SURVEY OF THE ARCHEOLOGICAL SITE OF NEMI. A TRAINING EXPERIENCE.

Cristiana ACHILLE[1], Francesco FASSI[1], Nora LOMBARDINI[2], Fiorella GAUDIO[1], Laura GALBUSERA[1]

[1]Politecnico di Milano, Dpt. BEST
P.zza L. Da Vinci, 32, 20133 Milano, Italy
(cristiana.achille, francesco.fassi, fiorella.gaudio, laura.galbusera)@polimi.it
[2]Politecnico di Milano, Dpt. DPA
Via Durando, 10, 20158 Milano, Italy
nora.lombardini@polimi.it

Keywords: Cultural Heritage, training, photogrammetry, laser scanning, diagnostics

The conservation of the Cultural Heritage(CH) passes through their understanding (in the extended meaning of the term) and the survey can contribute significantly in this knowledge process with the techniques that have been developed in the years. If the documentation is the first step towards the preservation of the historical-architectonic-archaeological heritage, the figure of 'surveyor' also acquires primary importance.
A 'good survey' requires knowledge of the instruments and techniques, familiarity with software for managing and processing data and clarity of purposes. The training is the base.
The reflection about the role of the 'surveyor' inside the Cultural Heritage safeguard inspired the summer school course that has been carried out in Nemi (Rome). The aim of the course, divided in theoretical and practical lessons, was to provide the base-knowledge required to deal with the of actual measure and representation topics through a critical, interpretative cognitive archaeological journey in the archaeological site of the Sanctuary of Diana. Additional topics was also the strategy and the possible methodologies for the data management, later upgradeability and moreover the usage, diffusion and web-publishing of elaborated data and results. Authors opinion is that the survey in the cultural heritage field must be accurate (metric), expeditious (but not superficial), at affordable costs; to get a good result the first 'step' to be overcame is the training of technical staff who will work in the future.

1. INTRODUCTION

Safeguarding and valorizing cultural heritage requires specialized professional figures with a wide spectrum of knowledge and skills. In Italy, schools and universities provide the basic training for operators safeguarding and valorizing cultural heritage. Several universities offer three-year plus degree courses (3+2), possibly accompanied by further specialization[1]. Though still based on the historical-critical and technical structure of traditional postgraduate courses and postgraduate schools in history of art, archaeology, restoration, the new schools and training possibilities offered in degree courses, now also foreseen for other subjects, pay greater attention to the legal and economic aspects and have a more incisive "in the field" training. Italian universities deal with several subjects linked to managing and using CH and also offer specific Training courses for those wanting to handle aspects of historical, architectural and protected landscape Heritage in-depth. The really wide CH horizon, especially in Italy, justifies this ample teaching spectrum and variety of teaching structures. For this, Universities offer, like in this case, training courses to be done in addition to ordinary courses and which represent a real theoretical-practical, hands-on moment for students on specific subjects.

[1] For some figures (like art historians, archaeologists, archivists, librarians) Italy has a postgraduate diploma taken in the "Postgraduate school on safeguarding, managing and valorising cultural heritage". Restorers are usually trained in the ICR schools (now Higher Institute for Restoration and Conservation) and the OPD (Florence Opificio Pietre Dure - (literally Workshop of Semi-precious Stones and Laboratories of Restoration)) or other recognised Regionally schools , more than in Universities.

1.1 Museums, Monuments, Archaeological sites in Italy[2]

Italy has the richest CH worldwide, it shows some 'numbers' to give the idea of the Italian situation [1]:
- 4.739 museums and similar institutions, public and private, open to the public (an average of 1.4 per 100 sq.km, 7 per 100,000 in habitants), in particular:
– 399 institutions under Ministry for Cultural Heritage and Activities (MiBAC) government: 198 museums, 201 monuments and archaeological sites
– 4.340 institutions (802 monuments, 129 archaeological sites, 3.409 museums) managed by other public boards, local authorities and private owners, 45.5% by Municipalities (2006)
- 62.701.994 visitors in institutions other than those under MiBAC government, 35.068.423 fee-paying visitors (2006)
- 33.105.821 visitors in MiBAC institutions (63% in the provinces of Venice, Florence, Rome, Naples), of which 15.609.313 feepaying visitors, for an overall revenue of 104.004.721 Euros

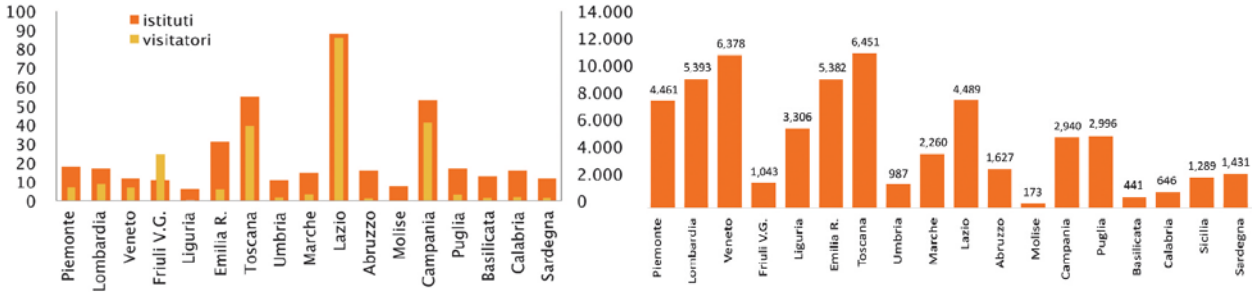

Figure 1: left MiBAC Institutions and visitors by region; right Archaeological and architectural properties classified by region[3] (1909-2004)

Archaeological Heritage
- 5.668 monuments and sites protected (1909-2004)
- 317 identified and documented underwater archaeological sites, 30 of these in 2008
- 210 authorisations to private and public institutions for research and excavations
Architectural Heritage
- 46.025 buildings and monuments protected (1909-2004)
- 7.690 statements of cultural interest since the Code of Cultural Heritage and the Landscape came into force (2004-2008), of which 1.050 refer to private properties and 6.640 to public owners or private non-profit bodies (including ecclesiastical institutions)
- 130.297 ministerial acts concerning 51.693 immovable properties
Historical, artistic and ethnographic Heritage
- 4.728 certificates of free circulation issued by MiBac Export Offices and 67 refusals
Archival Heritage
- 3.800 private archives declared of notable historical interest

These 'numbers' are just a summary of what Cultural heritage is really all about in Italy. The need to maintain these treasures must become concrete in training the staff which - at all levels- has to interact with this vast heritage. We need to offer training which effectively answers the necessary "conservation and maintenance" needs. Alongside 'academic' training, there has to continual updating[4] on the hardware and software evolution of survey instruments and available analysis and monitoring techniques.

[2] This booklet [1] presents synthetic data concerning the production, protection and promotion of culture in Italy. The figures refer to 2009 and have been provided by the National Statistical System, the General Directorates and Central Institutes of the Ministry for Cultural Heritage and Activities (MiBAC) as well as other reliable and sound sources.
[3] In Italian Region there are also the sites recognized by UNESCO. The aim of being included in the List of World Heritage sites is to preserve the heritage for the transmission to future generations. 44 Italian sites (2009): important historical centres (including Rome, Florence and Venice) cultural landscapes, archaeological monuments and sites, natural sites.
[4] The need for proper staff-training is also felt internationally, e.g. the CIF activity (International Training Committee of ICOMOS). The purpose of ICOMOS CIF is to promote international cooperation in the field of training and education in the protection, conservation and revitalization of monuments and sites, and built heritage in general; in order to

2. THE SURVEY IN THE CULTURAL HERITAGE FIELD

Survey activities are generally aimed at knowledge of size data, the geometrical characteristics of study objects, describing materials and construction techniques used.
Accurate documentation is of indispensable support to protecting and safeguarding cultural heritage (priorities indicated by the Ministry for Cultural Heritage and Activities in the 2010-2012 three-year period mention 'Conservation and protection of cultural and landscape heritage; promoting knowledge and fruition of heritage and cultural activities and modernizing and rationalizing operating structures'[2]). The availability of more and more refined survey techniques and methods allows you to choose –even case by case- what documentation is best and the most suited. In particular – in the immense Cultural Heritage area – the "survey" indicates all those operations executed to be able to represent an area, a monument, an object, ... for which we do not have suitable documentation or when it has to be upgraded because of modifications or alterations that have occurred. Measurements taken, based on a precise criterion, must provide graphic documentation, normally through representation on a reduced scale so that it may be used to study the object and/or for its upgraded documentation. Methods and instruments are chosen related to the peculiarities of the object to be surveyed and the need for detail required. A modern architectural and archaeological survey must be 'expeditious' yet detailed, not too expensive and repeatable [3,4]. A survey with these characteristics must be carried out by an operator with specific technical skills [5]. The subject of training is a real need. In recent years, the evolution of instruments has made it much simpler to use them. But this does not mean that generation of processed data is just as simple. As an example, the spread of laser scanners and their relative simplicity if use has increased the request for this type of survey. You use the laser scanner by placing it in a tripod and setting the acquisition window. The end result is a points cloud of great visual impact generating great satisfaction in whoever sees it. But it is not processed data. To build a 3D model or extract all the 2D information required, you need to process the points cloud and this requires technical and theoretical skills and the ability to process different types of data at the same time (this is also true for a series of new photogrammetric applications). Thus, if on the one hand the survey instrument and method evolution seems to make the acquisition stage easier and faster, we must not forget that a good survey (that is metric, to scale) is the result of a series of processes requiring clear intentions and specific competences. If what we want is a survey that really supports a CH documentation, conservation and valorization project. The speed at which the computer field, applied to Cultural Heritage, is evolving, implies training and updating as a pre-requirement for all those who want or will want to work with Cultural Heritage in various ways .

2.1 The experience of summer school

The purpose of the summer school organized by Milan Polytechnic was to place students in a real case study situation, in this case of the extended archaeological type.

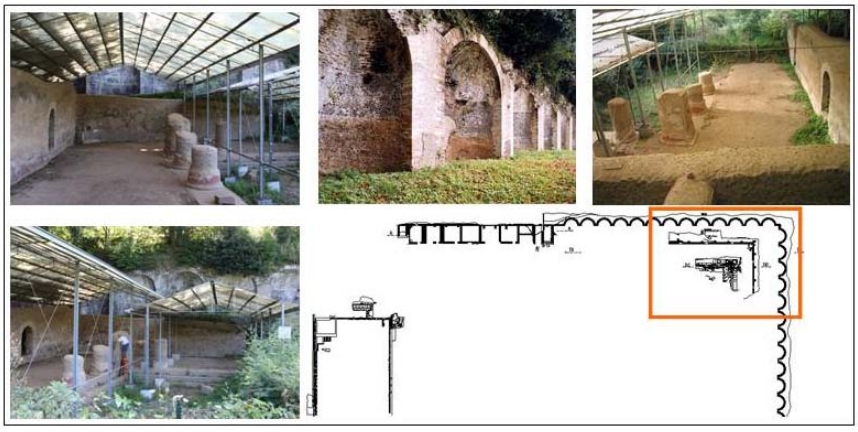

Figure 2 Some pictures of the archaeological area; the plant is shown the part measured by the students.

improve greater under-standing over the recognition of such heritage, technology, management, and doctrine, and to advise on the development of ICOMOS programs in this field (http://cif.icomos.org).

The course was divided into three parts: theoretical classes; on site survey; processing of data acquired. The first and third parts were held in Milan in the Polytechnic. The on-site survey was done in the Temple of Diana in Nemi. Nemi is a town in the province of Roma, almost in the centre of the Colli Albani on the volcanic lake of the same name.
The Sanctuary of Diana, situated on the northern shore of Lake Nemi, in an extremely suggestive environmental and landscape context, is one of the most studied and mentioned places of worship for the Latins[5] [6,7,8,9]. The summer school objective, its idea, was to transmit the 'modus operandi' of a surveyor presenting the students with a practical, real case and a pre-set documentation, analysis and planning purpose (the roof). During the 'field' work, students put theoretical notions supplied during class lessons into practice and analyzed them. The students covered the entire survey process: inspection, planning the type of instrumental survey, time-management, measurement activities, checking data acquired, processing, producing results. Field activities and the subsequent data processing and finalizing period taught them the traditional survey methods (celerimetric and topographical), enabled them to experiment with the more innovative 3D survey techniques (laser scanner and photogrammetry), create a material and deterioration survey of structures analyzed and assist in collecting samples. Once the field survey had been completed they had to face the problems linked to data rendering and presentation. All the stages were carried out in teams and this is also an integral part of the school: knowing how to work in groups so you all contribute to achieving goals and handling the inevitable problems - operational and processing - occurring when you do a survey of this kind with team spirit.

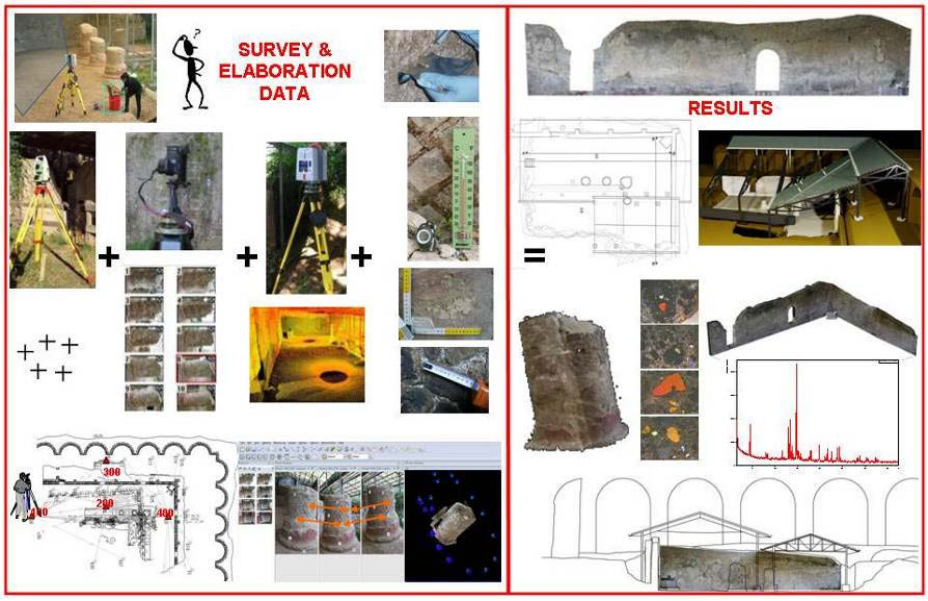

Figure 3: Image shows the workflow

2.2 ACQUISITION AND ELABORATION DATA

2.2.1 Topographic survey

The students did a topographic placement network useful for georeferencing the data then surveyed. They surveyed the points needed to draw maps and sections and compared them with those extracted from the laser scanner data; survey phogrammetric and laser scanner control points to georeference data. To survey the Sanctuary of Diana they materialized 4 tops on which to set up stations; when measurements to estimate network top coordinates had been taken, they acquired all the other topographic points needed to render the survey. The survey and precision with which on site operations were carried out was coherent with the final rendering scale fixed at 1:50 (1:20 for details). Final processing complies with tolerances set.

[5] The Superintendence for Archaeological Heritage of Lazio Region started excavation and restoration activities since 1989 aimed to a better understanding of the archeological sacred complex site.

2.2.2 Close range photogrammetry survey

“Photogrammetry allows you to reconstruct position, orientation, shape and size of an object from pictures: these pictures may originate as photochemical images (conventional photography) or as photoelectrical images (digital photogrammetry)” [10].
Considering the growing interest in the field of three-dimensional reconstruction and analysis through images in all scientific fields and the resulting technological evolution this is one of most interesting subjects in the CH field and was analyzed during the course. Nowadays you also obtain a good photogrammetric (metric) survey with common digital cameras; this allows a very expeditious, economical survey which is the most suited to CH sector needs. Cameras on the market with high resolution that are relatively cheap are suitable in those fields where data acquisition must be quick and where operating conditions are not always easy, as often occurs in the Cultural Heritage field. Students handled all the photographic data acquisition problems (using both common digital cameras and mobile phones[11]). They learnt how to calibrate common acquisition sensors (there are two strategies: Off-site and On-site. The first is done in the laboratory, the second on-site at the same time as the photogrammetric survey, what was done in Nemi), how to acquire images, how to pre-process them. They learnt the new three-dimensional modelling methods of image matching and image modelling. Techniques used to reconstruct detail automatically in the first case and simplified, expeditious reconstruction in the second .

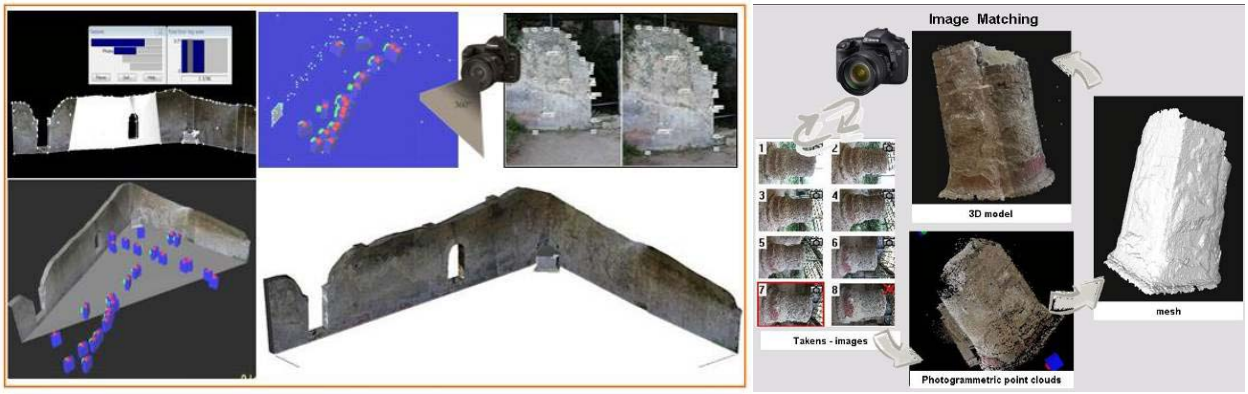

Figure 4. Today the results of photogrammetry elaborations are rectified images and 3D model.

The students faced with problems relating to: i) on site calibration; ii) image acquisition (common camera and mobile phone camera); iii) data elaboration (image orientation with manual, automatic and semi-automatic techniques; 3D model generation); iiii) generation of rectified images and orthophotos.

2.2.3 Laser scanner survey

3D scanner is a device that analyzed a real-world object to collect data on its shape. The collected data can be used to construct digital 3D models. There are different types of instruments with different functions and characteristics. The instrument must be chosen depending on survey type. For most situations a single scan will not produce a complete model of the subject. Multiple scans from many different directions are usually required to obtain information about all sides of the subject. At Nemi 14 point clouds have been made.
The ground Laser Scanner is not an invasive instrument so is suited to survey needs where special attention is required so as not to compromise state of conservation.
The problem is managing processing of the 'points clouds’ (millions of points). So it is important to establish how and to what extent data must be thinned out and filtered, related to the end product required. This type of instrument offers the great advantage of being able to acquire 'everything' and put data extraction off to a second stage.
Laser surveying has modified what is meant by a field survey. Considering acquisition speed, it is always better to survey the entire object so as to have a '3D photo' of actual state to then be able to extract all the information possibly needed (plants, sections, profiles, 3d models), even at different times to that of the survey itself. Without forgetting that having a laser survey available enables you to measure the object easily and immediately. The laser allows you to create a database which can be reprocessed at any time so there is no need to go back on site. Without forgetting that being able to 'colour' clouds increases scan information

content; the availability of free software where you can visualize scans and link information as text, images,… allows real integrated management of survey data increasing your knowledge of the object.

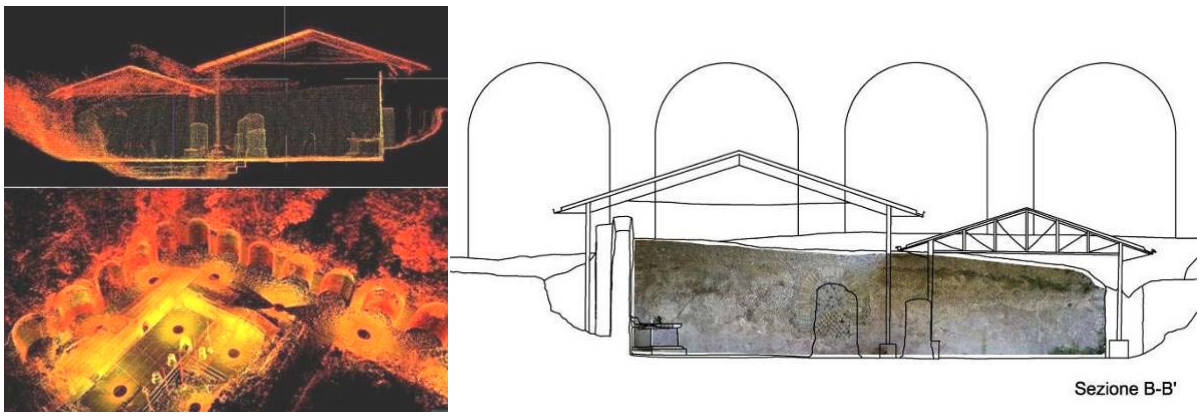

Figure 5. On the left: under, view of georeferenced point clouds; above extraction of vertical section. On right: one vertical sections (1:50 scale) extracted from laser scanner with the corresponding rectified image.

Figure 6. On the left: the textured point clouds; on the right an example how the materials data sheet can be linked to the 3D model.

The students faced with problems relating to: i) survey plan; ii) acquisition of point clouds (14 stations); iii) acquisition of panoramic images for to texture point clouds; • to georeference scans (using topographic targets); • extraction of plans, sections and vertical profiles; • texture of the point clouds with panoramic images; • link material data sheet to the 3D model.

2.2.4 The survey of the technical construction, the materials and their decay.

With the geometrical the survey of the technical and material construction has been made. Especially attention was dedicated to the identification of the several type of decays observed.
The observation of all the aspect of the object, in fact, is an important moment that represent the base of the conservation project. The archaeological site was restored (1996) according a project by the Superintendence for Archaeological Heritage of Lazio Region and was protected by a cover that, because provisional, nowadays reveals some weak points which induces new phenomena of decay. An important step of this part of the training experience is represented by the organization of the student work. For training the student must be guided with tools and methods tested and accepted by the scientific community but who require reasonable accommodation to the peculiarities of the object of study.
For this reason schedules were built for guiding the observation of each student. Each item on the card is designed with the intention of helping the student in a correct and exhaustive survey. The use of cards has been preceded by an appropriate explanation. Then students compiled the cards' items relating to the degradations observed. In the cards the students recorded the description of the material of the *opus reticulatum*, the roman technician applied in the wall faces of the ruins, with sketches, photos and a brief

report. In the same time were going on studies on material (mortars, stone) and decay sampled from *opus reticulatum* that façed the wall.

Figure 6. Example of compiled card with photos and sketches concerning the degradation of a plastered Mineralogic and petrographic characterization of the mortar sampled from the opus caementicium wall.

The humidity of the environmental (the Sanctuary is situated beside the lake and in the middle of the "bosco sacro" mentioned also by James Frazer in the *Golden Bough*) is influenced by the coverage and in some specific portions of the walls it is possible to see salts crystallized.
The students sampled also salts and, for offering more information about the environmental conditions (strongly influenced by external climatic conditions and by the existing coverage), surveyed during some days, with simple instrument, the temperature and humidity in specific points of the covered area.

2.2.5 The project of a new coverage

The students, organized in three groups, projected a new coverage for protecting of the archaeological remains of the "portico". The aim of the project is not only the protection, but also the valorization of the area, facilitating the accessibility of the ruins. The aim of the project is not a temporary structure, but a one that fulfills the problem of environmental impact, both from an aesthetic point of view and from the more technical compatibility with the environmental conditions. The cover, through the change of environmental conditions, should protect not should damage the ruins and in the same time has to respect the historic and landscape value of the place.

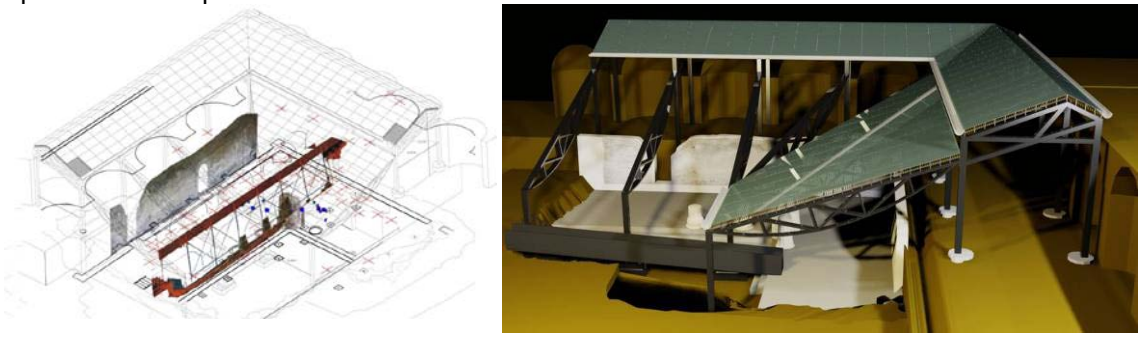

Figure 7. The coverage designed by Giorgia Cicalese, Stefania Fumagalli, Alessia Tosetto.

3. Conclusions

Reconstructing a cultural site requires an intense topographic, historical-archaeological, architectural and interpretation activity to acquire data at various levels of detail; and process it based on a digital protocol enabling you to integrate all the space information and metadata in a single virtual environment, without losing the information's original quality during processing. Today, it is recognized that an integrated use of survey solutions is the best solution for a metrically accurate survey with the necessary richness of detail. This care activity is definitely 'difficult' as it involves commitment from a motivational point of view and

immediate results and perception by society are not so evident. The cultural, practical difficulties occurring cannot be overcome unless you have an efficient organization able to keep the entire process under control right up to managing return information from results of the activities themselves. That is why training is a fundamental, non replaceable passage. For good results, teaching initiatives needed to train suitable professional figures must be taken (at the various training levels).
Heritage and cultural activities linked to it are legitimately considered a productive sector; first of all, for citizens who can gain knowledge of their history and cultural identity from it; secondly, for the financial aspects linked to related activities (conservation, maintenance, management use). One of the training objectives is to change the way of thinking and behaving to promote long-term prevention and care strategies, to contrast just immediate benefits.
Training is an important moment when you can become aware of the priceless value of cultural heritage together with the necessary technical skills. For that, the summer school experience proved to be valid and effective because it represented a real moment in which students could face the problems come up against, at all levels, in the CH sector. The students themselves where in favour of the 'theoretical lesson and field activities' method used because they were able to put what they had learnt in the preparatory lessons into real practice. In the CH sector, this training method must be stimulated as it improves knowledge and increases the interest and passion in future sector operators..

ACKNOWLEDGEMENTS

We would like to thank Giuseppina Ghini, Director of the Ships Museum and responsible for the archaeological dig and all staff involved for the great availability they showed. Thanks to prof. Roberto Bugini. ICVBC – CNR Milan for the research and analysis carried out on stone materials. Thanks to prof. Elsa Garavaglia for her useful advice on calculating wind strength and weight of snow.
Thanks to Marta Caroselli for the support during the characterization of materials and their decay.

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