

Fabbrica della Conoscenza

XV INTERNATIONAL FORUM

Le Vie dei  
Mercanti

Carmine Gambardella



**WORLD HERITAGE**  
and **DISASTER**

# **WORLD HERITAGE and DISASTER**

Knowledge, Culture and Representation

La scuola di Pitagora editrice



**Fabbrica della Conoscenza numero 71**  
Collana fondata e diretta da Carmine Gambardella

## **Fabbrica della Conoscenza**

Collana fondata e diretta da Carmine Gambardella

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**WORLD HERITAGE and DISASTER**  
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Le Vie dei Mercanti \_ XV International Forum

Carmine Gambardella  
WORLD HERITAGE and DEGRADATION  
Smart Design, Planning and Technologies  
Le Vie dei Mercanti  
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**WORLD HERITAGE and DISASTER  
Knowledge, Culture and Representation**

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## **Peer review**

Scholars has been invited to submit researches on theoretical and methodological aspects related to Smart Design, Planning and Technologies, and show real applications and experiences carried out on this themes.

Based on blind peer review, abstracts has been accepted, conditionally accepted, or rejected.

Authors of accepted and conditionally accepted papers has been invited to submit full papers. These has been again peer-reviewed and selected for the oral session and publication, or only for the publication in the conference proceedings.

## **Conference report**

300 abstracts and 550 authors from 30 countries: Albania, Australia, Benin, Belgium, Bosnia and Herzegovina, California, Chile, China, Cipro, Cuba, Egypt, France, Germany, Italy, Japan, Jordan, Kosovo, Malta, Massachusetts, Michigan, New Jersey, New York, New Zealand, Poland, Portugal, Russia, Slovakia, Spain, Tunisia, Turkey.

200 papers published after double blind review by the International Scientific Committee

## **Preface**

*A theme, that in addition to highlighting the word DISASTER, wants, as in all the editions of the Forum, place the emphasis on the word Culture, the systemic product of knowledge and applications, which has a plastic strength as Nietzsche pointed out, capable of healing broken parts, to recover lost parts, and as such belongs to humanity, the Man Artifex and Faber in its historical self-reproduction.*

*A faith in humanity's ability to achieve ever higher levels of knowledge to offer as patrimonial value, beyond disastrous contingencies, which contains reparative stem cells and also fortifies evolutionary processes involving the Skills and Work of Man, the fate of Landscapes, Territories, Cities, Architecture and Archaeology as Traces of Geography of the past that emerges in the Geography of the Present.*

*For these reasons, in Naples on 15 and Capri, on 16 – 17 June, the 15th "International Forum Le Vie dei Mercanti" will be held. An established event that in three decades has seen the participation of a scientific community from around the world grow, discussing multidisciplinary topics relating to the Landscape, Cultural Heritage, Government of the Territory, Design and Economics.*

*Therefore, I expect, along with the International Scientific Committee, contributions of studies and research relating to theories, concepts, applications, best practices to protect and preserve, in order to not only transmit to future generations the tangible and intangible patrimony of the World Heritage but also to orient the design processes and innovative planning for the modification that derive from the humus of identities and roots of the places, the regenerating sap of the places and of a "new", which, citing Argan, possesses a contemporary of what it does not have the same date.*

*The location is exceptional. Campania, with six sites included in the World Heritage List, two UNESCO Man and Biospheres, two assets on the List of Intangible Heritage, is one of the richest regions in the world for cultural and landscape heritage. It is therefore no coincidence that the Forum will be held in Aversa/Naples and Capri, with visits to the sites and presentations of operational projects by the scientific community of Benecon\*, a University consortium that hosts 250 researchers and distinguished professors of five Italian Universities, UNESCO Chair on Landscape, Cultural Heritage and*

*Carmine Gambardella  
President and Founder of the Forum*



Le Vie dei  
Mercanti

XV FORUM INTERNAZIONALE

# WORLD HERITAGE and DISASTER

Knowledge, Culture and Representation

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Earthquake, survey and advanced representation: knowledge, restoration and enhancement of the architectural heritage in the city of Ferrara, World Heritage Site

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## Abstract

The recent earthquake occurred in the Emilian territory has left many open questions. These issues, far to be definitely solved, are still committing technicians, scholars and safety operators.

Immediately after the first safety procedures, operations of restoration, consolidation and regeneration were needed. These actions must be led by a general research method based on survey, a fundamental activity leading towards all operations of knowledge and conservation.

Our research group here presents two case-studies, showing different ways to operate in such a situation of danger and urgency. Both the objects of study are located in Ferrara, where the architectural heritage suffered considerable damage due to the earthquake. The catastrophic event aroused the interest of administrators, and many initiatives were born immediately after. They are intended not only to put in security, but also to enhance and strengthen the cultural patrimony of the city.

The first case concerns the Church of Santa Maria della Consolazione, seriously damaged by the quake. Here an integrated survey was carried out, to document meticulously damages and injuries, for the purpose of conservation of the monument. The second one concerns Palazzo Schifanoia, showpiece of Ferrara's museum complex. Here, in addition to conservation, the museum managers took an approach based on the production of multimedia content.

The general aim is to emphasize the potential of an integrated approach, blending the use of both traditional and advanced survey methods.

**Keywords:** Earthquake, Ferrara, 3D Survey, Museums, Multimedia

## 1. Integrated, advanced and scientific surveying<sup>1</sup>

The dictionary architectural surveying is commonly associated to the practical measuring operation of a building. It is still necessary today to point out that surveying is not a simple reading and translation of metric data, but should seek representation by a graphic transcription of the global knowledge of the work, obtained through integrated studies, methodically planned and conscious of the constructive reality, capable of capturing its shape, special, dimensional, perceptive, technological and constructive values. It is an act of critical reading to be conducted rationally and scientifically, with complete consciousness of the building that is being surveyed, of its visible and invisible parts [1].

Following these general principles of the discipline, our research group has used widely diffused instrumentation and advanced techniques (laser scanner, total station, Leica 3d disto and fotomodelling) in an integrated manner on artefacts affected by the earthquake. We aimed to elaborate a three-dimensional model, scientifically queried about both the quantitative data, for example, the extrapolation of the geometry of space and of their measurements, using both qualitative characterization of material surfaces subject to degradation and collapse [2]. In this case, the new fotomodelling technologies have shown themselves to be especially effective, since from simple digital





Fig. 1 : The church of Santa Maria della Consolazione in Ferrara. isometric view of the point cloud model obtained by matching 52 scans in Faro Scene and then importing the whole model in Cyclone.

photographs it was possible to obtain the spatial position of the pixel of the "n" frames taken of the object. The result is the creation of a three-dimensional cloud of point, like that produced by a laser scanner, from which you can then switch to the mesh and the complete model with orthorectified texture, exportable in many digital formats. The use of software like Agisoft PhotoScan®, in analogy to what usually operates on point clouds taken with a laser scanner, allows us to overcome the problems of projection on the geometrical plane of representation of elements belonging to different floors and complex surfaces, including ruined frescoed vaulted ceilings.

## 2. Surveys and emergencies: The case of Santa Maria della Consolazione Church<sup>3</sup>

The Santa Maria della Consolazione Church of Ferrara, among the last works attributed to Biagio Rossetti, was built in the first fifteen years of the XVI century under order of Sigismondo and Ercole I d'Este. It was later annexed to the neighboring convent occupied by the Congregation of the Servants of the Observance.

### 2.1 Laser scanner surveys<sup>3</sup>

The integrated survey of this article is a good example of documentation of an architectural monument of value through the use of advanced technology to extract metric/geometric characteristics and subsequently convert them into digital data (Figg.1,2). The building was closed to the public for two years because of serious damage reported during the earthquake of 2012. It needed an accurate measurement campaign that, in addition to providing the usual dimensional data, would accurately highlight the failures and injuries flocked to the structures by the many earthquakes, in order to put in the technics in the condition of drawing up a focused and effective consolidation and restoration plan.

The building, part of a larger architectural complex, is made up of a 18.5 m wide main body of the Church, which is spread over three aisles, with a total length of more than 53 m and an internal height that exceeds 18.5m in the presbytery. The considerable size of the building and the particular static conditions following the earthquake necessitated a targeted planning of the relief operations. Having to occur in a very short time and in a situation of risk associated with the instability of the structures [3], the survey has seen the main use of laserscan equipment. The choice of a measurement system of an indirect type allows also the surveying of all those inaccessible areas because of distance or danger - that a direct survey would not have been able to capture with the necessary accuracy and precision. The laserscan technology, allows the extrapolation of a large amount of data in extremely short times, able to describe all parts of the building in maximum detail.



Fig. 2: Front of the church of Santa Maria della Consolazione in Ferrara. From left: photos during survey campaign and screenshots extracted from PointCloud.

For the survey of the Santa Maria della Consolazione Church [4], a Faro Focus 3D laserscan station was used (Fig.3), with an accuracy of 2 mm, a range from 0.6 to 130 m and an integrated 5 megapixel digital camera. This allowed us to acquire a model of the entire building in a single day of scans, returning a dense and complete PointCloud including the most affected and inaccessible areas of the building. The measurement campaign was carried out through the placement of 52 stations. 27 were used to document the external elevations and the front of the cloister while 23 were placed internally to adequately describe the spans and the presbytery, minimizing the possible occlusions. Two were placed in the attic to delineate the trend of the extrados of the vault placed to cover the nave. This was carried out with the aid of a set of 12 spherical targets in the scanner, strategically positioned during scans to ensure the necessary overlapping, which allowed the subsequent alignment of individual clouds through automatic recognition. The recording carried out in Faro Scene has produced .fls files exported in .ptx format, subsequently imported in Cyclone (Leica Geosystems HDS), where it was possible to interact with the complete PointCloud model, extrapolating screenshots and slices able to describe maps, elevations and vertical sections [5] in detail (Fig.4).



Fig. 3: The church of Santa Maria della Consolazione in Ferrara. From left: the laser scan station Faro Focus 3D used for the digital survey; the nave during the surveying operations; part of the vault collapsed in the earthquake.



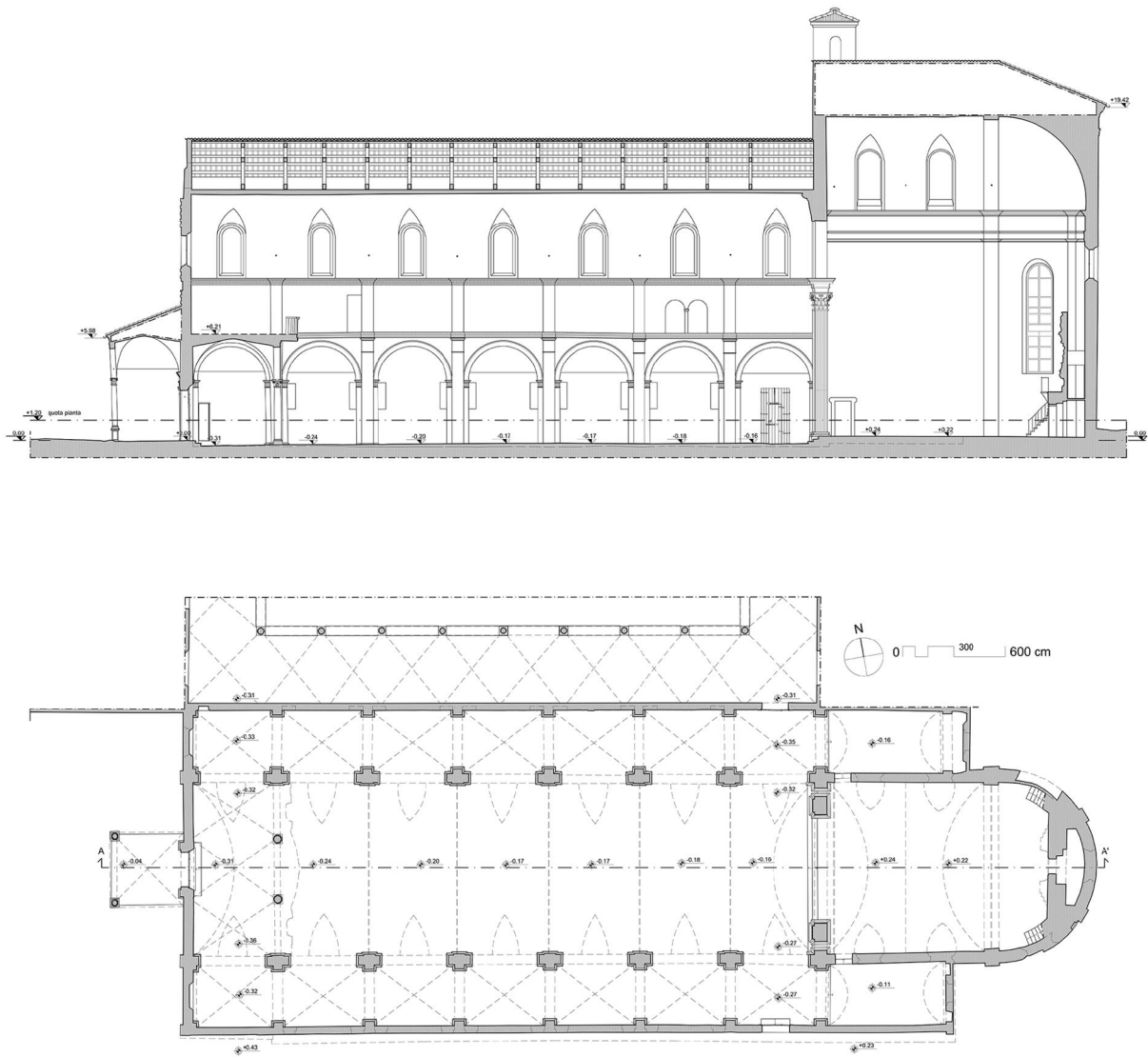


Fig. 4: Santa Maria della Consolazione. Plan and longitudinal section obtained by redrawing in Autocad 10 cm thick slices extracted from the point cloud (sectioned elements) and high-resolution screenshots based on a reference grid (projected elements, grid spacing 1 meter). The graphic processing of the data provided the realization of three graphic plates containing 2 plans, 3 cross sections, a longitudinal section and 3 fronts in 1:50 scale.

The quality of the cloud thus obtained, in addition to allowing the detection of collapse and degradations – has made the necessary interventions of consolidation, restoration and careful planning of the monitoring of structures feasible. It will also allow us to subsequently analyze the artefact various times, freeing the operator from the obligation of repeated visits, without affecting the scientific nature of the entire operation. By examining the PointCloud model, it is possible to extract any kind of significant section designed to document details of degradation, comparable to details found in a phase advanced study, or directly measure portions of the architecture within the same three-dimensional virtual operating system. More specifically, the subsequent requests for the delivery of a diagram that would document the progress elevation of the floor in each bay and of a report that would contain the lesion present on the arch of the apse in detail have been fulfilled in a very short time. This has been done without further direct measurements from the site, thanks to the direct interaction with the cloud of points.

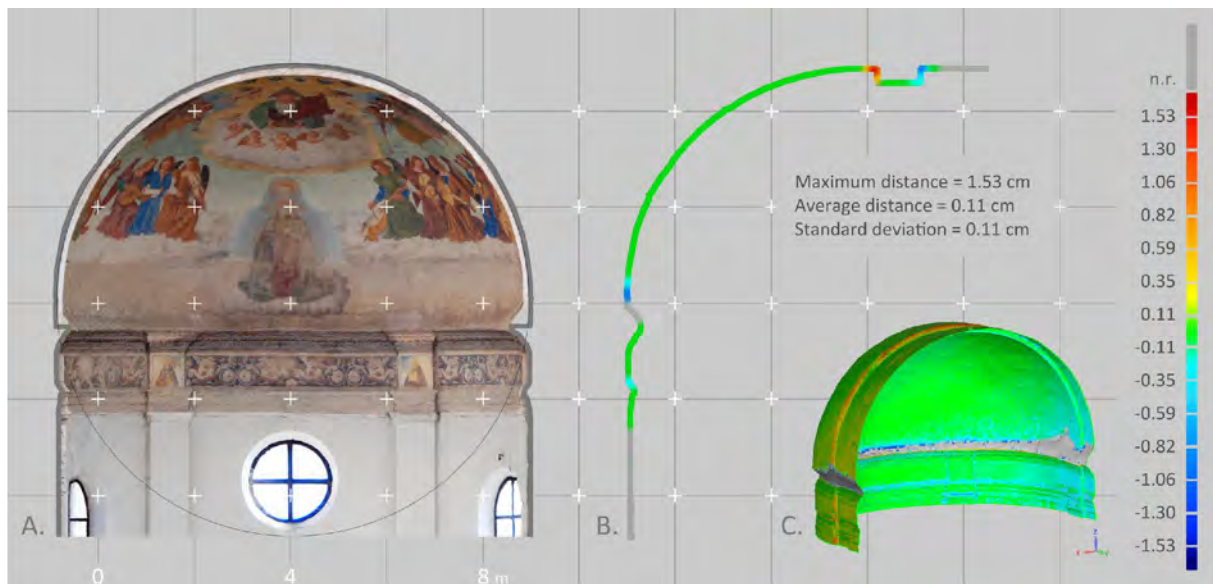


Fig. 5: Santa Maria della Consolazione. Geometric comparison between the 3D meshes of the apse half-dome (SFM model and digital scanning model). From left: cross section of the textured SFM model (A); Result of qualify: graph of the distribution of the error on the cross section (B); results of qualify on the three-dimensional model of the object (C).

## 2.2 Data integration and comparison with image-based modeling tools<sup>2</sup>

The laser scanner survey returned geometrically rich and extensive data, describing the architectural object in all its parts. However, we choose to operate on some points, and on considerable details, using the current techniques of structure from motion. The aim was to integrate color data [6] and facilitate the reading of the lesions (as in the case of the apse half-dome) or, locally, to document in greater detail morphologically complex organisms located in parts of the church made dangerous by the earthquake (as in the Baroque altarpiece located on the bottom of the apse). Furthermore, it has been possible to make a geometric comparison (quality) between two models, the one extracted from photomodelling operations and the one coming from the elaboration of laser scanner data [7]; this procedure is useful to establish methodological protocols to control the reliability (and thus the integrability) of different data, coming from differentiated tools and techniques.

In the case of the apse, the starting point is constituted of a set of 16 photographic shots (resolution 3872x2592) taken by a Nikon D700 digital camera mounted on a tripod. Particular attention has been dedicated to both the lighting conditions of the object and the quality of images, which needed to be correctly exposed, sharp in outline and noise-free. The ideal area for positioning the camera, corresponding to the one around the high altar, was not accessible because of the high risk of collapse of the vault above. It was therefore necessary to shoot from positions external to that area. Moreover, given the obvious inability to climb in altitude, the shooting point is always constrained to a plane, that of the floor, placed at a fixed height compared to the object that has to be measured. However, this did not affect the correct alignment of the photos, which returned a 5,800,000 polygons mesh, perfectly continuous and connected unless the inevitable occlusion zones above the molded cornices [9]. The comparison between the two models has provided a measure of the average distance and standard deviation that are nearly identical, both equal to 0.11 cm, with a maximum distance measuring 1,53 cm; the gap between the two surfaces is almost reduced to zero if we only consider the longitudinal section of the shell. This is even more interesting when we consider the size of the measured object (diameter of the apse half-dome 9.86 m) (Fig.5). The integrated survey returned a single output reference model, useful for extracting, in a first phase of graphic elaboration, all the plans and sections required by the client. It actually represents an examinable database of informations, attesting to the state of the building prior to the restoration planned for the current year.

## 3. From surveys to multimedia communication. The case of Palazzo Schifanoia<sup>1</sup>

In recent years, research on current methods of media communication based on the use of interactive virtual spaces has paved the way for the adoption of new systems to support visits to sites of cultural interest and museum spaces. The largest and most important museums of the world are replacing traditional audio guides with multimedia movies and innovative interactive guides, allowing use of content to be more engaging, effective, intuitive and customizable. Following the earthquake of 2012,

Schifanoia Palace, a small but prestigious structure and Civic Museum of Ancient Art in Ferrara, has been closed to the public. Still today, the Salone dei Mesi is the only accessible room. In synergy with the recovery operations of the building, a project for the creation of a museum using digital representation as its main instrument for communication of possibly complex scientific content was developed. The building has been subject to heavy changes that, over the centuries, have completely altered the nature of the Este townhouse, founded around 1385 by Alberto d'Este, originally surrounded by an elegant Renaissance garden.

The research project, supported by an agreement stipulated with the Civic Museum of Ancient Art [8], concerns the creation of multimedia products aimed at solving the problems of the informative apparatus, already recognized and reported by the manager himself. For example, in the famous Salone dei Mesi, both the controlled lighting of the surviving frescoes (for reasons of preservation) and the height of the painted scenes (6 meters) constitute a limit to the viewing of the famous cycle that covers the walls.

For these reasons, a 4 phase program was developed. This program includes the execution of digital models of the building obtained from the recently integrated surveys [10]. Virtual reconstructions will provide information on the history and architecture on the system thanks to reproductions and high-definition images of the painting cycles or of less accessible decorations. The highly detailed textured models, initially non-interactive, can now be followed on navigable screens on tablet devices over the network or during the tour route. They can be used as the basis of augmented reality projects that can contribute to a revival in the museums of Ferrara. In the definition of the communication format, particular attention has been paid to the needs of the young audiences in order to facilitate their approach to cultural issues that often do not arouse particular interest. Speed, immediacy and multitasking characterize the cognitive approach of the youths: the success of communication, even in the case of layered and not ephemeral content, is for this reason always subject to the quality of engagement achieved.

### 3.1 Four interactive "stories" for Palazzo Schifanoia<sup>2</sup>

If survey, intended in a scientific and integrated sense, must tend to the overall knowledge of an architectural object, it is equally important that this knowledge finds a clear and coherent synthesis in the post-production phase. This is an essential condition for setting a dissemination process that aims to reach the final user in an effective way. In this sense, it is necessary that both the metric and perceptual data output show a high quality. The narrative program built for Palazzo Schifanoia opens with an initial multimedia product, an animated sequence lasting about 7 minutes that chronologically narrates the transformation phases of the building from its foundation to the present day. The animation shows the volume of the building as a set of 3D diachronic models, which are gradually enhanced with increasing detail drawn on the available historical sources. Iconographic sources, materials and historical documents supporting it accompany each transformation. The models allow a comparison between the architectural solutions at different eras, communicating the historical and critical criteria used in the analysis of the artifact in a simple way (Fig.6).

The second multimedia product focuses on the most valuable area of the of the Este building: the Salone dei Mesi, commissioned by Borso d'Este around 1470 and characterized by a complex iconographic program with an astronomical and astrological theme. The model describes the original space, with a different access via a staircase, a large central fireplace and a dimming system of painted wooden panels that has disappeared today. The virtual reconstruction of the original access from the garden staircase will restore the vision of the room as it was at the time of Borso: the visiting experience thus opens an emotional comparison between past and present. The visual impact of the spectacular entrance to the salon offers multiple opportunities for exploration: the original access, rather angular, is opposed to the current nineteenth-century conception, where short side entrance includes the room in a visually monumental, symmetric field framed by a central point of view. The third phase is still focused on Salone dei Mesi, and it will illustrate different points of view and symbolic meanings of the frescoes, while the fourth phase involves widening the experience through the introduction of interactivity. Models, initially shown in animated clips, will become explorable, immersive and accessible through tablet devices, using I-Visit technology or exploration devices like Oculus 3D.

From a strategic point of view it is essential that, in the general visit of the palace, the viewing of information takes place inside the Salone. The experience gains value from being able to compare past and present, the visible and what has now disappeared, and to discover, thanks to the narrative patterns, hidden meanings and secret paths, as in the case of the painted perspectives.



**1391**

Pochi anni dopo Alberto promosse un significativo ampliamento del palazzo raddoppiandone la lunghezza.

1390  
1400

**1465-66**

Con Borso d'Este (1471-1472) si avviò un periodo di grandi trasformazioni del palazzo.

1470  
1480

**1469**

In questa fase il palazzo si affacciò sul suo splendido giardino all'italiana.

sul modello dell'Orto Pontassiano.

1470  
1480

**1476**

La facciata della facciata venne decorata con stucchi e pitture tra pomata e Ferrara e nel territorio intorno il conte Ludovico di Sesto e il signore di Casa Mirandoli di Sesto.

il Castello di Padoa.

1480

**1476**

Tra le opere più preziose sono state ritrovate anche sul portale in marmo.

1480  
1490

**1500**

Giannandrea ha il proprio spazio nel palazzo.

1510

**oggi:**

Il museo mostra al pubblico la sua preziosa collezione nel suo sereno ambiente storico recuperato.



Fig. 6: Palazzo Schifanoia, Ferrara. Some frames taken from the first informative-educational video made for the multimedia program of the museum.



### 3.2 Digital museumification and filing

Multimedia museumification brings together state-of-the-art technology with the historical object being described, thus anticipating the interaction between the communicative equipment and the area housing it by means of a careful design project connecting the site with virtual guides.

The various possible approaches differ depending on the content (strictly linked to the functionality of the guide itself), the size of the asset being exhibited and its nature (a tangible or intangible asset). One can therefore find large touch-screens containing databases of works where the visitor can freely cross-search information relating to history, iconography, authors, etc. (Uffizi Gallery in Florence), just as one may also find the same large interactive screen positioned in front of a single artwork (as is the case with the Polyptych of the Misericordia by Piero della Francesca in the Museo Civico of Sansepolcro). The latter will be positioned so as not to interfere with the viewing of the work, but rather to provide information – to those interested – regarding the restoration of the work, the technical and scientific procedures involved, and the views and comments of scholars and critics. Using multimedia devices to present a very large cultural heritage site whose characteristics are tangible, environmentally large-scale and to a certain extent also emotional, is of course a very different matter. The full-immersion experience proposed at the Museo delle Alpi (Alps Museum) at Forte di Bard in the Val d'Aosta succeeds very effectively in keeping together historical architecture and technology in order to describe the intangible dimension that makes this mountain chain so unique.

It is hoped that these virtual devices never actually substitute the asset itself, but rather accompany the user's knowledge of it; that they are not the object of attraction, but are used to enhance awareness through multi-level study and investigation according to the interests of the user. Moreover a keen design sensitivity favoring the integrated enjoyment of the asset together with the multimedia explanations relating to it (fixed or mobile, contemplative or interactive) should be a prerequisite for contemporary promotion appropriate to the value of our country's cultural heritage.

The acquisition of knowledge takes on a different nuance when the asset, as in the case of Palazzo Schifanoia, has suffered a trauma (an earthquake) that has temporarily compromised public access to parts of it. Areas off limits by force majeure will nonetheless be virtually represented inside the museum system to ensure "integral" viewing of the building.

To this end, UNESCO took part in the Fourth Session of the Global Platform for Disaster Risk Reduction held in Geneva in May 2013. The theme of the Conference was "Invest today for a safer tomorrow". UNESCO confronted this issue by discussing the use of science and technology within policies and practices regarding the risk to the cultural heritage. On that occasion the clear "disconnection" between science, politics and practice was underlined, and it was acknowledged that dialogue between the parties was the element that needed attention in the near future. There was also debate on the need to foster the resilience [11] of communities toward natural disasters, climatic changes and environmental upheaval, in order to deal with the consequences with less "damage". It was underlined that this improved capacity is based on a discerning knowledge of cultural assets and on the awareness of their importance, to which are tied both the development of public/private synergism and the guaranteed conservation of cultural assets during post-trauma recovery.

A proposal was advanced for a conscientious programme of documentation and sharing of cultural assets in digital form for the creation of a virtual international register. This archive would make it possible to maintain records of the life of the assets in an evolving way, i.e. allow an in-depth analysis in itinere on the basis of previous data, pursuing the idea of continuous knowledge by means of subsequent integrated research investigations.

[1] DOCCI, Mario, MAESTRI, Diego. Manuale del rilievo architettonico e urbano. Bari: Editori Laterza, 2009, pp. V-VI; MANDELLI, Emma. Il rilievo, strumento di conoscenza. In *Le mura di Massa Marittima, una doppia città fortificata*. Pisa: Pacini, 2009, pp.175-180.

[2] The themes published by the research group until now are: Cloister of the Carracci, San Michele in Bosco, Bologna; Palazzo Schifanoia and Salone dei Mesi, Ferrara; Mausoleum of Theodoric, Ravenna.

[3] A small portion of the intrados of the vault of the nave has collapsed during the survey (Fig.3). The scans realized on the same day, before and after the collapse, allow the documentation of the two different conditions of the church.

[4] The team is composed of: Prof. Arch. Manuela Incerti, Ph.D. Arch. Gaia Lavoratti, Ph.D. Arch. Stefania Iurilli, Eng. Piero Lusuardi, Dr. Anna Tonelli, Dr. Carlo Alberto Bozzi.

[5] In particular, for each section (horizontal or vertical) a slice of 10 cm of the point cloud has been extracted in correspondence of the cutting surface. The slice, re-imported in Autocad, has allowed the exact reshape of the section profile through a simple interpolation of points. For those parts in view, however, the method has been brought out through the importation and re-design in Autocad of high-resolution screenshots of the cloud, realized with Cyclone through the use of reference planes with a grid size of 1 meter.

[6] The integration was necessary because, given the state of emergency of the survey, the different laser scanner shootings were carried out over an entire day, in different lighting conditions (natural or artificial) depending on the time of day; as a consequence the acquired color data appeared not homogeneous and affected by the presence of artificial lights and headlights.

[7] The common nature of the output data produced by both laser instrument and SFM techniques allows to work on both meshes within the same 3D workspace, providing to properly align the models in respect to an identical reference system.

[8] Given the homogeneous shooting conditions the same occlusions are also detectable on the laser scanner point cloud.

[9] Director of the Civic Museums: Angelo Andreotti. Research Team: Angelo Andreotti, Marco Bertozzi, Manuela Incerti, Stefania Iurilli, Giovanni Sassu. Scientific coordinator Manuela Incerti. The first phase of the multimedia project described above has been completed and handed over in July 2014, the following are working progress.

[10] For the survey see INCERTI, Manuela. Il salone dei Mesi di Schifanoia: note per una lettura critica del rilievo. In Bruniana & Campanelliana, Ricerche filosofiche e materiali storico-testuali. 2009/2, anno XV.

[11] In ecology resilience is the speed with which a community (or an ecological system) returns to its initial state after having been subjected to a disturbance that has removed it from that state. The distortions can be caused either by natural events or by anthropic activities. Usually resilience is directly proportional to the variability of environmental conditions and to the frequency of disastrous events to which a species or an ensemble of species adapted itself (Enciclopedia Treccani).

#### Bibliographical References

DE LUCA, Livio. La fotomodellazione architettonica: Rilievo, modellazione, rappresentazione di edifici a partire da fotografie. Palermo: Dario Flaccovio Editore, 2011. ISBN: 978-88-579-0070-4.

“Disegnare Con”, Musei virtuali dell'architettura e della città, IPPOLITI Elena, ABISINNI Piero (eds.). vol. 9, n° 17, 2016.

DOCCI, Mario, MAESTRI, Diego. Manuale del rilievo architettonico e urbano. Bari: Editori Laterza, 2009. ISBN: 978-88-4209-068-7.

INCERTI, Manuela, CASSANI SIMONETTI, Matteo, DI FAZIO, Giuseppe. Colore e modello nel rilievo mediante fotomodellazione. In ROSSI, Maurizio, SINISCALCO Andrea (by). Colore e Colorimetria Contributi Multidisciplinari. Sant'Arcangelo di Romagna: Maggioli, 2013, vol. IX A. ISBN: 978-88-387-6241-3.

INCERTI, Manuela, IURILLI, Stefania. Schifanoia Palace in Ferrara A Virtual Storytelling For Its Knowledge And Dissemination. In GUIDI, Gabriele, SCOPIGNO, Roberto, TORRES, Juan Carlos, GRAF, Holger, REMONDINO, Fabio, BARCELÓ, Juan, BRUNET, Pere, HAZAN, Susan, DURANTI, Luciana (eds.), 2nd International Congress on Digital Heritage 2015. 28 sept- 2 oct. 2015, Granada: IEEE Conference Publications, 2015. pp. 41-49.

INCERTI, Manuela. Il salone dei Mesi di Schifanoia: note per una lettura critica del rilievo. In Bruniana & Campanelliana, Ricerche filosofiche e materiali storico-testuali. 2009/2, anno XV. ISSN: 1125-3819.

IPPOLITO, Alfonso, CIGOLA, Michela (eds.). Handbook of Research on Emerging Technologies for Digital Preservation and Information Modeling. Hershey, PA, USA: IGI Global, 2017, pp. 288-315.

MANDELLI, Emma. Il rilievo, strumento di conoscenza. In Le mura di Massa Marittima, una doppia città fortificata. Pisa: Pacini, 2009. ISBN: 978-88-6315-133-6.



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