Integrated survey in emergency situations:

The cave of San Michele Archangel, in the South of Italy, and the documentation in Emilia-Romagna Region, after the earthquake of May 2012

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Abstract: Two case studies of survey in emergency conditions highlight how the restoration and valorization of our material cultural heritage is linked with the preservation of what can be called a geometric memory. They derive by two completely different situations: a cave in a mountain and damaged constructions due to an earthquake.
A cave is a mysterious place, like a split in the ground. It reverses the common perception of the reality: the mountain, associated with the idea of solid, contains this empty space. This space is astonishing because it houses on architectural and historical valuable sanctuary: the monumental complex of Angel's Cave. The Cave and its branches hedge with a Basilica with Bizantinian frescos, some Martiryas (little chapels) with a small courtyard. The integrated survey by laser scanner technologies, by the Soprintendenza per i Beni Architettonici e per il Paesaggio, allowed to create a 3D data base able to document the morphometry of San Michele Site and the surrounding landscape, in order to enhance and restore, architectural and environmental features.
At the end of May 2012 a strong seismic sequence strokes Emilia-Romagna Region, in Italy, the first epicenter was near Ferrara, causing many deaths and incalculable damages to private houses and public historical monuments. Soon after the earthquake the Mibac, the Direzione Regionale per i Beni Culturali e Paesaggistici dell'Emilia-Romagna, with TekneHub, DIAPReM, of the Department of Architecture of the University of Ferrara and private companies, as Geogrà, surveyed all the mayor historical buildings of the Region that were soon after demolished or which needed urgent repairs.

Keywords: laser scanner, 3D survey, conservation, restoration

The preservation of geometric memory

Why is Geometric memory essential for Cultural Heritage? Which is the vision of "geometric memory"? The present generation is not able to protect and to preserve Cutural Heritage. Our heritage suffers heavy losses because of urban sprawl, environmental pollution, etc. Therefore Cultural Heritage documentation and data filling is an essential purpose. The major Cultural Organizations (ICCD, ICOMOS, UNESCO) are moving in this direction. In last decade technological innovation developed new 3D laser scanners aimed at geometrical survey. New machines allow to acquire morphological metric data, a high-density and accurate data in a really short time. This kind of datum becomes a support aimed at the creation of 3D data base of geometric memory of architecture. These data are democratic, since they are available even if not directly acquired. But the survey is not limited only to heritage enhancement: collected data are the basis for conservation, restoration, diagnostic and monitoring procedures.

A 3D database for the restoration and valorisation of the San Michele Archangel site in Olevano sul Tusciano (Salerno, Italy)

Olevano sul Tusciano is in the Campania Region, in the South of Italy. This amazing environment and these mountains are very important both for landscape value and for the permanence of many small historical centers, castles and fortifications. If you reach the top of these mountains you can glimpse a hole, similar to a mouth. And the astonishment for this huge natural cave increases when you become aware of the architectural and historical witnesses that it conceals. Inside this cave there is the monumental religious complex of St Michele Archangel. This place, until now is not so well known and visited from tourists, also because it’s really hard to reach by foot the top of the hill. However every Easter the statue of the Saint is moved in a crowded procession of local inhabitants, from this cave to the surrounding villages until the 8th of May, date in which the statue returns in the cave.

The place was used since the Neolithic period but the first historical data are linked to the IX century when it became a natural shelter for the bishop Pietro and, later, a pilgrimage destination. Bizantinian frescos, the church, the *Martirya* (little chapels), the sanctuary make this complex an unique example of religious cave in Italy.

The legend

The legend tells that in a remote time there was a rebellion of some angels against God, led by Lucifer. It is said that the last battle that led to the defeat of the rebel angels took place on the two peaks of Olevano, Monte Castello and Monte Aureo.

Archangel Michele was repaired in a narrow and cramped cave on the top of the hill where now stands the castle which gives its name to the mountain. The rebellious angel Lucifer took refuge in a beautiful cave in Monte Aureo. One day the devil visited the Archangel Michele to make joke of him and his little cave. He boasted of the beauty of stalactites and stalagmites of his cave, ample spaces of his cave and the superb views that could be seen from up there. Lucifer challenged him to visit his home. Archangel accepted and, after praised the beauty of the cave, asked him to sit on his throne. Lucifer accepted proudly but soon after the Archangel told him that he would have not leaved that chair anymore. They started fighting with the swords and during the duel the Archangel slowly pushed Lucifer outwards and made him fall into the ravine. Lucifer fell on a boulder where he angrily kicked the rock, leaving a footprint still visible and known as "the paw of the devil”.

Due to the kick Lucifer lost his balance and rolled up to the Tusciano River. Along the way of his fall vegetation disappeared forever. Even today you can see a band of bare rock and a fearful precipice that from the cave falls into the river that people call the "slip of the devil".

Fig. 01 – San Michele Archangel cave appears as a hidden hole in these amazing mountains, very important both for landscape value and for the permanence of many small historical centers, castles and fortifications spread in this natural paradise.

Archangel Michele won the evil and at the base of his statue it is written "Quis ut Deus". From this cave Saint Michele did many healings using the dripping water of the cave. He is the Patron of Olevano sul Tusciano and he is celebrated in many occasions during the year. On the 4th Sunday of Lent the statue of the Saint is taken from the niche in the cave and carried in procession to Salitto, in the church of Our Lady of Succors. It stays there until Monday, when it is moved to Ariano, in the church of San Leone Magno, and from here to Monticelli in San Marco, where it stays until the 8th of May. On this day takes place the big religious celebration which involves thousands of faithful. The statue, carried on shoulders, passing from the three major areas of Olevano, comes back into the cave.

Fig. 02 – Some images of the cave: the entrance ramp (top-fleft), C and D oratories (bottom-left) and Martyria A with its amazing Byzantine frescos representing the history of Christ’s life.

The site

The tricora

The small basilica is without façade, composed by three apses, rich in frescoes and open to the light. But the unity of the composition is given only by the colours of the paintings, since the church is formed by the extension of the walls of an existing building. This is recognizable by the bigger width of the walls of the apses. The three apses belong to the original basilica, located as to be immediately visible to those entering the cave. Furthermore they do not open on the same central axis but the two sides converge toward the center. This was a common typology common among ancient Christian archaeology, not only in Rome; it had its maximum diffusion in the 4th century but it was still present till the 6th century. Its origin dates back to ancient art, not only Christian, but also Hellenic. Christian *tricora* differs from pagan’s because it is always used for cemetery architecture, as *martyrium*. The *tricòm* was the place in which believers who came in the cave were used to pray before entering in the cemetery. Usually Christian tricora and Costantinian apses of the churches are aligned toward West, while in Olevano the church is oriented at Sud-East, as all the martyria.

The basilica

The *tricora* of the Angel cave was transformed in churc. The walls (16 m x 3,40 m) are without roof and closed by three apses. The most remarkable characteristic of the church of Olevano is that it is a *sine tecto* construction, without roof. This typology is extremely rare and very ancient; it dates back to the Greeck Cemetery Art of the first century BC. We have amazing exempla of this kind of constructions in Diocletian's Palace in Spalato, dating the beginning of the IV century, and in Philippopolis (now called Plovdiv, Bulgaria), at the entrance of the Palace of Philip the Arab: a huge apse, opened in width and in an open space.

These open buildings where an integral part of the Eastern monarchy ceremonial and Chirstian artists took from there these architectural elements. In the East were built the famous basilicas of Ebron and Efeso, with these characteristics, as well as the central nave of the church of Marusinac in Dalmanzia, of the fourth century, or the church on the grave of S.Eulalia in Merida, in Spain.
But on the walls of the Basilica in Olevano we can detect some grooves that served as support beams for a roof. Moreover the only fresco sited on the external side of the walls represent the Christ who introduce a monk to S. Michele and this monk carries in his hands a mock-up model of a church with a red roof. But these grooves were certainmade after the fresco that was damaged by these actions. In the end we can conclude that the church was designed in origin to be without roof. Further evidence to support this thesis is given by the low height of the walls, only 3,40m, too short to be covered by a roof, and by the thickness of the walls, only 44cm, not enough to support a roofing structure. For all these reasons it is thought that the fresco represents the roof just to indicate a completed church, or maybe it had a temporary roof in the past.

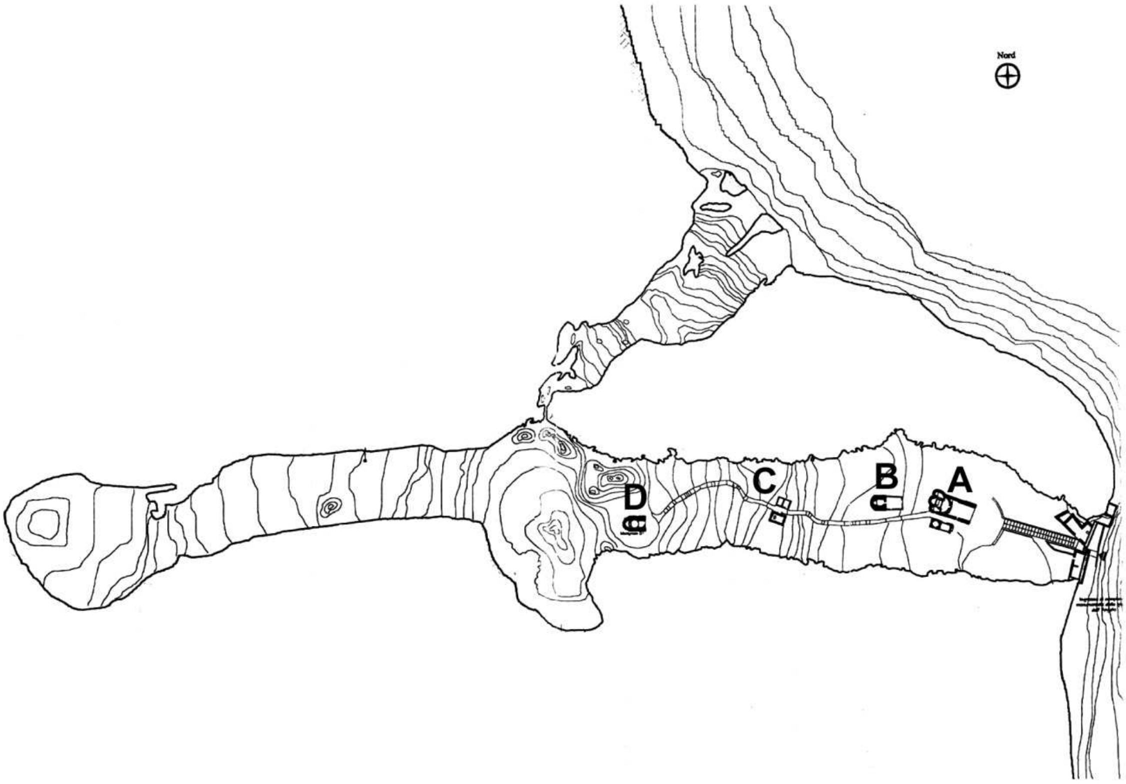

Fig. 03 – Schematic plan of the cave with the Basilica and Martyria A and B and Oratories C and D

Martyria A

The shrine A is located at about sixty meters from the entrance of the cave, on the left side of the basilica. The facade, 3.15 m high, is opened by a central arc that leads into a courtyard. The martyria presents on the sides two empty niches, plastered with decorations, framed by two smooth and masonry columns.
The pediment, shaped like a flattened gable, is decorated with a fresco in Byzantine style, representing, the enthroned Virgin with the Child between two adoring angels. Crossed the entrance there is a small rectangular atrium delimited on either side by a wall 135cm high.

An entrance arch brings into an octagonal adjacent room, covered by a cone dome with two lancets at the sides and one at the bottom. Outside there is a mansonry *arcosolium* leaning against a wall on the right side of the courtyard. The tomb is 33cm high and this level continues with a small wall that interrupts only on the North side of the small construction.

Martyria B

The second Martyria is on the back of the basilica, on the left, and it is bigger than Martirya A but it is not decorated. The entrance is decentralized on the right, surrounded by the wall of the atrium, 1,20m high. The cubicle has a trapezoidal plan with an apse at the bottom and the roof collapsed. The side façades have two small arched openings.

Oratory C

The Oratory C is near a small hill on a sloping area toward the entrance of the cave. It is characterized by a sequence of lancets. The entrance is open on the south side, towards a slow ramp. The gabled roof collapsed due to rot wood, because of the humidity of the cave. From the exterior the oratory seems like a small temple resting on an existing wall.

This architectural typology was common in Asia minor and in Syria but really rare in the rest of the world if not in miniatures and textiles dated after V century. Inside the oratory there is a stone altar.

Oratory D

The last oratory, on the top of the hill inside the cave, hided in the dark, is small, with a square plan, dome cover, and a small altar under the semispherical dome. The entrance is from west, and it is marked by small walls decentralized on the right. The oratory has an a apse decorated by a central mullioned, also if the central column got lost. Two side and rectangular niches hosted the lamps. A small wall starts from the left side of the church, it continues under the apse and it exits from the right side: this area was designed to host a Martyr's tomb.

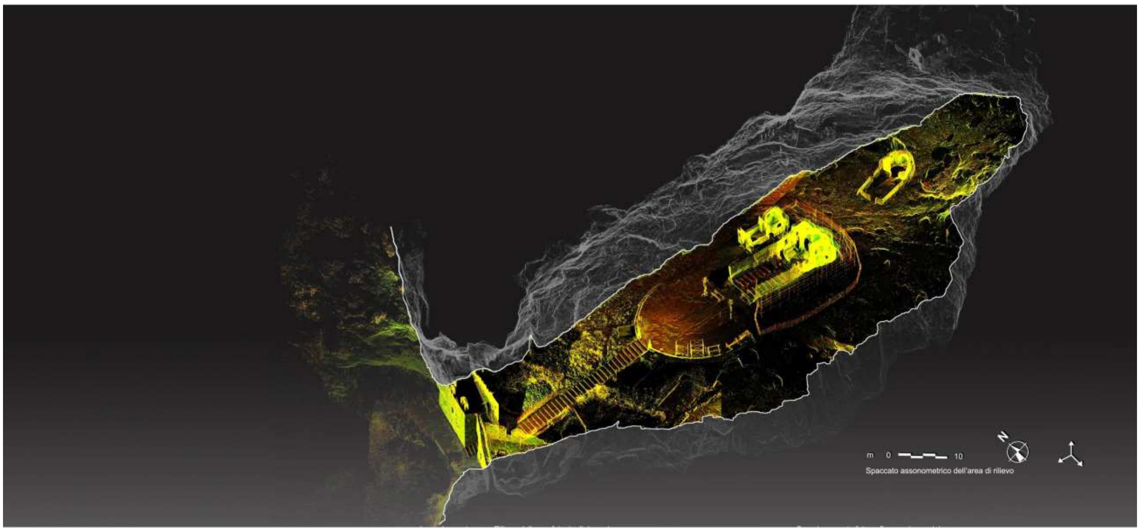

Fig. 04 – The axonometric representation shows in gray the mountain morphology, while in false colors the distribution of the inner space: the stairway at the entrance, the basilica and Martirya.

The survey

The challenge of San Michele Archangel site was the possibility of surveying the cave using new technologies in risky conditions and in a site with so many problems of accessibility.

The research project was finalized at giving a strong base for the restoration and valorization of the San Michele site and the surrounding landscape. In the meanwhile it was a good opportunity to verify an integrated survey process in a low accessibility area to implement the site's valorization.

The project was developed in collaboration with the *Soprintendenza per i Beni Architettonici e per il Paesaggio, il Patrimonio Storico, Artistico e Demoetnoantropologico per le Province di Salerno e Avellino* and the center *DIAPReM (Development of Integrated Automatic Procedures for Restoration of Monuments)* of the Department of Architecture of Ferrara University.

The survey was carried out in an emergency work situation: laser scanner was transported up to the hill, carried up on shoulders and the acquisition time was limited by the life of the batteries.

It was very important at the first time to understand how rock was cracking and the way in which the water dropping from the rock was damaging architectures and frescos.

The project was a good opportunity to evaluate:

- the feasibility level of technological survey in such extreme condition;
- the accuracy of the acquired data compared with the morphometric level of detail;
- the configuration of a comparative model aiming to show the degradation process and the loss or modification of the extraordinary architectural and artistic heritage;
- how the morphometric database could be enquired in order to define further scenarios of conservation and valorization of the site.

The three-dimensional data were integrated by a topographic survey to realize a model made of almost 2 billion of points by which it was possible to draw up the cave plans, sections, façades and a solid model in scale. Only the 3d laser scanner technology is able to acquire so quickly such a complex shape like a cave is. The 3D data base provided all the opportunities to achieve qualitative and quantitative analysis about architectural morphology, frescos state of conservation, etc.

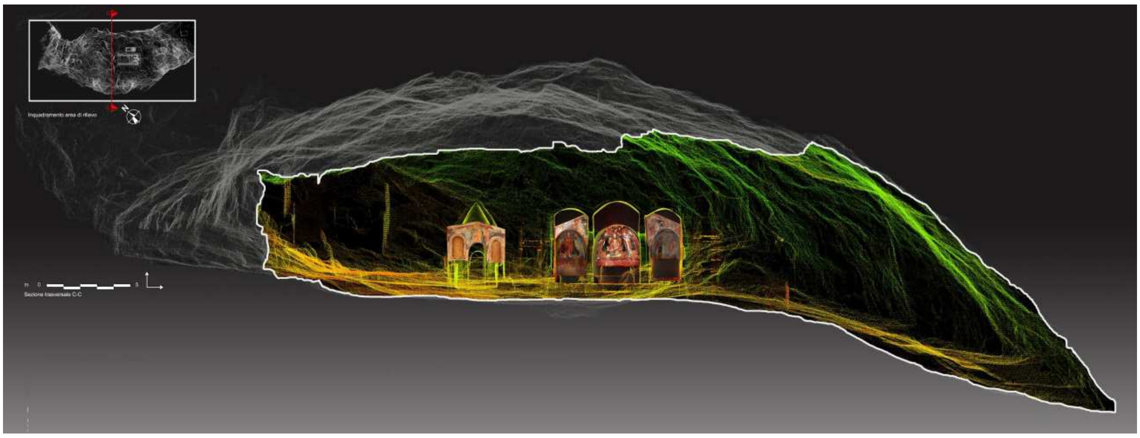

Fig. 05 – Cross section with the amazing frescos that decorate the church and the Martyria

Laser scanner 3D technology

Laser scanner 3d technology, historically adopted in engineering, is now more and more used for archeological and architectural scopes. The most common use is for the “as built” acquisition of data. In a really short time the scanner is able to acquire a large amount of data able to describe the surveyed environment as it is in that particular moment. These data could be used to obtain traditional bi-dimensional drawings, to design additions or modifications. Due to its high potential and to technical characteristics of the acquired data this kind of analysis is called “High Definition Survey”, HDS.

The final result of the acquisition made with laser scanner is a point cloud, a system of referenced point that describe quantitatively the reality.

The point cloud is made by a large number of coordinates (x, y, z), able to describe an object or an environment. In every station of acquisition by the scanner, the point cloud is centered in the middle of the machine. After this phase of field, a post processing of data is required in order to register all the scans in a unique coordinate system, a Plant Coordinate System. This operation is possible only if the point clouds are partly overlapped or if there are at least 3 defined points, called target among one scan and the other.

Fig. 06 – Longitudinal section. Only the 3d laser scanner technology is able to acquire so quickly such a complex shape like a cave is. The 3D data base provided all the opportunities to achieve qualitative and quantitative analysis about architectural morphology, frescos state of conservation, etc.

Laser scanner acquisition is articulated in three main phases: planning, acquisition of data on field and post-processing. The phase of planning is crucial for the achievement of a good result. It includes:

- logistics planning: accessibility of the site, possibility of connecting electric machines, required permissions, a budget for the work hours;
- scheduling of the work: identification of the target, how to use and deliver data, definition of the places in which put the scanner for the acquisitions and the targets in order to adequately overlap the stations. In this phase it is required to consider also all the other survey machines and instruments required, to estimate the overall number of point per each scan that we want to acquire, the level of detail and of completeness necessary, all the other auxiliary useful information, such as photos, drawings, sketches, etc.
- definition of standards: conventional codes, accuracy required and available from the machines;
- planning of the post process phase: registration (how and where), software, level of detail of the final model, definition of the workflow. It is very difficult to understand which kind of information we will be

able to obtain from the database. Generally, for example, we use different procedures and softwares to obtain 2D drawings and 3d models.

The High Definition Surveying enables to the creation of different ways of describing the reality. The registered point cloud itself, without any elaboration, is a discontinuous representation of the real environment from which we can extract all the measures we need. It could be described as a 3d photo of the acquired situation, as it is in that moment. Another possibility is to transform these points in geometrical elements like lines, surfaces or volumes. We can also mix these two ways of representing data, merging the point cloud with the geometrical models just of the areas we're particularly interested in.

But laser scanner technology is just an instrument; it couldn't be the solution for all the problems of survey. Generally it requires the combination of other instruments as photographic machine for photogrammetry, total station, GPS, notebook, etc. Usually the integrated survey use of all these instruments leads to a better and complete result.

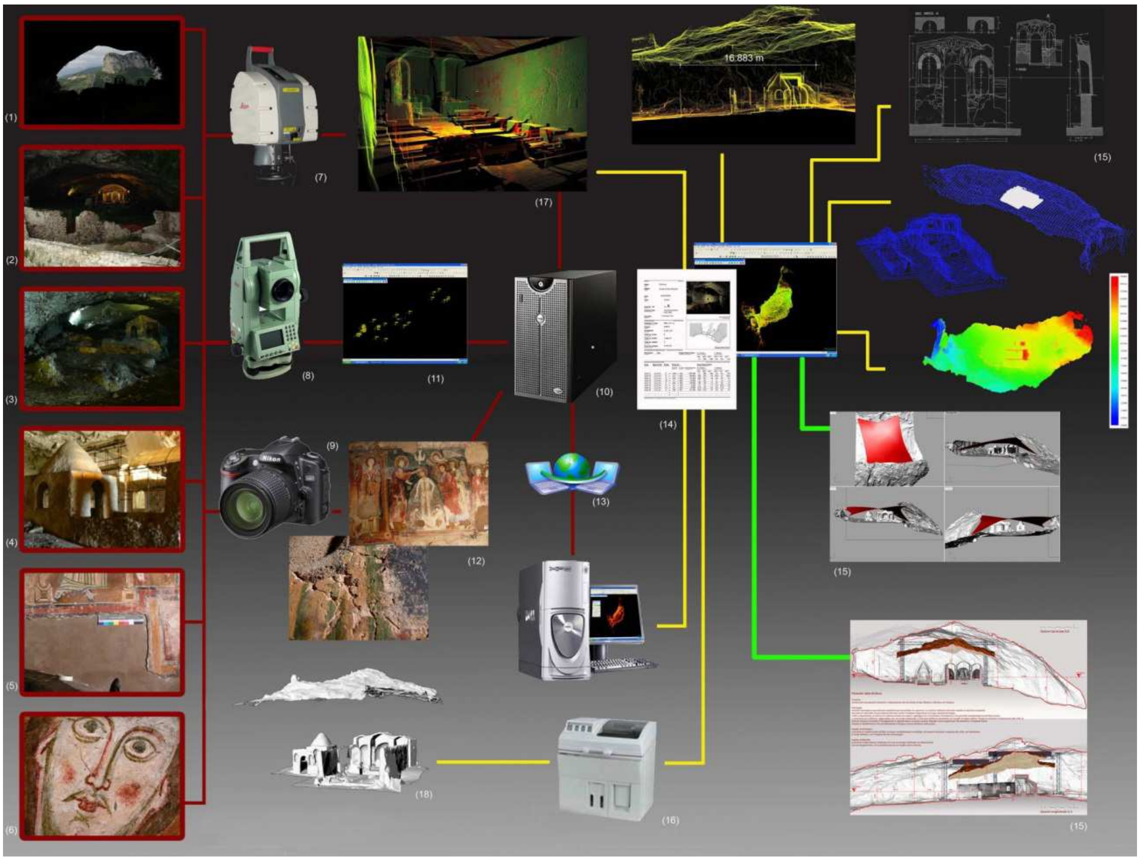

Fig. 07 – This is a graph representing all the phases of the process of documentation of the cave. The methodological layout represents the technologies for documentation and data filing. Geometric memory is set up integrating laser scanner and topographic survey: red lines show the different acquisition technologies (optical triangulation scanner, total station, camera, but for this kind of works also spectrophotometer and thermo-camera could be used) and yellow lines represent the ability to query databases and methodologies to "extract" different outputs: plans, solid or virtual models, analysis of the state of decay of materials, structural analyses, etc.

The survey of the frescos

The frescos date from the eight to the twelfth century. Some Martyria were decorated with amazing Byzantine frescos representing the history of Christ's life.The wall at the left of the Basilica represents

Infancy Gospel in two series: lives of Saints and the history of S. Peter. The wall on the right celebrates the crucial moments of the history of Salvation and Saints. The main apse represents Enthroned Virgin Lady with Child, among Saints. In the apse on the right, we can admire John the Baptist among Evangelist; on the left, the Christ gives the keys of the Paradise to S. Peter and a parchment roll to S. Paul.
These precious figures were in a severe risk of disappearing due to water dropping. This phenomenon causes the detachment of the paint layer in some parts and in other bulges and stick to it even the first layer of the substrate. Added to this is the rising damp, the surface deposits and, unfortunately, the actions of smugglers of art that have detached parts of the painted surfaces.
Frescos have been surveyed with laser scanner as well as by view to investigate materials and their state of conservation. All the results of the analysis were represented on orthophoto, using UNI-Normal Recommendations 1/80 and 1/88 (Stone Artefacts Regulation – ICR and CNR: “Macroscopic alterations of stone materials: Lexicon”). The survey of the colors of the frescos was carried out using a Kodak stripe.
The frescos were surveyed also using the value of reflectance acquired from laser scanner.
Reflectance is the intensity of the laser beam at the moment of the “impact” with the object and it allows the visual recognition of the different materials, of the surface specifications and of the state of conservation.
It is just a value and it is represented in false color.

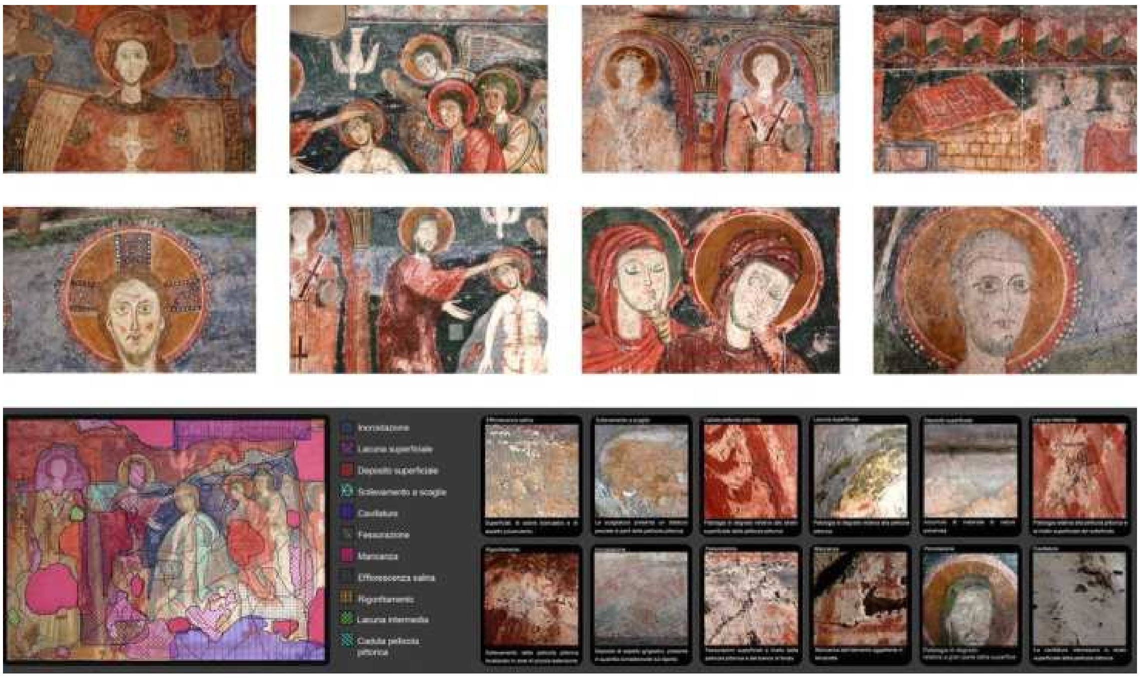

Fig. 08 – Details of the precious frescos that were in a severe risk of disappearing due to water dropping. The frescos were surveyed and analyzed by UNI-Normal Recommendations 1/80 and 1/88.

The project

The design phase is based on a critical approach to the integrated survey completed in an environment with a complex morphology and different levels of accessibility. This database was used to define a knowledge framework of morphological metric data. It was useful for the development of design solutions aimed at the repair, restoration and enhancement of the site. A detailed survey allowed the definition of tridimensional lines of slope, of repaving and for the identification of the paths for collection and drainage of water infiltrations. These drawings were used to define a touristic path inside the cave, that come across all the major areas, from the cult area, to that of burials, until the site of excavation. At the end this survey was used also to design a shell to protect these monuments from water dropping. This element was composed by a modular structure of aluminum trusses and a roof in plastic which reproduces exactly the same morphology of the cave, acquired with laser scanner technology. This shell is thought to be made in small assembled pieces, easy to be made, transported and assembled. This system is flexible and adjustable to the different levels of the ground and the roof could be fixed and suspended at the rock of the roof, after being consolidated.

Assembly the cover requires skilled labors. The choice of using modular elements in aluminum (more resistant at conservation), advantages the transport of the pieces on the site as well. The system of pillars does not requires foundations. The structure could be assembled on the ground, or at least at a height reached by a traditional scale. In a second phase these elements have to be lifted to the designed height using electric winches. After fixing the structure of the roof in suspension, vertical columns could be removed and stored or they can be used as support for lighting or sound system during the events that are still periodically held inside the cave. The main feature of the structure is its capacity of being completely dismantled. Since it is anchored and suspended from the rock, the roof does not interfere permanently with the integrity of the archeological site.

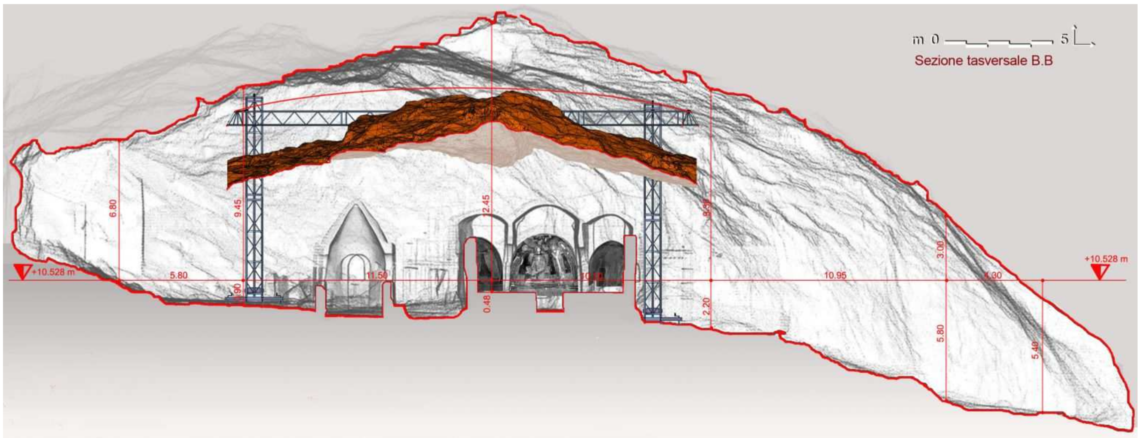

Fig. 09 – Design of a new shell to protect constructions from water dropping, which replicates the roof of the cave

The 3d model

The point cloud was processed to obtain a virtual 3D model in plaster, using ZCorp technology. This workflow allows to replicate accurately also complex natural and archaeological sites.

Finally we can conclude highlighting how 3D survey allowed the enhancement of this important historical site and induce the first step towards the protection of this architectural heritage.

Integrated survey after the earthquake in Emilia-Romagna Region, Italy May 2012

At the end of May 2012, a big earthquake strokes Emilia-Romagna Region, in Italy. The first epicenter of a seismic sequence was near Ferrara, causing many deaths and incalculable damages to private houses and public historical monuments. Soon after the earthquake the MiBAC, the Direzione Regionale per i Beni Culturali e Paesaggistici dell'Emilia-Romagna, in the person of the Director, Carla di Francesco, contacted our Department and TekneHub, Laboratory of Emilia-Romagna companies, (among this Geogrà, that helped us in this works). From the day after the earthquake until now we surveyed all the mayor historical buildings[1] of the Region, including that ones that were soon after demolished because, as the Town Hall of Sant'Agostino, they had so many structural damages that it was no possible to repair them.

This tragic event highlights all the deep fragilities of our current system of management of the territory. Today the web portal *openricostruzione.it* estimates an economic damage of 325.919.203,94 euro essential to carry out 354 reconstruction projects but the value is constantly increasing. It is not only an economic problem: it's an issue of memory loss of local material cultural heritage of churches, bell towers, city halls and private houses of the historical city center. In this context the surveys were aimed at the creation of an integrated documentation of the constructions to estimate structural damages, and to plan future actions of complete demolition, of partial reconstruction or of restoration.

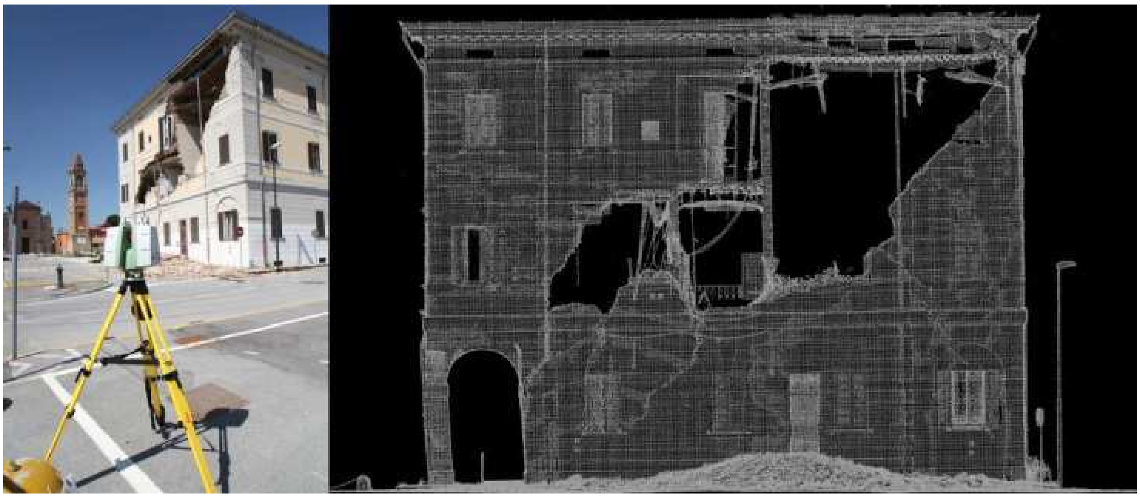

Fig. 10 – Photo and 3D visualization of the data base of the existing state after the earthquake in May 2012 of the Sant'Agostino Town Hall. The survey has been used for the final plan of interventions for safety measures and used in the final demolition. (DIAPReM/TekneHub with Geogrà srl).

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[1] - Bell tower of Buonacompra (Ferrara): emergency request on June 1, 2012
- Bell tower of Reno Cento (Ferrara): emergency request on June 1, 2012
- Tower of Carabinieri in Concordia sulla Secchia (Modena): emergency request on June 11, 2012
- Bell tower of Novi di Rovereto (Modena): emergency request on June 12, 2012
- Town Hall of Sant'Agostino (Ferrara): request emergency on June 21, 2012.
- Bell tower of the Church of SS. Senesio and Theopompus in Medolla (Modena): emergency request on June 22, 2012
- Bell Tower of San Martino di Carpi (Modena): emergency request on July 24, 2012
- Cathedral of Pieve di Cento (Bologna): emergency request on Sept. 10 2,012

- Concordia sulla Secchia: Town Hall, Duomo, Santa Caterina Church, Church of Fossa, the historical city center, surveyed using mobile laser scanner "Pegasus" of Leica Geosystem.

Fig. 11 – Phase of field of the survey of the bell tower of Buonacompra and subsequent visualization of the acquired registered 3D database. The survey was requested by the Regional MIBAC Emilia-Romagna to document the morphometric memory of the tower that has involved in a "controlled stripping" for securing the adjacent buildings. (DIAPReM/TekneHub with Geogrà srl)

Problems

The main problem related to these surveys was to operate in a condition of complete safety. Soon after the earthquake the Italian Protezione Civile delimited dangerous areas in which the entrance was forbidden. The surveys had to face these limits trying to acquire the most of the visible surfaces from the allowed position and in the least time possible. The acquired data emphasized the necessity of a reconsideration of traditional methods of processing laser scanner point clouds, since we had to consider all the shadow cones and portion of façade that it was not possible to survey, due to the limited points of views, as well as, for example, to the presence of steel scaffoldings. Considering these assumptions, the plan of the survey, before the phase of field, was crucial to analyze in deep the site situation we had to define all the phases and required elements to optimize times, costs and results. Integrated survey of different methodologies and instruments was, in most of the case, the best solution. Some of the surveyed constructions had already lost their original dimensions and decorative details, but the related survey had been crucial to preserve all the dimensional proportion and distribution scheme, in order to maintain it in the geometric memory of the history and to advice people who will be commissioned for the restoration or reconstruction of the monuments. In this way the documentation of the partially collapsed bell towers before their completely demolition, for example, has to be considered not only as a documentation of a witness of the past before their complete lost, but the first action towards the design of the new tower.

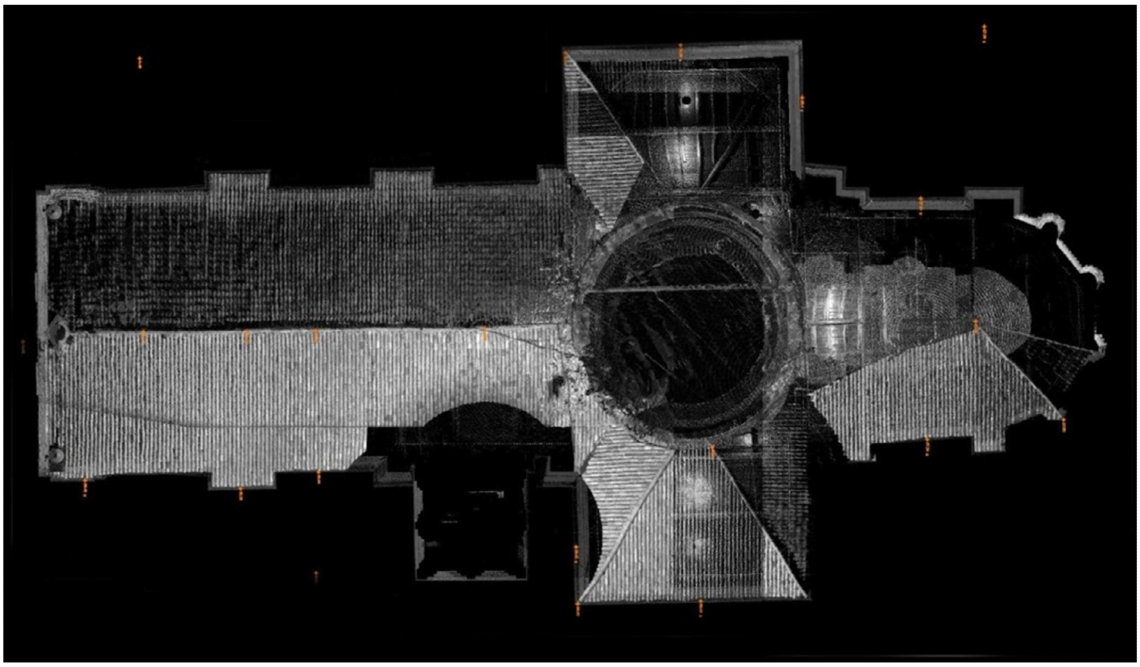
Figs. 12, 13, 14 – 3D visualization of the data base of the existing state after the earthquake in May 2012 of the Cathedral of Concordia sulla Secchia. The survey has been used to define safety measures and for the final plan of restoration. (DIAPReM/TekneHub)

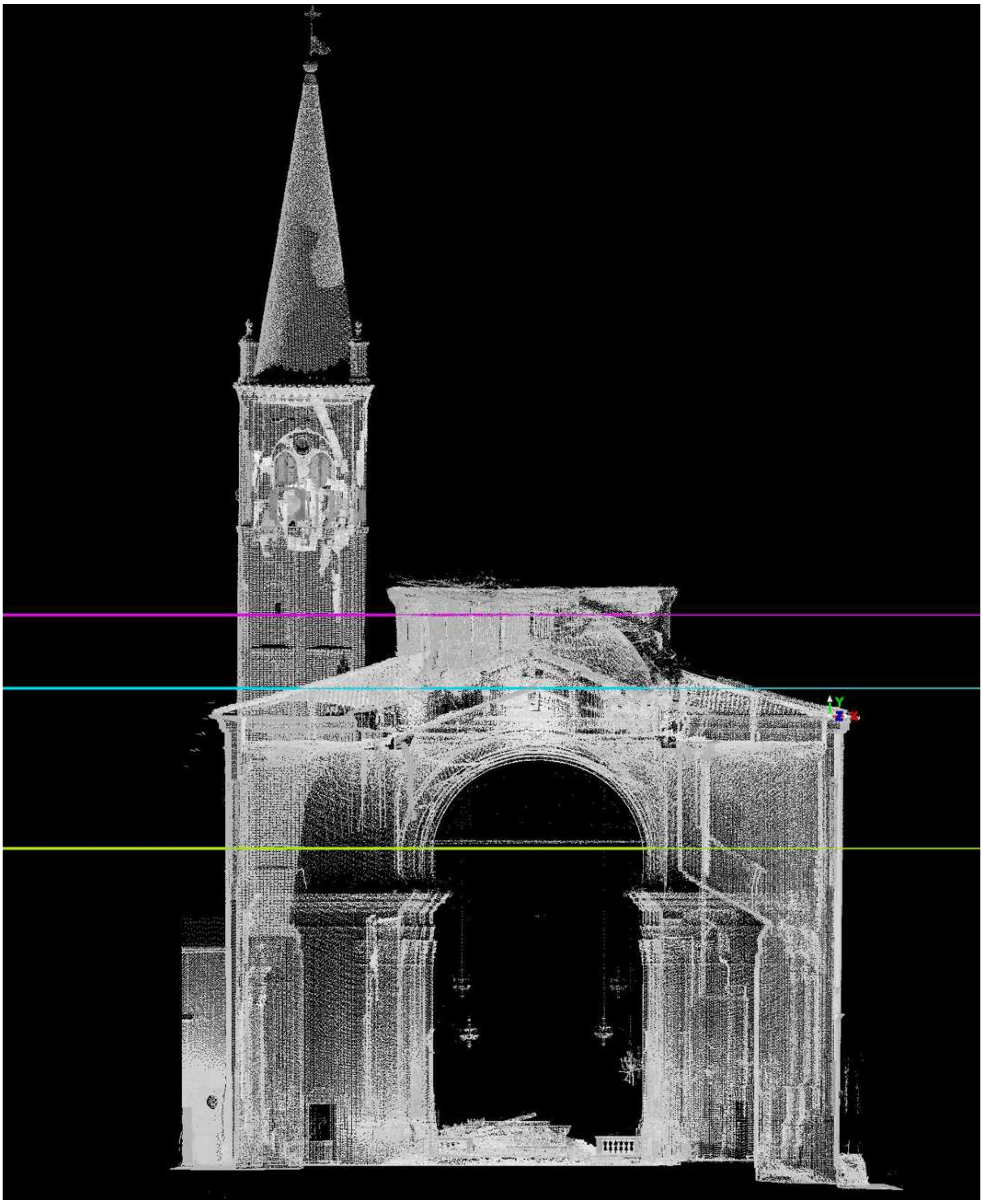
Where it was but not as it was. The style has to change, because it has to reflect our architectural way of expressions as well as for the society who built that building at that time. The material of construction will inevitably change and so the technology, which will inexorably follow modern procedures. Above all technology has to change, in the restoration of the existing tower as well as in the design of a new one, in order to be earthquake-resistant. Prevention as a first aid and return after the natural calamity.

Purposes and methodologies

Laser Scanner technology reveals to be very useful in these conditions because it allows to acquire a large amount of data in a very short time. It is also possible to set a high definition survey that could be a good solution in all the cases in which it is not possible to come closer to the building. The important feature in the adoption of this technology is the attention put in the preliminary plan of the survey and in the registration of the point clouds. In most of the cases it was not possible to set a system of target because it was not possible to approach directly the partially collapsed surface of the building, to reduce as much as possible the time of acquisition, for safety reasons.

Moreover laser scanner technology is at the moment one of the best in acquiring complex shapes that is not possible to describe with geometrical figures, as a building that has been damaged by an earthquake. A high density point cloud is able to detects and describes all the building damages, to properly identify the instability phenomena and to allow an appropriate consolidation project, or, in the worst cases, a demolition plan.





Figs. 15, 16, 17 – Documentation of the Cathedral of Pieve di Cento and visualization of the 3D database after registration of the scans. The survey was requested by the Regional MIBAC Emilia-Romagna and is used for the definition of executive interventions for safe and canopy cover of the drum of the transept. (DIAPReM/TekneHub with Geogrà srl and Digitarca snc)

Fig. 18 – The place was used since the Neolithic period but the first historical data are linked to the IX century when it became a natural shelter for the bishop Pietro and, later, a pilgrimage destination. Bizantinian frescos, the church, the Martiryas (little chapels), the sanctuary make this complex an unique example of religious cave in Italy.

Fig. 19 – The side of the stairs at the entrance to the cave.

Conclusions

This two case studies brightly highlighted the importance of the preservation of geometric memory as a first active step of modification of the reality. A tragic event like a disastrous earthquake put in evidence our fragility, ignorance and pursued deception of the reality in values, knowledge and best practices in architecture. A complete change of state of mind and of common practices is required and extremely urgent. New technologies offer us massive advantages in the task of documentation, valorization, enhancement, restoration and new construction. But these instruments will be useful if properly forced in the direction of a conscientious reconstruction of the urban centers, as well as for the comprehension of the deep historical interactions among landscape and human settlements, for the preservation of historical and religious values, for the economic and touristic enhancement. Finally the integrated 3D database could be seen as a starting point, a box that could connect and offer a material and metric support and the geometric memory as a platform of integrated analysis pointed at guiding our future action with awareness and responsibility.

Credits

San Michele Archangel site

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Survey after the earthquake in Emilia-Romagna Region

MiBAC, Ministero per I Beni e le Attività Culturali -

Direttore Regionale per i Beni Culturali e Paesaggistici dell'Emilia Romagna: arch. Carla di Francesco

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Imprint:

Proceedings of the 17th International Conference on Cultural Heritage and New Technologies 2012 (CHNT 17, 2012)

Vienna 2013

http://www.chnt.at/proceedings-chnt-17/

ISBN 978-3-200-03281-1

Editor/Publisher**:** Museen der Stadt Wien – Stadtarchäologie

Editorial Team: Wolfgang Börner, Susanne Uhlirz