

EDICULA

Educational Digital Innovative Cultural heritage related Learning Activities

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O5 EDICULA SYNTHESIS
D5.2: Teaching the innovation in post-graduate level
NTUA
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Introduction

This deliverable analyzes the teaching methodologies that should be applied in post graduate level emphasizing in transdisciplinarity, innovative thinking and hands-on experience. It is related to Task. 5.2

Teaching innovation is the crucial link for connecting new learning approaches and transdisciplinarity with hands-on training, advancing from applying a purely theoretical knowledge to solving and addressing grand challenges in real scale and real time.

Within this context, the innovation of the Holy Sepulchre rehabilitation encompasses all the above characteristics.

At post graduate level, Innovation is embedded in the curricula through various case-studies but equally important through the emphasis on merging basic scientific backgrounds with the demand for smart, effective and sustainable solutions to complex challenges. It is this mentality, i.e. Innovation in-line with fundamental know-how, that is infused into the post-graduate curricula, and thus transferred to the market and stakeholders upon the adoption of this mentality by the graduates. In this context, the Innovation of the Holy Sepulchre project was clearly presented during the NTUA seminar series.

This task is connected to the Multiplier Events E1 and E2.

1. Guidelines for Education and training in the conservation of Monuments, Ensembles and Sites

The protection of monuments is a characteristic field where the need for interdisciplinary cooperation has already been expressed in the Venice Charter for the conservation and restoration of monuments and sites. Additionally, the need for transdisciplinary education in this field has been expressed in the ICOMOS Guidelines for education and training in the conservation of monuments, ensembles and sites.

The General Assembly of the International Council on Monuments and Sites, ICOMOS, meeting in Colombo, Sri Lanka, at its tenth session from July 30 to August 7, 1993; Considering the breadth of the heritage encompassed within the concept of monuments, ensembles and sites; Considering the great variety of actions and treatments required for the conservation of these heritage resources, and the necessity of a common discipline for their guidance; Recognizing that many different professions need to collaborate within the common discipline of conservation in the process and require proper education and training in order to guarantee good communication and coordinated action in conservation; Noting the Venice Charter and related ICOMOS doctrine, and the need to provide a reference for the institutions and bodies involved in developing training programmes, and to assist in defining and building up appropriate standards and criteria suitable to meet the specific cultural and technical requirements in each community or region; Adopts the following guidelines, and Recommends that they be diffused for the information of appropriate institutions, organizations and authorities.

Aim of the Guidelines

1. The aim of this document is to promote the establishment of standards and guidelines for education and training in the conservation of monuments, groups of buildings ("ensembles") and sites defined as cultural heritage by the World Heritage Convention of 1972. They include historic buildings, historic areas and towns, archaeological sites, and the contents therein, as well as historic and cultural landscapes. Their conservation is now, and will continue to be a matter of urgency.



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Conservation

2. Conservation of cultural heritage is now recognized as resting within the general field of environmental and cultural development. Sustainable management strategies for change which respect cultural heritage require the integration of conservation attitudes with contemporary economic and social goals including tourism.

3. The object of conservation is to prolong the life of cultural heritage and, if possible, to clarify the artistic and historical messages therein without the loss of authenticity and meaning. Conservation is a cultural, artistic, technical and craft activity based on humanistic and scientific studies and systematic research. Conservation must respect the cultural context.

Educational and Training Programmes and Courses

4. There is a need to develop a holistic approach to our heritage on the basis of cultural pluralism and diversity, respected by professionals, craftspersons and administrators. Conservation requires the ability to observe, analyze and synthesize. The conservationist should have a flexible yet pragmatic approach based on cultural consciousness which should penetrate all practical work, proper education and training, sound judgement and a sense of proportion with an understanding of the community's needs. Many professional and craft skills are involved in this interdisciplinary activity.

5. Conservation works should only be entrusted to persons competent in these specialist activities. Education and training for conservation should produce from a range of professionals, conservationists who are able to:

- read a monument, ensemble or site and identify its emotional, cultural and use significance;
- understand the history and technology of monuments, ensembles or sites in order to define their identity, plan for their conservation, and interpret the results of this research;
- understand the setting of a monument, ensemble or site, their contents and surroundings, in relation to other buildings, gardens or landscapes;
- find and absorb all available sources of information relevant to the monument, ensemble or site being studied;
- understand and analyze the behaviour of monuments, ensembles and sites as complex systems;
- diagnose intrinsic and extrinsic causes of decay as a basis for appropriate action;
- inspect and make reports intelligible to non-specialist readers of monuments, ensembles or sites, illustrated by graphic means such as sketches and photographs;
- know, understand and apply Unesco conventions and recommendations, and ICOMOS and other recognized Charters, regulations and guidelines;
- make balanced judgements based on shared ethical principles, and accept responsibility for the long-term welfare of cultural heritage;
- recognize when advice must be sought and define the areas of need of study by different specialists, e.g. wall paintings, sculpture and objects of artistic and historical value, and/or studies of materials and systems;
- give expert advice on maintenance strategies, management policies and the policy framework for environmental protection and preservation of monuments and their contents, and sites;
- document works executed and make same accessible;
- work in multi-disciplinary groups using sound methods;



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- be able to work with inhabitants, administrators and planners to resolve conflicts and to develop conservation strategies appropriate to local needs, abilities and resources;

Aims of the Courses

6. There is a need to impart knowledge of conservation attitudes and approaches to all those who may have a direct or indirect impact on cultural property.
7. The practice of conservation is interdisciplinary; it therefore follows that courses should also be multidisciplinary. Professionals, including academics and specialized craftspersons, who have already received their normal qualification will need further training in order to become conservationists; equally those who seek to act competently in historic environment.
8. Conservationists should ensure that all artisans and staff working on a monument, ensemble or site respect its significance.
9. Training in disaster preparedness and in methods of mitigating damage to cultural property, by strengthening and improving fire prevention and other security measures, should be included in courses.
10. Traditional crafts are a valuable cultural resource. Craftspersons, already with high level manual skills, should be further trained for conservation work with instruction in the history of their craft, historic details and practices, and the theory of conservation with the need for documentation. Many historic skills will have to be recorded and revived.

Organization of Education and Training

11. Many satisfactory methods of achieving the required education and training are possible. Variations will depend on traditions and legislation, as well as on administrative and economic context of each cultural region. The active exchange of ideas and opinions on new approaches to education and training between national institutes and at international levels should be encouraged. Collaborative network of individuals and institutions is essential to the success of this exchange.
12. Education and sensitization for conservation should begin in schools and continue in universities and beyond. These institutions have an important role in raising visual and cultural awareness - improving ability to read and understand the elements of our cultural heritage - and giving the cultural preparation needed by candidates for specialist education and training. Practical hands-on training in craft work should be encouraged.
13. Courses for continuing professional development can enlarge on the initial education and training of professionals. Long-term, part-time courses are a valuable method for advanced teaching, and useful in major population centres. Short courses can enlarge attitudes, but cannot teach skills or impart profound understanding of conservation. They can help introduce concepts and techniques of conservation in the management of the built and natural environment and the objects within it.
14. Participants in specialist courses should be of a high calibre normally having had appropriate education and training and practical working experience. Specialist courses should be multidisciplinary with core subjects for all participants, and optional subjects to extend capacities and/or to fill the gaps in previous education and training. To complete the education and training of a conservationist an internship is recommended to give practical experience.
15. Every country or regional group should be encouraged to develop at least one comprehensively organized institute giving education and training and specialist courses. It may take decades to establish a fully competent conservation service. Special short-term measures may therefore be required, including the grafting of new initiatives onto existing programmes in order to lead to fully developed new programmes. National, regional and international exchange of teachers, experts and students should be encouraged. Regular evaluation of conservation training programmes by peers is a necessity.



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Resources

16. Resources needed for specialist courses may include e.g.:

- an adequate number of participants of required level ideally in the range of 15 to 25;
- a full-time co-ordinator with sufficient administrative support;
- instructors with sound theoretical knowledge and practical experience in conservation and teaching ability;
- fully equipped facilities including lecture space with audio-visual equipment, video, etc. studios, laboratories, workshops, seminar rooms, and staff offices;
- library and documentation centre providing reference collections, facilities for coordinating research, and access to computerized information networks;
- a range of monuments, ensembles and sites within a reasonable radius.

17. Conservation depends upon documentation adequate for understanding of monuments, ensembles or sites and their respective settings. Each country should have an institute for research and archive for recording its cultural heritage and all conservation works related thereto. The course should work within the archive responsibilities identified at the national level.

18. Funding for teaching fees and subsistence may need special arrangements for mid-career participants as they may already have personal responsibilities.

2. Teaching the innovation in post-graduate level

The post graduate level is ideal to apply new learning approaches since:

- the organizational character of post graduate programs is typically interdepartmental
- the students originate from diverse scientific disciplines
- the students have a more advanced educational and professional background
- the teaching approaches of the post graduate programs are typically more extensive and include hands-on experience.

At post graduate level, innovation is embedded in the curricula through various case-studies but equally important through the emphasis on merging basic scientific backgrounds with the demand for smart, effective and sustainable solutions to complex challenges. It is this mentality, i.e. Innovation in-line with fundamental know-how, that is infused into the post-graduate curricula, and thus transferred to the market and stakeholders upon the adoption of this mentality by the graduates. In this context, the Innovation of the Holy Sepulchre project was clearly presented during the NTUA seminar series (Task 2.1)

2.1 EDICULA curricula reformation complimentary Master programs (O2)

The EDICULA curricula reformation aims to identify the common ground to merge the different focus - spanning from purely analytical techniques, to archaeological documentation, to engineering aspects, to sustainability of Cultural Heritage - of three diverse, yet complimentary, Master courses, through their reformation, in order to address the needs of students from different scientific backgrounds and different professional dynamics.



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- National Technical University of Athens - Master Program “Protection of Monuments” with focus on the methodologies for the materials and preservation interventions
- Università degli Studi di Roma ‘La Sapienza’ - Post Graduate Program in “Science and Technology for the Conservation of Cultural Heritage” with focus on the techniques of the conservation interventions
- Bezalel Academy of Arts and Design - Post Graduate MUrbDes Program in “Urban Design” with focus on documentation and knowledge-based design

PM MSc aims to provide advanced education and specialization for researchers and professionals in conservation and restoration of architectural heritage and historic materials in order to develop competencies and skills to solve complex problems. It consists of two directions: (A) “Conservation and restoration of historic buildings and sites”, organized by the NTUA School of Architecture, and (B) “Materials and conservation interventions”, organized by the NTUA School of Chemical Engineering. The interdepartmental character of the program has been very decisive for its interdisciplinary character.

STCCH MSc aims at training researchers and experts in the field of CH conservation and archaeometry to analyze conservation problems and to detect deterioration processes, based on the physical, chemical and structural properties of materials, as well as to identify any possible remedies. Such experts make interventions in observance of the historical, artistic and architectural framework of artifacts, by contributing thus to their enhancement and protection.

MUrbDes MSc is a multi-disciplinary program, building on the knowledge-based design project, with the objective of enriching the quality of the environment in cities through innovative design that relates to the theoretical study of the spatial structure of the form of the city. This is supported by faculty in the Department of Architecture. Specific courses are based on the study of the city of Jerusalem as a historic, cultural, social and economic phenomenon and address the prevailing planning paradigms of the last two centuries, in cooperation with the activities of the UNESCO Chair in Urban Design and Conservation Studies

2.1.2 EDICULA NTUA Seminar Series

The EDICULA NTUA seminar series concerning the rehabilitation of the Holy Aedicule in the Holy Sepulchre has provided an educational analysis of the innovation of the Holy Sepulchre research.

The seminar “The rehabilitation of the Holy Aedicule of the Holy Sepulchre in Jerusalem” was designed and implemented by members of the National Technical University of Athens interdisciplinary team, scientific responsible for the Holy Aedicule’s rehabilitation of the Holy Sepulchre in Jerusalem, and proposed as the reformation of the optional course 3.8. “Interdisciplinary documentation, diagnosis, revealing and protection of Cultural Heritage towards sustainable development” of the NTUA Master Program “Protection of Monuments” Direction “Materials and conservation interventions”. It was organized from December 1st until December 7th, 2021 via webex, via daily three-hour sessions from 3 to 6 pm.

Each three-hour session corresponds to four didactic hours. Thus, including teaching and studying time, NTUA Seminar 1 sums up to 30 hours, for which optional courses of NTUA’s Master Program “Protection of Monuments” are accredited to 7 ECTS.

The seminar has been recorded and is uploaded at the EDICULA educational toolkit.



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WEDNESDAY 1 DECEMBER 2021 || 15:00-18:00 EET

15:00-16:00	Prof. A. Moropoulou	The innovation and challenges of the rehabilitation of the Holy Aedicule of the Holy Sepulchre – Scientific supervision
16:00-18:00	Prof. M. Korres	Architectural documentation of the Holy Aedicule in the open city of Jerusalem

<https://centralntua.webex.com/centralntua/j.php?MTID=m728ce6c2c3d77e4f47bdf00873636725>



THURSDAY 2 DECEMBER 2021 || 15:00-18:00 EET

15:00-18:00	Prof. A. Georgopoulos, Prof. G. Pantazis, S. Tapeinaki, R. Chliverou	Dynamic integrated geometric documentation of the monument before, during and after the rehabilitation Geometric documentation, network setup, structural health monitoring, data collection, photography and laser scanning, parameters for correct photography, monitoring of deformations, data processing, computational photography
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<https://centralntua.webex.com/centralntua/j.php?MTID=me8dbaa71de2bd6ed8fcec50da7021b2f>



FRIDAY 3 DECEMBER 2021 || 15:00-18:00 EET

15:00-16:00	Dr. K. Lampropoulos, Prof. A. Moropoulou	The structural evolution of the Holy Aedicule. Prospection of the Past
16:00-17:00	Dr. E. Delegou, Prof. A. Moropoulou	Characterization, archaeometry, archaeogene of building materials of the Holy Aedicule – Compatibility of conservation interventions
17:00-18:00	Dr. M. Apostolopoulou, Dr. E. Aggelakopoulou, Ass. Prof. A. Bakolas, Prof. A. Moropoulou	Historic mortars study – Design and use of compatible restoration mortars at the Holy Aedicule rehabilitation

<https://centralntua.webex.com/centralntua/j.php?MTID=m300f8e5c81260271f48075051596a282>



MONDAY 6 DECEMBER 2021 || 15:00-18:00 EET

15:00-16:30	Prof. C. Spyrakos, Dr. Ch. Maniatakis	Assessment of the structural response of the monument under static and seismic loads
16:30-18:00	Ass. Prof. Ch. Mouzakis	In situ evaluation and implementation of retrofit and strengthening measures of the monument – Construction site management

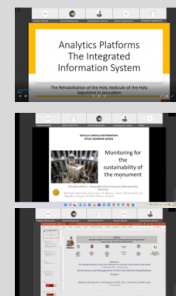
<https://centralntua.webex.com/centralntua/j.php?MTID=m8b7ccbeeb8f0ec0234a560b47419eb5b>



TUESDAY 7 DECEMBER 2021 || 15:00-18:00 EET

15:00-16:00	Em. Alexakis, Ass. Prof. D. Kyriazis, Ass. Prof. A. Doulamis, Dr. K. Lampropoulos, Prof. A. Moropoulou	An exemplary information system and methodology for the integrated management, analysis and dissemination of digital cultural heritage data coming from the rehabilitation of the Holy Aedicule
16:00-17:00	Dr. M. Karoglou, Prof. A. Moropoulou	Monitoring system for the sustainability of the monument
17:00-18:00	N. Moropoulos	Monitoring air and materials thermohygrometric characteristics Governance and Management of the Holy Edicule Rehabilitation Project

<https://centralntua.webex.com/centralntua/j.php?MTID=md910f90981ec328b471b56af17b9ee5b>



Interdisciplinary participation

In the EDICULA NTUA Seminar participated

- 28 postgraduate students and 15 lecturers from National Technical University of Athens
- 13 postgraduate and post doc students from Università degli Studi di Roma 'La Sapienza'
- 8 postgraduate students and researchers from Bezalel Academy of Arts and Design



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Summing up to a total of 64 participants of various disciplines from the scientific fields of natural sciences, mathematics, chemistry, geology, materials science and engineering, architecture, civil engineering, surveying engineering, information technology and archaeology.

Since the background and the mentality of the participants were of high level, the dialogue imposed was fast and clear, leading to 5 to 10 questions per every 3hour lectures.

2.1.3 Postgraduate curricula reformation (O2)

The EDICULA transdisciplinary education has been implemented through the reformation of post graduate courses to introduce students to innovation and knowledge related to novel research, theoretical, scientific, technological, socioeconomic advancements, holistic digital methodologies, sustainable approaches and management according to international expertise and standards and decision-making processes.

The core subjects have been adapted towards open-minded scientific specialization based on transdisciplinary collaboration. Optional subjects have been adapted to extend and deepen knowledge and capacities. This successful combination was achieved through the proposed framework, merging multidisciplinary theoretical and practical education, through laboratory and on-site surveys, experimental courses and educational visits and the elaboration of innovative postgraduate theses.

The UNIROMA1 postgraduate curricula reformation has been proceeded with the design and organization of 2 new compulsory core courses [*“Applied geosciences and bioconservation laboratory”* - *“Plant biology and conservation for cultural heritage”*] and 1 new optional course [*“Climate risk assessment of cultural heritage”*] within Post Graduate Program in *“Science and Technology for the Conservation of Cultural Heritage”*. 2021-2022 implementation has been evaluated to be taken under consideration within 2022-2023 implementation.

The NTUA postgraduate curricula reformation has been proceeded with the design and reformation of 3 optional courses [*1. Interdisciplinary documentation and guidelines for the exploiting and revealing of cultural assets augmenting their resilience: The rehabilitation of the Holy Aedicule of the Holy Sepulchre in Jerusalem (Course3.8)*; *2. Pilot rehabilitation interventions in emblematic use cases (Course 3.3)*; *3. Environmental management for the protection and revealing of cultural assets in sustainable development plans (Course 3.4)*] within Post Graduate Program in *“Protection of Monuments”* – Direction *“Materials and Conservation Interventions”*. The reformation of the 1st course took place in fall 2021-2022 and the implementation of the reformation of the 2nd and 3rd courses took place in spring 2022-2023, since after two academic years with no new calls due to COVID-19 restrictions, new postgraduate students were admitted in 2022-2023.

The BEZ Master postgraduate curricula reformation has been proceeded with the design of co-teaching and studio activities forwarding hands-on approaches [*new track in Conservation and Heritage – Jerusalem lab 2022 Growing Jerusalem*] within Post Graduate Program in *“Urban Design”*

2.2 Educational methodology evolution

Curricula reformation has been implemented with the evolution from the teaching of characteristic applications as case studies to deepen knowledge per intervention, towards the integrated and interactive seminars per emblematic case study that emphasize transdisciplinarity.

The innovative educational approach, where postgraduate students obtain competencies and skills to address multi-modal problems, has been implemented through problem-based learning on a real time / real scale rehabilitation scenario.



2.2.1 Transdisciplinary teaching approaches

The teaching methodologies that were applied in EDICULA curricula reformation emphasizing in transdisciplinarity are the following:

- Innovation serving as the key element for producing new knowledge and novel research, as the enabling factor to address the challenges of complex projects
- Innovation needed in the implementation process, with emphasis on technological advancements, holistic digital methodologies, sustainable approaches and management
- Open-minded scientific specialization based on transdisciplinary collaboration, with the coordinated involvement of various scientific disciplines, to address the multi-level challenges of complex projects of built cultural heritage protection
- Introduction of sustainability through a holistic approach – based on compatibility and performance criteria – crucial for both our contemporary built environment, and built heritage
- Competencies and technical skills gained to address multi-modal problems are gained through problem-based learning on a real time / real scale rehabilitation scenario
- The digital nature of the research served not only as a common language, but it was also purposely amplified as a prerequisite best practices lever to successfully address future challenges
- Demonstration of the necessity of scientific support in decision making, addressing problems in variable environments, under limited time and constraining social-political-religious conditions
- The role of communication strategies is an important factor for projects of such magnitude and is critical for society involvement and participation in decision making
- Know how transfer regards the development of a methodological transdisciplinary mentality, as an issues resolution, rather than a duplication of a depository of knowledge

The transdisciplinary teaching methodologies of innovation (D5.2.) have been explicated within the TMM_CH 2021 EDICULA Educational Panel and general methodologies were articulated within TMM_CH 2023 EDICULA Panel.

2.2.2 Innovation of the Holy Aedicule rehabilitation within transdisciplinary educational approach

The four introductory lectures by Prof. A. Moropoulou, Prof. M. Korres, Prof. A. Georgopoulos and Prof. Spyrakos strongly indicate the innovation of the rehabilitation; from the advanced technologies of non-destructive testing and 3D digital technology and modeling, to the integrated interdisciplinary approach at the worksite; the preservation and highlighting the values of the monument; the sustainability of the rehabilitation ensuring its preservation for the centuries to come. The lectures of the Civil Engineers aim to highlight the innovative applications in the structural assessment and redesign of the monument to ensure its structural stability

Prof. A. Moropoulou: The innovation and challenges of the rehabilitation of the Holy Aedicule of the Holy Sepulchre – Scientific supervision

This lecture aims to highlight the innovations applied and the transdisciplinary approaches adopted to address the multi-level challenges of elaborate projects of built cultural heritage protection, such as the emblematic rehabilitation project of the Holy Aedicule of the Holy Sepulchre. It serves to highlight that complex projects entail challenges that cannot be addressed efficiently without the coordinated involvement of various complementary scientific disciplines. This full-scale integrated project regarded all stages of cultural heritage protection, and as such it serves as an educational tool par-excellence. The need for



diagnosis, with emphasis in non-destructive testing, is highlighted as the prerequisite step of any engineering achievement and as the source of valuable information regarding the state of preservation of the CH asset and as the basis for the design of the appropriate interventions. The lecture highlights the importance of integrated governance and scientific support to decision making throughout all stages of complex projects. It also underlines the significance of worksite and laboratory organization to provide efficient technical and scientific support. The lecture emphasizes that all technical stages of the works need to be carefully pre-planned based on scientific rational, meticulously implemented, adjusted as required, systematically documented and on-site, real-time assessed and analyzed, with emphasis on non-destructive testing.

The lecture stresses the three fundamental goals of CH protection projects. The first regards the achievement of structural integrity of the CH asset, as this is the foremost requirement of any rehabilitation project. The second goal regards the revealing and preservation of values. In the emblematic project of the Holy Aedicule rehabilitation this is demonstrated with the revealing of the Holy Rock and the revealing, conservation and protection of the various interior and exterior decorations. Most importantly, it describes the historic revealing of the burial surface during the opening of the Tomb, the transdisciplinary documentation of its morphology and materials and the importance findings regarding the dating of the Tomb and the burial chamber. It demonstrates that rehabilitation projects such as that of the Holy Aedicule can function as invaluable source of new findings that validate or in-validate existing theories as well as provide new scientific data for future analyses. The third goal regards the overall sustainability of the rehabilitated monument in the environment of the church and the city of Jerusalem. The underground environment needs to be analyzed, especially the stability of its foundation and the water transport phenomena, as this is crucial to the sustainability of the monument, and appropriate measures need to be taken.

All the above are integrated in the Holy Aedicule Information platform, which fuses data from various disciplines, of various types and corresponding to all stages of the works, from prior to the initiation of the project and even after the completion of the works. ICT plays an increasing role in CH protection and regards innovations in data handling, management and 4D analysis. Finally, the role of communication strategies is analyzed, which is an important factor for projects of such magnitude and is critical for society involvement and participation in decision making.

Prof. M. Korres: Architectural documentation of the Holy Aedicule in the open city of Jerusalem

This lecture departs from the typical architectural analysis of the monument. It aims to demonstrate that in order to better understand the architecture of this CH asset, one needs to start from the geography and history of the whole region. The monument is located within a city full of history. Thus, the first step in any similar analyses is to understand the history of the area. The geomorphology of the city of Jerusalem is presented, in relation to the morphology of the abandoned quarry where the burial site and the site of crucifixion are located. Thus, it is highlighted that one should start their analysis from the large scale and then proceed to the intermediate and smaller scales. In the case of the Holy Aedicule this is even more crucial, since its configuration has changed throughout the centuries. The architecture of the Holy Aedicule is parallelized with the architecture of the Church of the Holy Aedicule. This is a typical approach in the architectural analysis of CH assets, where the architectural analysis of their surroundings must always be taken into account.

The lecture presents the various reconstructions pertinent to the historical phases of the Holy Aedicule and its surrounding Church of the Holy Sepulchre. It highlights the challenges of the architectural analysis, namely the necessity to correlate data with archaeological and historical analyses. It demonstrates that architectural analysis is not limited to just creating plans of the CH asset, but it needs to correlate information from various disciplines in order to “interpret” the structure in its whole entirety and the values and semantics it carries.

In the case of the Holy Aedicule the analysis regards the creation of architectural plans of the structure prior to the initiation of the works that document its deteriorated state and the extent of deformations. It also



presents detailed technical drawings of the intervention steps (disassembling of the facades), the required equipment (scaffold, lift devices, etc.), demonstrating the close cooperation of all engineering disciplines. It also regards the creation of detailed plans for the selected interventions (e.g. detailed plans of the observation window of the Holy Rock), as well as detailed plans of new findings (e.g. remnants of an earlier Rotunda pavement in a drilling position, or the analysis of the double columns of the Rotunda)

Finally, an important architectural analysis regards the correlation of the current structure with the structure of the Crusaders era, and the perceived presence of remnants of the monolithic Tomb. It was performed in parallel and independently with the non-destructive prospection of the monument with ground penetrating radar; the results of the architectural analysis coincided with that of NDT and the actual findings during the works. It highlights the importance of transdisciplinarity and the scientific merits of the relevant analyses.

Prof. A. Georgopoulos: Dynamic integrated geometric documentation of the monument before, during and after the rehabilitation - Geometric documentation, network setup, structural health monitoring, data collection, photography and laser scanning, parameters for correct photography, monitoring of deformations, data processing, computational photography

The lecture presents a brief overview of the geometric documentation of monuments, as the procedure of acquiring, process, presenting, archiving and storing of data to determine the position, the true form, shape and size of a cultural heritage asset in the 3D space at a given moment in time. The lecture emphasizes the temporal nature of the geometric documentation, which is important for CH protection as it records the present state of a CH asset, but can support analyses regarding its past or future states. The lecture presents the main techniques utilized for the 3D documentation of the Holy Aedicule throughout all stages of the works, as well as the practical and technical challenges encountered and the solutions provided to address them. The creation of the 3D model of the Holy Aedicule is the main documentation product, however, it is important to realize that such a comprehensive model is the outcome of cumbersome analyses, processing and updates, combining thousands of photos and data from laser scanners.

The cooperation with other disciplines, such as materials science and architecture, allows the creation of unique products such as the 3D representation of the Holy Rock, i.e. the remnants of the original Constantinean Aedicule structure, by combining non-destructive ground penetration radar data in correlation with an architectural analysis. The geometric documentation is also supporting the cleaning and protection of the decorative elements of the monument and presents them in digital and VR form.

It is important to realize that the creation of the 3D model of the monument and the relevant “virtual tour” video, regards a form of the structure that is not observable or accessible by the pilgrims or the public. It presents the actual details of the monument in the correct light (as compared to the dark lighting conditions of the actual monument), without obstructions and truly accessible in every position, orientation and cross-section. As such, it functions as an effective scientific and technical tool for understanding the structure, its morphology, form and dialogue with its environment. The products of the 3D model can be used in all stages of the works, ranging from the creation of required plans and sections to the creation of virtual tours for educational and promotional purposes.

The lecture also presented the work relevant to the structural health monitoring, which entailed the setup of a local coordinate network, the collection of displacement data and their analysis to monitor and verify the reduction of deviations from verticality during the works. The structural health monitoring demonstrates the transdisciplinary character of the rehabilitation works; the resetting of the dislocated columns – verified through the monitoring of their displacement – was the prerequisite step for the reassembly activities, as well as the removal of the iron frame.

Finally, the lecture highlighted the challenges of high-resolution scientific photography, such as big-data processing and the benefits and capabilities of computational photography to produce emblematic representations such as the 3D textured model of the open Tomb or the Onion Dome.



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Prof. C. Spyrakos, Ass. Prof. Ch. Mouzakis, Prof. M. Kavvadas, † Prof. P. Marinou, Dr. Ch. Maniatakis, V. Zafeiris: Structural Assessment

Over the centuries, the Holy Aedicule has sustained considerable damage and deformation. It has also undergone many attempts at reconstruction and interventions designed to restore the site's structural integrity. The most recent attempt at restoration was completed in 1810, by the architect Komnenos. Since that effort, however, this unique monument has experienced significant additional

damage and deformation, which demanded immediate interventions to reinstate its structural integrity and ensure its sustainable preservation. The deformations of the Holy Aedicule, for example, had reached a dangerous-enough point during the first half of the 20th century, when an iron frame was installed around the structure in 1947 by the British Mandate to help prevent a collapse. This frame, however, represented only a temporary solution, and since then the situation has grown worse, as evidenced by the additional buckling of the aedicule's stone facade and the structure's generally poor state of preservation.

The properties of the restoration mortar that the team selected were assessed by finite element model of the structure, was developed using the 3D documentation and materials data to assess the structural performance of the Aedicule and to verify the repair material's structural performance prior to its application. Furthermore, because the aedicule features different layers of materials that could not

be completely dismantled, the team also determined that it was necessary to apply compatible and performing grouts, along with the new mortars, to strengthen and homogenize the various layers from different construction phases of the monument. The volume of the mortars and grouts necessary to rehabilitate the aedicule were estimated through the volumetric information extracted from a 3-D geometric model.

The aedicule was examined under both static and seismic loads via elaborate finite element modeling and analysis. The bearing structure of the Holy Aedicule's Tomb was assessed in terms of the seismic forces that may threaten its structural integrity as well as the static loads from its constituent materials. The seismic forces were based on the historical seismicity of Jerusalem, according to the current provisions of Eurocode 8 and the available, international scientific literature. According to the seismic hazard map of Israel, a peak ground acceleration of 0.13g accounts for rock conditions at Jerusalem. This peak ground acceleration would have a 10 percent probability of being exceeded in 50 years.

To calculate the acceleration spectrum, the provisions of the current Eurocode 8 were applied for a Type 1 design earthquake spectrum—meaning, for regions of high or moderate seismicity—and a maximum value of 1.4 as the “importance factor,” which puts the site on par with hospitals, power plants, and police stations for protection during the period following an earthquake. The numerical analysis provided the contours of maximum principal stresses for the main bearing body of the structure prior to the interventions. The analysis also revealed significant cracks in the internal vaults of the aedicule, at the wall that separates two chambers within the structure, and at the area of the internal stairwells where the thickness of the masonry is reduced.

Based on the findings of the NTUA study, a series of interventions were planned, including restoration mortars and grouts, as well as various new reinforcement systems. When these proposed materials and interventions were incorporated into a modified finite element model of the aedicule, it became clear to the team that the proposed rehabilitation would provide adequate strength and reinstate the monument's structural integrity.

The importance of the monument, the complexity of the project, and the site's historical and religious significance—in particular, the need to preserve the Holy Rock—meant that the organization of the worksite and the scheduling of the timetable had to accommodate various restrictions and engineering challenges. Moreover, the site had to remain accessible to pilgrims and to those engaged in the performance of religious functions. In combination with safety requirements, this meant that most of the work had to be accomplished



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at night. Finally, a strict deadline was set to complete the rehabilitation work within 12 months after the signature of the Common Agreement to make sure that Easter celebrations could be held at the rehabilitated Holy Aedicule.

To protect the pilgrims and others at the site, the work areas were concentrated on the north and south sides of the aedicule, creating a corridor to the interior of the monument that was separated from the rest of the Rotunda by metal panels. The work site included a material storage area within the Church of the Resurrection and a conservation laboratory in the Latin Gallery, which is located on an upper floor of the church to the northeast of the aedicule. The steel frame installed by the British in 1947 at the north and south facades was examined via another fine element model, which indicated that the framing could not be used as a retaining wall during the repositioning of the aedicule's stone cladding. Instead, the frames were further supported and pinned at the base and the existing steel rods connecting them at the top were re-tensioned. The structural analysis of the frame also led to the use of diagonal, wide-flanged steel HEB 200 beams to strengthen the structure, which was then able to be used as a retaining wall.

Because the British engineers had not installed a steel frame on the east or west facades, a new frame was designed and installed to support those sides of the aedicule. Due to the configuration of the front facade and the fact that the monument had to remain open to the pilgrims, four vertical HEB 200 beams were fixed to the rock foundation and functioned as cantilevered supports.

The changes to the deviations from vertical were verified throughout all the phases of the work by comparing them to documented information.

Following the strengthening of the main masonry, the external stone panels were reassembled. The first step to this process involved the use of titanium bars to anchor the cladding. Titanium bars were chosen for their significant durability and high level of compatibility with the historical masonry.

Two key details were examined during the tests: the connection of the titanium bars to the cladding, and the bond between the bars and the existing interior wall. One end of the deformed bars was either threaded or curved. Two different types of connections between the titanium bars and the stone cladding were adopted. In the first case, a hole was drilled in the stone and the threaded end of the titanium bar was fixed with a titanium nut and washer; the hole was then filled in with a matching piece of stone. In the second case, the curved end of the bar functioned as a hook. Depending on the depth of the masonry wall, the test then used either a nut and a washer—in the case of walls with a shallow depth—or else a deformed bar was anchored directly to the wall using mortar, in the case of walls with a greater depth. A compatible and performing restoration mortar was used, presenting a compressive strength of 16 MPa over a period of 28 days and a bond strength of 0.15 MPa. The mortar was injected into a 20 mm diameter hole for the nut and washer test or a 38 mm diameter hole for the mortar anchorage test.

This 3-D geometric model was used, in conjunction with information regarding the applied materials and implemented interventions, to optimize the finite- element model. This optimized model was used to assess the retrofitted bearing structure, and it confirmed that structural integrity was indeed achieved.

A numerical analysis of the aedicule's foundation system reveals a differential settlement of the structure due to a long-term reduction in the rubble's stiffness. The proposed interventions will involve the excavation of the natural rock and the construction of a peripheral drainage and ventilation gallery, in combination with grouting of the rubble and/or removing it and replacing it with compatible and performing mortar and stonework. An excavated area south of the aedicule will be drained and ventilated, and the existing reinforced-concrete slab of the floor will be replaced by a 15 cm thick glass-fiber-reinforced concrete slab that might also feature a glass opening to facilitate an inspection of the antiquities. The peripheral drainage and ventilation gallery will include the installation of an open canal and pipes in a space below the perimeter gallery to drain the rising underground water between the new foundation and the natural rock. A ventilating system will be constructed for the best aeration and humidity regulation of the perimeter corridor, the



cistern, and an earlier excavation site. In addition, a new functional sewage and rainwater network will be constructed within the perimeter of Rotunda to replace the complex existing network.

2.2.3 Educational material - Publications derived from the rehabilitation of the Holy Aedicule

1. *"Integrated diagnostic research project and strategic planning for materials, interventions conservation and rehabilitation of the Holy Edicule of the Holy Sepulchre in the Holy Church of the Resurrection in Jerusalem"*, A. Moropoulou, E. Korres, A. Georgopoulos, C. Spyarakos, (2016) 109 p., ISBN 978-618-82612-0-4
2. Presentation on the completion of the Holy Sepulchre's Holy Aedicule Rehabilitation "Conservation, reinforcement and repair interventions for the rehabilitation of the Holy Sepulchre in Jerusalem. Scientific Responsible: A. Moropoulou, National Technical University of Athens" (2017) 141 p., ISBN 978-618-82196-4-9
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11. 10th Annual Conference on “New studies in the archaeology of Jerusalem” [Jerusalem, 26-28/10/16, joint collaboration of the Israel Antiquities Authority, Tel Aviv University and The Hebrew University of Jerusalem]. Invited presentation: “Sustainable rehabilitation of the Holy Sepulchre: Interdisciplinary scientific study and monitoring – Scientific integrated governance of the project”, a collective work presented by Prof. A. Moropoulou
12. 2nd International Conference on Art and Archaeology [Jerusalem, 11-14/12/2016]. Invited presentation: “Interdisciplinary planning and scientific support in the field of rehabilitation of the Holy Aedicule of the Holy Sepulchre”, a collective work presented by Prof. A. Moropoulou
13. University of Oxford School of Archaeology: Fifth Anniversary of the Mica and Ahmet Ertegun Graduate Scholarship Programme in the Humanities [Oxford, 23/10/2017]. Invited presentation: “The Rehabilitation of the Holy Aedicule of the Holy Sepulchre”, a collective work presented by Prof. A. Moropoulou
14. Institut für Christkatholische Theologie, Universität Bern [Bern, 21/03/201]: Invited lecture: “The rehabilitation of the Holy Aedicule of the Holy Sepulchre”, a collective work presented by Prof. A. Moropoulou
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2.2.4 Innovation transfer to the Varnakova Monastery rehabilitation

The case of the Varnakova Monastery in Fokis rehabilitation of the Katholikon has served as a case study, where the transdisciplinary EDICULA methodology is also being transferred taking into consideration the challenges of big scale and emblematic monuments rehabilitation.

The purpose of the rehabilitation project of Varnakova Monastery was to revoke the pathology of the monument, highlight its historical and aesthetic values, and, finally, make it once again safely accessible.



The Interdisciplinary study and rehabilitation project proposal included multispectral and interdisciplinary analysis:

- historical documentation and important aspects of the monument,
- architectural analysis and proposals,
- on site non destructive testing,
- structural analysis, regarding the stability of the monument, as well as proposals
- characterization of historical materials and diagnosis of their decay, as well as the design and selection of compatible and performing restoration materials,
- project management plan for the rehabilitation project.

Elements of historical significance were documented and placed in the center of the rehabilitation project in order to be protected and highlighted.

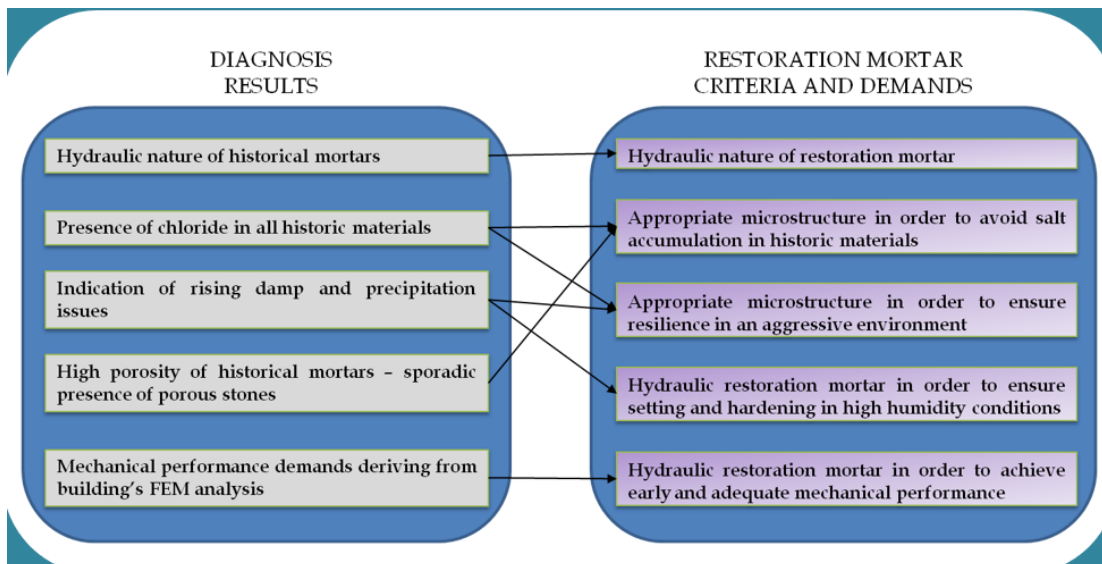
Architectural features and elements were documented and acted as:

- Important input information for the interdisciplinary study
- Core values, which must be protected and highlighted

On site non-destructive testing provided complementary information regarding “unseen” features and pathology.

The examination of the current state provided information regarding the vulnerability of the monument, while analysis of different repair scenarios revealed the optimum solutions to reinstall structural integrity.

Historical mortar characteristics acted as the basis for the design of restoration mortars, while their decay indicates the factors which negatively affect resilience of the materials. Characterization of the historical stone acted as the basis for the selection of the new restoration stone.



Rehabilitation focal points were:

Protect important historical and architectural features:

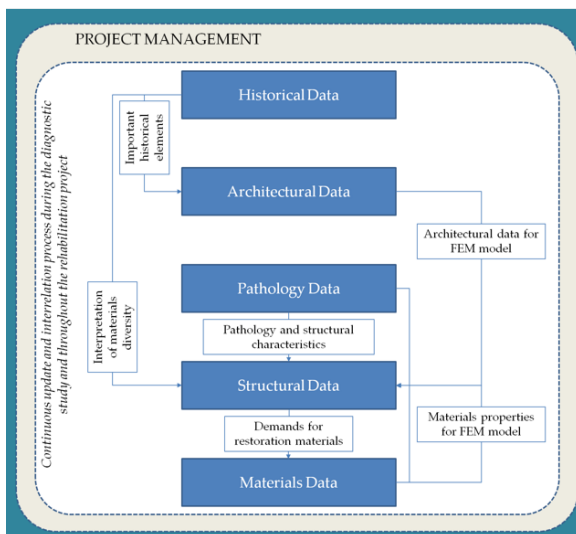
- No damage should be caused to the Byzantine era floor of the Catholicon.
- The possible existence of murals should be investigated, before applying the coatings on the interior surfaces of the temple.



Reveal and highlight historicity:

- The outbuilding should be removed from the west side of the Catholicon.
- The outer surface of the walls should remain uncoated. The stone elements (doorsteps, headers, etc.) should be visible.
- The metal frames and metal doors and windows should be replaced with new wooden elements, of traditional form

The interdisciplinary methodology, along with the project management plan allowed for the dynamic readjustment of the restoration plan



The project followed specific stages, which in many cases were interlinked, allowing for dynamic readjustments:

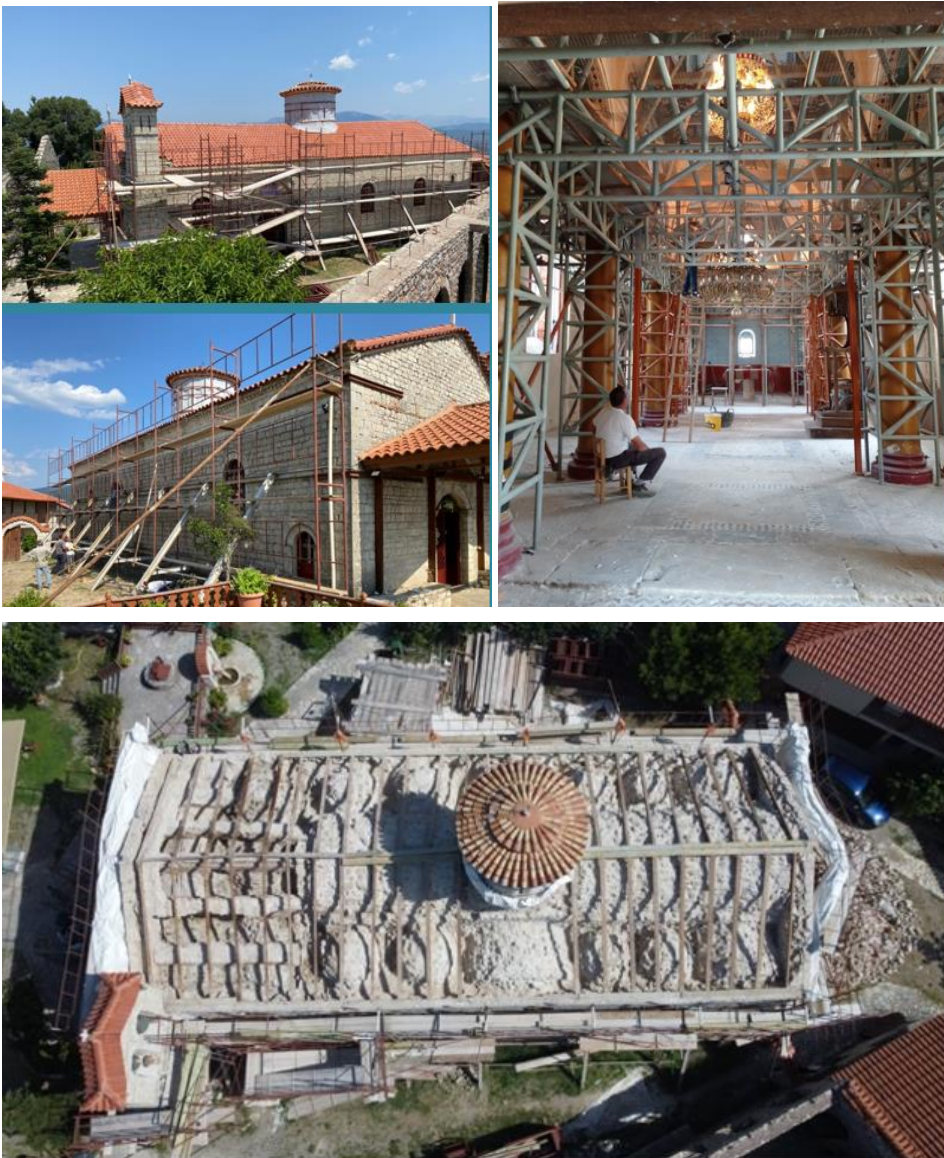
- Installation of supports and scaffoldings
- Restoration of the roof
- Masonry restoration, cleaning repointing and grouting
- Reinforcement of arches
- Restoration of domes and vaults
- Removal and restoration of plasters
- Resetting of arches
- Excavation works around the perimeter of the Temple for project purposes



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The NTUA Interdisciplinary team continuously supported the project, throughout the works:

- Application of NDT to assess the interventions
- Documentation of new findings
- Readjustments of restoration interventions and materials

The interdisciplinarity, as well as the diversity of the research and rehabilitation teams, allowed for a multileveled analysis, throughout the implementation of the rehabilitation project.

The innovative project management plan and continuous NTUA scientific support allowed for optimization of the rehabilitation, through a dynamic process throughout the project, according to the new findings, revealing the values of the monument, while ensuring structural integrity and sustainability.

Historical documentation continued throughout the rehabilitation project, as new findings emerged, thus providing data and guiding the optimum rehabilitation process, revealing and highlighting the values of the monument.



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Educational visit to Varnakova Monastery

An educational visit of the students of the NTUA Master Program “Protection of Monuments” Direction “Materials and Conservation Interventions” was organised to Varnakova Monastery on April 28th 2023.

The case of the Varnakova Monastery in Fokis rehabilitation of the Katholikon was presented in real time – real scale, with emphasis on the transdisciplinary EDICULA methodology being transferred, taking into consideration the challenges of big scale and emblematic monuments rehabilitation.



2.3 New skills developed leading to PhD thesis assignment and elaboration

Graduates of the participating Master programs have developed new skills through these reformed curricula and will be well prepared for the job market. The assessment of these reformed courses was achieved in parallel, through the elaboration of one doctoral thesis per University partner, focusing on the transdisciplinary approach in the protection of CH in complex environments. They function as higher level evaluation tool to assess the benefits of the reformed curricula and their educational applicability for innovative research.

The UNIROMA1 Department of Earth Sciences has assigned a PhD thesis to Adi Sela Wiener, which is already under elaboration, with the title “Redefining urban heritage materiality: a conceptual study of Jerusalem” under the co-supervision of Prof. Gabriele Favero (Department of Environmental Biology, Sapienza University of Rome) and Dr. Laura Medeghini (Department of Earth Sciences, Sapienza University of Rome). The following first results were presented at the TMM_CH 2023 Conference.

Natural conditions, including geology, have a great influence on human settlements, ab initio in determining location, through their development over time, and defining the material culture of their inhabitants. The image of Jerusalem is of a stone city, serving its tangible materially and intangible character. In the city of



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Jerusalem, geology plays a pivotal role that nowadays is still significant. Hence, in this study, several topics were explored, focusing on the geology of the city and its vicinity, together with its early research and mapping. Two well-known geologists Leo Picard and Moshe Avnimelech identified the Turonian, Cenomanian, and the Senonian cities of Jerusalem. Based on these early publications, it is suggested that exploring the connection between the city's natural conditions, its built environment and urban development, offers a surprising interdisciplinary approach for compatible materialities. The definition of materiality in the fields of geology, architecture, and urbanism, along with material and materiality definition as a basis for a statement of significance of cultural heritage and its conservation. By analyzing the nexus of these compatible materialities and highlighting their contemporary perspective it is possible to develop an interdisciplinary cultural heritage discourse, providing a tool for the Historic Urban Landscape approach that regards the city as a multi-layered and where geology, geomorphology, and other natural and environmental resource have a great role.

NTUA has opened a new PhD position within EDICULA concept at the NTUA School of Rural, Surveying and Geoinformatics Engineering. It was announced in September 2022 and will be assigned at the end of academic year 2022-2023. This new PhD position will be supervised by Prof. A. Doulamis within the subject "Decision making in the analysis of technologies of image analysis / computer vision in the structural condition of materials of cultural heritage monuments". Following the assignment, it will be further investigated whether this PhD thesis can be elaborated as a cotutelle de thèse with BEZ. Within the scientific topics of EDICULA, supervised by Prof. A. Moropoulou. PhD candidate M. Alexakis is now accomplishing his PhD thesis on an integrated information system platform to store and analyze scientific data collected at the rehabilitation of the Holy Aedicule. This PhD thesis, in synergy with EDICULA project, is funded by the Greek Partnership Agreement (PA) 2014-2020 within the Research Program RESPECT "An exemplary information system and methodology for the integrated management, analysis and dissemination of digital cultural heritage data coming from the rehabilitation of the Holy Aedicule".

BEZ has been inquiring for a practice-based PhD assignment in cooperation and co-supervision with the Hebrew University, which will be helpful in order to achieve the assignment, since the Israel academic framework for PhD elaboration is different than the European.

2.4 Call to develop a new EDICULA Academic position

Through the development of the postgraduate curricula reformation and the elaboration of PhDs in EDICULA project, and in particular at NTUA - which led the EDICULA model work within the rehabilitation of the Holy Aedicule - a need for a new academic position at NTUA in the level of Assistant Professor or Associate Professor has been identified, in order to advance the dissemination of the knowledge and the transdisciplinary approach developed within the rehabilitation of the Holy Aedicule of the Holy Sepulchre in Jerusalem. The scientific area proposed is "Scientific support on decision making for the interdisciplinary documentation and monitoring of monuments, through characterization of building materials, decay diagnosis, and assessment of rehabilitation interventions". Synthesis of the knowledge created within the rehabilitation of the Holy Aedicule has to be developed from the level of a unilateral science, such as Materials Science, and advanced to an interdisciplinary decision making system and interdisciplinary disciplines. This need has to be expressed at a European level to secure its sustainability.

Similar academic positions might also be elaborated and requested in UNIROMA1 and BEZ, in accordance to their institutional framework.



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2.5 Upscaling EDICULA curricula reformation. Future perspectives

2.5.1 Towards a Joint Master Degree

The curricula reformation can act as the first step towards a post-EDICULA future creation of a Joint Master Degree that will contribute in European level to provide new skills to the professionals requested in the field of the conservation of Cultural Heritage, in accordance with the European Skills Agenda.

UNIROMA1 has developed a “Tuning matrix” that is still being completed by all EDICULA academic partners, in order to identify the needs and objectives of such a Joint Master Degree and serve as a basis for its design, as a post-EDICULA proposal. The tuning matrix will serve as the guide to design the joint syllabus of the proposed Joint Master degree.

The EDICULA reformed courses will be part of the future joint curricula. Contents developed in the EDICULA hands-on and the EDICULA immersive experience will also be included.

Reaching the final stages of the EDICULA Project, an open discussion on the re-examination of the proposed core courses and optional courses for the transdisciplinary joint degree was held. The discussion revolved over several issues including content, management, and feasibility.

There is a huge difference when considering a Joint Master’s Degree that is run by one university with a collaboration of two other academic institutions, or when it is officially run by all three academic institutions together. Issues as length of the programme, language barriers, host institution and learning tuition will need to be addressed.

Based on experiences gained in existing master's programmes in cultural heritage conservation at Sapienza, the tracks are mainly of a fixed path with limited electives. Mobility to other academic institutions may be difficult to administrate. Considering a joint degree, the elective courses will need to be supervised.

In the case of a full Joint Master’s Degree, one semester should be mandatory in each academic institution. Additionally, in each semester one core course will be mandatory, and elective courses should be offered from a wide range of courses at the university.

Flexibility in learning modules and special courses, including summer campus and workshops for master’s degree students as well as young researchers should be offered to increase attractiveness.

The profile of the student intake will need to be discussed together with the possible options for the students on graduation. What are the learning objectives of a joint programme, and in what fields of activity should we prepare the programme's graduates?

For instance, in Italy the complete and holistic treatment of material culture is currently discussed. i.e., not just the treatment of the materials but their values and significance of properties; not just the retention of the authenticity of the materials but continuing the craftsmanship.

In any Joint Master’s Degree in cultural heritage conservation, as in other field of knowledge, the question of relevancy and innovation should be significantly examined, aiming to be ahead of time in aspects of science, theory, and approach.



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2.5.2 Towards alliances for innovation

Based on the intellectual outcomes of EDICULA as above, and focusing on the issues described below and as follows in deliverable D5.3 in real-world education.

A. Transferability potential of transdisciplinary teaching methodologies

The EDICULA curricula reformation highlighted the innovations applied and the transdisciplinary approaches adopted to address the multi-level challenges of elaborate projects of built cultural heritage protection, such as the emblematic rehabilitation project of the Holy Aedicule of the Holy Sepulchre. It highlights that complex projects entail challenges that cannot be addressed efficiently without the coordinated involvement of various complementary scientific disciplines.

This full-scale integrated project regarded all stages of cultural heritage protection, and as such it served as an educational tool par-excellence.

EDICULA curricula reformation covered the educational needs for emerging professional profiles of scientists in the protection of monuments since new roles and responsibilities among diverse disciplines (i.e., architects, engineers, archaeologists, conservators and natural scientists) are required in the post-industrial era for sustainable development. Taking into consideration the increasing presence of humanities disciplines in the field of CH and the introduction of trans-disciplinarity as applied in the case of Holy Sepulchre rehabilitation, the EDICULA educational innovation is that it emphasizes that this transdisciplinary collaboration can be instrumentalized through education with common base the various universal educational tools.

The graduates of this seminars are expected to serve as a “nucleus” of Change-of-Mentality, introduced to new ideas, know-how and expertise.

The transferability potential of the EDICULA project responds to contemporary research priorities relevant to Cultural Heritage, such as advanced diagnosis, monitoring and assessment of decay and pathology, mapping and assessment of environmental impact in real scale and real time, strategic design of conservation interventions, integrated environmental management of CH for its sustainable preservation.

B. Hands-on training as transferability focal point

The transferability potential was tried in another case study during the Hands-on Workshops. These priorities are also relevant to other engineering and scientific fields, thus, EDICULA serves as a lever for exploiting innovation in diverse disciplines towards the enhancement of the skills obtained through higher education studies.

Hands-on experience within EDICULA has been conceived as a key part of Problem-based Learning and of analogous educational approaches and conceived as an essential component for achieving learning outcomes in a wide range of courses.

EDICULA hands-on experience was implemented through:

- Proceeding with the organization of multiplier events such as (i) Hands-on events in Jerusalem and Alexandria, (ii) special conference sessions in Athens.
- Promoting students to a professional and entrepreneurship mentality by advancing education in collaboration with enterprises concerning technical works and digital applications, and thus enhancing learning outcomes to ensure professional qualifications.



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EDICULA Hands-on expected results:

- In situ education, at the Holy Sepulchre in Jerusalem, its setting and context, including religious routes and ceremonies functioning as the prime educational nucleus, being a transformation from a problem-based learning approach into a unique approach towards real-world learning, for application to other historic buildings and real or digital applications in the four countries.
- In-situ education for archaeologists, introducing innovation in engineering with emphasis on non-destructive testing and evaluation methods and georeferenced multi-spectral and multi-semantic data.

Hands-on framework

The significance of hands-on experiences within cultural heritage conservation studies was examined during the first task of the EDICULA Hands-on Framework that aimed at exploring state-of-the-art courses combining hands-on methodologies in higher education studies.

The task included a Survey on Hands-on methodologies. It aimed at gathering relevant information, studied and analyzed, that has served as a preliminary basis for future consideration. For the survey, a methodology of an online questionnaire was chosen. A great emphasis was put on the objectives, learning outcomes, methodologies, and assignments of each of the given examples. The questions addressed issues such as constructive alignment between the learning outcomes, the course's objectives, pedagogic tools, and the added value of the hands-on feature and experience to the successful implementation of the learning outcomes.

Hands-on educational activities

The EDICULA hands-on activities can be divided into two categories: courses and workshops that provide hands-on experiences as their main objective, and courses that offer a hands-on experience as part of a broader course syllabus. Most courses fall under the first category. Looking at the course type, most are only for undergraduate or for postgraduate students, whereas some are open to all students including post-professional and Ph.D. students. In general, the number of credit points acquired for a course varied from two credit points to twelve and is mostly related to the course type. Terms of entry varied as well, and only half of the surveyed courses have conditional terms of entry as completing previous courses or admission requirements like software, theory, and introductory site visits. The average number of participants per course is fifteen to twenty students.

Hands-on activities objectives and learning outcomes

A distinction between the objectives and learning outcomes of the two types of courses may be noted: workshops and short-term courses, that focus on acquiring a particular skill or focusing on a specific material, mostly appear in undergraduate courses, and comprehensive and longer courses that award a higher number of credit points. The second type of courses is usually designed for postgraduate students, where the hands-on experience seeks to emphasize a holistic approach and a multidisciplinary integration of previously acquired training and knowledge that were gained separately and jointly expressed in the hands-on course. Analysing the questionnaires, characteristics of Problem-Based Learning were noted:

- Experiencing a real-world project and a simulation of an actual conservation project.



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- Coping with hands-on experiences and in-situ work whether at a site or in a museum.
- Multidisciplinary synthesis at all levels: from the pedagogical approach throughout the methodologies, to the given assignments and their final evaluation.
- Collaboration among participants who come from various backgrounds to simulate a real project team.
- Expressing a variety of skills among which knowledge and understanding, applied skills, autonomy of judgment, and communication skills.
- Improving problem identification, critical thinking, results analysis, reporting and developing initiatives and hands-on skills.

Hands-on pedagogical methodologies

Due to the nature of hands-on courses and workshops, in all the received answers, without any exception, the aspect of operating in-situ was emphasized. Driven by a holistic approach and a multidisciplinary attitude, the pedagogical methodologies, both the primary ones as well as the secondary ones, include a broad span of lectures, visits and tours, and meetings with stakeholders throughout practical excavation and conservation works, field laboratories, case study analyses, problem-based, group, and constructive learning.

Multiplier Event E1 the Holy Sepulchre Hands-on Experience

The three-days international workshop, entitled: The Historic City of Jerusalem, The Holy Sepulchre: A Hands-on Experience, took place between 3-6 April 2022 in Jerusalem.

The distinctiveness of the workshop has been its educational approach, content, program, structure, and participants. The flexibility in scale, moving from macro to micro, from the urban scale to a single site onto conservation materials was demonstrated. These while exploring and using nondestructive technologies advanced methodological techniques of conservation all related to previous experience gathered from the Holy Sepulchre Rehabilitation Project. Analyzing the advantages and disadvantages of holding an international, experimental, multidisciplinary workshop, examining the effectiveness of a one-time short-term workshop on learning outcomes, and gained skills, and studying their contribution, and added values for modules in a cultural heritage and conservation curriculum.

The Jerusalem hands-on experience workshop was applied to introduce students and professionals to the complex array of scientific and engineering challenges in the protection of monuments that offer the backbone for achieving scientific thinking by merging theoretical background with practical training. Applied on a pilot scale the workshop seeks optimum hands-on experience by both:

- Analysis of the relevant hands-on methodologies that can be applied in other fields of knowledge than cultural heritage.
- Using technologies and scientific tools for the protection of cultural heritage (i.e., non-destructive technology, analytical and modeling techniques, and AR technologies)

The workshop activities were led by experts from various fields, all operating non-invasive instruments for the benefit of either materials, engineering or documentation and interpretation aspects of the conservation and rehabilitation of historic monuments.

For the Hands-on Experience a day and a half were assigned. The First day was split into three parts, each one of them focusing on the conservation aspects of monuments rehabilitation projects. In order to enhance the hands-on experience, the participants were split into smaller working groups. Local experts took part in this day, presenting the methodology of their instruments and the used technology. All experts were



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allocated the most suitable location within the Citadel to assure maximum participants' experience while using the equipment and learning how to read their data outputs. Each part was concluded by a short presentation of the methodology used at the Rehabilitation Project of the Holy Aedicule, and a wrap-up of the topic. The first part of the Third day was a direct continuation of the in-situ hands-on experience and consisted of a visit to the IAA Laboratories at Har Hotzvim, Jerusalem including the analytical and mobile labs, which capabilities and instruments were presented during the previous day.





Hands-on experience – Monday, April 4th, 2022

<i>Location:</i>	The Citadel – Tower of David Museum	
09:00 - 09:30	Opening of the Hands-on Experience L. Weinblum (IAA)	
Part I 09:30 - 11:15	Materials Conservation and Architectural Planning Dilemmas - building materials characterization and decay diagnosis on site, supported by analytical techniques Prof. A. Moropoulou, Dr. E. Delegou (NTUA) Prof. G. Favero, Prof. L. Sadori, Dr. L. Medeghini, Dr. S. Capuani, Dr. F. Franca, Dr. A. Ciccola (Sapienza) Dr. Y. Asher, M. Shor, Y. Maor (IAA) Y. Carmel, E. Sklar (Centaur Conservation); D. Avital (DMDA), E. Cohen (Eli-El Technologies)	
	09:30 – 10:45	Dino Lite / XRF (Nondestructive Methodology) * Methodology * Hands-on
		IRT (Nondestructive Methodology) * Methodology * Hands-on
		FTIR-ATR (Sampling Procedures) * Methodology * Hands-on
	10:45 - 11:00	What is the importance of material analysis in conservation works? Discussion: E. Sklar, Y. Carmel
11:00 - 11:15	The EDICULA conservation methodology Prof. A. Moropoulou / Dr. E. Delegou	
11:15 - 11:30	Coffee Break	
Part II 11:30 - 13:15	Engineering Engineering aspects of the renovation and conservation of the Citadel - an open archaeological site Dr. K. Lampropoulos (NTUA) Eng. Y. Schaffer, Eng. A. Levy (Schaffer & Ronen Conservation Engineering); Dr. U. Basson (GeoSense Ltd.)	
	11:30 - 12:45	Monitoring system for cracks and movement * Methodology * Hands-on
		FLAT JACK structure strength according to field data * Methodology * Hands-on
		GPR * Methodology * Hands-on
	12:45 - 13:00	The EDICULA conservation methodology Dr. K. Lampropoulos
13:00 - 13:15	What is the importance of structural analysis in conservation works? Discussion: Eng. Y. Schaffer	
13:15 - 13:45	Lunch Break	
Part III 13:45 - 15:30	Conservation and Interpretation A. Wiegmann, S. Halevi, A. Freiberg (IAA) Prof. M. Caine (Hadassah Academic College)	
	13:45 - 15:00	Photogrammetric models at the service of Conservation Planning * Methodology * Hands-on
		3D Scanning of Architectural Objects and Inscriptions * Methodology * Hands-on
15:00 - 15:30	Pros and Cons of Advanced Documentation Methods Prof. M. Caine	
15:30 - 16:15	Daily Summary	

Hands-on experience – Tuesday, April 5th, 2022

<i>Location:</i>	IAA Laboratories 4 Ha-Marpe St. Har Hotzvim, Jerusalem	
09:00 - 12:00	Visit to the IAA Laboratories Analytical and Mobile Lab.; Conservation of Pottery Lab.; Conservation of Glassware Lab.; Metallic Implements and Objects Lab.; Organic Materials Lab.	
12:00 - 13:00	Lunch Break	
13:00 - 13:30	Transportation to the Jerusalem Historic Centre	
<i>Location:</i>	Jerusalem Historic Centre	
14:00 - 16:00	Cultural Mapping, Cultural Significance and Communities Engagement Activity Architect S. Groag; Architect A. Sela Wiener; Architect K. Potdar (BEZ)	



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One of the Jerusalem hands-on workshop objectives was learning from the Holy Aedicule Rehabilitation Project. Thus, technologies and techniques of non-destructive methodologies, previously used in the Rehabilitation Project, needed to be performed on-site and be used by the participants. Collaboration and assistance of high-level experts were required, including outsourcing experts in addition to IAA experts. The variety of offered methodologies and techniques was highly appreciated by both the participants, for whom it was a first-time experience, and for those that were already familiar with them but had a chance for in-depth learning.

The integration of the current workshop activities with the know-how experience of the previous Rehabilitation Project demanded a very well-integrated and organized plan with a strict timeframe for each of the workshop days. The wide range of activities, the hands-on necessity and the sensitive instruments involved, required working in small groups. The participants were divided into three heterogeneous groups, simultaneously working on different techniques in different locations on site. The workshop also included lectures, given in-situ. The purpose of the lectures was to ensure a common knowledge base for all participants. Analysis of the participant's feedback clearly indicates that the lectures are needed but should focus and provide theoretical inputs about the used or to be used techniques, and more time should be allocated to hands-on experience.

The added value has been for both participants and tutors and thus it is particularly important for developing hands-on modules in cultural heritage conservation curricula, strengthened by results of a preliminary stage survey on hands-on methodologies in postgraduate and undergraduate courses in academic programs in the field of cultural heritage and conservation studies.

The EDICULA Project, as a successor of the Holy Aedicule Rehabilitation Project, has enabled to highlight the importance of learning the work methodologies, techniques, and technologies from successful, challenging, and complex real-world projects. The implementation of their conclusions on projects with similar characteristics will empower any project's planning, execution, and understanding. Empowering all involved professionals to benefit from previously acquired knowledge and experience that can easily be used for planning additional multiplier events dedicated to hands-on experience and activities in broad cultural heritage conservation content and in various locations worldwide

Multiplier Event E2 The Alexandria Hands-on workshop

The EDICULA Alexandria Immersive Experience added value is complimentary to the Holy Sepulchre Hands-on experience since it has expanded the EDICULA framework into other grand challenges in CH. It has acted as an exemplary test case, providing immersive experience in the Shallalat excavation in Alexandria, according to the interdisciplinary approach implemented in the Holy Sepulchre rehabilitation.

The Alexandria hands-on workshop – which was necessary for the production of 3Dimensional and Non Destructive in situ educational material for the Alexandria immersive event – took place in Alexandria from June 1st to 3rd, 2022 and was organized by HRIAC in cooperation with NTUA, and supported by the Patriarchate of Alexandria and all Africa, the Consulate General in Alexandria and the Hellenic Community of Alexandria. The following aspects were presented:

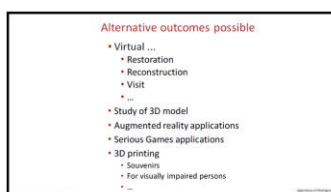
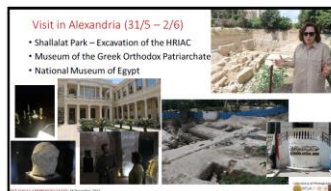
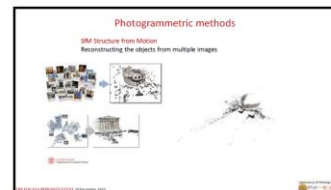
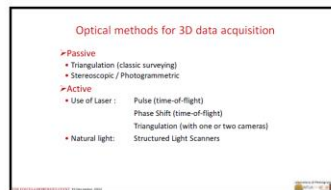
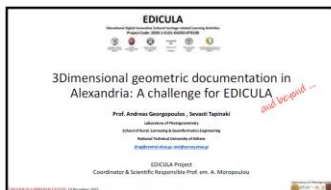
- The rehabilitation of the Holy Aedicule of the Holy Sepulchre in Jerusalem
- 3Dimensional geometric documentation of the Holy Aedicule and the RESPECT open access data platform: A challenge for EDICULA
- Hands-on methodology in Protection of Monuments using Non Destructive Techniques
- The excavation works at the Shallalat Gardens in Alexandria. Meeting the innovations of the Holy Aedicule rehabilitation within EDICULA: New perspectives in excavation strategies



HRIAC represents a classical archaeological association, that emphasizes on excavations, and aims to reveal cultural assets of different historical periods, like the revealing of the Alexandrian Hellenistic period of great interest for archaeologists, architects et als.

3Dimensional geometric documentation in Alexandria

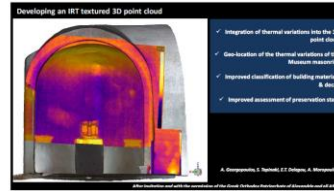
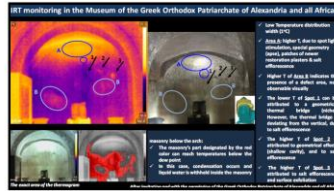
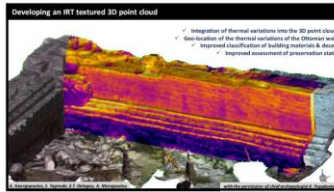
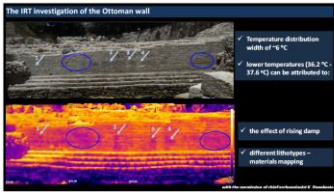
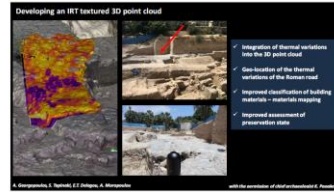
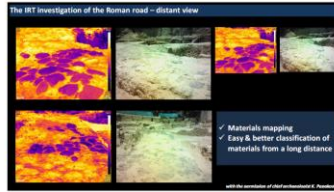
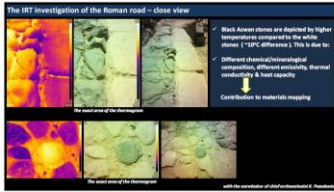
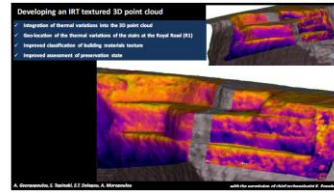
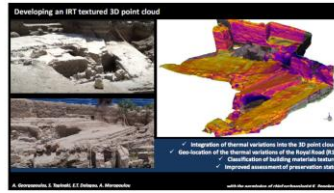
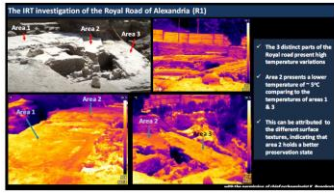
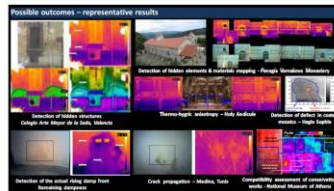
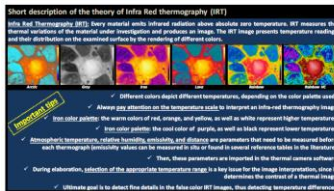
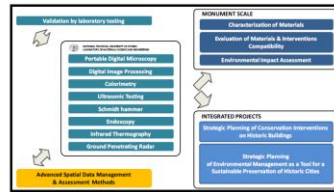
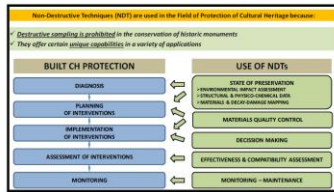
In the Alexandria hands-on workshop, the 3Dimensional geometric documentation of the Holy Aedicule was presented by Prof. A. Georgopoulos, combined with outcomes from RESPECT “An exemplary information system and methodology for the integrated management, analysis and dissemination of digital cultural heritage data coming from the rehabilitation of the Holy Aedicule” Research Program funded by PA 2014-2020, and the Research Program «Exhibition and dissemination events of the results of the rehabilitation works and the research of the Holy Sepulchre in Jerusalem”, both coordinated by NTUA in synergy with the EDICULA project.





Hands-on methodology in Protection of Monuments using Non Destructive Techniques

In the Alexandria hands-on workshop, non-destructive techniques used in the field of protection of monuments were analyzed by Dr. E.T. Delegou. The interdisciplinary approach of integrating the IRT results into the 3D model can enhance our interpretation capabilities about the preservation state of a monument, since the temperature readings are attributed to space, allowing the quantitative classification of building materials and decay, in terms of thermal properties variations.





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IRT monitoring in the excavation of the Shallalat Gardens & in the Museum of the Greek Orthodox Patriarchate of Alexandria and all Africa demonstrated significant information about the preservation state of the monuments under investigation. In particular:

- Different materials
- Materials of different textures
- Areas of rising damp , as well as areas at the risk of condensation
- Defect areas not visible by naked eye

were detected and displayed.