In *3D Recording and Modelling in Archaeology and Cultural Heritage,* eds. Remondino, F., & Campana, S.: 13-14. *BAR International Series*, *2598*.

Štuhec, S. (2017), “3D Digital Recording: Basics.” In *3D Digital Recording of Archaeological, Architectural and Artistic Heritage,* eds. Novaković, P., M. Hornak, M. Zachar, and N. Joncic: 15-22. University of Ljubljana Press: Ljubljana.

Stuhec, S. and Zachar, J. (2017), “Digital Photogrammetry” In *3D Digital Recording of Archaeological, Architectural and Artistic Heritage,* eds. Novaković, P., M. Hornak, M. Zachar, and N. Joncic: 33-52. University of Ljubljana Press: Ljubljana.

Triplet (2017), “Visualizing Medieval Iberia’s Contested Space Through Multiple Scales of Visibility Analysis.” In *Digital Methods and Remote Sensing in Archaeology. Quantitative Methods in the Humanities and Social Sciences*, eds. Forte, M. and Campana, S.: 199-227. Springer: Cham.

Verdonck, L., Launaro, A., Vermeulen, F., & Millett, M. (2020). “Ground-penetrating Radar Survey at Falerii Novi: A new approach to the study of Roman cities.” *Antiquity, 94*(375), 705-723.

Vermeulen, F. (2017), “Towards a Holistic Archaeological Survey Approach for Ancient Cityscapes.” In *Digital Methods and Remote Sensing in Archaeology. Quantitative Methods in the Humanities and Social Sciences*, eds. Forte, M. and Campana, S.: 91-112. Springer: Cham.

Zachar, J. and Horňák, M. (2017) *“3D Recording in Archaeological Practice.”* In *3D Digital Recording of Archaeological, Architectural and Artistic Heritage,* eds. Novaković, P., M. Hornak, M. Zachar, and N. Joncic: 53-84. University of Ljubljana Press: Ljubljana.

Zubrow, E. B., Evans, T. L., & Daly, P. (2006). “Digital Archaeology.” *Digital Archaeology. Bridging method and theory, London*: 10-31.

Additional readings may be provided at the beginning of the course.