

# GRADUATION PLAN

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**Stefanos Koufopoulos**

(4624866)

[stefkoufop@gmail.com](mailto:stefkoufop@gmail.com)

[s.koufopoulos@student.tudelft.nl](mailto:s.koufopoulos@student.tudelft.nl)

aE **INTECTURE Architectural Engineering** Graduation Studio

Mentors: **Mauro Parravicini** (Architecture) &

**Marcel Bilow** (Research & Building Technology)

(‘make’ / ‘shelterlands’)

## Choice of Studio

The *aE* graduation studio allows me the opportunity to explore deeply a much-desired specific topic on shelters. Undoubtedly the studio demands both, to develop an innovative general design for shelter, and to investigate existing or new broad and extreme fabrication techniques and materials for the actual shelter implementation. While interested in researching in an alternative topic than the usual, the *aE* studio encourages this opportunity, to focus/delve into the specific theme, to be practical and to get fascinated by sophisticated structures.

# Graduation Project

## Title

### **Shelters for Archaeology**

An Architectural Sheltering System for Monuments & Excavation Sites,  
in the case study of Ancient Eleon in Greece.

## Keywords:

*archaeological site, shelter, canopy, transitional, temporary, module, reversible*

## Problem Statement

In the various Mediterranean countries and more specifically in mainlands such as Italy, France, Greece and its islands, Turkey and large islands such as Cyprus, there has been preserved to our days a vast number of archaeological sites. While, their dating spreads through several long historical periods, these sites are located in areas with different characteristics and landscapes. For instance, in Greece, some sites or settlements currently in need date back to the prehistoric period rather than the ancient-classical era. There also numerous archaeological sites that require protection dating to the Hellenistic, Roman, early Christian, Byzantine up to the post Byzantine period. There are also sites of ruined vernacular architecture of various dates.

Sites range from isolated small-scale structures either foundation remains or partly standing roofless buildings (for instance a small chapel) to large scale monumental ruins or even settlements (such as a roman forum). All those sites can be categorized as archaeological sites.

Undoubtedly a varying factor for their evaluation is the escalation of importance of each site as a work of architecture, art or even of major or not historic significance. There are numerous sites considered so far "insignificant" but this may change in the future. What about those remarkably noteworthy sites in several aspects, in which their most valuable parts or ensembles need urgent or immediate protection. Heritage sites share few common characteristics such as the partial preservation of their original layout and in most cases the lack of protective roofing. In most cases once archaeological sites are excavated and unearthed they become extremely vulnerable to weather conditions, corrosion is accelerated and sometimes even manmade threats arise, such as theft.

On the one hand, contemporary archeological practice is continuously underway unearthing and revealing new sites, findings and evidence which is added to the existing significant stock that in several cases waits for its further protection, study, conservation and highlighting-promotion. Due to their number and the cost, many sites are treated sporadically and therefore numerous inevitably remain neglected. Undoubtedly, on site process of an archeological mission requires plenty of time and effort. But the archeological season is usually limited in the summer period when the working conditions are rather more appropriate. In

general, the conditions are not ideal neither for summer intense field work nor for all-year round. So, a new and ongoing excavation site has to pause during winter till next summer season and this becomes a major issue for this paper. Thus, the practitioners face with the dilemma of assessing sites' potential in order to select those that are the most emergent priority for action.

Therefore, some small or medium scale sites remain on hold. This means that they are either 'open' sites that can suffer from deterioration while waiting for the beginning or continuation of a future conservation phase or sealed through their reburial. For example, this is the yearly reburial routine on excavation sites or the installation of a temporary canopy over a roofless monument.

## **Objective**

On the other hand, there is an amount of workload that is inevitable to go through without an acceptable working condition that a temporary shelter offers to an 'open' site. The main purpose is to protect the valuables for a considerable period of time avoiding repetitive reburial or removals. The second purpose is to address and ameliorate operational issues for the specialists' working environment (free span) and also, to create a highlighting structure to pinpoint the existence of a place of importance for locals and visitors. The creation of new shelters will create pop-up landmark spots. Then, it depends to whether it will be substituted by another 'permanent' shelter after its completion. Therefore, its presence will affect temporarily the site and it will mainly be used for a 'transitional' period

The thematic focus rests upon an innovative solution addressing the majority of such ruined monuments and archaeological sites. The research and design drives towards a state-of-the-art proposal in which the advantages of a repetitive module-component building system along with advantages of new digital fabrication techniques to be taken into consideration. Of course, it is necessary to create a meaningful architectural result in relevance to the according sheltered monumental site(s).

The main objective of the project is to create a prototype structure that responds to the specific requirements for the overall given context. The original intention is to create a modular and flexible design that can be efficiently manufactured, transferred and assembled on site, addressing not only in a case-study context but even in a broader one. From that perspective, it can be addressed both as a product for archaeologists, restorers, conservators and other heritage specialists.

The requirements of the design have to be defined (site, span size, standards, climate). Therefore, the canopy design both responds to protective requirements for the artefacts and the people and also to reversibility (requirement for any archaeological site) and reuse. The shelter/canopy design has to protect sites during no action periods (ex. in-between excavation missions) for the significant time (1-10 years) required to conclude the archaeological, conservation or restoration studies and work.

## **Overall Design Question**

While located in the Greek (Mediterranean) context, the overall question relies on 'how

to create a modular, sustainable and reversible architectural-structural system as a transitional shelter which protects damaged or endangered monuments, and archaeological sites and excavations?

### **Thematic Research Question**

How to create an innovative and modular componential system for a structure with an envelope, for a considerable period as a transitional archaeological shelter with various spans and variations of form, in order to be assembled easily on various sites? Therefore, the thematic focus and technical question is based on built precedents in order to find: "Which is the ideal system(s), for a modular and flexible archaeological shelter installation with various spans and variations as a combination of structure and envelope?"

### **Project Location(s)**

Although the project aims to find application to a wide Mediterranean (and European) context, the design assignment focuses on sites in Greece. This is due to convenience in language and access to information from bibliography, visits, digital databases-archives, etc. In Greece, there are numerous excavations and archaeological sites with monuments. More specifically, as a starting point the selection of a specific area with dense existence of monuments to zoom in, is necessary. This is the province of ancient Corinth (1h distance from Athens) where, in reality, in that province there are certain sites that respond to the objective. These potential sites are inside the archaeological site of Ancient Corinth (1. new shelter for the mosaics of the south Stoa, 2. mosaics in the southwest Frankish area), the Lechaion (the ruins of an early Christian basilica) and a Roman Villa (Katounistra). Also, there are other sites in progress such as: the Ancient Thouria (ancient temple excavation in Kalamata), the Ancient Eleon excavation (in progress discovery of an ancient city).

### **Design Assignment**

The final result of the architectural design shall be a set of structure types of shelters using components of different or adjustable sizes that could apply to the different scale and characteristics of each site. For this reason the major architectural principle is that the structures should form a "library" of different but compatible components. Those components have to be fully studied as geometrical forms and in construction detailing by considering aspects such as workability, the need for a minimum footprint within the ancient ruins, safety and the quality of form.

### **Relevance**

The graduation project is oriented towards embracing and preserving the cultural value of our global and more particularly European heritage, which is celebrated all around Europe every now and then and more particularly in this year 2018. Also, it aims to the subsequent possibilities for the protection and highlighting and exploitation of points of interest within archaeological sites.

By either looking in a broader geographical context or selecting a case-study location, the shelter project still addresses a large interesting scholarly and artistic framework, which joints architecture, building technology, manufacturing for the sake of archaeology. So, its value is multifaceted and eventually it will require a multi-disciplinary approach. Even though it doesn't tackle an obviously immediate societal issue (such as dwelling or climate), it focuses on a sustainable upgrading of the architectural safeguarding of cultural heritage, which is significant as well. Therefore, the social aspect can be considered rather as socially indirect but physically and culturally direct.

There are various types of protective structures used for temporary or permanent protection of archaeological sites internationally. Mainly, their design is not based to a single theoretical principle but varies depending on the location, the form and the extent of the ruins and the scientific education and the overall culture of the designers.<sup>1</sup>

Now, the topic of archaeological protection on site is not the initial priority because even if it is a nonstop task, the major issue concerning the first-class sites around the world has been widely addressed. Guidelines arriving from the charters and more specific publications discuss each European state excavations policy<sup>2</sup> that complies with the ratified European Convention for the Protection of Archaeological Heritage (Law 3378/2005).

## Process

### Method description

The methods for research and design of this project are:

- Bibliographical research and study of published papers, presenting and criticizing built examples and providing guidelines.
- Case studies for argumentation over building techniques and innovative use of contemporary materials,
- Field research with site visit to the site(s) and other examples to evaluate,
- Contact and consultation by specialists (Ephorate of Antiquities, American & French archaeological schools/missions in Athens, archaeologists, conservators)
- Research by design (sketch & digital modelling of various systems and solutions),
- Research by model making and trial-and-error testing (Geometrical/ structural/ material exploration).

## Literature

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<sup>1</sup> ETEPAM (2008) p.1-2.

<sup>2</sup> Pantos, P. ( )The legal framework for the archaeological excavations in Greece: From the 20th to the 21th century.

Abbreviations:	DAM: Deutsches Architekturmuseum and Frankfurt am Main (Germany)
	ETEPAM: Society for the Research & Promotion of the Scientific Restoration of Monuments
	GCI: The Getty Conservation Institute
	ICCM: International Committee for the Conservation of Mosaics
	ICSA: International Conference on Structures & Architecture
	IJCMEM: International Journal of Computational Methods & Experimental Measurements
	IJSS: International Journal of Space Structures
	NTUA: National Technical University of Athens
	STREMAH: Structural Repairs and Maintenance of Heritage Architecture
	SSRMHB : Structural Studies, Repairs and Maintenance of Historical Buildings

## **Bibliography** (chronological)

### **About Technique**

- Engel, H. (1967) *Tragsysteme: structure systems*. Stuttgart: Deutsche Verlags-Anstalt.
  - Donin, G. (ed.) (1982) *Renzo Piano: pezzo per pezzo, piece by piece*. exhibition catalogue, Rome: Casa del Libro Editrice.
  - Buchanan, P. (1993) *Renzo piano building workshop : complete works*. Vol. 1, London: Phaidon.
  - Escrig, F., Brebbia, C.A. & International Conference on Mobile and Rapidly Assembled Structures (1996) *Mobile and rapidly assembled structures II*. MARAS II June 1996 Seville. Southampton: Computational Mechanics Publications.
  - Vandenbeg, M. (1996) *Soft Canopies: Detail in Building*. London: Academy editions.
  - Schock, H.-J. (1997) *Soft Shells: Design and Technology of Tensile Architecture*. Basel: Birkhäuser.
  - Piano, R., Brignolo, R., Frampton, K. & Evans, H. (1997) *The Renzo Piano logbook*. London: Thames & Hudson.
  - Escrig, F., Brebbia, C.A., Wessex Institute of Technology & International Conference on Mobile and Rapidly Assembled Structures (2000) *Mobile and rapidly assembled structures III*. MARAS III Madrid, Southampton: WIT Press (International series on advances in architecture, 11).
  - Schulitz, H. C., Sobek, W., Habermann, K. J., Söffker G. & Thrift, P. (2000) *Steel construction manual*. Basel: Birkhäuser.
  - Bahamón A. (2004) *The magic of tents : transforming space*. New York: Harper Design International.
  - Kaltenbach, F. (ed.) (2004) *Translucent materials : glass, plastics, metals*. Edition Detail (Detail Praxis), Basel: Birkhäuser.
  - Charleson, A. (2005) *Structure as architecture : a source book for architects and structural engineers*. Oxford: Elsevier.
  - Otto, F., Nerdinger, W., Meissner, I., Barthel, R., Breusing, C. & Architekturmuseum der Technischen Universität München (2005) *Frei otto, complete works: lightweight construction, natural design*. Basel: Birkhäuser.
  - Hegger, M. (2006) *Construction materials manual*. Basel: Birkhäuser.
  - Place, W. (2007) *Architectural structures*. Hoboken: Wiley.
  - Bechthold, M. (2008) *Innovative surface structures : technology and applications*. London: Taylor & Francis.
  - Drew, P. (2008) *New tent architecture*. London: Thames & Hudson.
  - Eekhout, M. (2008) *Methodology for Product Development in Architecture*. Amsterdam: IOS Press.
  - LeCuyer, A. (2008) *ETFE: Technology and Design Structures*. Basel: Birkhäuser.
  - Popovic Larsen, O. (2008) *Reciprocal Frame Architecture*. Elsevier: Architectural Press.
  - Cashola Schmal, Peter (ed.) (2009) *The Pavilion - Pleasure and Polemics in Architecture (= Der pavillon: lust und polemik in der architektur)*, exhibition catalogue, DAM, Dezernat für Kultur und Wissenschaft, Ostfildern: Hatje Cantz.
  - Seidel, M. (2009) *Tensile Surface Structures: A Practical Guide to Cable and Membrane Construction*. Berlin: Ernst&Sohn
  - Kula, D. & Ternaux, É. (2013). *Materiology : the creative industry's guide to materials and technologies*. Basel: Birkhäuser.
  - Adriaenssens S., Block P., Veenendaal D. & Williams C. (2014) *Shell structures for architecture: form finding and optimization*. Abingdon, Oxon: Routledge.
  - McLean, W. & Silver, P. (2015) *Air Structures*, London: Laurence King Publishing.
  - Llorens J. (ed.) (2015) *Fabric Structures in Architecture*, Cambridge: Woodhead Publishing.
- <https://www.sciencedirect.com/science/book/9781782422334>

### **About Context**

- Serrao K. & Anagnostopoulou G. (1988) *Monument sheltering with new structures*, Student Thesis, NTUA, School of Architecture, Athens.

- Stanley-Price, N. (ed.) (1991) *The Conservation of the Orpheus Mosaic at Paphos, Cyprus*. Marina del Rey, CA: The Getty Conservation Institute, pp.36–41. <[http://hdl.handle.net/10020/gci\\_pubs/orpheus\\_mosaic](http://hdl.handle.net/10020/gci_pubs/orpheus_mosaic)>
- Ben Abed Ben Khader, Aïcha & Demas, Martha & Roby, Thomas (eds.) (2008) *Lessons Learned: Reflecting on the Theory and Practice of Mosaic Conservation: Proceedings of the 9<sup>th</sup> ICCM Conference, Hammamet, Tunisia, 29 Nov – 3 Dec 2005*. LA: GCI. <[http://hdl.handle.net/10020/gci\\_pubs/lessons\\_learned](http://hdl.handle.net/10020/gci_pubs/lessons_learned)>
- Theocharidou K. (ed.) (2008) *Στέγαστρα και Κελύφη Προστασίας Αρχαιολογικών Χώρων. (= Shelters and Protective Shells for Archaeological Sites)*, Conference Proceedings. 1/6/2007, Thessaloniki: ΕΤΕΠΑΜ, In Greek w/ English summaries.
- Vanore, Margherita (ed.) (2010) *Archaeology's places and contemporary uses. Erasmus intensive programme 2009|2010 design workshop*, Venice: IUAV.
- Roby T. & Demas M. (eds.) (2013) *Mosaics In Situ: An Overview of the Literature on Conservation of Mosaics In Situ*, LA: The Getty Conservation Institute. <[http://getty.edu/conservation/publications\\_resources/pdf\\_publications/pdf/lit\\_review.pdf](http://getty.edu/conservation/publications_resources/pdf_publications/pdf/lit_review.pdf)>

## Articles & Papers

(chronological)

### About Sheltering

- Agnew, Neville & Coffman, Richard (1991) "Development and evaluation of the Hexashelter", at: Stanley-Price, N. (ed.) *The Conservation of the Orpheus Mosaic at Paphos, Cyprus*, Marina del Rey, CA: GCI, p.36–41.
- S. Hebbelinck, A.H. Hendrickx, M. Mollaert & J. Haase (2001) "New Ideas On The Use Of Systematically Constructed Tension Structures To Cover Historical And Archaeological Sites", *SSRMHB VII, WIT Transactions on the Built Environment*, Vol.55, WIT Press.
- Voziki, K.T. (2005) "Protective Structures on Archaeological Sites in Greece" at: *WSEAS International Conference on Environment, Ecosystems and Development, Venice, Italy, 2-4 Nov, 2005*, p.120-125. <<http://www.wseas.us/e-library/conferences/2005venice/allpapers.htm>>
- Gelez S., Aubry S. & Vaudeville B. (2011) "Nexorade or Reciprocal Frame System Applied to the Design and Construction of a 850 m<sup>2</sup> Archaeological Shelter", *IJSS*, vol. 26, issue 4, Dec 2011, pp. 303–311. <<http://dx.doi.org/10.1260/0266-3511.26.4.303>>
- Mollaert M., De Laet L., Verdonck A., S. Lombardi S., Beccarelli P. & Zanelli A. (2011) "Textile shelters for archaeological or heritage areas: design references", *STREMAH XII, WIT Transactions on The Built Environment*, Vol. 118, WIT Press, pp.387-398.
- Ladstätter, S. & Zabrana, L. (2012) "The Shelter Construction for Terrace House 2 in Ephesos: A Unique Museum and Scientific Workshop" at: Korka, E. (ed.) (2014) *The Protection of Archaeological Heritage in Times of Economic Crisis*, Conference Proceedings, From Past Experience to New Approaches and Synergies: The Future of Protection Management for Archaeological Heritage in Times of Economic Crisis", New Acropolis Museum, 23-25/5/12, 234-242.
- Demas, M. (2013) Protective Shelters for Archaeological Sites, chapter 4, at: Roby T. & Demas, M. (eds.) (2013) *Mosaics In Situ: An Overview of the Literature on Conservation of Mosaics In Situ*, LA: GCI, p..... <[http://getty.edu/conservation/publications\\_resources/pdf\\_publications/pdf/lit\\_review.pdf](http://getty.edu/conservation/publications_resources/pdf_publications/pdf/lit_review.pdf)>
- Zanelli A., Rosina E., Beccarelli R., Maffei R. & Carra G. (2013) "Innovative solutions for ultra-lightweight textile shelters covering archaeological sites", *Proceedings of the 2nd ICSA 2013*, Guimarães, Portugal, July 2013, CRC Press, Taylor & Francis Group, pp.1-8. <<https://www.researchgate.net/publication/276274334>>
- Cabello-Briones, C. (2014) "Effects of open shelters on limestone decay: the case-study of the Bishop's Palace archaeological site in Witney (England)", *June 2014, Conference: The 2nd International Congress on Science & Technology for the Conservation of Cultural Heritage*, at: Sevilla, Spain
- Barozzi M., Viscuso S. & Zanelli A. (2015) Design novel covering system for archaeological areas. In: Proceedings of VII International conference of Textile Composites and Inflatable Structures (Structural Membranes 2015). Barcelona, 19-21 October 2015, p. 105-114,
- Zanelli A. (2015), "Architectural fabric structures in refurbishment of archaeological and cultural heritage areas", chapter 15 at: Llorens J. (ed.) (2015) *Fabric Structures in Architecture*, Cambridge: Woodhead Publishing, p.481-527. <<https://doi.org/10.1016/B978-1-78242-233-4.00015-2>>
- Llorens J. & Zanelli A. (2016), "Structural membranes for the refurbishment of architectural heritage", *International Symposium on Novel structural skins - Improving sustainability and efficiency through new structural textile materials and designs*, *Procedia Engineering* 155, p.18-27.
- Corio, E. et al. (2017) "Conception and Parametric Design Workflow for a Timber Large-spanned Reversible Grid Shell to Shelter the Archaeological Site of the Roman Shipwrecks in Pisa", *IJCMEM*, Volume 5, Issue 4, p.551–561.

- Aslan Z., Court S., Teutonico J.M. & Thompson J. (eds) (2018) Protective Shelters for Archaeological Sites: proceedings of a symposium, Herculaneum, Italy, 23–27 September 2013, The British School at Rome.

## Other

- Wilson, A. - Architen Landrell Associates (2009) "ETFE; The New Fabric Roof", *Interface Magazine*, January 2009.
- Roberts, S.J. (2014) *Designing Form-Active Portable Shelters: Parametric Frameworks for Small-Scale Equilibrium Structures / Landscapskunst En Locatietheater: Temporary Structures for Art, Theater, and Living at the Oerol Festival, NL*, Master Thesis, TU Delft. <uuid:652a0fea-604c-429f-8290-f2476a5ccc6f>

## Websites

(all last accessed at 23/4/2018)

- Lynch P. (2016) "ETFE: The Rise of Architecture's Favorite Polymer" 06 Apr 2016. ArchDaily. <<https://www.archdaily.com/784723/etfe-the-rise-of-architectures-favorite-polymer/>>
- "Students of Ball State Construct Parametric Tensegrity Structure for Local Art Fair" 04 Oct 2014. ArchDaily. <<https://www.archdaily.com/553311/students-of-ball-state-construct-parametric-tensegrity-structure-for-local-art-fair/>>

### Abbreviations:

MCS: Ministry of Culture and Sports  
 EL: Hellenic Republic  
 FSA: French School at Athens  
 BSA: British School at Athens

ASCSA: American School of Classical Studies, Athens  
 UoA: National & Kapodistrian University of Athens  
 EBAP: Eastern Boeotia Archaeological Project  
 CIG: Canadian Institute in Greece

- [https://histosm.org/#8/23.84583/38.63404/0/archaeological\\_site](https://histosm.org/#8/23.84583/38.63404/0/archaeological_site)
- Shelters for Archaeological Sites with Mosaics, MOSAIKON Initiative (2014) GCI  
[http://www.getty.edu/conservation/our\\_projects/education/shelters/](http://www.getty.edu/conservation/our_projects/education/shelters/)
- Excavations activity per year (2018) MCS, EL.  
<https://www.culture.gr/el/service/SitePages/excavation.aspx>
- Interactive culture map of Greece, Odysseus platform (2012) MCS, EL.  
<http://odysseus.culture.gr/a/map/gmaps.jsp>
- The American School of Classical Studies at Athens (2018)  
<http://www.ascsa.edu.gr>
- Maps, GIS data, and archaeological data for Corinth & Greece  
<http://www.ascsa.edu.gr/index.php/excavationcorinth/maps-and-gis-data-for-corinth-and-greece>
- ASCSA Digital Collections, Corinth Excavations  
<http://corinth.ascsa.net/>
- Excavation Sites (2016) FSA  
<https://www.efa.gr/index.php/en/recherche/sites-de-fouilles>
- Graphic and photographic archives (2011) FSA  
<http://archimage.efa.gr>
- Online Chronicle of excavations, journal of hellenic studies: archaeological reports (2018) BSA & FSA  
<http://chronique.efa.gr/index.php/fiches/maps/>
- <http://www.persee.fr>
- Digital Archive of Archaeological Projects and Research, CIG.  
<http://portal.cig-icg.gr/>
- EBAP excavations  
<https://ebapexcavations.org>
- Ancient Thouria Excavation  
<http://ancientthouriaexcavation.gr/en/>
- Excavations, Faculty of History and Archaeology, UoA  
<http://en.arch.uoa.gr/research-congresses/excavations.html>
- Museum of ancient eleutherna  
<http://en.mae.com.gr/orthi-petra-cemetery.html>
- Archaeology & Arts, online magazine  
<http://www.archaiologia.gr>
- excavation shelter, TESS engineers  
<http://www.tess.fr/en/projet/excavation-shelter>
- <http://www.bibracte.fr/fr/an-innovative-shelter-to-protect-the-remains>
- TensiNet association (2015-18)  
<http://www.tensinet.com>
- mdt sun protection systems (2018)  
<https://www.mdt-tex.com>
- <http://www.rpbw.com/project/lbm-travelling-pavilion>
- <http://www.freiotto.com/>
- <https://www.unstudio.com/en/page/8140/prototype-ii>
- <http://domesindex.com/buildings/stegastro-tymbwn-mara8wna/>
- <http://www.kathimerini.gr/776975/opinion/epikairothta/politikh/anaskafikos-toyrismos>
- <http://www.biris-tsiraki-architects.com/biris/εργα/1990-2000/ακρόπολη-90/>
- SO-IL (2014) *Veiled*, Aegean Sea, Greece. Hotel, Concept design, Venice Biennale, Greek Pavillion. <http://so-il.org/projects/veiled>