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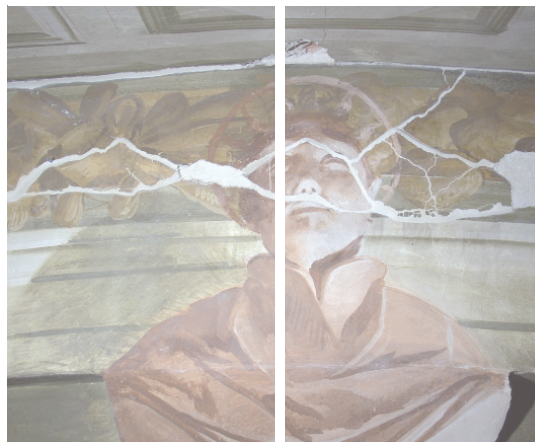
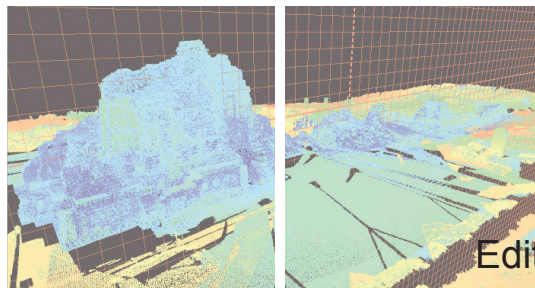
# International Conference Built Heritage 2013 Monitoring Conservation Management

POLITECNICO DI MILANO



CENTRO PER LA  
CONSERVAZIONE E  
VALORIZZAZIONE DEI  
BENI CULTURALI

POLITECNICO DI MILANO  
**150**



Online Proceedings of the Conference  
**BUILT HERITAGE 2013**  
**Monitoring Conservation  
and Management**



Milan, Italy  
18-20 November 2013

Editor in chief M. Boriani  
Edited by R. Gabaglio, D. Gulotta

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Milan - Italy, 18-20 November 2013  
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## Day 1 - November 18th, Monday

### Room Rogers - Conservation and management

P.M. Koufopoulos & M. Myriantheos *The master plan for Wadi El Deir, Sinai Egypt: research and interventions*

M. Wu, S. Hu, Z. Xue, C. Shi *Monitoring and maintenance of built heritage within the daily management system: a case study of world cultural heritage Suzhou classic gardens in China*

L. De Marco, G. Franco, A. Magrini *Guidelines for eco-efficiency in the UNESCO site of Cinque Terre: an example of best practice*

A. Cazzani & C. Sangiorgio *Inventory, preservation and valorization of Historic roads In the Lombardy Region (Italy). Current policies and future plans*

K. Basili, R. Codello, G. De Vettor, P. Gasparoli, F. Pianezze, A.T. Ronchi, G. Totaro, F. Trovò *Wear processes in architectural heritage: definition, studies, contrasting measures. The case of UNESCO World Heritage Site "Venice and its Lagoon"*

S. Pratali Maffei & A. Marin *Forte Marghera and the entrenched field of Venice: a participatory process of planning and valorization*

R. Picone *Farmhouses in the Phlegrean Fields between archaeology and architectural palimpsest. A multi-disciplinary approach*

C.F. Carocci & C. Circo *"Needs-based architecture" in the Cyclades. A project for the enhancement and conservation of the architectural heritage and the rural landscape*

F. Colosi, R. Gabrielli, E.S. Malinverni, R. Orazi *Strategies and technologies for the knowledge, conservation and enhancement of a great historical settlement: Chan Chan, Perú*

E. Ciocchini, A. Maiocchi, F. Zangheri *The chapel of the Blessed Virgin of Miracles: a multidisciplinary approach for the project of conservation and reuse*

D. Concas, G. De Cesare, G. Capri *Santa Teresa from convent cloistered nuns to 'open' museum for the community*

C. Carocci, F. Campisi, I. Tranchina *The medieval Castle of Fossa (AQ). Analysis and restoration project*

I. Huic, M. Vujasinović, M.O. Šćitaroci *St. Mary on Lastre church in Beram, Istria, Croatia -multidisciplinary research, recommendations for restoration and further maintenance*

S. Dandria, F. Gabbrielli, M. Giamello, E. Giorgi, A. Magrini, E. Manzoni, F. Randazzo

*Grancia of Cuna: from the complexity of the historical building to a composed knowledge for the project*

G. Cardani & L. Binda *Guidelines for the masonry quality evaluation in built heritage*

E. Bersani, M. Giambruno, S. Pistidda *Planning for the historic built in developing countries: challenges and opportunities through the case study of Multan (Pakistan)*

M. Faliva *New York City Local Law 11/98: consequences of administrative regulations on the conservation of buildings*

K. Penna, E.S. Taylor, J.L. Tinoco *From paper to people: the complexities of developing guidelines for preservation education in developing countries*

#### **Room IV - ICT and new technologies**

F. Fassi, C. Achille, C. Monti, L. Fregonese, S. Parri, F. Rechichi, A. Mandelli, C. Monti, F. Gaudio, L. Galbusera *A yard of the future: the main spire of Milan Cathedral*

C. Pisu, P. Casu, S.M. Grillo *Multidisciplinary approach to the documentation of the XVIII century marble altars in Sardinia*

G. Fangi *Spherical photogrammetry for cultural heritage metric documentation: a critical examen six years after the beginning*

L. Pecchioli, F. Mohamed, M. Pucci, B. Mazzei *Museum of the sculptures of the basilica of Saint Silvestro integrating the visit at the catacombs of Priscilla in Rome*

C. Maierhofer, R. Krankenhagen, P. Myrach, J. Meinhardt, U. Kalisch, C. Hennen, R. Mecke, T. Seidl, M. Schiller *Monitoring of cracks in historic concrete structures using optical, thermal and acoustical methods*

V. Palieraki, C.E. Adami, E. Vintzileou *In-situ measurements using radar and boroscopy techniques: Case Study - Hagia Sophia Museum of Trabzon, Turkey*

Telmo Dias Pereira & D. Mateus *Monitoring noise and vibration emissions in Santa Clara-a-Velha Monastery*

L. Giorgi & P. Matracchi *The towers of San Gimignano. Architectural diagnostic for knowledge and conservation*

V. Russo, P. Cappelletti, G. Ceniccola, M. D'Amore, R. Landolfo, F. Portioli *Interdisciplinary conservation issues of an "unstable" architecture: researches about the bell tower of St. Augustine the Greater in Naples*

C. Giannico, A. Ferretti, S. Alberti *Satellite Radar interferometry: a new monitoring tool for cultural heritage sites*

A. Furini, M. Paternò, A. Pellegrinelli, P. Russo *Integrated measurement techniques for the monitoring of the ancient walls of Ferrara*

A. M. Manferdini *Documenting lost heritage. The experience of the survey of architectures damaged by the earthquake in the Emilia area, Italy*

J. Barton & R. Parsons *Use of leading edge Laser scanning and modelling technologies for Heritage conservation*

V. Bayarri, E. Castillo, J.M. García-Moncó, J. Calonge Diez *Integration of traditional and innovative techniques to resolve a complex case: monitoring the movement and temperature influence of the canvas in the south transept of the Church of the Convent of San Luis in San Vicente de la Barquera (Cantabria)*

A. Lionello, C. Rossi, P.P. Rossi *Testing and monitoring for the control of strengthening interventions of Santa Maria Gloriosa dei Frari in Venice*

E. Coisson & F. Ottoni *Monitoring historical structures, from their past to their future*

## **Room G.2 - Materials, preventive conservation and maintenance**

S. Sestini, M. Sammartino, M. Laurenzi Tabasso *Monitoring the performance of stone conservation treatments: technical and economic aspects*

E. Tesser, L. Lazzarini, R. Ganzerla, F. Antonelli *The decay of silicone resins applied for the consolidation of stone in Venice*

G. Bearman, E. Doehne, L. Beegle, W. Hug, R. Reid, R. Bhartia *Remote Detection of Biofilms on Stone*

S. Sasso, L. Scrano, E. Ventrella, M.G. Bonomo, A. Crescenzi, G. Salzano, S.A. Bufo *Natural biocides to prevent the microbial growth on cultural heritage*

A. Velosa, F. Rocha, A. Haugen *Mortars in Norway from the Middle Ages to the 20th Century: conservation strategy*

S. Voltolina, C. Aibéo, T. Cavallin, E. Egel, M. Favaro, V. Kamenova, L. Nodari, A. Pavlov, I. Pavlova, S. Simon, P. Scopece, E. Verga Falzacappa, A. Patelli *Assessment of atmospheric plasma torches for cleaning of architectural surfaces*

P. Ortiz, R. Ortiz, J.M. Martin, M.A. Vázquez *RIVUPH: an Andalusian project for risk analysis in historical cities*

R. Vecchiattini, G.L. Pesce, G. Quarta, L. Calcagnile *Sampling problems in the radio-carbon dating of old mortars and plasters with the "pure lime lumps" technique*

G. Litti, A. Audenaert, J. Braet, L. Lauriks *Energy environmental monitoring in historical*

*buildings; a simplified methodology for modeling realistic retrofitting scenarios. The case study of Schoonselhof Kasteel in Antwerp (Belgium)*

J. Sasaki, K. Koizumi, D. Ogura, T. Ishizaki, K. Hidaka *Research project on the conservation of Hagia Sophia, Istanbul - results of environmental monitoring*

R. Hendrickx, H. De Clercq, F. Decock, F. Descamps *Hygrothermal analysis of the façades of the former veterinary school in Anderlecht (Belgium) for the risk assessment of internal thermal insulation*

A. Caratelli, A.M. Siani, G.R. Casale, A. Paravicini, C. Bertolin, D. Camuffo *Indoor measurements of microclimate parameters in the Mithraeum in the Baths of Caracalla (Rome, Italy)*

H. Norrström *The EEPOCH Project - Multidisciplinary in a multiple case study*

I. Papayianni, M. Stefanidou, V. Pachtla *Survey of repaired and artificial stone at archaeological site of Pella five years after restoration works*

D. Gulotta, C. Tedeschi, S. Goidanich *Long-term evaluation of the salt decay susceptibility of NHL repair mortars*

A. Calia, D. Liberatore, N. Masini *Approach to the study of conservation of historical masonry mortars by means of the correlation between porosimetry and penetrometric test. First results*

## **Poster Session A**

E. de Almeida *Historic Center of Salvador, Bahia, Brazil: dilemma between conservation and cultural consumption*

Balayet Hossain *Historical imprints of Panam Nagar*

T. Basirico & K.B. Fazio *A multidisciplinary approach to the sustainable restoration of historical buildings: the case study of the San Francesco ex-convent in Piazza Armerina in Italy*

J.N. Bastos *The Algarve XVI-Th century Rural House – intervention for survival*

J.N. Bastos *The Fortress of Sagres (Portugal) - an heritage and restoration practice*

J. Bruin et al. *Uncovering mono-functional developments in a Seventeenth-century canal-zone block in the Canal District of Amsterdam World Heritage*

S. Bruni et al. *Post-earthquake recovery of architectural heritage: diagnostics, GIS documentation and restoration*

G. Buyukmihci & A. Ozkan *Integrity of conservation and sustainability techniques in a special historic site*

P. Chiodi et al. *A multidisciplinary approach: the conservation of an ancient bridge over the greater Zab river as part of community development plan of Deralok hydropower project under japanese international cooperation agency loan*

V. Cinieri & E. Zamperini *Lifecycle oriented approach for sustainable preservation of historical built heritage*

S. Colombo *An application of memory studies to museology: the case of Pinacoteca Ambrosiana between 1960s and 1990s*

F. Converti *The technological innovation of the knowledge areas: The Tourist Board of the City of Peastum*

T. Dreyfuss et al. *Transmitting Malta's legacy of forts and fortifications through the reuse of an abandoned 16th century warehouse*

R. Fabbri & S. Ciliani *For the valorization of the Monumental UNESCO Heritage: the system of signs pedestrian tourism in Ferrara and Modena*

B. Ferri & A. Maturo *Built cultural heritage and urban development: elements for a cultural planning in Pescara city*

C. Gentile et al. *Diagnostics and preservation strategies applied to historic iron infrastructures: the Paderno arch bridge (1889)*

P. Giandebiaggi & C. Vernizzi *The Roman amphitheater in Durres: the survey as a means of multidisciplinary knowledge for urban regeneration, architectural recovery and archaeological excavation*

K. Keutgens & B. Delmotte *Study of the architectural history of the St. Martin's Church, Zaventem, Flanders, by means of preliminary material-technical research*

C. Mura *Knowledge of modern architectural heritage in Sardinia through construction techniques. The case of rural architecture of Arborea (OR)*

B. Davide Petriaggi et al. *The restoration of the Domus of the Mithraeum of the Painted Walls (Ostia): a methodological approach*

S. Sadeghi *A concealed garden: critical view on the restoration of Ghasr Prison, Tehran, Iran*

G. Sanfilippo et al. *A systemic approach for the restoration project: the church of St. Anna in Piazza Armerina (EN)*

G. Verdiani et al. *Ad impossibilia nemo tenetur. Three case studies on built heritage elements at risk*

M.R. Vitale et al. *Methods and strategies for the 'sustainability of the ancient built-up: studies and preliminary analysis on the "Monte" quarter in Piazza Armerina*

## **Day 2 - November 19th, Tuesday**

### **Room Rogers - Conservation and management**

M. Landoni *Conservation project on Nandin hall at Vat Phou archaeological site (Laos PDR)*

J. Cassar, S. Cefai, M. Galea, R. Grima, K. Stroud, A. Torpiano *Preserving the Megalithic Temples of Malta - the interdisciplinary approach*

R. Buzancic *Restoration of Diocletian's mausoleum in Split*

G. Bagnasco Gianni, S. Bortolotto, P. Favino, A. Garzulino, M. Marzullo, E. Riva, R. Simonelli, S. Valtolina, A. Zerboni *Past&Present at Tarchna & Tarquinia: a flexible approach to make visible the invisible*

W. Terlikowski & P.L. Narloch *Specificity of research and reconstructions of ancient wall constructions in Syria, the area of Palmyra*

P. Pesaresi *The Herculaneum Conservation Project's programmed maintenance cycles for the archaeological site of Herculaneum*

D. Cavezzali & A. Giovagnoli *Conservation works of the Hall of Masks in the Domus Aurea, Rome*

G. Putaturo *Restoration of the Villa Reale of Monza*

P.N. Barrera & P.E. Bartholomew *Anthropology of Design: how traditional Korean architecture is redefining the terms of conservation, collaboration, and sustainable management*

A. Baila, L. Mazza, A. Anzani *Conservation and restoration of polychrome stone mosaics in the architectures of the historical park of Villa Tatti Tallacchini: the music pavillion - Cafe house*

T.L. Park *The process surrounding the preservation of historical wooden architecture in Japan*

F. Ottoni, F. Aureli, C. Mambriani, P. Mignosa *An integrated conservation process between history and hydraulics. The case of the ancient masonry "Tower of waters" in Colorno, Parma*

M. Borsotti & C. Campanella *An architectural project for existing buildings from understanding to writing*

M. Carlessi & A. Kluzer *Past, present and future of the forgotten places in the ancient "Ospedale Maggiore" (Ca' Granda) in Milan. Studies, surveys, analysis, prospects and projects*

A.C. Glória *The "private" cultural heritage: management, right and public fruition. The case of Cedovim manor's house (Vila Nova de Foz Côa, Portugal)*

#### **Room IV - ICT and new technologies**

S. Janvier-Badosa, C. Stefani, X. Brunetaud, K. Beck, L. De Luca, M. A-Mukhtar *Documentation and analysis of 3D mappings for monument diagnosis*

S. Bortolotto, A. Castiglioni, A. Castiglioni, N. Cattaneo, S. Massa *Complex Archaeological Sites: An integrated stratigraphic framework for progressive knowledge acquisition and representation*

A. Versaci, A. Cardaci, D. Indelicato, L. Fauzia *Integrated survey methodologies for the knowledge, restoration and valorization of modern architecture. The case study of the archaeological museum of Siracusa designed by Franco Minissi*

G. Bearman, E. Doehne, J. Voss, K. Merrill, R. Bagaria *Citizen Science and Mobile Phone cameras as tools for monitoring World Heritage*

T.E. Boothby *Ars sine scientia: how incorrect design theories lead to correct designs*

S. Arangio, S. Molinaro, F. Bontempi *Basic modeling for the forensic investigation of the collapse of a masonry structure*

K. Papadopoulos & E. Vintzileou *The new 'poles and empolia' for the columns of the ancient greek temple of Apollo*

Epikourios M. Vasic, D. Coronelli, C. Poggi *A multidisciplinary approach for the assessment of great historical structures: ties of "Duomo di Milano"*

S. Arangio, F. Bucchi, F. Bontempi *Pushover seismic analysis of masonry buildings with different commercial codes*

B. Benedetti & S. Montanari *Methodology and technology in two new museums in Saudi Arabia*

M. Negrini & N. Di Blas *Digital storytelling for Cultural Heritage: a modular, multi-channel, multi-scenario approach*

G. D'Amico, A. Del Bimbo, A. Ferracani, L. Landucci, D. Pezzatini *Onna project: a na-*

*tural interaction installation and mobile solution for cultural heritage*

M. Barcaro & E. Oliviero Scigno, *enriching the visitor's experience with a tablet*

### **Room G.2 - Materials, preventive conservation and maintenance**

C. Pasquarella, C. Balocco, E. Marmonti, G. Petrone, G. Pasquariello, R. Albertini *An integrated approach to the preventive conservation of cultural heritage: Computational Fluid Dynamics application*

C. Pasquarella, G. Pasquariello, C. Balocco, E. Sacconi, M. Ugolotti, O. Maggi, R. Albertini *An integrated approach to the preventive conservation of cultural heritage: indoor biological environmental monitoring*

E. Rosina & E. Rotta *Environmental protection and control systems for architectural and archaeological heritage*

A. Bonazza, I. Natali, I. Ozga, G. Bartolozzi, C. Cucci, V. Marchiafava, M. Picollo *Pollution effects on typical Florentine lithotypes: a multidisciplinary approach*

C. Di Benedetto, S. Bianchin, A. Langella, M. Favaro, A. Gambirasi, A. Colella, G. Luca, M. Soranzo, M. de' Gennaro, P. Cappelletti *The Neapolitan Yellow Tuff: experimental investigations about effectiveness of antishrinkage treatment*

S. Lugli, S. Minghelli, P. Zannini *Barium silicate consolidation of historical sandstones*

V. Tornari & A. Moropoulou *Crack micromorphology detection in stone samples by digital holographic speckle pattern interferometry*

L. Brizi & P. Fantazzini *Internal structure of porous media studied by the apparent water self-diffusion coefficient in the field gradient of a portable single-sided NMR instrument*

N. Proietti, D. Capitani, V. Di Tullio, R. Olmi, S. Priori, C. Riminesi, A. Sansonetti, F. Tasso, E. Rosina *MOdiHMA at Sforza Castle in Milano: Innovative Techniques for Moisture Detection in Historical Masonry*

M. Rossetto *Capillary rising damp in historical buildings: electrophysical charge neutralization technology - a needful "zero impact" instrument to prevent and resolve the problem once and for all*

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A. Goppion, A. Gioria, G. Cotrufo *Museology meets conservation: Goppion display-cases with multiple microclimate*

A. Bernardi, F. Becherini, A. Vivarelli, C. Ghiretti, E. Mendez Bertolo, L. Pockel , M.D. Romero-Sanchez, N. Tellado, R. Wandsdr n Application of innovative technologies for energy storage to Cultural Heritage buildings

M. Filippi, M. Rota, P. Picchi *The accreditation process for Museums in Regione Piemonte. Preventive conservation and indoor environment monitoring*

A. Grimoldi, D. Del Curto, A. Landi, C. Manfredi, L. Valisi *From rest/cons to en/eff: indoor environment and building preservation*

L. de Santoli, C. Calice, V. Coccia, V. Fazio *Multidisciplinary approach for renewal of historical center: the case study of Ceglie Messapica (BR)*

## **Poster Session B**

F. Agnello & R. Prescia *Integrated studies for the enhancement of complex historic monuments*

W. Bagiński *Using location-related knowledge to maintain a historic residence*

V. Bayarri-Cayón et E. Castillo *New processing tools for heritage conservation and documentation*

N. Benabdelkader & M. Morandotti *The historical site of Mansourah*

R. Cacciotti et al. MONDIS *Knowledge-based system: application of semantic web technologies to built heritage*

I. Cerato et al. *From the dig to 3D reconstruction and AR dissemination. The case study of the Roman kiln of Massa (IT)*

S. Karaman et al. MNEMOSYNE: *visual profiling for personalized cultural content delivery*

G. Leucci et al. *The Foggia Cathedral: an in situ integrated geophysical and mechanical study on the wooden structures of the ceiling*

M.F. Mancini et al. *From video sequence as a database for the generation of 3D models to video as a tool for architecture communication*

S. Pallara & C. Caiulo *Energy saving for historical heritage: the domotised lighting system of the Cathedral of Nardò (Lecce - Italy)*

B. De Roo et al. *Conservation of past times: data models for ensuring the future of our heritage*

I. Rubino *Step by step: exploring heritage through a mobile augmented reality application at Palazzo Madama - Museo Civico d'Arte Antica (Turin, Italy)*

E. Sassoni & C. Mazzotti *Assessment of masonry mortar compressive strength by double punch test: the influence of mortar porosity*

G.M. Ventimiglia *Role of diagnostic surveys in the conservation of the former mother-church of Santa Margherita di Belice in Sicily: preliminary tests and restoration site checks*

S. Zambruno et al. *Photographing the past: using cloud computing and photo-modelling for 3D historical architecture modelling*

### **Day 3 - November 20th, Wednesday**

#### **Room Rogers - Conservation and management**

A. Saisi, M. Guidobaldi, C. Gentile, L. Cantini *Dynamic and seismic assessment of the Gabbia tower in Mantua, Italy*

I. Stoyanova *Promoting a Nineteenth-century Italian Technology: the Crystal Skies of the Milanese Gallery "Vittorio Emanuele II"*

G. Vella & E. Messina *Fruition and valorization of disused manufacturing settlements: the "tonnare" of the Gulf of Castellammare case-studies*

A. Sanna & G. Monni *Recovery, reuse of designs of the Carbonia's dwelling. Proposal for a "Handbook for the Recovery of Modernist Building"*

Y. Salman, Z. Önsel Atala, N.B. Yöney *A model for an integrated multi-disciplinary approach for the preservation of 20th Century and modernist architectural Heritage*

R. Lozano Galvez *The multidisciplinary in the protection of the 20th Century architectonic patrimony*

P. Dellavedova *Instruments for the preservation and promotion of the 20th century built heritage: the case study of Legnano (MI)*

D. Sarti & L. Varra *The organization of a districtal museum: the Textile Museum of Prato between the preservation of an industrial heritage and the development of a sustainable system*

E. Invernizzi & M.M. Locatelli *Central Karakorum National Park and the Northern Areas territory: the "Cultural Heritage Routes" Project*

N. Berlucchi *A fortress for Brescia: the enhancement of the Castle and the Cidneo Hill*

K. Rajangam & P. Modi *Nakshay - a community led culture mapping initiative an attempt towards best practices and successful conservation*

P. Giandebiaggi, M. Rossi, C. Tedeschi *The "survey of memory". Cultural heritage in cemeteries: development of a catalogue protocol from the "representation" of multidisciplinary*

*disciplinary researches*

P. Gasparoli & A.T. Ronchi *Crespi d'Adda. Beyond the Management Plan: regulatory instruments for the management of built heritage transformations*

M. Achenza, I. Giovagnorio, L.G.F. Cannas *The 'earthen cities' itinerary*

J. Bruin et al. *Knowledge is Power: Monitoring the World Heritage site of Amsterdam, a policy analysis*

K. Rajangam & P. Modi *Heritage information management package (himp) -technology and experience driven approach towards efficiently managing india's built heritage sites*

#### **Room IV - ICT and new technologies**

S. Hermon, F. Niccolucci, K. Yiakoupi, A. Kolosova, G. Iannone, M. Faka, P. Kyriacou, V. Niccolucci *Documenting architectonic Heritage in conflict areas. The case of Agia Marina Church, Derynia, Cyprus*

L. Guerriero, S. Barba, E. De Feo, F. Fiorillo, A. Manco *Multidisciplinary analysis: the early christian complex in Cimitile (Italy)*

G. Verdiani, A. Peruzzi, M. Gualandi *The Piacenza Cathedral, from the digital survey to a complete multimedia documentation*

N. Masini, F. Gabellone, G. Leucci, R. Persico, F. Soldovieri *Enhancement of the information content available from non invasive diagnostics for restoration and knowledge of architectural heritage*

C.F. Carocci & A. Scudero *The restoration project of the church of Saint Agata in Tusillo (AQ, Italy) within the framework of the post-earthquake reconstruction plan*

M. Dolce, E. Speranza, R. Dalla Negra, M. Zuppiroli, F. Bocchi *Constructive features and seismic vulnerability of historic centres through the rapid assessment of historic building stocks. The experience of Ferrara, Italy*

R. Fabbri *Complex monumental heritage: problems and operational programs for post seismic restoration*

A.G. Mazzeri *Mantua Ducal Palace: one year after the earthquake. From emergency management to seismic improvement and programmed maintenance*

K. Nedvěďová & R. Pergl *Cultural Heritage and floods*

F. Niccolucci, A. Felicetti, N. Amico, A. D'Andrea *Quality control in the production of 3D documentation of monuments*

G. Guidi, P. Rodríguez Navarro, S. Gonizzi Barsanti, L.L. Micoli, M. Russo *Quick textured mesh generation in Cultural Heritage digitization*

P. Ronzino, F. Niccolucci, A. D'Andrea *Built Heritage metadata schemas and the integration of architectural datasets using CIDOC-CRM*

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M. Riggio, J. Sandak, A. Sandak, I. Santoni, L. Babinski *Degradation of wooden surfaces in historical buildings: integrated sensing and modeling techniques for monitoring and conservation*

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A. Verganelaki, N. Maravelaki, V. Kilikoglou, I. Karatasios, I. Arampatzis, K. Siamos *Synthesis and characterization of a calcium oxalate-silica nano-composite for stone conservation*

G. Cappelletti, P. Fermo, A. Piazzalunga, G. Padeletti *Transparent hybrid films for stone preventive conservation*

T. Dreyfuss & J. Cassar *Ammonium oxalate treatment application in the presence of soluble salts: laboratory results on soft limestone*

M. Matteini, C. Colombo, G. Botticelli, M. Casati, C. Conti, R. Negrotti, E. Possenti, M. Realini *Ammonium phosphates to consolidate carbonatic stone materials: an inorganic mineral treatment greatly promising*

E. Sassoni & E. Franzoni *Evaluation of hydroxyapatite effects in marble consolidation and behaviour towards thermal weathering*

M. Favaro, M. Chiurato, P. Tomasin, F. Ossola, N. El Habra, I. Svensson, E. Beckers, V.J. Forrat Pérez, M.D. Romero Sánchez, A. Bernardi *Calcium and magnesium alkoxides for conservation treatment of stone and wood in built heritage*

S. Tamburini, M. Favaro, A. Magro, E. Garbin, M. Panizza, F. Nardon, M.R. Valluzzi *Geopolymers as strengthening materials for Built Heritage*

R.S. Adhikari, E. Lucchi, V. Pracchi *Historical buildings: energy performance and enhancement*

M. Legnér & A. Luciani *The historical indoor climate. A long-term approach to conservation environments within heritage buildings*

F. Romano, M. Gaudenzi, C.M. Joppolo, L.P. Romano *Temperature and humidity in museum display case: a simulation tool and experimental validation*

G. Cavaglià, M. Mangosio, I. Caltabiano, C. Curti *Intervention strategies for the energy retrofit of the built heritage: a case study in Turin*

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A. Alomari et al. *Experimental study on the role of freezing-thawing in the degradation of stones in the castle of Chambord*

P. De Berardinis et al. *Strategies for improving energy of the historic masonries of the minor centres of Abruzzo Region*

A. Bonazza et al. *Climate impact and innovative materials for the preservation of Built Heritage: the EC NANOMATCH project*

C. Conti et al. *First results on diethyl oxalate as a new product for the conservation of carbonatic substrates*

M. Coppola et al. *Analysis and conservation of ancient Egyptian gypsum-based binders and mortars from the temple of Ramesses II in Antinoe*

G. Corso et al. *Pigments and binders in Pompeian four styles wall paintings*

C. Daffara et al. *The challenge of infrared imaging of frescos: thermal quasi-reflectography unveils hidden features of artworks*

E. Galán & P. Aparicio *The environmental risk assessment applied to cultural heritage. A methodological approach*

M. Jadicicco Spignese & Z. Faravelli *Historical buildings current value*

C. Kyi et al. *Investigations into the suitability of the free radical molecule nitric oxide (NO•) in the treatment and control of biodeterioration*

E. Lombardi et al. *Strategies for increasing the scale of biocleaning treatment through sulfate crust bioremoval*

T. Meier et al. *Ultrasonic surface measurements for the investigation of superficial*

*alteration of natural stones*

A. Osman & J. Kościuk *Characterization of binding lime mortar used in the ruins of Anba Bishoi Monastery near Sohag (Egypt)*

M. Pretelli et al. *Indoor Microclimate effect on heritage buildings: the case study of Malatestiana Library*

A. Proto et al. *Ca-based absorbents for NO<sub>x</sub> measurement in atmospheric environments surrounding monumental and archeological sites*

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R. Terra et al. *Restoration of San Petronio Basilica: four year project between innovation and eco-sustainability*

D. Vandevoorde et al. *Influence of environmental conditions on water adsorption measurements performed by non-destructive in situ applicable techniques*

C. Kapridaki & N. Maravelaki *TiO<sub>2</sub>-SiO<sub>2</sub>-PDMS nano-composite with self-cleaning properties for stone protection and consolidation*

C. Zambella et al. *Environmental monitoring of the St. Gennaro and St. Gaudioso catacombs in Naples*

## **The Piacenza Cathedral, from the digital survey to a complete multimedia documentation**

*Giorgio Verdiani<sup>1</sup>; Alessandro Peruzzi<sup>2</sup>; Massimo Gualand<sup>2</sup>*

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### **1. Introduction**

The Piacenza Cathedral is a classic, solid and evident example of ancient and rich architecture, it shows the work of man in an extended timeline, with all the evolutions, the casualties, the twist of fate a building yard developed across ten centuries may encounter. According to what it is possible to see nowadays the image of this monument is composed by a various set of constructive phases, all coordinate to a wise plot of harmonization, but clearly done in different periods and with different methods. So any intervention needs to start from the knowledge of the building, from a clear recognition of the base plot behind the architecture. If the main elements show clearly the presence of multiple phases, the inner part of the buildings, the non public and non easily reachable spaces, contain even more and less clear signs of different construction layers. So it is worth to be said that if the more visible and clear parts of the cathedral are in the need of a good knowledge for correct approaches in restoration and management. Because of their meaningful appearance, the most “in deep” details and inner parts are at the same time linked to the “life” of the building in itself, while they are the base of its structural and environmental wealth. For these reasons any serious documentation process extended to the building as a whole, should only be an integral one, with the maximal coverage. So the survey work of the Piacenza Cathedral was an extended, articulated, challenging and involving operation. Being the survey of such a complex building it took time and attention to produce a correct and complete documentation, the time needed for planning and for the effective survey operation were calibrated according to the will to produce a full and judicious coverage of all the exterior and interior parts of the whole church. One of the most important decision was linked to the optimization of the entire survey work, developing a survey plan based on the logic of the “minimal effort/maximum result” that should be the base of any graphical, design and architecture procedure.

### **2. The story so far**

To understand how rich and articulated are the structures that compose the Piacenza cathedral it is useful to look back to some short notes about its main historical phases. According to the main studies about this building and about the Piacenza urban settlement the area of the actual church was the place of many transformations since the Roman period<sup>1</sup>. The first Piacenza cathedral, probably a quite simple building, was destroyed during the barbarian incursions operated by Totila in the 546 A.D..The following new church, dedicated to St. Giustina, was later damaged by an earthquake in 1117, this disaster was the occasion to start planning a new cathedral with meaningful characteristics, a building suitable to the increased needs of the renewed Piacenza. The yard started in 1122. Probably because of it was to be constructed in between

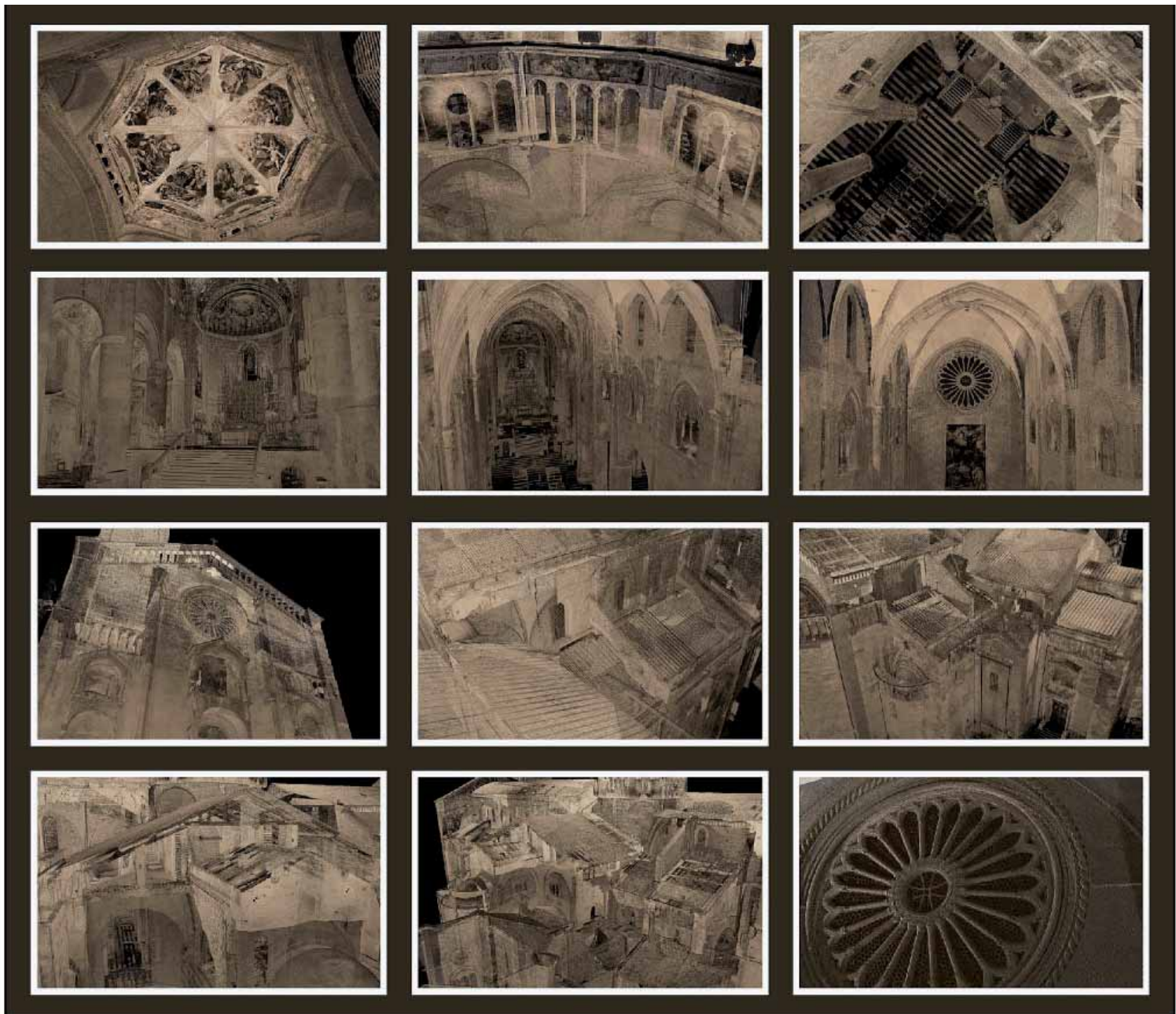
the previous building, the development of the church was planned starting from the façade; overall since the beginning there has been the choice to give the church a double level solution, with a quite large crypt dedicated to St. Giustina, characterized by the presence of 104 columns with richly decorated capitols decorated with floral and vegetal patterns. The Cathedral has a Latin cross plan, with the central nave larger and higher than the lateral ones. All of the naves are characterized by round arches supporting cross vaults with round arches in the lateral naves and point arches in the central one. The head of the cross is closed with a complex structure composed by the crypt and the triple transept dedicated to St. Maria, the space of the transept is well connected and in perfect continuity with all the other spaces. The nave crossing is surmounted by a high octagonal tambour, enriched by a gallery from which it is possible to access the outer gallery passing all along the external masonry of the tambour and accessing the attic space between the vault and its roof. The presence of a system of galleries to move and inspect the whole building is a typical feature of this kind of churches, and in Piacenza it becomes a very characteristic element because of its articulation, allowing to move continuously from the inside to the outside and to numerous remote spaces. The most active period of the ancient yard goes from the 1122 to the 1160, with the completion of the crypt, of the transept and of the lateral naves. About the completion of the cathedral there are more than one hypothesis, but probably it is possible to intend its completion before the end of the XII Century, because of the numerous intervention of enrichment happened until the second half of the XIII Century. In this way the Piacenza cathedral can be included in the same time range of other northern cathedrals, like the ones of Modena and Parma. Together with them, Piacenza gave its contribution in the definition of the "Padan Romanesque" language, with its severe and solid aspect, integrated by meaningful narration defined by statues, symbols, stone patterns and a sophisticated use of the materials. The main façade of the Piacenza cathedral is based on a quite flat surface, dominated by continuous planes, where the prominent entrances and the carved loggias gain an even more robust importance. The material used for the whole cathedral is mainly the local sandstone, with the lower part of the façade enriched using Verona's pink marble. The front of the cathedral faces the main square in the town, placed almost in one of its corner, the cathedral in itself influences the whole urban tissue and the square, originally derived from the first Roman plot, in time it received a large number of transformations, the most of them were aimed to enhance and improve the relationship with this main front. So the relationship between the urban space and the cathedral is even more important in the understanding the sense of this place. In 1333 the bell tower was completed, it has a narrow and massive structure made of bricks, with a light sequence of arches and columns opening the bell cell immediately beneath the high conic roof. The square base is founded over one of the cathedral bay, defining an evident enlargement of its walls. The conic roof is completed with a golden copper statue, representing an angel, called Angil dal Dom (the angel of the cathedral).

A curious element in this bell tower is the presence of a large cage, hanged to

the masonry almost forty meters over the ground, and realized according to the will of Ludovico il Moro to be used as a punishment for people condemned for heinous crimes.

### 3. The survey campaigns

Any good survey works has two main steps: the planning and the campaign, this obvious consideration was at the base of the Piacenza cathedral survey. The whole work was made thanks to the collaboration between the “Facoltà di Architettura” (now Dipartimento di Architettura) in Firenze and Area3D s.r.l. Livorno. The whole survey was a digitally born work, based on the use of both time of flight and phase shift 3D laser scanner technologies to allow a good, reliable, and easy to manage dataset, all the survey work was integrated by a general topographical network and by an accurate photographical documentation. The survey phases were divided in two main sessions, each session



A selection of views from aligned pointcloud of the Piacenza Cathedral  
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had a duration of seven days. In this way it was possible to have a good control on the quality of the gathered data and an optimal organization of all the operators involved in the survey. The first survey session has been conducted by six operators divided in three groups. The first group has operated using a phase shift 3D laser scanner (a Cam/2 Faro LS880), used in all the internal spaces of the church. The second group has operated using a Time of Flight 3D laser scanner (Leica ScanStation), used to cover the fronts and to operate along the roofs and from the streets around and the building surrounding the cathedral. The second survey session has been operated by five operators divided in three units. This time the 3D laser scanners were both based on phase shift technology (a Cam/2 Faro LS880 and a Cam/2 Faro Photon 120), used to complete the internal spaces and the external galleries of the church. The third unit was involved in the photographic documentation, aimed to produce highly detailed ortophotos and document all the useful reference details for the further drawing and surface model creations.

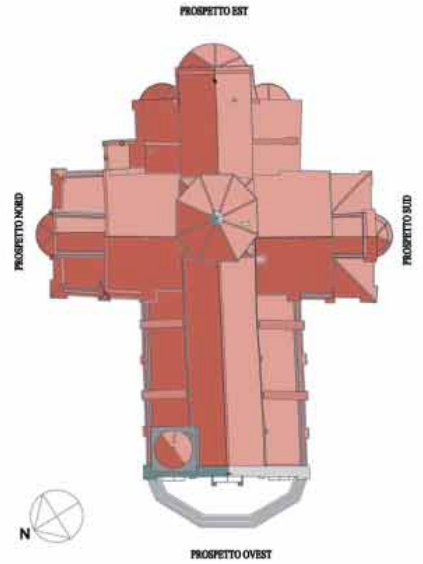
A complete topographic network was developed to allow the full integration of all the scans. The total station (Leica TCR 705) was operated by two surveyors, gathering a main network of points over all the 3D laser scanner targets and a secondary network based on the geometrical features recognized all over the cathedral, this secondary network was used as a sort of backup to resolve any later alignment issue. The overall time needed for the topographical survey was about seven days. The topographical network has covered all the external fronts, has passed by the main external galleries and was developed across the roofs and the bell tower, obviously it has crossed all the main internal spaces from the crypt to the attic, to allow a well consolidated and closed network some station points were taken from the frontal square, targeting the attic and the galleries across the openings in the main façade. With all the 3D scans aligned on the topographical network, it was easy to optimize the overall survey work, because, as it is well known, such a condition allows a well working reference system with better and faster alignment with a lower number of scanning operations and a meaningful reduction of the need for large overlapping between one scan and the following one.

To get a general idea about the extension of the surveyed building it can be useful to list its quantitative data: the total accessible floor surface is about 3.312 square meters; the accessible floor surface beneath the roofs is about 2.332 square meters; the total length of all the external galleries is about 299; the overall length of the staircases is about 240 meters; the whole building has a length of 85,66 meters from the main entrance to the external wall of the apses; its main largeness is 70,47 meters along the transept, the height of the tower bell is 67,09 meters from its attach to the ground to the statue at its top; the internal height of the main dome is 38,33 meters. The final aligned point cloud composed by the various 3D scans it's made of about 1.660 millions points, gathered from 317 scanning stations, the topographical stations operated to build the whole network are 88.

The survey work started in 2008 but the final post processing was completed in all its 2D and 3D products only in the late 2010. Overall it is worth to say that the quality and richness of the dataset can be considered as a work in



PROSPETTO CAMPANILE LATO OVEST



PLANIMETRIA DI RIFERIMENTO SCALA 1:500



PROSPETTO OVEST

The main front with photographic texture of the Piacenza Cathedral

progress and new and specific data treatments are still going on starting from the original pointclouds.

#### **4. Post processing of the Cathedral dataset**

The main task in the 2008-2010 productions was the realization of a complete 2D set of drawings, aimed to produce clear, detailed and great looking images of the state of the cathedral, with a full architectural detail about every meaningful elements. So, after the organization of the whole amount of gathered data, a long operation of data treatment started to produce more and more detailed representation of the cathedral. The first step was the alignment of all the scans according to the Topographical network. This was done using Cam/2 Faro Scene software and Gexcel 3D Reconstructor. The following processing was aimed to extract traditional drawing and the photoplan imaging combined with the vectors coming from the drawings. In this way it was possible to produce a complete and easy to use set of descriptive vector drawing in a fully compliant condition towards any CAD software. This kind of representation is referred to common and well consolidated representation standards, but it's also, for these reasons the most usable from any kind of users and the one with better change to survive data obsolescence in the long run. So the whole set of drawing was archived in DWG and PDF format, to allow a better efficiency in further preservation and dissemination of this documentation. For this same reason the pointcloud dataset was archived in the original FLS (IMP for the Leica Scanstation) format, but also exported into a PTX format and archived.

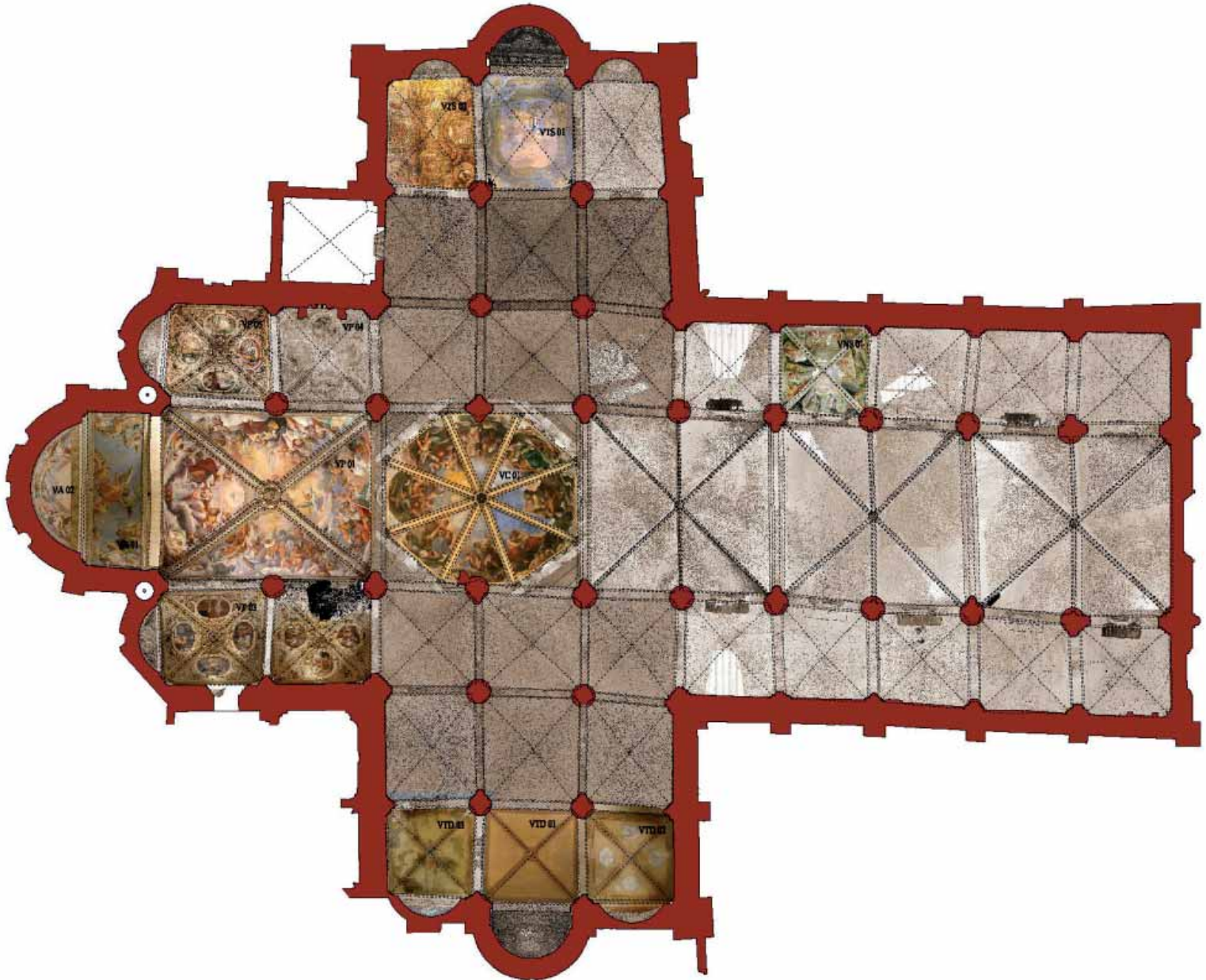
The set of 2D drawings were organized to present the whole building in all its richness, a special attention was reserved in creating drawings with full usable features for archiving the state of the cathedral and creating a correct base for any further restoration action. This set of drawings was organized in the following thematic graphic groups: One ground floor plan; one crypt plan; three plans of the attics; one plan of the roofs; twenty sections; four fronts; one upside plan view looking towards the vaults; four fronts with photographic textures applied.

To complete the documentation of the Cathedral "as it is" it was produced a set of drawings with axonometric representations of the building with transparencies and some part removed to allow an even clear reading of the whole architectonic apparatus. These kind of drawings even if they may seems more popular than technical are quite useful to better communicate the organization of the spaces.

All the drawing were realized with the target to obtain a 1:50 representation scale and all the details were calibrated to this aim. In this way all the main needs for the creation of a comparison with further drawings and about the use of these drawings as a base for any restoration purpose are satisfied.

At the same time there was the creation of a full set of 3D surface models, dedicated to develop a digital animation for multimedia dissemination of this important monument. All the models were completely textured from the data gathered in an extended and specific photographic campaign.

At the same time the 3D digital model was developed according to a logic



The plan looking towards the vaults of the Piacenza Cathedral

aimed to produce a good and versatile base, capable to be reused for further BIM usage while for certain specific parts there was the testing of innovative visualization solution, like direct pointcloud visualization inside some rendering software based on the voxelization of the points. This last solution was specifically used for the animation sequence inside the crypt, giving back a very good quality and a well convincing effect of that space.

In general the work on this large building was guided to produce a “state of the art” work, careful about the architectural language, inspired by the great survey of the past, useful for documentation, monitoring and visualization and in its own way a “summa” of all the good procedure such a Built Heritage monument is worth to deserve for a contemporary and well working documentation.

### Aknowledgements

The Survey of the Piacenza cathedral was operated in two separate campaigns, the

group participating to the first one was composed by: Massimo Gualandi, Alessandro Peruzzi, Giorgio Verdiani, Sergio di Tondo, Francesco Tioli, Elia Carli. The Second one was composed by: Alessandro Peruzzi, Giorgio Verdiani, Filiberto Gualandi, Michelangelo Tiefenthaler, Francesco Tioli and Elia Carli. The photographic survey was done by Alessandro Peruzzi, Giorgio Verdiani and Federico Piras.

The data treatments, drawing preparations, modeling and post processing were done by: Alessandro Peruzzi, Massimo Gualandi, Daniele Fedeli, Riccardo Crosara, Federico Piras, Monica Sahugon, Valerio Palandri.

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### **Notes**

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