## 2.19 Three-dimensional model for preservation and restorationof architectural heritage

### Three-dimensional model for preservation and restoration of architectural heritage

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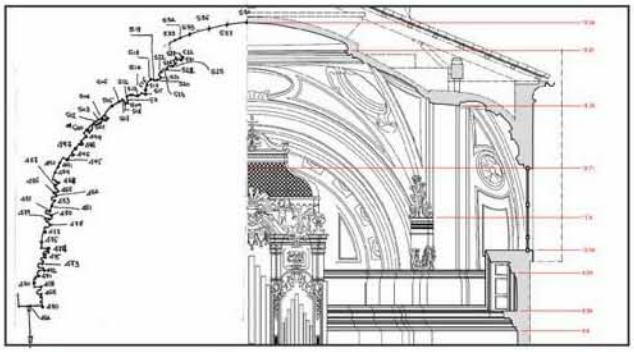
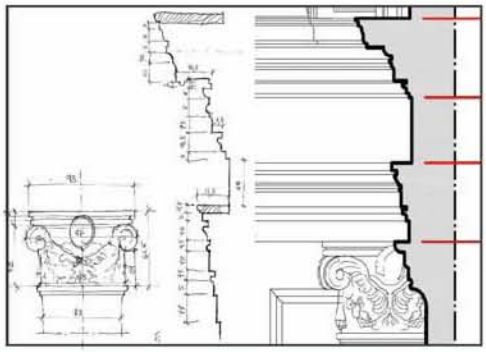
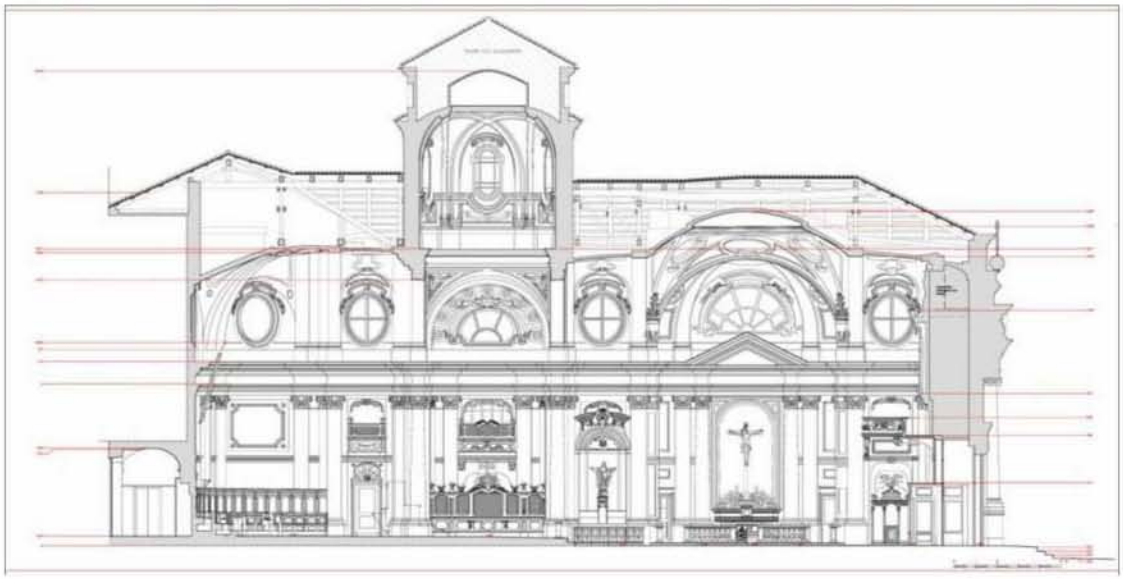
The research focuses on developing guideline, creating a simple three-dimensional model designed to represent both the complexity of the "cultural heritage" morphology, as well as the need to manage the process of restoration in all its phases: from first findings to the restored final output.







**The "Chiesa della Misericordia" case study**

The first phase of the research was the architectural survey (in scale 1 to 50) and the graphical restitution of the baroque church of the Misericordia, located in Turin. The active participation to the survey was possible thanks to a collaborative project signed by the Department of Building Engineering and Territorial Systems of the Politecnico di Torino and the Confraternita della Misericordia, the Friary that owns the historical building. The research team directed by professor Secondino Coppo and composed by the engineers Bocconcino, Marchis, Piumatti, and Vitali was particularly careful to examine the following aspects:

- restitution of architectural details with direct metric techniques;
- interpretation of the cross section geometries starting from "total station" surveys, with eidotype support (Fig. B);
- profile tracing starting from the measured points "cloud", with a distance from the horizontal plane (accuracy of ± 2,5 cm);
- geometry reconstruction of the visible profiles starting from the solid image vectorialization and from the projection of the lines traced on the 3D model;
- redrawing of the architectonical elements starting from the digital images perspective correction;
- restitution of the building floor and vaulted ceiling plan, starting from the orthoimages. Some operating data of relieve.

The model has been completed notwithstanding the scarce archive documents and the practical difficulties of access to the upper parts of the hall. The detail level of the graphic information and the metric accuracy have been determined according to the content of the scale 1 to 50 drawing.

The operating times have been scheduled and followed according to the following scheme:

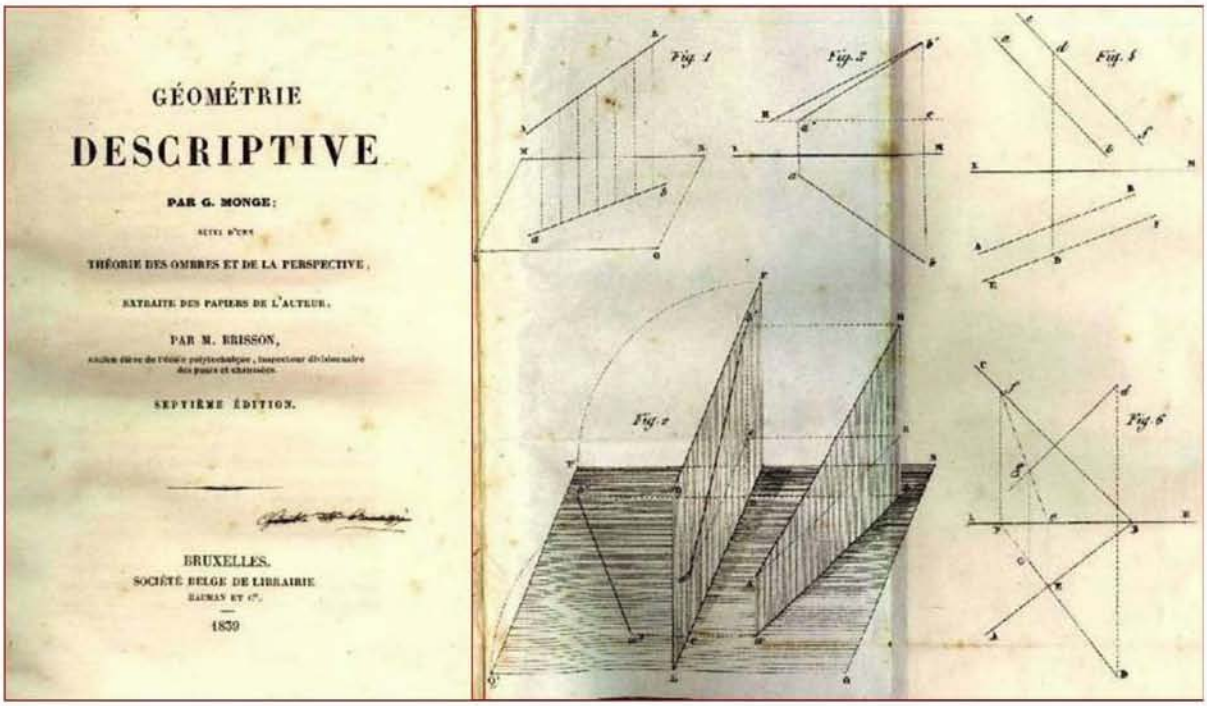
- 15 days for ground and first floor planes;
- 20 days for the longitudinal sections, in the lower part of the internal cornich);
- 15 days for the complete longitudinal sections;
- 7 days for the vault planes;
- 7 days for the details in the scale 1 to 20 (façade strip corresponding to the side fracture)

**From sketching to the wooden models, and over.**

Sketches, from the origin of the history are media, for transferring information and for centuries the drawing activities remained bounded to the figurative representation without giving the necessary data for an operational activity. In the mid Nineteenth Century Retdtenbacher , within the Industrial Revolution society, affirmed that technical drawing was the engineer can transfer his design thoughts in order to leave nothing to the free interpretation of the receiver of his message. But the drawing activity is important not only for designing but also for manufacturing the object with precision. The physical scale models, manufactured by architects and technicians are the only real mean to give concreteness to the design ideas.

Wooden model of the Church of the Gran Madre, Piedmontese woodcarver artisan according to a design of the architect Ferdinando Bonsignore, 1818, Torino, Museo Civico d'Arte Antica e Palazzo Madama (n. 1491/L)

Treatise illustrations of the Sixteenth and Seventeenth Centuries were pleasant pictures but were unable to bring the information for a definite practical realization of the object itself. Only with the birth of the *Descriptive Geometry* – an exact science bounded to the name of Gaspard Monge, a knowledge covered by military restrictions – the measure enters the quantitative graphical representation of the technical objects.


GÉOMÉTRIE

DESCRIPTIVE

PAR G. MONGE;

SUIVI D'UNE

THÉORIE DES OMBRES ET DE LA PERSPECTIVE,

EXTRAITE DES PAPIERS DE L'AUTEUR,

PAR M. BRISSON,

SEPTIÈME ÉDITION.

BRUXELLES.
SOCIÉTÉ BELGE DE LIBRAIRIE
HAUMAN ET Cie.

1839

Gaspard Monge, (1839), *Géométrie descriptive*, Hauman, Bruxelles (VII ed.)

**The Italian state of the art of a quantitative science.**

A fundamental stage of the actual research performed was the evaluation of an effective need of a 3D tool for representing the complex morphology of the cultural heritage, but also for managing the complete restoration process during all its phases. Therefore an inquiry has been done in some architectural firms that operate in important restoration yards within the Piedmont region. This set of interviews was aimed to test and to verify the real and concrete possibilities of an application of the model in practical and professional activities, and for evaluating the cost/benefit frames. From these interviews emerged the model here presented, that has been directly applied to a real case study.

**The search for structure in three phases:**

- the first one is documentation and recording the state of the art

- the second one is focus on different applications and new methods of relief of the various stages of the building and mapping of degradation

- the third phase is to create a three dimensional model to be implemented with all the information gleaned in various stages of restoration, in order to return at the end of an entire overview of the evolution process of restoration, a three-dimensional database that contains information of different nature. The model could also be used to simulate more roads and fields for action, and then be used as decision support; be used to verify the stability and safety of buildings in relation to major structural movements and deformations

Stages of the building: application of the tear sheets for

One of the stages of the building of Misericordia was the degradation of the handcrafted mapping carried out by restorers. Specifically in the second phase is to propose the mapping of degradation not only on a stand-dimensional but a three-dimensional model. The need arises from the need to have detailed metric for quantifying the square meters of operations, work actually carried out or planned, and thus could not be offset by the actual surface projection representations, as in the presence of curved surfaces on time ....

The research aims to compare different methods and assess the cost-effectiveness.

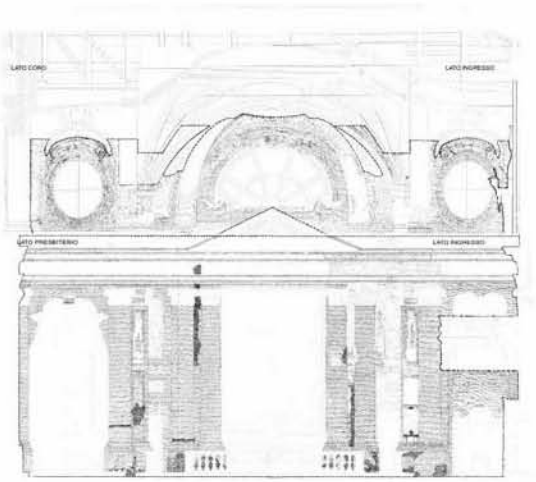
**Methods compared:**

a) traditional (hand mapping), two-dimensional (emphasis on very detailed)

b) digital two-dimensional (emphasis on very detailed)

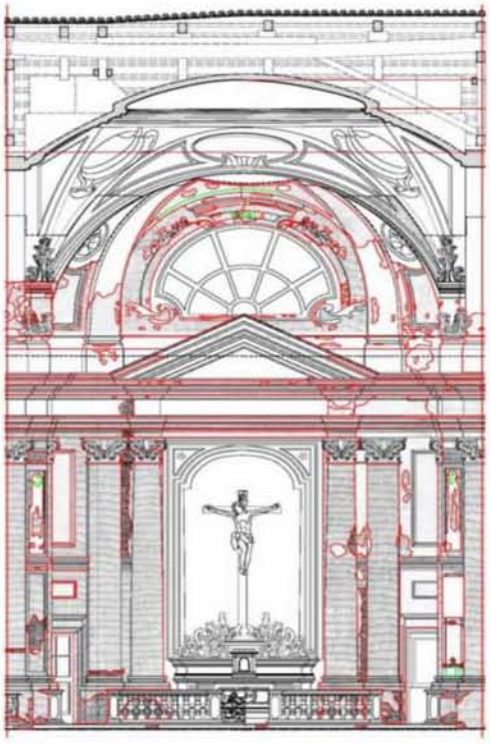
c) digital three-dimensional (two-dimensional mapping model projecting three-dimensional)

d) digital direct (directly on the picture solid), three-dimensional.



The proposal is to apply the traditional method applied to a three-dimensional model, starting from the classic procedure for mapping degradation, handmade on site by a restorer on a sound basis, as in the case of *Chiesa della Misericordia* in Turin (relieve scale 1:50).

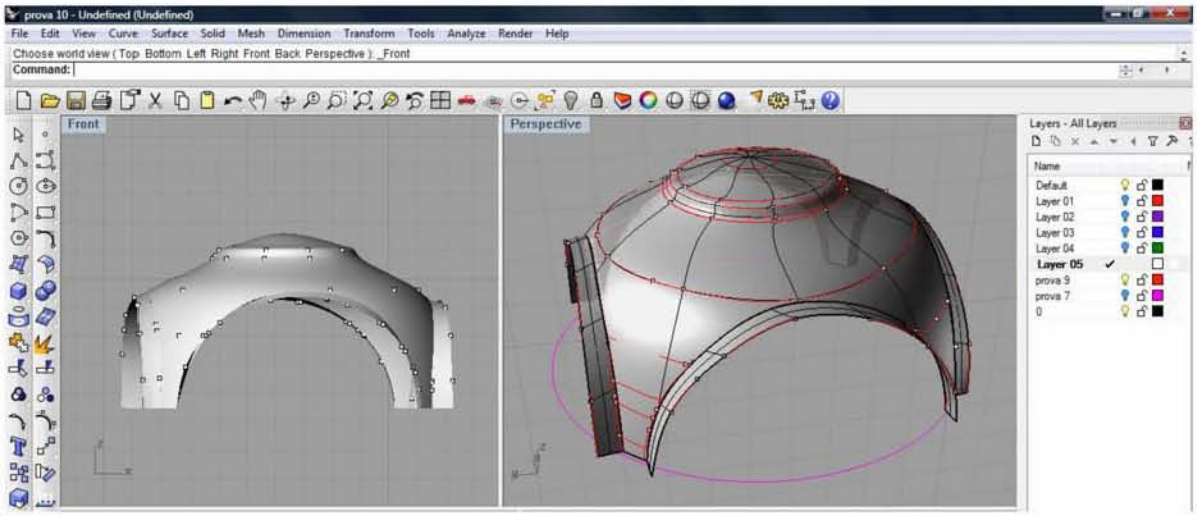
In the second stage it will be located throughout the map in digital form to facilitate the phases of reproduction, verification, calculation of the area.



The survey, in 1:50 scale, has created a three-dimensional model which will be projected on the regions, so that individual areas as close as possible to reality so as to also facilitate the calculation to quantify the areas affected by restoration.

The innovative part has been to propose the mapping of degradation not only on a stand-dimensional but a three-dimensional model, so you have no real offset surface representations in projection, as in the presence of curved surfaces, the times ....

Therefore created a three-dimensional model of the building is going to project areas mapped on the model. Need to be careful that the spread on three-dimensional surfaces coincide and that the level of errors are acceptable.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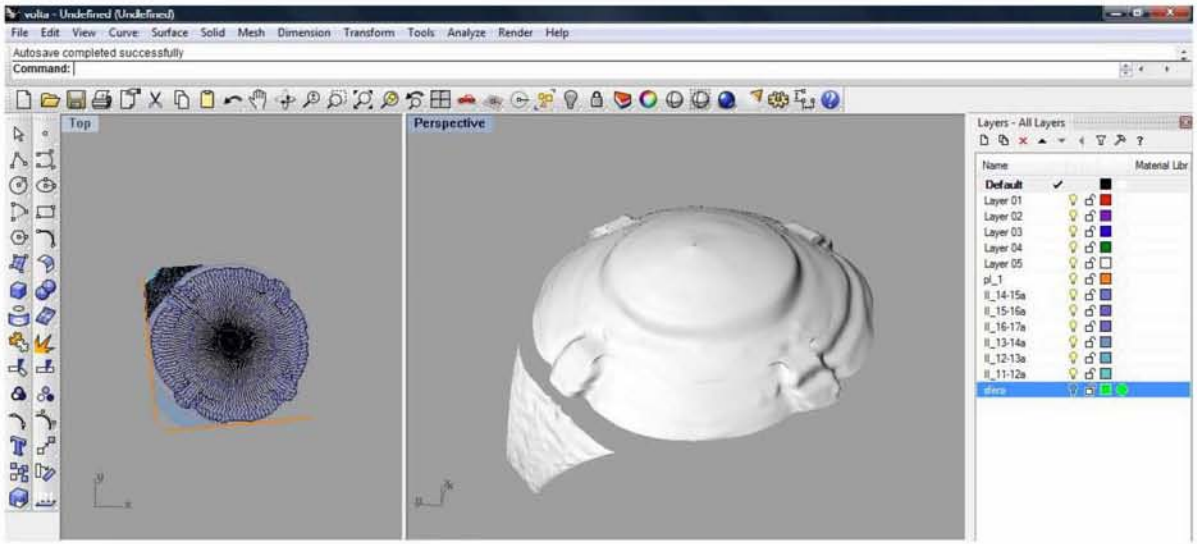
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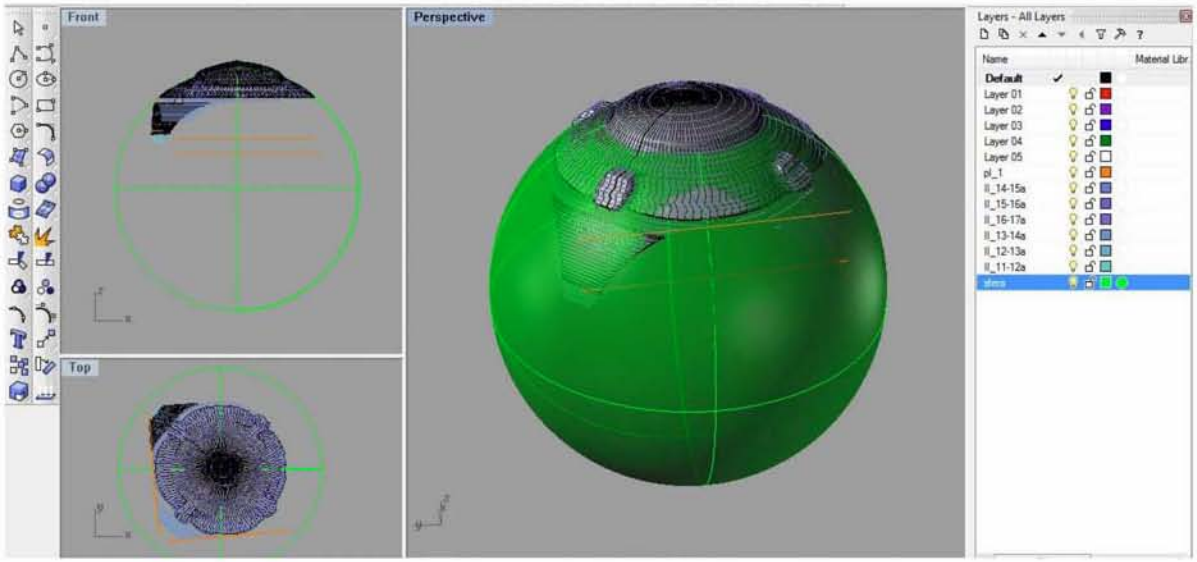
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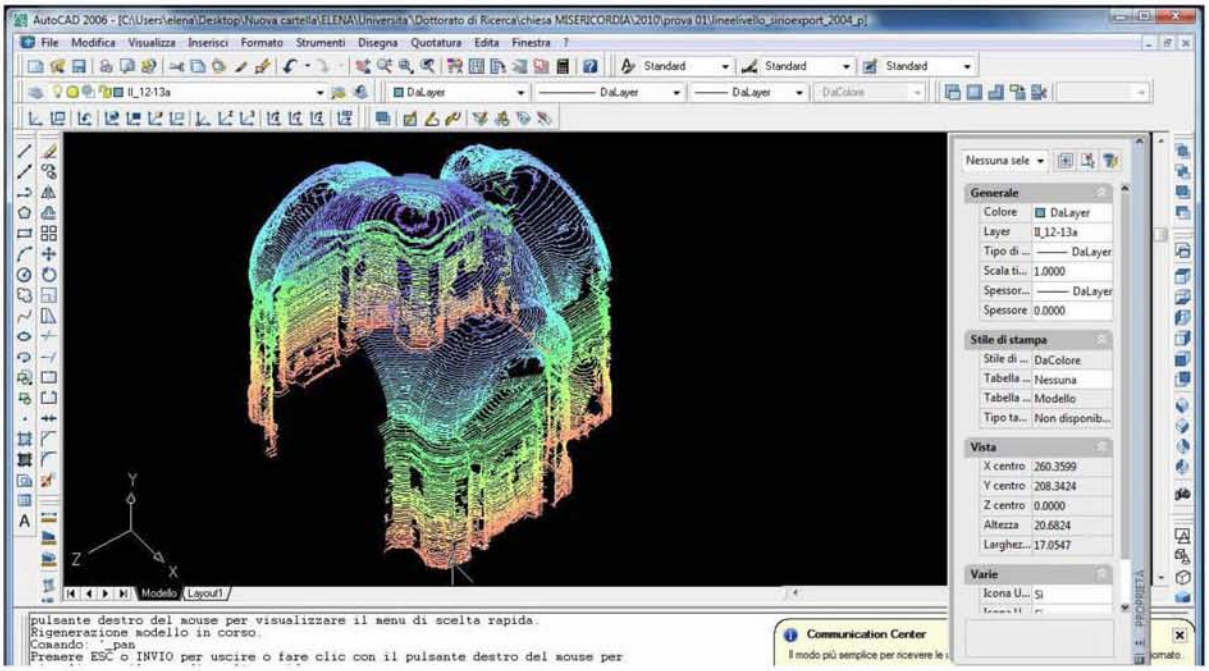
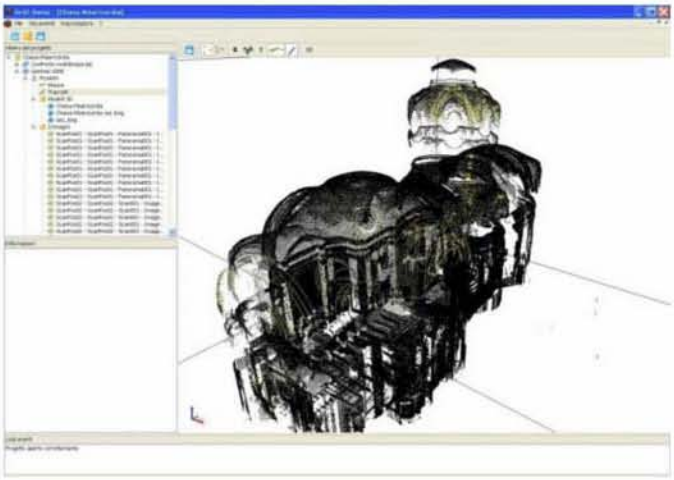
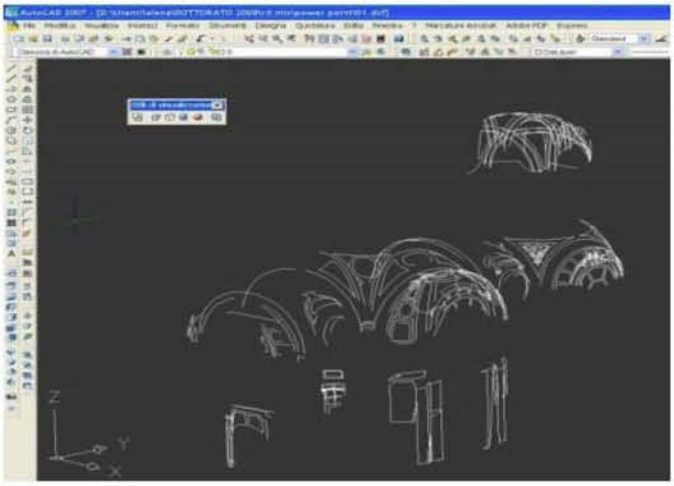



3D model based on architectural surveys in scale 1:50 performed by the team of Department of Building Engineering and Territorial Systems and Department of Land, Environment and Geo-Engineering.

The second method compares the mapping directly from a digital three-dimensional medium using the Image sound, with the help of the software Sirius. Polylines drawn solid image are exported and saved to each software in order to have the areas already mapped digitally and in three dimensions. This should reduce errors, speed up operations and cut costs.

The simple model can be constructed by integrating multiple technologies as demonstrated by laser scanners, photogrammetric survey, direct relief. The model also can collect the entire previous history of the property and subsequent transactions can happen in the future, the nature of maintenance work, information, etc.





Test vector image sound - software testing Sirius (beta version) developed by SIR, Spin off of Politecnico di Torino.

The aim of the research will be to create a model, three-dimensional mathematical, implementation, consultation and assistance to "large" restoration projects that will assist the structural analysis, allowing easier display of dynamic strain, analysis and lighting noise. It could also be a valuable tool for decision support, therefore, may simulate several possible scenarios for intervention. This model appears therefore an excellent support for recovering, ordering and monitoring information about materials and data (stage of restoration, photographs, sampling points, results of diagnostic tests, etc.) collected dynamically during the "life" of the cultural heritage, allowing to document its complete history.

Several stages of construction: application of towels for ripping, tearing and opening of the "pentagon" after "ripped" the frescoes

Turin, Chiesa della Miseicordia, before and after restoration

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