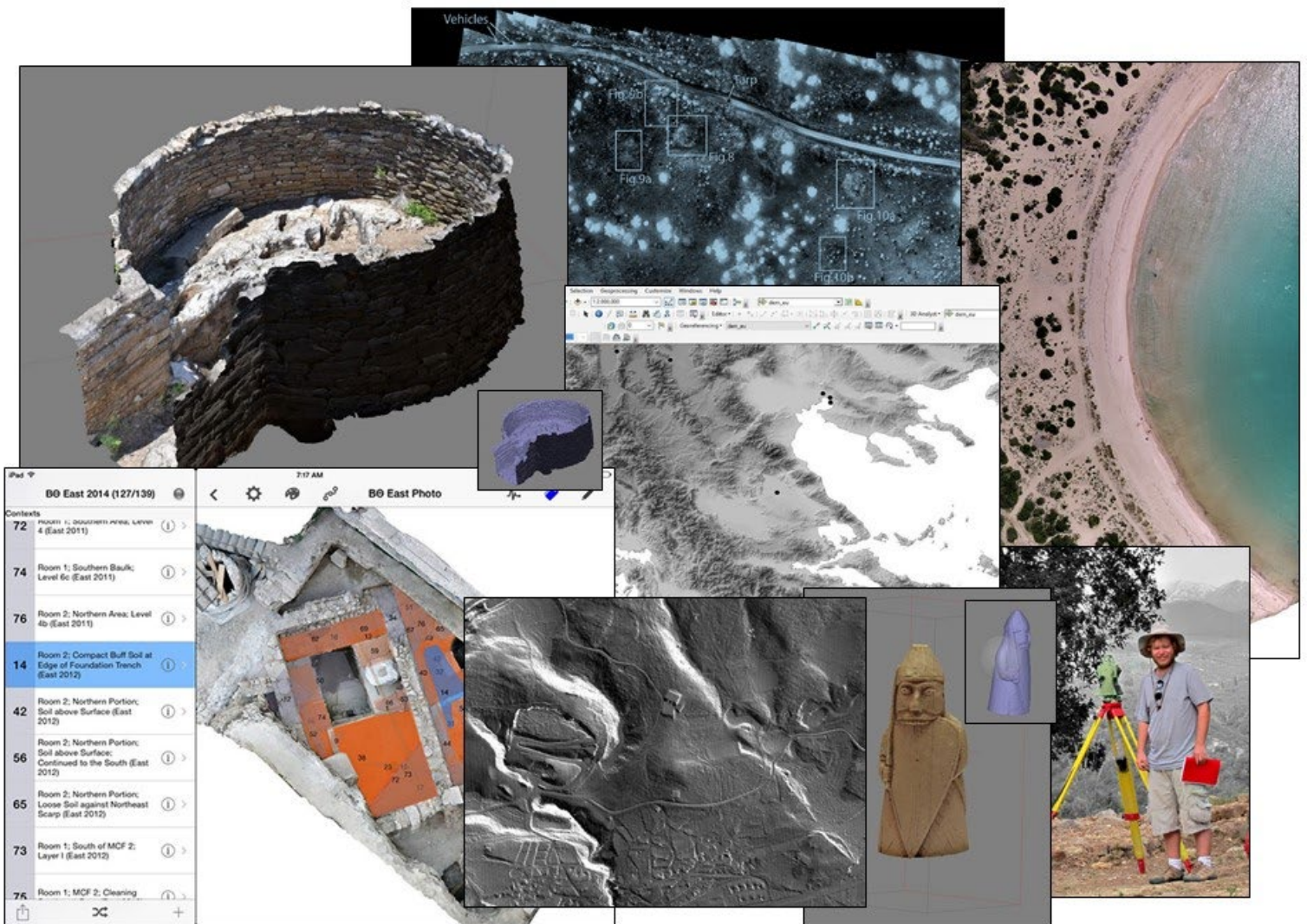


A310

**Introduction to
Digital Archaeology and Virtual Reality**



Fall Semester 2019

ARChLab

Mondays/Wednesdays, 11:00-12:40 AM

Course Instructor: Hüseyin Çınar Öztürk

Hours Available: Immediately after class or by appointment

Introduction to Digital Archaeology and Virtual Reality

1. Course Description

Archaeological methodology has been changing at a revolutionary pace throughout the last decade. Today old ways of recording and interpreting archaeological data are being replaced by digital and computational methods, and virtual reality has become a key component of archaeological projects and cultural heritage management (*CHM*) alike. The main aim of this course is for the student to develop a comprehensive understanding of the new possibilities offered by the most recent tools and methods in analyzing the past, as well as to acquire a practical skill set, which will be useful in both archaeological fieldwork and cultural heritage management projects.

Upon the successful completion of the course requirements by the end of the semester, students will have gained theoretical knowledge on and develop a deep familiarity with:

- archaeological databases and data management;
- tablet-based digital excavation recording systems, such as iDig;
- nondestructive methods of archaeological exploration and remote-sensing such as LIDAR, Ground Penetrating Radar, and Thermal Imaging;
- airborne imaging and its uses in archaeology;
- international digital archaeology case studies, such as Kaymakçı and Keros;
- the role of Geographical Information Systems (GIS) in archaeological research and interpretation of spatial data;
- online and digital publication of archaeological projects.
- the impact of archaeological sciences in modern analysis and interpretation of the past (e.g. aDNA studies, micromorphology, zooarchaeology, paleoethnobotany)

Students will also gain practical experience in 3D modeling and photogrammetry, which is fast becoming the norm on fieldwork projects. They will also have hands-on practice of spatial recording using a total station. Upon the successful completion of the course requirements, they will be able to:

- create 3D models of excavation trenches or buildings;
- create 3D models of archaeological artifacts (statues, weapons, etc.);
- digitally record architecture using photogrammetry-based orthophotos;
- fly a drone and take aerial photos;
- set-up and use a Total Station for spatial recording;
- create orthomaps and DEMs (digital elevation models), using drone photographs.

This course requires no previous archaeological fieldwork experience; however, since it is designed as a higher-level archaeology class, a substantial level of archaeological, historical, or anthropological knowledge is expected.

2. Course Resources and Activities

Given the ever-changing nature of the subject matter, rather than a particular textbook, we will be using chapters and articles from recent and up-to-date publications and online sources. The state of the discipline is such that half of the reading list changes every year. The readings, lecture slides, and workflows/technical tutorials for the computer-based projects will be regularly posted on Moodle as PDFs.

For the computer-based projects, the students may choose to use the computers in the CYA ARCHLab or their own computers. For the 3D modeling assignments, they can use their own DSLR cameras, or a camera provided by CYA. At the end of the semester the instructor will have the three best models 3D-printed and

proudly present them to the winners.

3. Course Requirements

- a) **Large object / Area 3D modeling:** Using the tutorial provided, you will create a 3D model of a large object or an area, such as a statue, garbage bin, the interior of your room, a tombstone or memorial monument from a cemetery, your incredibly motionless friend's body, the slope of a hill, an ancient wall from the Philopappos Hill, etc...
- b) **Small object 3D modeling:** Using the tutorial provided, you will create a 3D model of a small object, such as a stone artifact or a piece of jewelry. As archaeological objects in museums cannot be photographed from all angles, neither would it be legal to do so without a permit, you will need to choose a modern object.
- c) **2D digital recording of architectural features or trench sections:** The days of architectural illustrators using their plumb bobs and rulers have long gone. In this assignment, you will learn how to use photogrammetry-based orthophotos to create publication-quality 2D stone plan illustrations of architectural features or vertical trench sections.
- d) **DEM and Orthomap:** The increasing quality of digital airborne imaging and the decreasing prices of drones revolutionized the archaeological practice. In this assignment, you will create digital elevation models (a fancy term, which simply means a 3D representation of a terrain's surface) and mosaic orthomaps (aerial maps, corrected according to ground control points), using the photo-set provided.
- e) **Grant Application:** You will write an official archaeological project grant application for a fictional excavation or survey project of yours. You will need to: i) come up with a methodology incorporating the knowledge you acquired in our course, ii) determine which advanced tools or techniques to utilize, iii) calculate your expenses, iv) justify your choices regarding the terrain, geology, topography, and history of the fictional research area, v) hopefully convince the grant committee, which consists of the instructor. No budget limits. (ca 2500 words)
- f) **Final Exam:** Your knowledge on both technical (e.g. how do we use *thermal imaging* as a remote sensing tool in archaeology?) and theoretical/ethical (e.g. do digital methods and the pace and accuracy they provided prevent us from thinking deeply about fundamental issues?) aspects of the course will be assessed.
- g) **Class participation:** The frequency and quality of the questions raised and contributions to in-class discussions and practice will determine your class participation grade.

4. Grading and Evaluation

Your grade for this course will be based on the following distribution:

Assignment	%	Deadline
Large object / Area 3D modeling	15%	9 October
Small object 3D modeling	15%	23 October
2D architectural / trench section illustration	15%	4 November
DEM and orthomap	10%	4 December

Archaeological Project Grant Application	20%	Outline: 20 November First Draft: 4 December Submission: 11 December
Final Exam	20%	18 December
Class participation	5%	

- Students may choose to write a short research paper (2500 words) instead of the Archaeological Project Grant Application assignment.
- If you intend to upgrade the course to 400-level, one additional 3D model and a research paper (4000 words) will be required, in which case the Archaeological Project Grant Application assignment will become mandatory.
- For 5 pts. extra credit, which will be added to the Final Exam score, students may create an additional 3D model.

7) Use of Laptops and Tablets

In-class or on-site use of laptops and other devices is permitted if that facilitates course-related activities such as note-taking, looking up references, etc. Laptop or other device privileges will be suspended if there are indications that they are not being used for class-related work.

8) Attendance Policy

Only one unexcused absence will be allowed in accordance with the CYA policy. Further unexcused absences will lower your final grade. Please contact the Director of Academic Affairs in the case of an absence due to illness.

9) Accommodations for Students with Disabilities

If you are a registered (with your home institution) student with a disability and you are entitled to learning accommodation, please inform the Director of Academic Affairs and make sure that your school forwards the necessary documentation.

Class Schedule

1. 9.9 Introduction to Digital Archaeology

Fundamental concepts
Stratigraphy and fieldwork methodology
The history of digital archaeology and introduction to course

2. 11.9 Basic Principles of Photography & 3D Modeling

3. 16.9 Photogrammetry I

Introduction to photogrammetry
Workflow for artifact/small object and large object/area photogrammetry
Data Collection in Zooarchaeology: Incorporating Touch-Screen, Speech-Recognition, Barcodes, and GIS

Guest Lecturer: Dr Flint Dibble

- 4. 23.9 Photogrammetry II**
Photogrammetry workflow review
Stratigraphical recording
3D recording and field archaeology

- 5. 25.9 Remote Sensing in Archaeology**
Geophysical Methods of Remote Sensing
LIDAR
Thermal Imaging
Satellite Imagery
Case studies

- 6. 30.9 The use of drones in archaeology I**
History of aerial photography and archaeology
Aerial imagery as a remote sensing tool
Types of drones
Case studies

- 7. 2.10 GIS and Spatial archaeology I**
GIS and spatial recording in archaeology
Spatial recording tools: theodolite, GPS, d-GPS, Total Station
GIS software solutions: an overview

- 8. 7.10 GIS and Spatial archaeology II**
GIS and Survey and Excavation Methodologies
Guest Lecturer – Dr Denitsa Nenova

- 9. 9.10 Field Work I**
Surveying with Total Station & analogue architectural drawing

- 10. 11.10 Field Work II**
Surveying with Total Station & analogue architectural drawing

- 11. 14.10 Archaeological Illustration and the Digital Age I**
Photogrammetrical orthophotos and architectural illustration
Photogrammetry and trench section drawings
Workflow for 2D digital recording of architectural features and trench sections

- 12. 16.10 ARCHLab day**
2D illustration practice

- 13. 21.10 Digital documentation of archaeological fieldwork I**
Archaeological Fordism: The paper form revolution
History of archaeological databases
Archaeological databases: what to record?
Software solutions

- 14. 23.10 Digital documentation of archaeological fieldwork II**
Real-time tablet-based digital documentation.
Case Studies: Kaymakçı, Keros, Agora & iDIG

15. 30.10 The use of drones in archaeology II

Drones and macro-scale 3D modeling
Topographic Maps
Orthophotos and Digital Elevation Models
Workflow for DEMs and Orthomaps

16. 4.11 Cultural Heritage Management and Digital Age I

Can a virtual museum save Palmyra?
Museum collection management
New Media: museums & archaeological sites
3D reconstruction

17. 11.11 Cultural Heritage Management and Digital Age II

The Internet, Social Media, and the presentation of archaeological projects
Open Access to archaeological data (or the lack thereof)

18. 13.11 Formal What?: Ontology, Cidoc-CRM and integrated archaeological big data

Guest speaker: Dr George Bruseker

19. 18.11 New Approaches in Archaeological Sciences I

Ancient-DNA Revolution and human past
Archaeological critique

20. 20.11 Archaeological Illustration and the Digital Age II

History of archaeological illustration
Small object (pottery, stone tool, etc.) illustrations and digitization
Is automated small object illustration possible?

21. 2.12 New approaches in Archaeological Sciences II

Zooarchaeology, Paleoethnobotany, Physical Anthropology
Introduction to micromorphology and geo-archaeology
Guest lecturer: Laura Magno

22. 4.12 Wiener Lab Visit

We will visit a state-of-the-art archaeological science lab, [The Wiener Lab, ASCSA](#)

23. 9.12 Theorizing Digital Archaeology I

Critical approaches
Efficiency vs Slow Archaeology Debate

24. 11.12 Theorizing Digital Archaeology II

Discussion
General Review for the Final exam

Readings

- Ajayi, O. G., A. A. Salubi, A. F. Angbas, and M. G. Odigure. 2017. "Generation of Accurate Digital Elevation Models from UAV Acquired Low Percentage Overlapping Images," *International Journal of Remote Sensing* 38, pp. 3113–3134.
- Averett, E. W., J. M. Gordon, and D. B. Counts, eds. 2016. *Mobilizing the Past for a Digital Future: The Potential of Digital Archaeology*, Grand Forks, ND.
- Balletti, C., C. Beltrame, E. Costa, F. Guerra, and P. Vernier. 2015. "Photogrammetry in Maritime and Underwater Archaeology: Two Marble Wrecks from Sicily," ed. L. Pezzati and P. Targowski, Munich, Germany, p. 95270M.
- Bruseker, G., N. Carboni, and A. Guillem. 2017. "Cultural Heritage Data Management: The Role of Formal Ontology and CIDOC CRM," in *Heritage and Archaeology in the Digital Age*, ed. M. L. Vincent, V. M. López-Menchero Bendicho, M. Ioannides, and T. E. Levy, Cham, pp. 93–131.
- Callaway, E. 2018. "Divided by DNA: The Uneasy Relationship between Archaeology and Ancient Genomics," *Nature* 555, pp. 573–576.
- Campana, S. 2017. "Drones in Archaeology. State-of-the-Art and Future Perspectives: Drones in Archaeology," *Archaeological Prospection* 24, pp. 275–296.
- Casana, J., J. Kantner, A. Wiewel, and J. Cothren. 2014. "Archaeological Aerial Thermography: A Case Study at the Chaco-Era Blue J Community, New Mexico," *Journal of Archaeological Science* 45, pp. 207–219.
- Chase, A. F., D. Z. Chase, J. F. Weishampel, J. B. Drake, R. L. Shrestha, K. C. Slatton, J. J. Awe, and W. E. Carter. 2011. "Airborne LiDAR, Archaeology, and the Ancient Maya Landscape at Caracol, Belize," *Journal of Archaeological Science* 38, pp. 387–398.
- Connolly, D. 2009. *Record Sheet and Report Templates, Risk Assessment Forms & Other Guides*, 3. ed., London.
- Conolly, J., and M. Lake. 2006. *Geographical Information Systems in Archaeology*, Cambridge, UK ; New York.
- Dibble, W. F. 2015. "Data Collection in Zooarchaeology: Incorporating Touch-Screen, Speech-Recognition, Barcodes, and GIS," *Ethnobiology Letters* 6, p. 249.
- Homsher, R. S., M. J. Adams, A. B. Prins, R. Gardner-Cook, and Y. Tepper. 2017. "New Directions with Digital Archaeology and Spatial Analysis in the Jezreel Valley," *Journal of Landscape Ecology* 10, pp. 154–164.
- Huggett, J. 2015a. "Challenging Digital Archaeology," *Open Archaeology* 1.
- . 2015b. "A Manifesto for an Introspective Digital Archaeology," *Open Archaeology* 1.
- Kristiansen, K. 2009. *The Discipline of Archaeology*.

- Morgan, C., and H. Wright. 2018. "Pencils and Pixels: Drawing and Digital Media in Archaeological Field Recording," *Journal of Field Archaeology* 43, pp. 136–151.
- Musson, C., R. Palmer, S. Campana, and Aerial Archaeology Research Group. 2013. *Flights into the Past: Aerial Photography, Photo Interpretation and Mapping for Archaeology*, Heidelberg.
- Olson, B. R., W. R. Caraher, and S. Heath. 2015. *Visions of Substance: 3D Imaging in Mediterranean Archaeology*.
- Opitz, R. S., and T. D. Johnson. 2016. "Interpretation at the Controller's Edge: Designing Graphical User Interfaces for the Digital Publication of the Excavations at Gabii (Italy)," *Open Archaeology* 1.
- Pavel, C. 2010. *Describing and Interpreting the Past: European and American Approaches to the Written Record of the Excavation*, București.
- Reich, D. 2018. *Who We Are and How We Got Here: Ancient DNA Revolution and the New Science of the Human Past*, First edition., New York.
- Roosevelt, C. H., P. Cobb, E. Moss, B. R. Olson, and S. Ünlüsoy. 2015. "Excavation Is Destruction Digitization: Advances in Archaeological Practice," *Journal of Field Archaeology* 40, pp. 325–346.
- Sapirstein, P., and S. Murray. 2017. "Establishing Best Practices for Photogrammetric Recording During Archaeological Fieldwork," *Journal of Field Archaeology* 42, pp. 337–350.
- Stanco, F., S. Battiato, and G. Gallo, eds. 2012. *Digital Imaging for Cultural Heritage Preservation Analysis, Restoration, and Reconstruction of Ancient Artworks*, Boca Raton.
- Strasser, T. F., S. C. Murray, A. van der Geer, C. Kolb, and L. A. Ruprecht. 2018. "Palaeolithic Cave Art from Crete, Greece," *Journal of Archaeological Science: Reports* 18, pp. 100–108.
- Vermeulen, F. 2016. "Towards a Holistic Archaeological Survey Approach for Ancient Cityscapes," in *Digital Methods and Remote Sensing in Archaeology*, ed. M. Forte and S. Campana, Cham, pp. 91–112.
- Vincent, M. L. 2017. "Crowdsourced Data for Cultural Heritage," in *Heritage and Archaeology in the Digital Age*, ed. M. L. Vincent, V. M. López-Menchero Bendicho, M. Ioannides, and T. E. Levy, Cham, pp. 79–91.

Online Sources

3D Model Reconstruction <https://www.agisoft.com/index.php?id=32>.

A Comprehensive Beginner's Guide to Aperture, Shutter Speed, and ISO
<https://petapixel.com/2016/06/25/comprehensive-beginners-guide-aperture-shutter-speed-iso/>.

Archaeology-related articles in Remote Sensing Journal

https://www.mdpi.com/search?q=archaeology&authors=&journal=remotesensing&article_type=&search=Search.

Autodesk ReMake - How to Take Photos for Photogrammetry – YouTube

<https://www.youtube.com/watch?v=D7Torjfec4>.

Conversation Piece: Disciplining the Digital | Issue 6 - June 2017 | Issues | British Art Studies

<https://www.britishartstudies.ac.uk/issues/issue-index/issue-6/virtual-reproduction>.

Digital Photogrammetry applied to Archaeology Research Papers - Academia.edu

https://www.academia.edu/Documents/in/Digital_Photogrammetry_applied_to_Archaeology.

Farago, J. "The Ancient Syrian City ISIS Is Destroying, Preserved Online - The New York Times"

<https://www.nytimes.com/2017/02/15/arts/design/palmyra-syria-isis.html>.

Harmon, A. "Why White Supremacists Are Chugging Milk (and Why Geneticists Are Alarmed) - The

New York Times" <https://www.nytimes.com/2018/10/17/us/white-supremacists-science-dna.html>.

Home | CIDOC CRM <http://www.cidoc-crm.org/>.

Home | Rekrei <https://projectmosul.org/>.

How LiDAR was used to uncover archaeology in South Downs – YouTube

<https://www.youtube.com/watch?v=iVnzsYLatNI>.

Lewis-Kraus, G. "Is Ancient DNA Research Revealing New Truths — or Falling Into Old Traps? - The

New York Times" <https://www.nytimes.com/2019/01/17/magazine/ancient-dna-paleogenomics.html>.

Inking Archaeological pottery with ILLUSTRATOR - Open Shape (bowl rim) - 1 – YouTube

https://www.youtube.com/watch?v=3F2c0_UIDS0&t=.

Magnetometry at Stonehenge – YouTube <https://www.youtube.com/watch?v=7ippAA86Bdc>.

National Geographic - Lost Treasures of the Maya Snake Kings – YouTube

<https://www.youtube.com/watch?v=SwihfJgRRvs>.

Reich, D. "Opinion | How Genetics Is Changing Our Understanding of "Race" - The New York Times"

<https://www.nytimes.com/2018/03/23/opinion/sunday/genetics-race.html>.

— — — "Opinion | How to Talk About "Race" and Genetics - The New York Times"

<https://www.nytimes.com/2018/03/30/opinion/race-genetics.html>.

Supplemental Material for Excavation is Destruction Digitization: Advances in Archaeological Practice: Journal of Field Archaeology: Vol 40, No 3

<https://www.tandfonline.com/doi/suppl/10.1179/2042458215Y.0000000004?scroll=top>

The Legacy of Ancient Palmyra (Getty Research Institute)

http://www.getty.edu/research/exhibitions_events/exhibitions/palmyra/index.html.

The magic of lidar 3d mapping – YouTube <https://www.youtube.com/watch?v=0XdqGNu9bhk>.

The PRESIOUS Project | Presious <http://www.presious.eu/>.

Zimmer, C. "Clues to Africa's Mysterious Past Found in Ancient Skeletons - The New York Times"

<https://www.nytimes.com/2017/09/21/science/africa-dna-migration.html>.