

## LEARNING GEOMATICS FOR RESTORATION: ICOMOS SUMMER SCHOOL IN OSSOLA VALLEY

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#### ABSTRACT:

Documentation and preservation of widespread rural heritage are today possible only if you can activate processes of conservation headed by local communities, thereby recognizing the link between the communities and their culture. The cultural heritage places (villages, sites and landscapes) can take different values; action is needed respecting the right of communities to identify the values contained in them. 'Collaborative networks should be set up at different levels among multiple stakeholders in order to address issues related to heritage and create new value chains through innovative synergies. Dynamic, flexible, inclusive and integrated processes of engagement need to be employed for assessing long-term social impacts of heritage conservation programmes' (Icomos, 2014).

In 2011 the 3DSurvey Group of the Politecnico di Milano in collaboration with the Canova Association initiated an annual summer school program entitled 'Laboratory of Places 2017, Ghesc and surroundings, History, survey, evolution Laboratory of Places'. The definition of "Laboratory of Places 2017, Ghesc and surroundings" links the idea of an inhabited space to an open space suitable for study, research, and an interactive absorption and confrontation of differing ideas. Founding elements of the project involve educational collaborations with university, but equally important will be the development of programs with local schools, associations, and public administration (Quaderni di Ghesc, 2010).

### 1. INTRODUCTION

#### 1.1. Canova Association

Canova Association is an international non-profit organization founded in 2001 in the medieval village of Canova, Oira di Crevoladossola, Italy, Canova is an institutional member of ICOMOS Italy since 2010.

The principle goal of the Canova Association is the preservation and enhancement of rural medieval stone architecture.

Canova Association presents a rich program of events each year, some reserved for members only but the majority open to the public. These occasions are meant to increase the involvement of people dedicated to the continuation and protection of European and our local heritage of ancient rural stone architecture.

Art and architecture intertwine, stimulating research and debate, revolving around the conviction that old stone construction can offer adequate if not superior models in our search today for sustainable human dwelling solutions. The continuing insensitivity to this fact is resulting in indiscriminate demolition and renovation, forever cancelling the precious heritage of rural stone architecture in Italy and Europe. The intention and goal of the Canova Association are to reverse this tendency, carrying out activities aimed at sensitizing both the public and private sector.

For over ten years the Canova Association organizes fields school regarding the theme of architectural restoration in collaboration with Italian and foreign universities.

The participants followed by a master builder, have the opportunity to know and learn the techniques of typical Ossola architecture from the best perspective, the one that sees them engaged directly. In recent years, the field schools take place in the suggestive medieval abandoned village of Ghesc. It is a village across the river from Canova. Large trees grew up are

living within the walls of the houses, and the place exudes a charming air of mystery. Ghesc is the ideal stage for what we like to call the "Infinite Laboratory," and is the playing field of the International Canova Field School program (Canova Association, web site).

### 2. SUMMER SCHOOL

#### 2.1. Ghesc rural village

'Ghesc is a minuscule medieval village, uninhabited for more than one hundred years. The encroaching forest has gradually embraced its buildings and terraces, creating a highly evocative and fascinating environment. Hidden between the Swiss alpine border and the narrow Ossola Valley, Ghesc is located in the municipality of Montecrestese. Thanks to its relative isolation, the Ossola Valley has kept its secrets well hidden. It is an area of extraordinary natural beauty with an abundance of undiscovered stone villages. Ghesc is essentially composed of seven houses, only one of which still conserves its original stone roof, and the rest are in varying states of neglect. The village was equipped with a bread oven and a watermill for grinding flour, both of which are existing but non-functional. An analysis of the surrounding landscape clearly illustrates nature's steady march in reclaiming its original territory. The retaining stone walls of the stream have been seriously compromised and the terracing once cultivated with vineyards, rye and hay are now home to chestnut and beech forest. Historical documents referring to Ghesc are rare but those that do exist apparently demonstrate its ancient origins. A document dating back to 1411 attests to the payment of tithes owed to the Municipality of Montecrestese, referring to the then current name of Gexo. Both the Teresian cadastral maps of 1722 and the Rabbini Maps of 1863 clearly identify the area in more recent times. The surroundings of the village of Ghesc is

particularly rich in historical and architectural sites. Many terraces, relatively well conserved, encircle the nucleus of houses. In the little valley below the village, there is a mill house built for grinding rye as well as two lime kilns for the production of lime mortar, a fundamental material in the traditional building trade. The presence also of an ancient tomb-like enclosure built in the terracing and a "balma" ( a large room created by excavating beneath a giant boulder ), as well as the Celtic site of Castelluccio a short distance away, is testimony to the area's long history of human habitation' (Quaderni di Ghesc, 2010).



Figure 1. The Ghesc village in Rabbini Cadastre, 1863

## 2.2. Summer school activities in Ghesc

The primary goal of the 'Laboratory of Places 2017, Ghesc and surroundings - History, survey, evolution' is to create a collaborative experience involving students, teachers, and members of the Association and the local community to contribute to the documentation of Ghesc, thereby actively participating in its rediscovery and preservation.

The summer school is organized into four parts:

- introductory 'best practice' and theoretical lectures;
- survey activities in Ghesc;
- processing of the acquired data;
- research and discovery of the territory.

The aim of the summer school is to enable students to know how to use tools and methods after proper theoretical preparation, and then to be able to process the collected data in a critical way.

The principal aims of the course can be summarized as follows:

- i. encourage the learning of modern and innovative survey methods.

The course is organized so that students, divided into small groups, follow all the steps of a geometric survey.

The first step, preliminary to the knowledge of existing buildings comes from the geometric survey phase.

In the case as Ghesc, where buildings that present themselves aggregates, the survey should not be restricted to a single building but must permit the reading of the aggregate as a whole. The geometric survey must, therefore, contain all the elements necessary to represent in plane-altimetric form the constituent elements of the aggregate.

In situations like this, the geometrical survey phase is required to highlight the elevation profile of the entire complex

The geometric study allows you to locate the exact position of both individual buildings than in adherence; also allows a correct reading of the different levels and the thickness of the walls.

In particular, the activities include the design of the topographic network, which will serve to place and to ensure the correct georeferencing of all different surveys. Using a total station it is possible to detect the coordinates of the topographic network points. When the topographic network is ready the acquisition of target position can start, targets (both laser and photogrammetric close range and UAV) are appropriately placed on the buildings and on the ground. To create time efficiency the topographic and laser scanner survey are conducted simultaneously. When the acquisition phase is complete the data (point cloud) is then processed correctly (alignment, cleaning, georeferencing) in order to prepare maps and sections (2D representations).

The last representation scale is equal to 1:50, standard scale for the architectural project.

In this way, the geometry of all the elements that describe the spaces, the size of the bearing elements and not, and those of connection (stairs, vaults, floors, ...), and the presence of specific elements (such as recess, chimneys, etc.) can be highlighted.

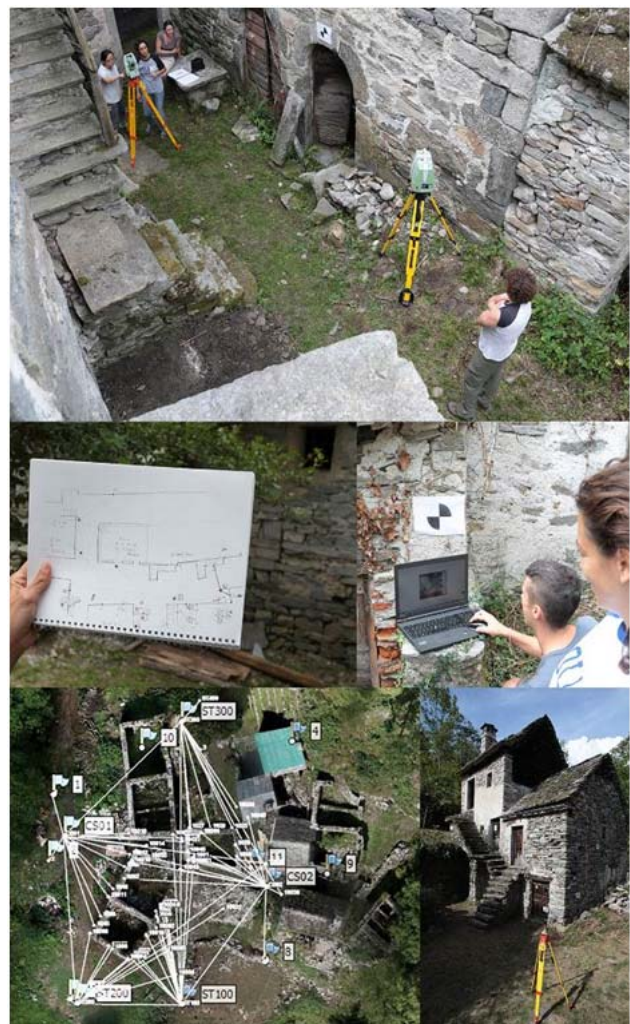


Figure 2. Survey on field, from place sketch to surveying topographic network

In particular in historic villages, as this Ghesc, the difficulties of the geometrical survey are linked to the accessibility of some areas (such as cellars or small spaces).

It can make up for the lack of access by acquiring the necessary information from the survey of adjacent structures or integrating



different survey techniques (typically laser scanner and photogrammetry). The representation of the survey results through maps, profiles, sections, and three-dimensional models (also in schematic form) is useful for the purposes of a correct understanding of the spaces and of the various units, as well as preparatory for the subsequent analysis.

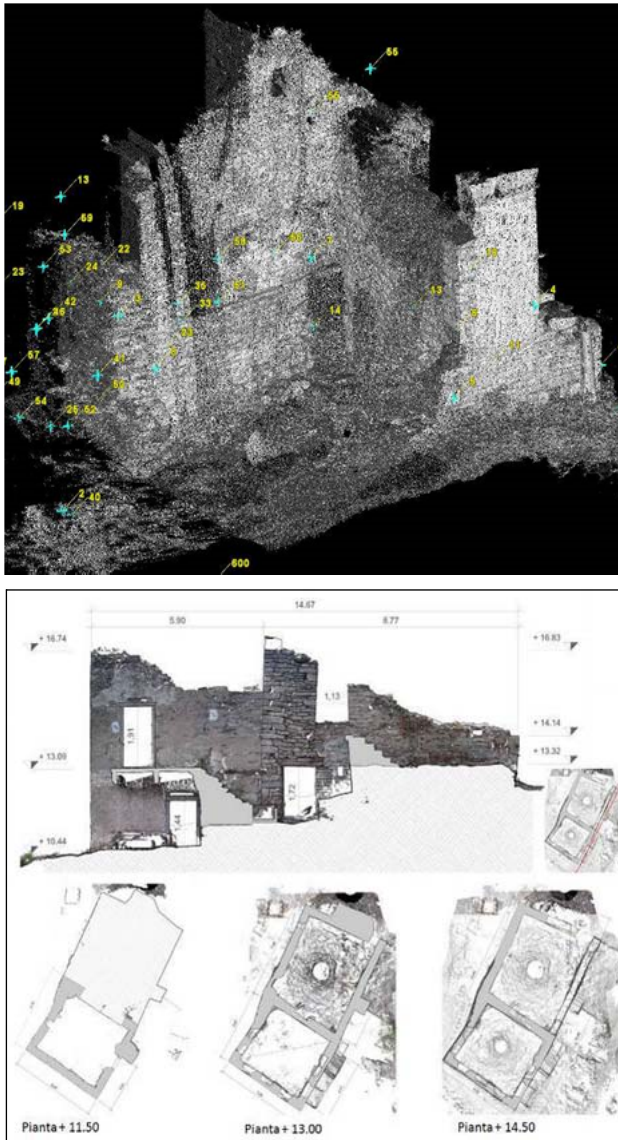


Figure 3. Drawings (plans and sections) produced starting from laser scanner data

The geometric survey, in the specific case of CH, must also be accompanied by the texture description. For this reason, it is essential to know the photogrammetric surveying techniques. Attendees at the end of the course are able to design and produce a photogrammetric survey campaign, to manage the data and extract orthophoto, sections and textured models. Students learn to design the photogrammetric survey, by properly setting the digital camera parameters, respecting the GSD corresponding to the proper scale of restitution and processing images in order to obtain orthophotos and 3D models. In addition to the traditional close range survey, students must also design a UAV survey, from the elaboration of this kind of data are generated plan

representations of the entire village. Today the characteristics of individual survey instruments are distinguished by an equal level, to make their integration more powerful and flexible, able to return a much better result and able to adapt to the morphological needs of different objects. The combination of the techniques allows optimising the process of acquiring and modelling using each instrument to the best of its characteristics and performance (Remondino, 2011).

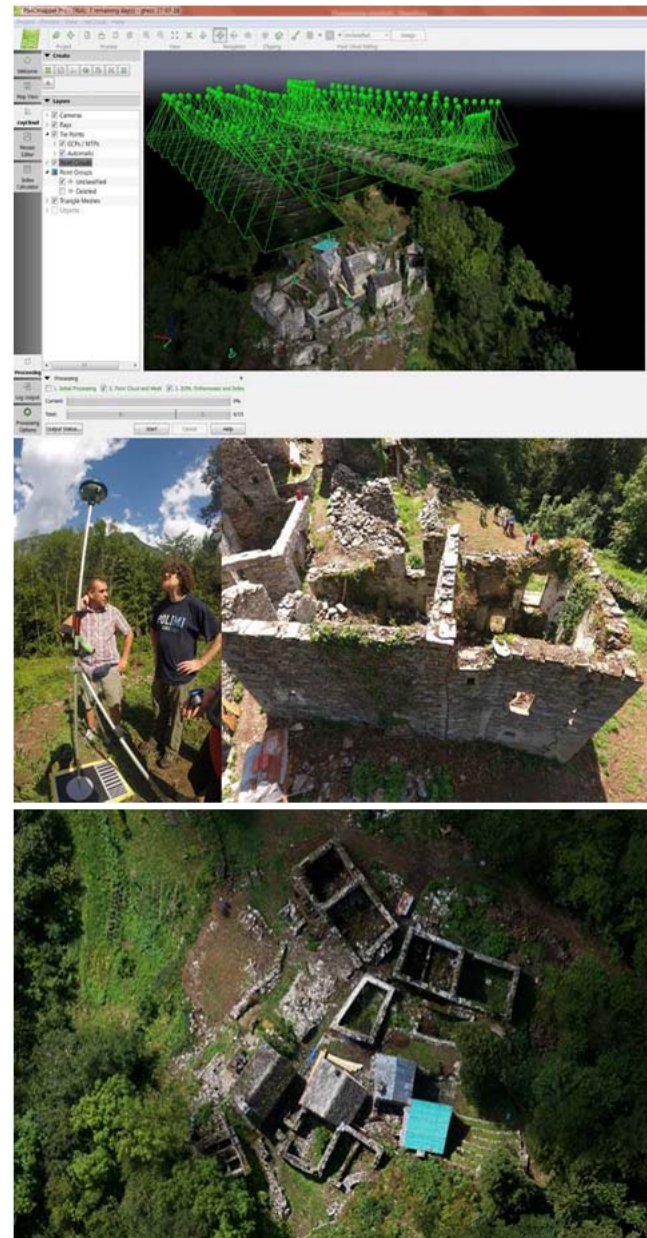


Figure 4. UAV survey: design, data acquisition, elaboration and final orthophoto of the entire village

ii. Promote the learning of methods to investigate and recognize materials. The correct activities (conservation and maintenance) on cultural heritage should also include a specific analysis of the materials that compose it. The material survey is required to document the quality and state of conservation of materials and constituent elements of the building. On orthophotos, the phase of materials and decay recognition can begin using appropriate norms, as ICOMOS\_Monuments & sites, glossary stone. Only at the end of this phase accurate



analyses are proposed, to sustain conservation actions. Substantial time is dedicated to recognize and study local materials, the same that are used in maintenance activities. Of the materials studied; the origin, the physico-mechanical characteristics, the types of production (handmade and/or industrial), the uses in the architectural building, the durability, the causes of deterioration including the methods to prevent and remove it where possible.

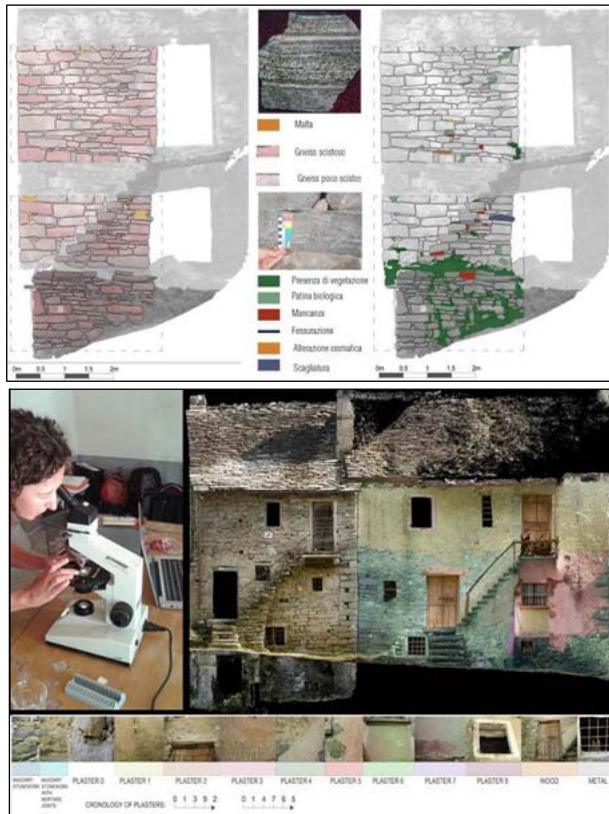


Figure 5. Materials and decay recognition

iii. Make a diagnosis based on the surveys and analysis carried out. Another important type of study is the crack pattern of the building, under investigation. On orthophotos are represented visible cracks, along with the necessary dimensional descriptions.

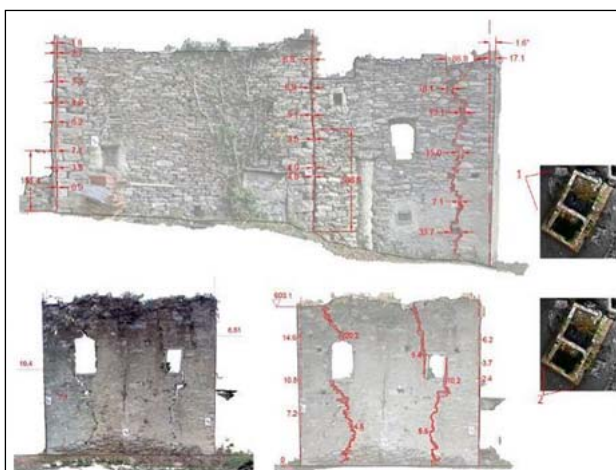


Figure 6. Recognition of the crack pattern on orthophoto

The drawing of the crack pattern begins with a preliminary examination (visual and photographic) of the structure; then the availability of a metric support (orthophoto) also allows for the quantitative study of the status quo. This type of survey should then be compared with the building's history, materials, and decay state. Only a combination of all examinations will allow for possible proposal for intervention. With the comparison of survey made in different years, it is feasible to observe the evolution of the crack pattern, thereby triggering the monitoring of structures. After identifying the causes, it proceeds through the identification of the interventions, respecting the specificities of the different local materials and the use of appropriate Ossolano construction techniques.

iv. Promote the dissemination of user-friendly and low-cost technologies to ensure the widest possible diffusion of the necessary tools for the documentation, conservation and monitoring of cultural heritage; encourage the use of new tools and techniques so that they support the various phases of the conservation process; tools as means and not as the ends. Documentation and study of C.H. need to integrate different professions and diverse skills.

Today it is important to be aware of the hiring surveying techniques and digital 3D documentation and the impact they have in the process of analysis, interpretation and representation of an artefact.

It is important to dedicate a part of the activities to select in which ways to present the data, elaborations and analysis; so caring of issues related to data management hardware and software and promoting active use of the documents produced.

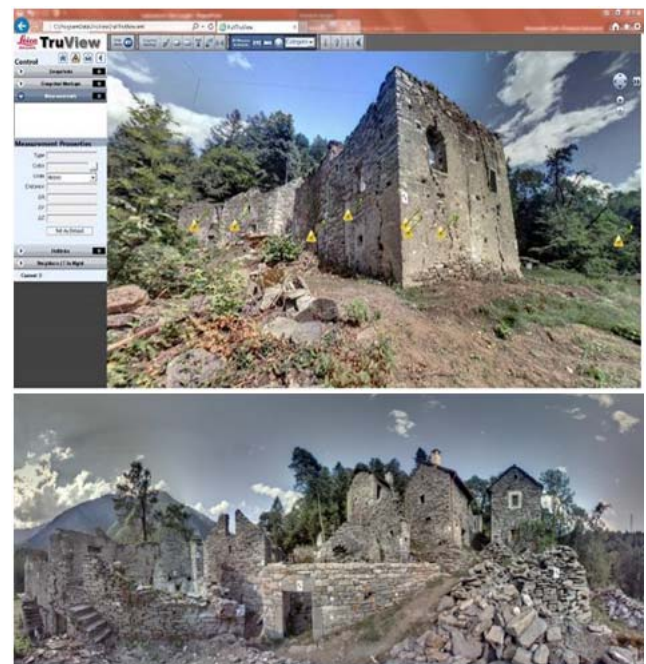


Figure 7. Panoramic images of survey point clouds.

In addition to the survey of the buildings, it's been given time also to the study and modelling of small finds (preserved at the Museo Rosminiano di Domodossola) through the use of a structured light scanner, from the acquisition of range images to the final mesh generation. The aim of the activity is to produce 3D digital models that help both for the study and documentation of individual objects, and for activities related to the enhancement of the same objects (hypothetical reconstruction, web visualisation, 3D printing ...).





Figure 8. Structured light scanner survey of small objects, modelling and 3D printing

v. Build capacity for the 'virtual design' of interventions based on the collected data. Based on the collected data (maps, sections, 3D models, history, material ...) it's possible to develop hypotheses about the original form. This delicate phase brings together the contribution of all study carried out. Starting from survey data and historical research hypotheses are produced about the shape/structure of the buildings at different stages of their life. These assumptions can be used for dissemination activities related to the presentation of local history.

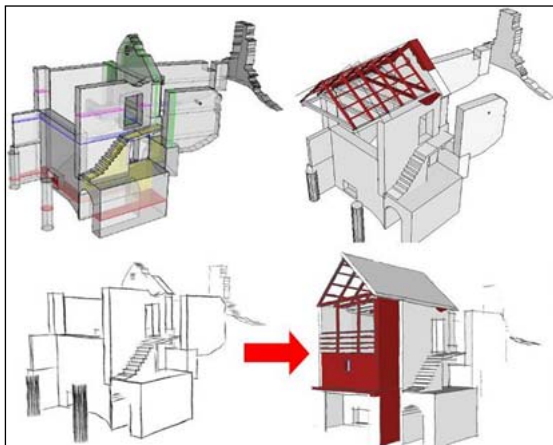


Figure 9. Digital reconstruction hypothesis starting from survey data and historical investigations

vi. Enhance the use of digital techniques to promote the site, even from a touristic point of view. Paragraph six of the Italian 'Codice dei Beni Culturali e del paesaggio' describes the enhancement as "the exercise of the functions and the regulation of activities aimed at promoting knowledge of cultural heritage and to ensure the best conditions of use and public access to the heritage, even by people with disabilities, to promote the development of culture."(D.L. 2004). The enhancement activities of Cultural Heritage are based on knowledge and requiring conservation and renewal

projects, and also must include multiple data use modes (in large format).

The debate on the cultural heritage enhancement strategies attributes to heritage itself an increasingly significant role in the context of development models based on local identity and enhancement of the resources of the territories (Manuel, 2011).

It is necessary to process the data while keeping in mind its potential future employment, not only for the necessary conservation work but also for the dissemination and valorisation via web at various user levels.

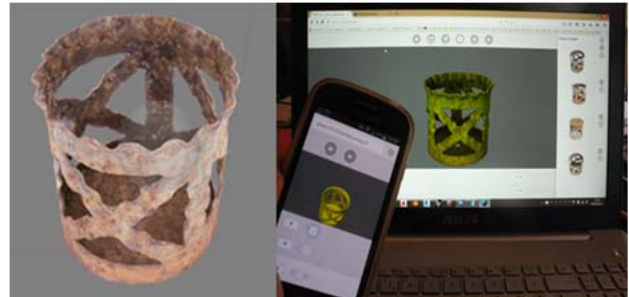


Figure 10. Sharing 3D digital models of small objects via web

The close cooperation between university and Canova Association has resulted in the development of digital products (movies and 3D models) easily shared online that describe both the village and a small object. These kinds of products actively contribute to the enhancement project.



Figure 11. Two frames extracted from the movie made from the photogrammetric survey



vii. Develop data-sharing procedures with online platforms to provide and ensure access to useful information for conservation practices (share platforms and tools for the dissemination of knowledge acquired). Through the use of shared platforms, one can aspire to bridge the technological gap between experts, technicians and conservators, between managers and end users of data and information.

The increasing spread of digital surveying techniques is not matched by equally rooted dissemination of data management systems.

Especially CH field hardware and software systems are often not suitable for supporting data from photogrammetric surveys or laser scanner (referenced in particular to point clouds and 3D models, not to the two-dimensional representations).

For this reason, it is necessary to investigate data sharing procedures that do not necessarily involve specific skills in the use of dedicated software and purchase of expensive hardware/software.

There are now several online platforms (Rechichi et al. 2016; M. Di Benedetto, 2014) that allow one to correctly display the three-dimensional data, by adding accurate information on the subject, both in text and in raster format.

The involvement and sensitisation of local communities are also implemented through the networking of data and final elaborations.

The availability of information via web helps to increase the interest in the territory raising awareness of cultural heritage; allowing citizens to recognize their identity in that heritage, to recognize it as their own and, therefore, to cooperate for its preservation.

viii. Promote knowledge of the territory and its peculiarities by offering students lectures on the history of the Ossola Valley as well as guided tours to places of interest, thus gaining a broad and coherent awareness of the local culture. The summer school also represents an opportunity for revitalization and rediscovery of forgotten places.

During the stay, students are accompanied by the Canova Association to discover the surrounding area.

In particular, Canova presents the history of the place and also organizes visits to explore the richness of the valley.



Figure 12. A moment of guided tours around Ghesc

ix. Actively contribute to the conservation process through the dissemination of best practices through ongoing dialogue between scientific and local communities, in order to avoid duplication of effort.

The activities, carried out with the Canova Association, have precisely the purpose of placing the attendees in a position to appreciate the importance of a correct intervention on built heritage. The intervention is understood as 'respect' in the use of

local materials and 'respect' of the good practices that lead to their efficient use. In particular, the 'good practices' are reflected in the re-discovery of ancient expertise or in the ability that certain traditional ways of working compare to the uses and customs of the modern building.

x. the disciplines of geomatics and restoration by their nature require teamwork. It is, therefore, necessary to learn to work together, encouraging multidisciplinary work and dynamic interchange among the summer school participants.



Figure 13. Data processing at Villa Raghezzi and Ghesc

### 3. CONCLUSION

The modern geomatics survey methods allow to document and represent the territory and architecture with impressive results both from the geometrical point of view and from the final output (texture).

There is a wide range of sensors and technologies to detect and process geometrical data, and obtain 2D/3D detailed metric information and finally share them through web applications or online DB.

The current three-dimensional digital surveying techniques (laser scanners and photogrammetry) are characterized by a level of complexity far superior to most traditional direct survey methods currently in use.

The complexity is in particular linked to the management and use of data, but the results of the elaborations generate digital copies of objects with an accuracy degree a priori fixed and a 'rendering' (texture) suitable for the analysis that the conservation project requires.

Case studies like this confirm that there isn't a survey technique that contains all the characteristics to be able to respond to requests that occur from the first moment of survey at the final stage. Flexibility in the acquisition phase, the process of automation, accuracy, costs, file size, and texture reconfirms, in this case, the necessity for integration of the techniques, a

complementary/simultaneous use of instrumentation to the best of their characteristics and performance.

The choices depend on different factors. Some are technical, others are logistics (e.g., electricity, ...) and economic.

At the end of processing the data, the digital models obtained are the basis from which to extract other products, such as orthophotos, 2D vector-based representations, reconstructions, movies, animations, ...

In the particular case of Ghesc survey activities have led to development two types of models: detail and general.

The detailed models ensure the correct representation of the architectural features (large scale) while general models offer overviews of the village and its environment.

All these products are needed in the areas of documentation, support to conservation and protection activities, training and research.



Figure 14. Final presentation of the activities, Croppomarcio

'Laboratory of Places 2017, Ghesc and surroundings, History, survey, evolution' is an attempt to ensure that the applications of technologies for Cultural Heritage respond to clear objectives while avoiding the risk of only ensuring the advancement of knowledge in the technological sectors at the expense of conservation practices. It is necessary to work in close cooperation with the Canova Association as it is integrally rooted in the territory and offers access to a deep understanding of local traditions, culture and history.

This approach offers a good balance and mix between cultures, knowledge, materials and traditional and innovative technologies.

The overwhelmingly positive response we have had from past editions of the summer school has confirmed what we most passionately believe - that the first and most important step towards revitalization and preservation lies in an efficient collaboration with the local community.

For the year 2017, the goal remains the same: to involve, through relevant activities and study, students and professionals in the process of recovery and rediscovery of Ossola territory.

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