

ARCHITECTURE HERITAGE and DESIGN

Carmine Gambardella

XVI INTERNATIONAL FORUM

Le Vie dei  
Mercanti



**WORLD HERITAGE and KNOWLEDGE**

Representation | Restoration | Redesign | Resilience

**ARCHITECTURE HERITAGE and DESIGN | 2**  
Collana fondata e diretta da Carmine Gambardella

## **ARCHITECTURE HERITAGE and DESIGN | 2**

Collana fondata e diretta da Carmine Gambardella

Scientific Committee:

**Carmine Gambardella,**

UNESCO Chair on Landscape, Cultural Heritage and Territorial Governance  
President and CEO of Benecon,  
Past-Director of the Department of Architecture and Industrial Design  
University of Studies of Campania "Luigi Vanvitelli"

**Federico Casalegno,**

Massachusetts Institute of Technology, Boston

**Massimo Giovannini,**

Professor, Università "Mediterranea", Reggio Calabria

**Bernard Haumont,**

Ecole Nationale Supérieure d'Architecture, Paris-Val de Seine

**Alaattin Kanoglu,**

Head of the Department of Architecture, İstanbul Technical University

**David Listokin,**

Professor, co-director of the Center for Urban Policy Research  
of Rutgers University / Edward J. Bloustein School of Planning and Public Policy, USA

**Paola Sartorio,**

Executive Director, The U.S.- Italy Fulbright Commission

**Elena Shlienkova,**

Professor, Professor of Architecture and Construction Institute of Samara State Technical University

**Luis Palmeiro Iglesias,**

Director UNESCO Chair Forum University and Heritage,  
Universitat Politècnica De València UPV, Spain

**Nicola Pisacane,**

Professor of Drawing – Department of Architecture and Industrial Design\_University of Studies of Campania "Luigi Vanvitelli"  
Head of the Master School of Architecture – Interior Design and for Autonomy Courses  
Department of Architecture and Industrial Design - University of Studies of Campania "Luigi Vanvitelli"

**Pasquale Argenziano,**

Professor of Drawing – Department of Architecture and Industrial Design\_University of Studies of Campania "Luigi Vanvitelli"

**Alessandra Avella,**

Professor of Drawing – Department of Architecture and Industrial Design\_University of Studies of Campania "Luigi Vanvitelli"

**Alessandro Ciabrone,**

Ph.D. in Architecture (University of Campania) and Territorial Governance (Université Paris X)  
UNESCO Vocations Patrimoine 2007-09 / FULBRIGHT Thomas Foglietta 2003-04

**Rosaria Parente,**

Professor in Architecture, construction and geodesy, EPU European Polytechnic University Sofia (Bulgary)

**Riccardo Serraglio,**

Professor in Architectural History, Department of Architecture and Industrial Design  
University of Studies of Campania "Luigi Vanvitelli"

**Danila Jacazzi,**

Professor in Architectural History, Department of Architecture and Industrial Design  
University of Studies of Campania "Luigi Vanvitelli"

**Sabina Martusciello,**

Professor in Industrial Design, Department of Architecture and Industrial Design  
University of Studies of Campania "Luigi Vanvitelli"

**Editorial Committee:**

Pasquale Argenziano

Alessandra Avella

Giovanni Bello

Alessandro Ciabrone

Maria Luigia Di Bennardo

Rosaria Parente

Nicola Pisacane

Carmine Gambardella

WORLD HERITAGE and KNOWLEDGE  
Representation, Restoration, Redesign, Resilience  
Le Vie dei Mercanti  
XVI International Forum di Studi

Editing: Giovanni Bello, Alessandro Ciabrone,  
Maria Luigia Di Bennardo

Il volume è stato inserito nella collana Architecture, Heritage and Design, fondata e diretta da Carmine Gambardella, in seguito a a peer review anonimo da parte di due membri del Comitato Scientifico.

The volume has been included in the series Architecture, Heritage and Design, founded and directed by Carmine Gambardella, after an anonymous peer-review by two members of the Scientific Committee.

©

Proprietà letteraria riservata

ISBN 978-88-492-3633-0

È assolutamente vietata la riproduzione totale o parziale di questa pubblicazione, così come la sua trasmissione sotto qualsiasi forma e con qualunque mezzo, anche attraverso fotocopie, senza l'autorizzazione scritta dell'editore.

**Carmine Gambardella**

**WORLD HERITAGE and KNOWLEDGE**  
**Representation, Restoration, Redesign, Resilience**  
Le Vie dei Mercanti \_ XVI International Forum

**WORLD HERITAGE and KNOWLEDGE  
Representation, Restoration, Redesign, Resilience**

**Le Vie dei Mercanti  
XVI International Forum**

Napoli | Capri  
14 - 15 - 16 June 2018

*President of the Forum*

**Carmine Gambardella**  
President and CEO Benecon,  
UNESCO Chair on Cultural Heritage,  
Landscape and Territorial Governance

International Scientific Committee

Components:

**Aygun Agir,**  
Professor, Department of Architecture, Istanbul Technical University, Turkey

**Ahmed Abu Al Haija,**  
Professor and Head, Environmental Design, Urban and Architectural Heritage,  
Faculty of Engineering, Philadelphia University, Jordan

**Ali Abu Ghanimeh,**  
Vice president Al al-Bayt University Almafraq – Jordan

**Pilar Garcia Almirall,**  
Professor, UPC Ecole Tecnica Superior d'Arquitectura Barcelona, Spain

**Harun Batirbaygil,**  
Head, Department of Architecture, Okan University, Istanbul, Turkey

**Artur Beu,**  
Professor, University of Art, Tirana, Albania

**Cevza Candan,**  
Professor, Istanbul Technical University, Turkey

**Federico Casalegno,**  
Professor, Massachusetts Institute of Technology, USA

**Alessandro Ciambone,**  
Benecon UNESCO Chair, UNESCO and Fulbright Former Fellow, Italy

**Joaquín Díaz,**

Professor and Dean, Technische Hochschule Mittelhessen-University of Applied Sciences, Department of Architecture and Civil Engineering, Germany

**Yurdanur Dulgeroglu,**

Professor and Head of the Department of Architecture, Istanbul Technical University, Turkey

**Yonca Erkan,**

Chairholder UNESCO Chair, Kadir Has University, Turkey

**Kutgun Eyupgiller,**

Professor, Department of Architecture, Istanbul Technical University, Turkey

**Yankel Fijalkow,**

Professor, Ecole Nationale Supérieure d'Architecture Paris Val de Seine, France

**Xavier Greffe,**

Professor and Director, Centre d'Economie de la Sorbonne Paris, France

**Manuel Roberto Guido,**

Director Enhancement of Cultural Heritage, Planning and Budget Department, Italian Ministry of Heritage and Culture, Italy

**Bernard Haumont,**

Professor, Ecole Nationale Supérieure d'Architecture Paris Val de Seine, France

**Tatiana Kirova,**

Professor, Polytechnic of Turin, Italy

**Alaattin Kanoglu,**

Professor, Istanbul Technical University, Turkey

**Ilknur Kolay,**

Professor, Department of Architecture, Istanbul Technical University, Turkey

**Mathias Kondolf,**

Professor, and Chair, Landscape Architecture and Environmental Planning, University California Berkeley, USA

**David Listokin,**

Professor, Edward J. Bloustein School of Planning and Public Policy, Rutgers University, USA

**Andrea Maliqari,**

Professor and Rector of the Polytechnic University of Tirana, Albania

**Sabina Martusciello,**

President of the Degree Course in Design and Communication, University of Campania 'Luigi Vanvitelli', Italy

**Massimo Menenti,**

Professor, Department of Geoscience and Remote Sensing, Faculty of Civil Engineering, Delft University of Technology, The Netherlands

**Rusudan Mirzikashvili,**

Ministry of Cultural Heritage, Georgia

**Doe Morelli,**

Professor, University of Campania 'Luigi Vanvitelli', Italy

**Louise Mozingo,**  
Professor, and Chair, Landscape Architecture and  
Environmental Planning, University California Berkeley, USA

**Maria Dolores Munoz,**  
Professor, UNESCO Chair, EULA Environmental Centre,  
University of Concepcion, Chile

**Florian Nepravishta,**  
Professor and Dean of the Faculty of Architecture and Urbanism,  
Polytechnic University of Tirana, Albania

**Luis Palmero Iglesias,**  
Professor, Director of the Forum UNESCO  
University and Heritage (FUUH) Programme Universitat  
Politècnica de València UPV, Spain

**Jorge Peña Díaz,**  
Professor, Facultad de Arquitectura,  
Instituto Superior Politécnico José Antonio Echeverría, Cuba

**Rosaria Parente,**  
Professor in Architecture, construction and geodesy,  
EPU European Polytechnic University Sofia (Bulgary)

**Michelangelo Russo,**  
Professor, Università di Napoli Federico II, Italy

**Paola Sartorio,**  
Executive Director, The U.S.- Italy Fulbright Commission, Italy

**Lucio Alberto Savoia,**  
Ambassador, Secretary General Emeritus,  
Italian National Commission for UNESCO, Italy

**Maria Anita Stefanelli,**  
Professor, Department of foreign languages, literature and Culture,  
Università degli studi RomaTRE, Italy

**Elena Shlienkov,**  
Professor, Professor of Architecture and Construction  
Institute of Samara State Technical University, Russia

**Eusebio Leal Spengler,**  
Professor, Historiador de la Ciudad de La Habana,  
Presidente de Honor del Comité Cubano del ICOMOS, Cuba

**Isabel Tort,**  
Professor, Universitat Politècnica de València UPV, Spain

**Andrey V. Vasilyev,** Professor and Director, Institute of Chemistry  
and Environmental Engineering,  
Togliatti State University, Russia

**Yaliang Xiang,**  
Professor, China Academy of Art, China

**Yang XiuJing,**  
Professor and Director, China Academy of Art, China



Scientific and Organizing Local Committee

**Alessandro Ciambrone**, Coordinator of the scientific program and relationships with the International Scientific Committee

**Rosaria Parente**, Scientific Assistant of the International Committee President

**Giovanni Bello, Giuliana Chierchiello, Enrico De Cenzo, Vincenzo Ferraro** Graphics and layout

**Dario Martimucci**, Web master

**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 650 authors from 36 countries:

Albania, Australia, Benin, Belgium, Bosnia and Herzegovina, Brasil, Bulgaria, California, Chile, China, Cipro, Cuba, Egypt, France, Germany, Italy, Japan, Jordan, Kosovo, Malta, Massachusetts, Michigan, Montserrat, New Jersey, New York, New Zealand, Poland, Portugal, Russia, Slovakia, Spain, Switzerland, Texas, Tunisia, Turkey, United Kingdom.

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

## Table of content

- P 12** Preface  
Carminé GAMBARDELLA
- 13** **ID 004**  
Drawings and Paradoxes: The Image and the Three Fictional Dimensions of Architecture  
Pedro António JANEIRO
- 19** **ID 006**  
Reconstruction, Addition, Grafting, Overlapping and Subtraction. Five Approaches to Intervention in Historic Contexts  
Antonello MONACO
- 23** **ID 009**  
The knowledge as an instrument for recovery and valorize the rural architecture in Sicily  
Andrea D' Amore
- 34** **ID 011**  
An evaluation on how to implement the Historic Urban Landscape (HUL) approach in a critical case study: the city of Valparaíso, Chile  
Andrea ORTEGA
- 43** **ID 012**  
From recovery manuals to historic and construction BUILDING INFORMATION MODELLING (H-BIM). Strategies for historical sicilian centres  
Tiziana CAMPISI, Daniela SIDELI
- 53** **ID 013**  
SWOT analysis for the redesign of historic university building stock  
Simone LUCENTI
- 62** **ID 014**  
Metric survey and possible representations of Historic Architectural Heritage: the case of the Santa Giustina Abbey  
Alessandro PIOVANO, Fulvio RINAUDO, Roberta SPALLONE
- 71** **ID 017**  
Research and design in the area of Early Christian basilicas in Cimitile  
Pasquale MIANO
- 81** **ID 018**  
The landscape as a testimony, or a resource for the future?  
Nadia FABRIS
- 87** **ID 019**  
The newly founded centers in the Agro Pontino: from the local to the global, from the past to the contemporary, to the future  
Alberto BUDONI, Maria MARTONE
- 97** **ID 020**  
Conversions and Resilient Materials  
Emanuele Walter ANGELICO

## Table of content

- 104 ID 021**  
Analysis of Masonry Ancient Neapolitan Helical Staircases  
Francesco FABBROCINO
- 112 ID 022**  
Recomposition of architecture in the historical city. The San Bernardino area in Padua, Italy  
Enrico PIETROGRANDE, Alessandro DALLA CANEVA
- 122 ID 023**  
Facades of Krakow's townhouses from the turn of the 19th and 20th century – protection and restoration  
Beata MAKOWSKA
- 131 ID 024**  
Sustainable rehabilitation and reconversion of Palácio da Rosa (Lisbon) in a dance school  
Sara CARVALHO, António LEITE, Jorge RIBEIRO
- 141 ID 025**  
Change of urban landscape in correlation with archaeological heritage in contemporary Serbia and knowledge  
Natasa ZIVALJEVIC-LUXOR, Nadja KURTOVIC-FOLIC, Hartmut PASTERNAK
- 153 ID 026**  
The recovery of illegal settlements: a case study  
Claudia de BIASE
- 162 ID 027**  
Piazza Medaglie d'Oro and the Vomero hill in the Società pel Risanamento's projects in Naples. 1885-1964  
Elena MANZO
- 172 ID 028**  
The cycle highway RS1 in Essen: a model of green-oriented mobility to promote urban history  
Ilaria PONTILLO
- 177 ID 031**  
A place for technology transfer and digital techniques applications for survey and representation: the ancient fort of Nagaur in Rajasthan, India  
Minakshi JAIN, Pietro MASSAI, Luca ROSSATO
- 187 ID 032**  
The Chinese house inside the ex-foreign concession in Hankou: description of Lifen  
Francesco MAGLIOCCOLA
- 197 ID 033**  
Literature as a representation of changes in urban landscapes after 1945 (on Polish, Czech and Slovak examples)  
Joanna CZAPLIŃSKA

## Table of content

- 203 ID 034**  
App and Go Edutainment for Micro\_Cities on the Sicilian Ionian Coast  
Marinella ARENA
- 212 ID 037**  
Traditional Knowledge of Disaster-Resilient Design in World Cultural Heritage, Japan - For Consisting Cultural Conservation and Disaster Mitigation -  
Takeyuki OKUBO
- 220 ID 039**  
Geo-climatic applicability of sunspaces in European climates including resilience to climate changes  
Giacomo CHIESA
- 229 ID 040**  
Design of indoor climate-control passive systems in buildings: experiences for a PhD course  
Giacomo CHIESA, Mario GROSSO, Mehrnoosh AHMADI, Matteo BO, Giovanni MURANO, Marianna NIGRA, Elisa PRIMO
- 239 ID 041**  
The Sanctuary of Castel Petroso: reflections on architectural representation  
Piero BARLOZZINI, Fabio LANFRANCHI
- 247 ID 042**  
Abandoned Railways and Cultural Heritage. Networks for spread regeneration  
Francesca CASTAGNETO, Stefania DE MEDICI
- 257 ID 044**  
Innovative instruments of territorial environmental management: the need for a regulatory approach  
Michele RUSSO
- 263 ID 045**  
The Redesign of Boundary between River and Ground. A Technological-Environmental Approach for the Resilience of River Corridors and Health of Inhabitants  
Michele DI SIVO, Filippo ANGELUCCI, Cristiana CELLUCCI, Daniela LA-DIANA
- 272 ID 046**  
To save from oblivion and destruction. A historical-juridical perspective on the cultural heritage's protection  
Maria NATALE
- 280 ID 047**  
Structural morphology of the oldest Church in Capocastello (AV)  
Ingrid TITOMANLIO

## Table of content

- 288 ID 048**  
Seismic safety evaluation and push over analysis of the oldest church in Capocastello (AV)  
Ingrid TITOMANLIO, Giuseppe FAELLA, Vito IANNACCONE
- 297 ID 049**  
Ancient roads of Southern Etruria: historical evolution and digital investigation  
Michele MAGAZZU'
- 304 ID 050**  
PCM in the energy redevelopment of social housing  
Frida BAZZOCCHI, Vincenzo DI NASO, Ilaria TORTORELLA
- 314 ID 051**  
The Visibility of the Monumental Heritage and the Network Society  
Matteo Giuseppe ROMANATO
- 323 ID 052**  
Ziride and Hammadite palatial architecture and its influence on Norman architecture in Sicily  
Lamia HADDA
- 333 ID 054**  
A spatial multi-criteria analysis model to identify intervention strategies for the recovery of abandoned olive groves. The case study of Lucca Hills  
Simona BONELLI, Massimo ROVAI, Maria ANDREOLI
- 343 ID 055**  
Landscape redevelopment as a tool for the enhancement of rural areas. A project proposal for the case study area of Padule di Bientina (Lucca – Italy)  
Silvia MICHELOTTI, Massimo ROVAI, Maria ANDREOLI
- 353 ID 056**  
The reconstruction of an Image. The experiences of Quaroni and Piacentini in Basilicata  
Antonio BIXIO, Giuseppe DAMONE, Enza TOLLA
- 361 ID 057**  
The aggregation of the building elements in horizontal structures  
Francesco Pio ARCELLA
- 368 ID 058**  
New trends in local government policies: between the need for reducing land consumption and participatory urban regeneration models  
Marco CALABRO'

## Table of content

- 376 ID 059**  
The main pillars reconstruction of the Basilica di Collemaggio  
Alberto FRANCHI, Pietro CRESPI, Marco ZUCCA, Nicola GIORDANO, Nicola LONGARINI
- 383 ID 060**  
The Promotion of the cultural heritage: brand new challenge, same old problems  
Antonio LIGUORI
- 389 ID 061**  
The earthen architecture culture and Campidanese house. Strategies for recovery and enhancement of the Quartu Sant'Elena's Old Town Centre  
Alessandra PUSCEDDU, Mario CERASOLI
- 399 ID 062**  
Sicilian rural borghi, urban and architectural entities between concreteness and immateriality  
Alberto GNAVI, Silvia Maria RIPA
- 409 ID 064**  
The built heritage copied and replicated. Reproduction processes of the urban heritage: transcription, restitution and displacement  
Giuliana QUATTRONE
- 417 ID 065**  
The built heritage copied and replicated. Reproduction processes of the urban heritage: transcription, restitution and displacement  
José Miguel SILVA
- 427 ID 068**  
The role of Italian cultural heritage in sustainable urban regeneration. New references from four case studies  
Francesca ACCICA, Irene POLI, Chiara RAVAGNAN, Francesca ROSSI
- 436 ID 069**  
Smart Heritage Strategy: a new intelligence for resilient historical centers  
Chiara AMATO, Giulia BEVILACQUA, Silvia URAS
- 446 ID 070**  
An inclusive approach to Digital Heritage for knowledge and conservation of European assets: the INCEPTION project  
Federica MAIETTI, Federico FERRARI, Marco MEDICI
- 456 ID 071**  
"The commercial relations between Great Britain and the Kingdom of the Two Sicilies in the XIX Century"  
Vincenzo PINTAUDI

## Table of content

- 467 ID 072**  
“The Value of Social Media for Reconstructing Lost Heritage in the British Overseas Territory of Montserrat, Site of an Ongoing Volcanic Crisis.”  
Gracelyn CASSELL
- 477 ID 073**  
Architecturale experiences in the churches of the foundation centers of the “Opera Nazionale per i Combattenti”  
Riccardo SERRAGLIO
- 487 ID 074**  
Functional behaviours in the requalification of public residential buildings  
Carla CHIARANTONI
- 495 ID 076**  
Observing urban landscapes. View-points for the representation of contemporary city  
Antonella SALUCCI, Niccolò SARDO, Marta MAGAGNINI
- 505 ID 077**  
The Design to valorise local tradition in exhibitions for future generation  
Laura GIRALDI, Isabella PATTI
- 512 ID 080**  
Made in stone  
Agnieszka KOSIK WOLNY
- 521 ID 083**  
Integrating governance of the National Reserve of Coyhaique, Chile, into regional sustainable development  
Theresa TRIBALDOS, Stephan RIST
- 529 ID 084**  
Increasing resilience of Cultural Heritage Assets: the “BIMtoBAcademy” project  
Marcello BALZANI, Fabiana RACO, Theo ZAFFAGNINI
- 535 ID 085**  
Enjoyment of the Cuban Contemporary Architectural Heritage: an innovative cultural visitor route to connect the UNESCO site of Old Havana to the National Schools of Art  
Cristina COSCIA, Rocco CURTO, Valeria GADALETA, Jorge PEÑA DÍAZ, Diana ROLANDO
- 545 ID 086**  
Applying Resilience Thinking for the Cultural Landscape of the inner areas: new tools of knowledge and adaptive management  
Maria Rita PINTO, Katia FABBRICATTI, Lucie BOISSENIN



## Table of content

- 555 ID 087**  
The complex dialogue between contemporary language and preservation of the ruins in the restoration of Paul II's fortress at Cascia  
Stefano D'AVINO
- 563 ID 088**  
Landscape analysis of railway structures in heritage assessment: Bridges on the Victoria-Temuco railway line  
Ignacio BISBAL GRANDAL, Françoise Anais LOUBIÈS, Nicolás Andrés MORAGA HERRERA
- 573 ID 090**  
Architectural Representation: a Tool for Urban Regeneration The Colour Plan of Egadi Islands  
Angela Alessandra BADAMI
- 583 ID 091**  
From the traditional to the virtual museum: a strategic cultural, social, environmental and economic resource for Europe  
Cristiana CARLETTI
- 594 ID 092**  
Wedge-shaped bricks spires and domes. Construction and decorative aspects  
Francesco DI PAOLA, Giovanni FATTA, Calogero VINCI
- 606 ID 093**  
Pottery from the south-west area of the Castle of the Monte in Montella: the decorative repertoire  
Iolanda DONNARUMMA, Gaetana LIUZZI
- 617 ID 097**  
Principles of cultural landscape Restoration  
Sara POURYOUSEFZADEH
- 626 ID 098**  
The representation of complex systems. New communication strategies  
Maria Elisabetta RUGGIERO
- 633 ID 100**  
How the historical heritage affects the urban flow of people? The case study of Lecco  
Mattia ALBERGANTI, Chiara BONAITI
- 642 ID 101**  
The tomb of Henenu, Luxor, Egypt: underground surveying  
Ernesto ECHEVERRÍA, Flavio CELIS, Antonio MORALES, Fernando da CASA

## Table of content

- 651 ID 102**  
The preservation of the architectural heritage of the twentieth century: the laminar structures of reinforced concrete  
Monica MARTINEZ, Ernesto ECHEVERRIA, Gonzalo GARCIA-ROSALLES, Kevin MORENO
- 659 ID 104**  
Decline and Resilience of a Mediterranean City: the Case of Syracuse during Thirteenth Centuries  
Elina GUGLIUZZO
- 665 ID 105**  
The Sanctuary of Santa Maria delle Grazie at Fornò: studies for the restoration and seismic strengthening  
Alberto CUSTODI, Nicola SANTOPUOLI
- 675 ID 106**  
Urban design and sprawled archaeology. From the “ancient vs new” dichotomy to pre-existence as design material  
Raffaele SPERA
- 684 ID 107**  
Material and immaterial heritage as a strategic resource facing structural shifts: the case of the Fès-Meknès region (Morocco)  
Letizia DI PASQUALE, Maria Rita GISOTTI
- 694 ID 109**  
Derna: a gateway of Libya. The ethical value of identity and the vision for the birth of a new urbanity  
Calogero MONTALBANO
- 704 ID 110**  
“...But what use is this art history?”  
Anna MANDIA
- 709 ID 111**  
The representation for the use of hidden heritage: the case of Genoese artificial caves  
Massimo MALAGUGINI
- 719 ID 112**  
The color of the city. Restoration and conservation of the painted facades of Palazzo Boschetti-Dalanzo then Avagnina in Carrù  
Maria Paola MARABOTTO
- 728 ID 113**  
A Resilient Environmental and Social Design Strategy  
Francesca MUZZILLO, Fosca TORTORELLI

## Table of content

- 732 ID 115**  
Natural disaster and environmental risks. Facts, needs and challenges in Italy  
Benedetto DE VIVO
- 738 ID 116**  
Ductility-based incremental analysis of masonry structures strengthened with composites  
Giancarlo RAMAGLIA, Francesco FABBROCINO, Gian Piero LIGNOLA, Andrea PROTA, Gaetano MANFREDI
- 747 ID 117**  
The technology of reinforced concrete elements.Determination of project parameter: concrete cover  
Roberto CASTELLUCCIO, Maria INFANTE, Veronica VITIELLO
- 757 ID 118**  
The “Cartilla de mantenimiento” as a tool for the protection and maintenance of the earthen architectural heritage in Tunja, Colombia  
Elena ZANET, Francesca DE FILIPPI
- 767 ID 119**  
The Deception of Colour: Digital Reconstruction of finctae et pictae Architectures  
Gabriella LIVA
- 776 ID 120**  
The role of overstrength in damage propagation and monitoring of architectural heritage  
Bernardino CHIAIA, Antonio VENTURA
- 783 ID 121**  
ICTs to train on World Heritage and Tourism: the case of “Tourism Management at UNESCO World Heritage Sites” MOOC  
Ilaria ROSANI, Silvia DE ASCANIIS, Maria GRAVARI-BARBAS, Lorenzo CANTONI
- 792 ID 122**  
Local identities & excellences. An industrial network to re-produce uniqueness through waste reutilization  
Elisabetta BENELLI, Laura GIRALDI, Francesca FILIPPI, Jurji FILIERI
- 799 ID 123**  
Sinkhole hazard in the metropolitan area of Naples,Italy  
Anna SCOTTO DI SANTOLO, Melania DE FALCO, Giovanni FORTE, Antonio SANTO
- 807 ID 124**  
A requalification project hypothesis for the Bagnoli/Agnano (Naples, ITALY) ex NATO Headquarter Area  
Mariateresa RUGGIERO

## Table of content

- 816 ID 125**  
Strategy to re-active an urban landscape  
Valeria SCAVONE
- 823 ID 128**  
Two outstanding examples of vernacular architecture in Talas town, Anatolia  
Duygu TURGUT
- 831 ID 129**  
Paul Bellot architecture: between resilience and redesign of “sacrum”  
Maria Carolina CAMPONE
- 841 ID 133**  
Greek Orthodox merchants in Western Mediterranean sea: commercial and canonical matters  
Antonio MATASSO
- 845 ID 134**  
Protection and Integration of linear watercourse cultural landscape in urban development ----- A case study of Orléans and Yangzhou  
Liang PENG
- 857 ID 136**  
Russian approaches to estimation and experience of monitoring of radon radiation  
Andrey V. VASILYEV
- 862 ID 137**  
Approaches and results of estimation of noise impact to the health of population  
Andrey V. VASILYEV
- 870 ID 138**  
Automobile transport noise modeling and estimation in town conditions  
Andrey V. VASILYEV
- 875 ID 139**  
Majolica and Architecture. Treatment of the lacune. The case of the bell tower of San Paolo Bel Sito  
Saverio CARILLO
- 885 ID 140**  
The historical context and the urban regeneration  
Federica CAPRIOLO

## Table of content

- 894 ID 141**  
Typological classification of vaulted structures in masonry churches  
Daniela CACACE, Gianfranco DE MATTEIS
- 904 ID 142**  
Innovative systems for the redevelopment of historical buildings: BIM application  
Simona COLAJANNI, Giusy Emanuela LO CACCIATO, Achille Roberto PORCASI
- 914 ID 143**  
Evaluation of the indoor comfort of the Arabic-Norman architecture for its valorization  
Simona COLAJANNI
- 922 ID 144**  
Structural behaviour of masonry vaults according to architectural types  
Gianfranco DE MATTEIS, Daniela CACACE
- 932 ID 145**  
Design with Nature: The connection between Critical Regionalism and Biomimicry in a Moroccan village  
Pedro MARTINS-MOURÃO, Pedro JANUÁRIO
- 942 ID 146**  
Preservation of historic buildings: two examples in Sant'Agata de' Goti, Italy  
Annachiara PIRO, Annalaura VUOTO, Filomena de SILVA, Pierpaolo D'AGOSTINO, Fulvio PARISI, Francesco SILVESTRI, Anna SCOTTO di SANTOLO
- 952 ID 147**  
Sports Architecture: the soccer stadiums of the twentieth century in Brazil and Portugal  
Beatriz ATTA, Pedro JANUÁRIO, Jorge BOUERI, João SOUSA MORAIS
- 960 ID 148**  
Data taking and quality control for complex surveys: Case study Sagrada Família  
Juan CORSO, Jordi CASALS, Adria MARCO, Daniel LÓPEZ, Pilar GARCIA ALMIRALL
- 971 ID 151**  
Territory visions: dimensions of observing, measuring and returning  
Laura FARRONI, Marco CANCIANI, Matteo Flavio MANCINI, Silvia RINALDUZZI
- 981 ID 153**  
Reuse or Recycle?  
Ludovico ROMAGNI

## Table of content

- 989 ID 159**  
Survey between protection and orientation of transformations. The case study of Florida  
Rita VALENTI, Claudia FARACI, Sebastiano GIULIANO, Emanuela PATERNO, Flavio SPADARO
- 998 ID 160**  
Public Buildings accessibility in Fortaleza's Historical Center  
Camila BANDEIRA PINHEIRO LANDIM, Pedro Miguel GOMES JANUÁRIO, Márcia Maria VIEIRA HAZIN, Geórgia MORAIS JEREISSATI
- 1009 ID 161**  
The museum building and its role in conservation of artifacts in Albania  
Etleva BUSHATI, Florian NEPRAVISHATA
- 1019 ID 162**  
The use of new technologies in the commemoration projects of the centenary of the apparitions of Fatima  
Geórgia MORAIS JEREISSATI, Pedro Miguel GOMES JANUÁRIO, Márcia Maria VIEIRA HAZIN, Camila BANDEIRA PINHEIRO LANDIM
- 1029 ID 163**  
The implementation of the Smart City paradigm in complex and user-centric domains  
Mariacarla PANARIELLO
- 1037 ID 164**  
Traditional games and culture  
Antinea AMBRETTI
- 1041 ID 165**  
The "Right" to the quality of the "Preservation" for Italian architecture of the Second half of the 20th century  
Carla BARTOLOZZI, Gentucca CANELLA
- 1051 ID 167**  
Design 4.0. Practices and processes of diffuse and circular design for the enhancement and development of local cultural heritage  
Jurji FILIERI, Elisabetta BENELLI, Laura GIRALDI
- 1060 ID 171**  
Historic urban centers. Construction characters and seismic vulnerability  
Tiziana CAMPISI
- 1070 ID 172**  
Internet of things and artificial intelligence technologies preserve cultural heritage  
Marin MARINOV, Maria KOKORSKA

## Table of content

- 1078 ID 175**  
Italian grain silos from the 1930s: inventory, knowledge, conservation and reuse  
Stefania LANDI
- 1088 ID 178**  
Destructive tests for mechanical characterization of in situ structural timber  
Francesco GUARINO, Alberto MANDARA, Gianfranco DE MATTEIS
- 1098 ID 179**  
Correlation between NDT results and mechanical strength of structural timber  
Gianfranco DE MATTEIS, Francesco GUARINO, Alberto MANDARA
- 1108 ID 180**  
From information to knowledge Building new learning strategies in heritage field through graphics and new technologies  
Marina PUYUELO, Pedro FUENTES, Mónica VAL
- 1118 ID 183**  
Three Schools: Torino, Avellino, Palermo  
Efisio PITZALIS
- 1128 ID 184**  
Mediterranean Bio-Cultural Landscape: network of expertise  
Marina FUMO, Gigliola AUSIELLO, Monica CANNAVIELLO, Antonella VIOLANO
- 1138 ID 185**  
Virtual community content sharing to support decision making process in protection, conservation and promotion of cultural heritage and landscape  
Antonio TUFANO, Roberto VALENTE, Modestino MATARAZZO, Enza GRAZIANO
- 1148 ID 186**  
Design 4.0. Practices and processes of diffuse and circular design for the enhancement and development of local cultural heritage  
Caterina GATTUSO
- 1155 ID 187**  
Hidden river: recovering the memory of a city  
Maria Grazia CIANCI, Francesca Paola MONDELLI
- 1165 ID 188**  
The role of evaluation in B.I.M. models: from the representation to the simulation of the design  
Giovanna ACAMPA, Fabiana FORTE

## Table of content

- 1172 ID 189**  
Adaptive and dynamic facade: a new challenge for the built environment  
Sergio SIBILIO, Roberta IAVARONE, Simona MASTANTUONO, Maria MANTOVA, Luigi D'AUSILIO
- 1183 ID 190**  
Preliminary energy analysis of the school building stock in the Province of Caserta  
Sergio SIBILIO, Nicolò FALCIONE, Anna IMPROTA, Antonio ROSATO
- 1191 ID 193**  
Post-seismic rebuilding in Irpinia and resilience  
Maria Antonietta FALCI
- 1201 ID 194**  
A simplified analysis for seismic risk assessment of reinforced concrete school buildings  
Gianfranco DE MATTEIS, Pasquale BENCIVENGA, Francesco GUARINO, Carmela NOLA
- 1210 ID 196**  
The Mudéjar Style: An interpretation key of the Ibero-American Baroque architecture  
María Fernanda GARCÍA MARINO
- 1220 ID 197**  
The rediscovery and enhancement of the historical "Wool Road" through its recognition and reuse project  
Paola CONDOLEO, Andrea ROLANDO, Daniela ORENI, Alessandro SCANDIFFIO
- 1230 ID 198**  
Sewell mining settlement: Construction of a unique landscape as an adaptive process to a complex and hostile territory  
María Dolores MUÑOZ, Ignacio BISBAL
- 1240 ID 200**  
REDESIGN + RESILIENCE= Stories of Alternation  
Maria Dolores MORELLI
- 1247 ID 201**  
A resilient pedagogy. The LANDesign® Project for "school-work alternation"  
Enrica PAGANO
- 1256 ID 202**  
Know to preserve: Archaeological remains of the triconch architectures in Turkey  
Danila JACAZZI, Raffaella FIORILLO



## Table of content

- 1264 ID 203**  
Green infrastructures and Eco-Planning: the Aversa conurbation  
Salvatore LOSCO
- 1274 ID 204**  
A New Role of Museums in Industrial Type Cities and Renovation Programs for the “Center-Periphery” Opposition: the Case of the Museum Quarter Togliatti Concept  
Elena SHLIENKOVA, Elena SPERK
- 1285 ID 205**  
Documenting the Architectural Heritage. From the survey to the three-dimensional modelling  
Pamela MAIEZZA
- 1293 ID 206**  
The connection between the Architectural Roman heritage and the Theory of Nodes as a management tool  
Isabel TORT AUSINA
- 1302 ID 207**  
Productive green in the city: opportunities for eco-oriented transformations  
Raffaella DE MARTINO, Barbara DI VICO, Rossella FRANCHINO, Caterina FRETTOLOSO
- 1313 ID 208**  
Aldo Rossi: Berlin, 1960-1997  
Maria Luigia DI BENNARDO
- 1322 ID 211**  
The Real Estate Fund for the redevelopment of Public Administration Properties  
Francesco VERDE
- 1331 ID 212**  
Complex Representation of Knowledge  
Gilda EMANUELE
- 1335 ID 226**  
Designing the resilience. A masterplan for the Opportunity Areas of Bromley  
Giovanni BELLO
- 1341 ID 230**  
The evolution of information disclosure through the Open Institutes  
Luciana ABATE

## Table of content

- 1351 ID 231**  
Knowledge and representation between ethics and aesthetics  
Rosaria PARENTE
- 1361 ID 232**  
The Future of Representation: parametric modeling in the HBim environment  
Giuliana CHIERCHIELLO
- 1371 ID 270**  
Representing World Heritage properties, cultural landscapes and contemporary architectures: Amsterdam and Rotterdam  
Alessandro CIAMBRONE
- 1382 ID 271**  
Itineraries of urban identity  
Isabella PATTI



Le Vie dei  
Mercanti

XVI INTERNATIONAL FORUM

WORLD HERITAGE and KNOWLEDGE

Representation | Restoration | Redesign | Resilience

Naples 14 - Capri 15|16 June 2018

## An inclusive approach to Digital Heritage for knowledge and conservation of European assets: the INCEPTION project

Federica MAIETTI<sup>1</sup>, Federico FERRARI<sup>1</sup>, Marco MEDICI<sup>1</sup>

<sup>(1)</sup> Department of Architecture, University of Ferrara, Italy

federica.maietti@unife.it - federico.ferrari@unife.it - marco.medici@unife.it

### Abstract

One of the main challenges to be faced at European level is to contribute to an understanding of cultural identity. In this direction, new technologies and digital cultural heritage should play an innovative role, enhancing heritage accessibility for as many people as possible by using ICT functionalities and applications. Nevertheless, we are witnessing to a more and more growing dichotomy between engaging user experiences and the enrichment of the scientific knowledge. Within this framework, the EU funded project “INCEPTION - Inclusive Cultural Heritage in Europe through 3D Semantic Modelling” is consistently aligned by accomplishing the main objectives of accessing, understanding and strengthening European cultural heritage by means of enriched 3D models where semantic attributes are linked to geometric models for management of heritage information.

The interdisciplinary and user-centred project aims at developing an innovative approach for creating interoperable 3D semantic models in H-BIM environment to be collected and shared on the INCEPTION Platform for visualization, management, deployment and valorisation of heritage buildings and sites. Advanced 3D documentation methodologies identifying different “layers” of data to be surveyed and managed, and semantic ontology and data structure for information catalogue allow accomplishing the main objectives of knowledge, protection, conservation, monitoring and safeguarding of assets, respecting values of the pre-existing.

**Keywords:** Conservation, Digital Heritage, 3D data capturing, 3D semantic modelling, Inclusiveness

### 1. Introduction

One of the main challenges to be faced at European level is to contribute to an understanding of Europe's culture and intellectual basis. In these efforts, new technologies and digital cultural heritage should play an important innovative role. New and innovative technologies are a great opportunity to understand access, enhance and preserve cultural heritage. Information and Communication Technologies (ICT) are constantly evolving and new digital media are increasingly used for accessing and understanding cultural heritage.

The enhancement of digital cultural heritage accessibility is the ability to access cultural contents and resources for as many people as possible by using ICT functionalities and applications (websites, databases, digital libraries, virtual applications, etc.) overcoming cultural, environmental and management barriers for an easy and spread fruition. Nowadays it is possible to integrate different information in order to access cultural assets in many different ways and for many different purposes, thanks to new languages of interactive media aimed at innovative ways of communication of cultural heritage.

Beyond the application of ICT for management, research, diagnosis, conservation and restoration procedures, education and enhancement, new technologies allow the communication and dissemination of cultural assets that become more and more accessible for new knowledge and experiences; through digital technologies broad categories of users have access to tangible and intangible cultural assets. The availability of databases collecting different information allows achieving the widest accessibility and interoperability at a multidisciplinary level.

New applications allow accessing sites and objects from the heritage site, or such as in labs, museums, classrooms, or even in personal homes or offices. Users have more and more interactive possibilities to access the knowledge about different sites and objects, to exchange the knowledge between each other, and to enrich the knowledge with their findings and complementary insights by means of interactive platforms and social media. The development of data capturing technologies and graphics features has maximized the enhancement of digital contents for virtual tour applications, serious games and many different immersive and interactive experiences that enable a sustainable access and enjoyment of heritage sites even by young generations.

As part of 3D integrated survey applied to Cultural Heritage, digital documentation is gradually emerging as effective informative support in addition to the shape, morphology and dimensional data [1]. The implementation of data collection processes and the development of semantically enriched 3D models is an effective way to enhance the dialogue between ICT technologies, different Cultural Heritage experts, users and different disciplines, both social and technical.

Innovative strategies in heritage documentation can be achieved through the implementation of effective data collection processes and the development of semantically enriched 3D models.

The increasing development of 3D laser scanner technologies allows creating high definition databases based on even more detailed three-dimensional morphometric data. These “digital archives” are an extremely valuable research tool in cultural heritage field: the “geometric memory” is essential for knowledge, protection and sustainable conservation of Cultural Heritage, although there are still some limits to the exploitation of 3D models obtained by laser scanner survey. The growing numbers of un-exploited and “un-interpreted” 3D models points out the remarkable need for innovative methods that could benefit from the informative value provided by new systems for surveying and representations as well as data management tools.

In this direction, advanced technologies and digital data are becoming increasingly significant in helping and supporting research, knowledge and activities related to conservation and enhancement of Cultural Heritage. The use of new technologies allows great advances not only for the surveying and representation of the built heritage during analysis phase but also for the management of the resulting data to be used for conservation and restoration procedures in a single process no longer divided into steps but unified into an overall digital model / database [2] for intermediate checks, testing, monitoring, maintenance, implementation, etc.

In this framework, this paper will present methodologies developed under the EU funded project “INCEPTION - Inclusive Cultural Heritage in Europe through 3D Semantic Modelling” focused on new avenues for accessing, understanding and strengthening European cultural heritage by means of enriched 3D models where semantic attributes can be effectively helpful in the protection, conservation and safeguarding of cultural heritage and landscape, respecting the values of the pre-existing.

## **2. Overall framework**

The possibility to achieve interoperable models able to enrich the interdisciplinary knowledge of European cultural identity is one of the main outcomes of “INCEPTION - Inclusive Cultural Heritage in Europe through 3D Semantic Modelling”, funded by European Commission within the Programme Horizon 2020 (Work Programme “Europe in a changing world – inclusive, innovative and reflective Societies”, Call - *Reflective Societies: Cultural Heritage and European Identities*, Reflective-7-2014, *Advanced 3D modelling for accessing and understanding European cultural assets*).

INCEPTION project methodology is based on five main steps. The first one is focused on an effective, cross-disciplinary and collaborative work among partners, allowing to define the data collection process, stakeholders’ requirements and case studies setup. The second one is related to the setting up of an integrated and optimized 3D data capturing procedure, and the third step is aimed at the integration of semantic attributes to the 3D digital geometric models in order to manage effectively heritage information. The development of an interoperable Semantic Web H-BIM Platform is the fourth step, preliminary to the deployment and valorisation of 3D models, enabling a wide and easy access to the data by citizens, non-expert users and public at large [3].

Therefore, the overall project workflow is developed starting from requirements (what kind of data, information and visualization issues can be collected and managed by a 3D model according to specific users and needs), the integrated data capturing and holistic heritage documentation, the semantic enrichment via 3D modelling in H-BIM environment, and the models deployment and enhancement through the INCEPTION platform.

At the end of the third year of activity, the project is facing different challenging actions aimed at models’ deployment and widespread sharing, starting from a methodological and technical advancement in 3D data capturing and holistic digital documentation.

This paper will present the inclusive approach to digital heritage for knowledge and conservation of Cultural Heritage, developed under INCEPTION, starting from the meaning of integrated 3D survey within the wider framework of the “holistic digital documentation” (including all relevant data – in

addition to geometries and dimensions – according to the purpose of the data capturing), up to the approach to the semantic modelling, focusing on heritage buildings and sites. The 3D modelling in H-BIM environment and the development of the platform for deployment and valorisation of enriched 3D models will allow accomplishing the main objectives of accessing, understanding and strengthening European Cultural Heritage. According to the overall INCEPTION workflow, the H-BIM modelling procedure starts with documenting user needs, including experts and non-experts [4]. The identification of the Cultural Heritage buildings semantic ontology and data structure for information catalogue will allow the integration of semantic attributes with hierarchically and mutually aggregated 3D digital geometric models for management of heritage information.

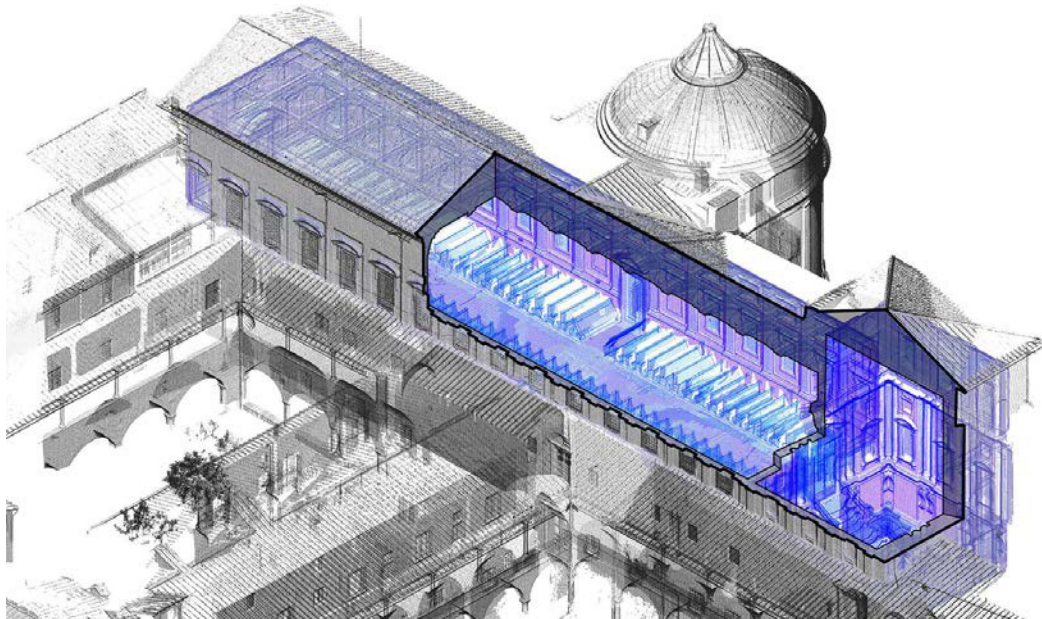
### 3. Integrated 3D survey and holistic digital documentation

Integrated digital documentation under INCEPTION is carried out through a holistic approach: holistic documentation needs to cover assets of critical information regarding a monument's main attributes and characteristics, able to define it as a whole and to identify its significance and main needs.

The overall interdisciplinary approach is aimed to include documentation, analysis and management of all the different data, in order to meet visualization, protection and preservation issues, involving all the aspects of digital content management, representation and reproduction.

Through the 3D digitization of a monument, various aspects of recording concerning diagnostics (building material and decay patterns), construction durability and architectural documentation, new digital content management may be achieved.

Methods and processes for data collection are continuously developing and today are characterized by an effective interdisciplinary. Skills on 3D laser scanner survey, diagnostic procedures and historical research, as well as about environmental condition assessment or management of metric and dimensional data support the vision of integrated digital documentation for cultural heritage assessment [5]. The inclusive approach to digital documentation is focused on the 3D data capturing and modelling of heritage buildings and sites, through the digital representation of the shape, appearance and conservation condition, in addition to a set of semantic information able to enrich research and deployment applications [6].



**Fig. 1:** Laurentiana Library, Florence, by Michelangelo, an example of complex architectural “geometry” to be detected.

3D laser scanner technologies allow creating high definition databases based on even more detailed three-dimensional morphometric data. These “digital archives” are an extremely valuable research tool in cultural heritage field: the so-called “geometric memory” is essential for knowledge, understanding, protection and sustainable conservation of Cultural Heritage. Starting from “geometric memory” it is possible to extract not only geometric features but also many different data for the enhancement of documentation and information for conservation, diagnostics, monitoring and restoration project, and for heritage promotion and exploitation.



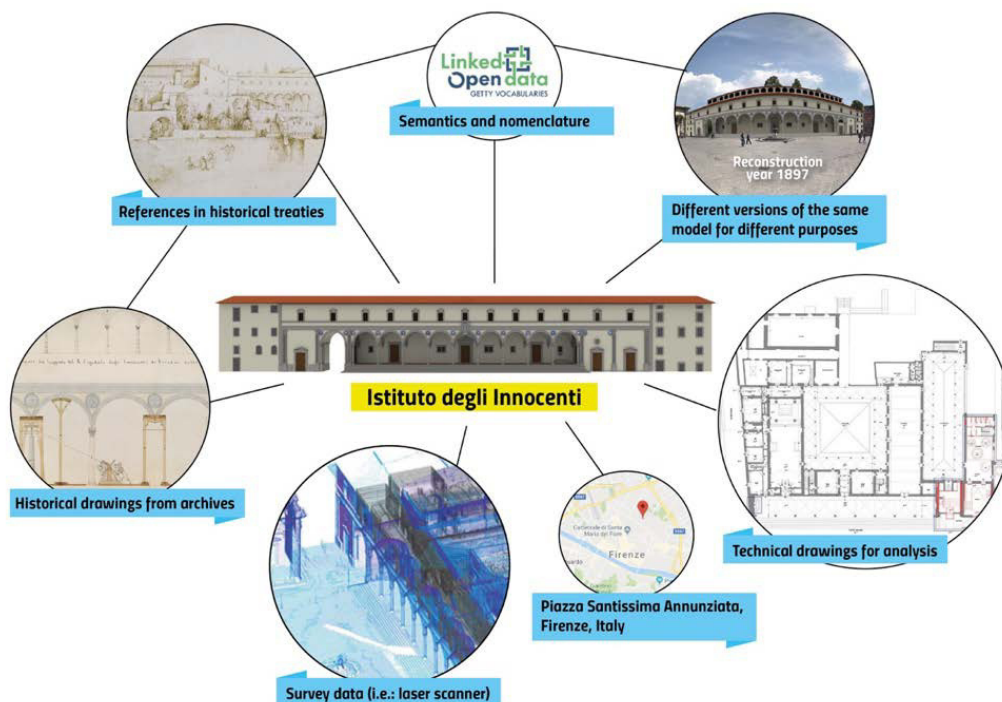
This is the main direction toward INCEPTION is moving: setting up a methodology able to break through the barriers caused by segmentation in collecting documentation data by establishing a common framework through 3D documentation of Cultural Heritage buildings and sites. From one side, applications under development allow accessing digital information both from the heritage sites (via mobile devices) and off-site (offices, research labs, museums, etc.) in order to improve access and knowledge possibilities, thanks to interactive experiences and improved digital contents. On the other hand, enriched 3D digital models available in an open-standard format can be easily accessible and reusable by researchers, scientists, experts, curators, and professionals in different cultural heritage fields, facilitating cross-disciplinary research, dissemination, education and business opportunities.

#### 4. H-BIM modelling and semantic enrichment

Semantic 3D reconstruction of heritage buildings and sites supposes an interdisciplinary approach based on the collaboration of various experts from different disciplines towards the development of 3D models integrating semantic data. If 3D data can be captured following a more commonly shared procedure (set up, within INCEPTION, by the Data Acquisition Protocol), terminology and interpretation have a large diversity and variability when looking at semantics, due to different competencies, skills and languages.

Making data aggregable asks for a Semantic Web structure in order to give back to different users a new way to look at the information in a Cultural Heritage context. A semantic web structure means also that the relations, properties and composition of the “nodes” of the information give a new insight different from a list of the same concepts or a database structure. Since now, consistently structured data are missing in for Cultural Heritage architectures.

One of the main challenges in 3D modelling is related to an effective BIM approach for cultural heritage knowledge, semantic enrichment and model management. Starting from an improved procedure of 3D data capturing [7] and documentation, INCEPTION proposes an improvement in this methodology by recognizing that buildings are a set of elements named by an architectural style nomenclature and organized by spatial relationships. At the moment, a shared library for historical elements does not exist. Starting from the Heritage Building Information Modelling (H-BIM) approach the necessity of the libraries' implementation is under development within INCEPTION by avoiding the oversimplification of the shapes. When used in models of Cultural Heritage, semantic BIM [8] will be able to connect different users (e.g. scholars, technicians, citizens, governments), supporting the need for interpretation of the Cultural Heritage model, in addition to the common BIM features of 3D visualization, technical specification and dataset [9].



**Fig. 2:** Schema of the INCEPTION methodology, based on the example of Istituto degli Innocenti by Brunelleschi: from the holistic documentation and data capturing up to semantically enriched 3D models.

#### 4.1 The Ontology setting up

The first step in creating semantic BIM for cultural heritage is defining the ontology: a formal representation of knowledge as a hierarchy of concepts within the cultural heritage domain, starting from a definition of concepts and their relationship. The linguistic definitions related to the ontology concepts can also be used as shared vocabulary to denote the types, properties and interrelationships of cultural heritage aspects [10].

The issue of naming architectural elements can be tackled in different ways and by consulting different sources. In the field of classical architecture, it is possible to check several books that deeply analyse and summarize which “rules” were basically adopted in classical buildings. When mainly based on classical orders, ancient architecture is easier to understand and name, even if the building practice often differs from the theory. For instance, just to list some of the most known theoretical books from the past, we can mention *De architectura* by Vitruvius; *De re aedificatoria* by Leon Battista Alberti; and *I quattro libri dell'architettura* by Andrea Palladio, some of the major treatises that influenced architectures all over the world for centuries. Nevertheless, local practices introduced several variations, as well there are a lot of different constructive techniques, shapes and decorations that were not standardized. Every building is the final result of different influences and combinations in order to solve practical problems, as well as further additions and changes over time.

For this reason, aiming at the standardization in heritage documentation, data handling and management, the INCEPTION project is developing common parameters, setting a nomenclature or “glossary of names” as a starting point to semantic enrichment and modelling in BIM environment [11]. The recognition of shapes, either manually or automatically performed, is possible only if single architectural elements (or their variations) are identified and univocally classified following a shared procedure.

Over the years, several architectural dictionaries have been produced. Thousands of architectural names have been collected and managed following a specific sorting. A traditional thematic dictionary, for example, collects names in alphabetical order, for a specific language, describing every single name and without the requirement of conceptually linking them together. On the other hand, an architectural treatise explained by graphics gives more consistency to the nomenclature, setting up a specific relation between elements.

This defines two different kinds of issues within INCEPTION: setting up of a common glossary of names for all Demonstration Cases under development by involving scholars and experts; organizing names following a structure that could ensure the linking between elements which could be re-used in the IT development phase.

#### 4.2 The Nomenclature setting up

The need for the definition of an international “glossary” for architectural heritage and by extension for Cultural Heritage has arisen. This need has originated from the fact that there are various methodologies regarding heritage documentation. As previously explained, various vocabularies and thesauri are used in the field of conservation, while the variety of “uniqueness” of each cultural artefact turns its categorization into a difficult effort. In addition, not only spatial information needs to be standardized, but also the related metadata. In order to face this issue and start setting a methodology to define a shared vocabulary, an extensive analysis of the State of the Art was performed. Herein in the field of Architecture and Heritage, the UNESCO Thesaurus as a general Vocabulary, the UK Archival Thesaurus as a general archive, the Centre National d'Archaeologie Urbaine for Archaeology and Heritage sites, the Pactols Thesaurus by Frantiq in the Archaeology field and the Getty Art & Architecture Thesaurus (AAT, but also TGN), are some of the Vocabularies checked.

The availability of so many different active sources providing valuable information that would be interesting to be reused, means both valuable but potentially competing information needs to be connected. Since this information is constantly in development, linking is preferable rather than copying a “static” version at a certain date. This is even truer for Heritage nomenclature.

Semantic Web technology and Linked Open Data principles make it possible to define an open H-BIM ontology without having the complexity of defining the complete schema as a copy of external sources. This State-of-the-Art technology is developed by members of the W3C organization and is at the moment a mature technology with mature supporting tools. INCEPTION makes use of the tools available supporting these standards.

The above-mentioned vocabularies and thesauri define a nomenclature for the Cultural Heritage domain. Before this valuable knowledge can be used as linked open data the following steps need to be defined: (i) translate the vocabularies / thesauri in a technology that supports linked open data; (ii) interlink the different vocabularies / thesauri and link them together; (iii) filter what is relevant for the H-BIM ontology within INCEPTION.

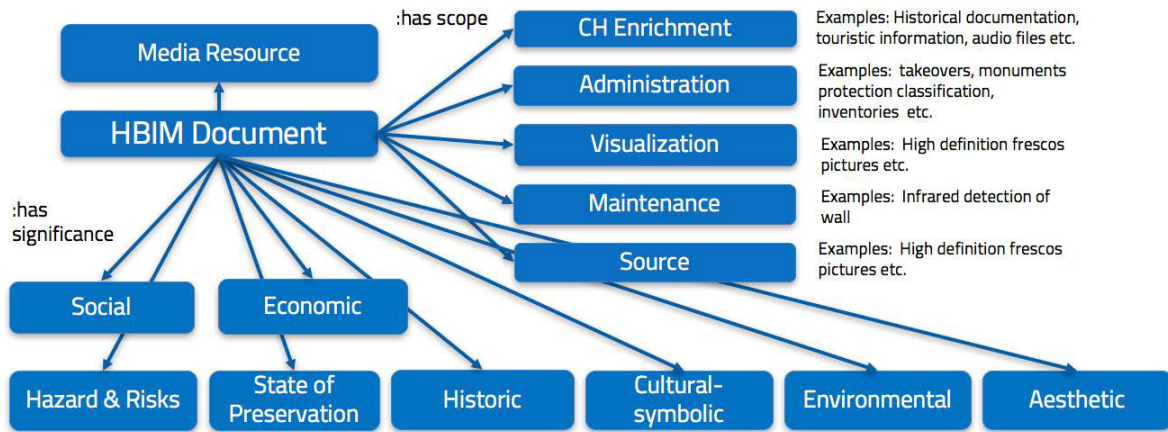


Fig. 3: H-BIM document ontology.

The starting point for semantic organization and glossary definitions for cultural heritage buildings is the integration of the glossary with ifcOWL (in order to start working on H-BIM modelling defining specific parts of the model), ifcOWL as Semantic Web serialization on schema level for IFC schemas will be followed where possible for BIM content stored/exchanged via IFC. Even if the analysis of available nomenclatures is continuously going on, by analysing national and international resources, for the Web service set up, the Getty Vocabularies were chosen as a starting point, including AAT - Art & Architecture Thesaurus, TGN - Getty Thesaurus of Geographic Names and ULAN - Union List of Artist Names.

The Getty vocabularies contain structured terminology for art, architecture, decorative arts, archival materials, visual surrogates, conservation, and bibliographic materials. Compliant with international IT standards, they provide authoritative information for cataloguers, researchers, and data providers. In the new linked, open environments, the vocabularies provide a powerful tool to be adopted within the INCEPTION project, even if a filtering activity is required in order to make them suitable. Furthermore, where an existing vocabulary will not correctly cover a specific definition, it will be integrated. Current work is creating an ontology as a valuable base for possible upgrading about what is expected/required in H-BIM.

The AAT, TGN and ULAN contain structured terminology for art and other material culture, archival materials, visual surrogates, and bibliographic materials. Compliant with international standards, they provide authoritative information for cataloguers and researchers, and can be used to enhance access to databases and websites. The Getty Vocabularies are produced by the Getty Vocabulary Program (GVP) and grow through contributions. The procedure under INCEPTION is aimed at extending the H-BIM ontology based on the classification available in Getty, integrating this with the 'BIM' classification generated from the IFC schemas.

## 5. Towards applications and digital tools for Heritage fruition

So far, the INCEPTION project has defined the approach and the methodology for semantic organization and data management toward H-BIM modelling, and the preliminary nomenclature for semantic enrichment of heritage 3D models. The organization of consolidated knowledge is performed following a specific workflow in order to get them suitable for their reuse into H-BIM semantic model, accordingly to digital documentation and capturing protocols that have been developed.

According to the INCEPTION workflow the H-BIM process starts documenting user needs, including and engaging not only experts but also non-experts. The demand has been leading us to "how" and "what" surveying information to be included in H-BIM. The surveying procedure produces a variety of different data, formats and outputs. It is essential to process that data without losing important information like metadata and paradata while editing and developing the digital elements of the H-BIM. A methodology of archiving digital data and linking them to the final product is one of the main outcomes. Before and during the creation of H-BIM, the nomenclature (vocabularies, thesaurus, etc.) is critical to maintain a common typology and to support interoperability.

Starting from the standardization for H-BIM modelling, the methodology for merging IFC models and semantic data has been defined. The development of a semantic 3D reconstructions, integrated with intangible information and social environment, structuring digital representation of buildings and sites will lead to the creation of models more accessible and implementable in a Heritage-BIM environment, based on Open BIM standard (IFC, IFD, etc.).





**Fig. 4:** Example of “on-site” application tested in the Italian Demonstration Case, the Istituto degli Innocenti in Florence.

Thanks to the use of data collected by Demonstration Cases, the identified methodological workflow and the technical tools and procedures will be further tested and stressed by end of the project. This will allow, from one side, to check the real validity of what has been developed until now and, on the other side, to upload several contents to the platform, bringing it into life and make it a significant dissemination tool.

Now, each INCEPTION demonstration case will produce data that will be hosted by the brand-new platform, allowing to test the validity of the platform itself (3D models and versioning, animations, images, etc.) and further developments (immersive environments, Virtual Reality, Augmented Reality, etc.).

The INCEPTION platform will be populated by using validated Demonstration Cases’ results and developing user-oriented applications to fulfil the user requirements, as well as to deliver exploitable innovation with a long-term impact. The deployment of 3D models with integral narratives will be tested on the heritage sites in on-site and off-site applications.





**Fig. 5:** Digital reconstructions of the façade of Istituto degli Innocenti in different eras through the use of a BIM model.

## 6. Conclusions

The integration between BIM environments and three-dimensional acquisition technologies is one of the challenges to be faced in order to guarantee an effective collaborative process in the heritage preservation field.

Starting from the implementation of the integrated 3D data capturing procedure for heritage applications and the identification of the Cultural Heritage buildings semantic ontology, the project is developing guidelines for 3D parametric and semantic modelling in a Heritage-BIM environment, based on Open BIM standard, improving a “BIM approach” for Cultural Heritage.

3D models generated through INCEPTION methods and tools will be accessible for many different users. Semantic enrichment will generate 3D models for multiple purposes depending on the needs and level of knowledge of the end-users. The semantic enrichment will link geometric information for 3D visualisation, historical information, and geotechnical data as well as structural information for material conservation, maintenance and refurbishment.

The current work is to create an ontology as a valuable base for possible up-grading about what is expected/required in H-BIM [12]. However, it is important to understand the difference between BIM standards and the Semantic Web technologies. Indeed, the ifcOWL is defined as a serialization of an IFC schema definition, in order to enable the use of contents semantically managed. For this reason, within INCEPTION, H-BIM is meant to be an ontology to support storage of semantic knowledge available for Cultural Heritage buildings and architectural complexes, as well as their related information [13]. The integration of Getty vocabularies and ifcOWL is a complex but feasible task, focusing on the actual queries, communications and current H-BIM work. Furthermore, within INCEPTION, we have the chance to test such integration, achieving positive results as well as beginning an implementation, thanks to the use of a “glossary of names” gathered by the Demonstration Cases analysis.

Once data are collected and aggregated thanks to the use of semantic technologies, the most valuable goal is strictly related to dissemination capabilities. Indeed, the richness of the INCEPTION project is represented by accessibility to a crowdsourced database of both scans and reconstructions, with different level of confidence by their source data.

Therefore, the INCEPTION platform will have to contain, visualize, manage, update, and exchange technical and divulgative information regarding historical heritage, through the use of 3D BIM models. Any form of digital or digitized content, stored or linked into a 3D H-BIM model, as well as semantically indexed by the use of the INCEPTION ontology, will allow the use of different navigation systems.



The need of a future re-use of such broad and descriptive source of measurement data demands new applications to facilitate information accessing collected in three-dimensional database without compromising the quality and amount of information captured in the survey.

Looking at the future development of the INCEPTION platform, the integration of qualitative and quantitative data, beginning from the data capturing phase, will allow the possibility to make qualitative query on quantitative data within a database of multiple CH buildings and, therefore, to better understand the cultural European complexity from its tangible heritage.

Databases allow users to understand how each survey-phase was carried out (scans, topographic support, images acquisition, etc.) and thus to obtain the maximum possible amount of morphological information; this procedure means to work with complex interfaces that are based on the programming languages of the software used to complete the survey itself.

Furthermore, tools for improved visualization and management of 3D models are becoming increasingly important in the preservation, protection, and collection of our cultural and natural environment; making easier the access to monuments, artefacts, building and culture, these technologies are actually enhancing the learning process, motivating and understanding of certain events and historical elements for the use of students and researchers [14].

Currently, efforts in developing the user interface are concentrated on providing direct or partially controlled access to the large three-dimensional scale models, also by means of immersive navigation. The creation of large digital spaces properly set up in terms of both form and dimensions, will make possible to navigate, enter, and extract its qualities and specifications (measurements, colours, materials, historical documentation, conservation records) in real time.

Current efforts are focused on creating immersive and easy-to-use 3D visualizations that can be accessed from a wide range of users. The field of experimentation underlying the integrated, interdisciplinary research effort shares many aspects (dimension and complexity of the data) with heritage surveys, and the results obtained so far give us reason to hope that these optimization processes can be exported.

New simplified navigation interfaces are also being developed for users with lower levels of expertise to facilitate access to and navigation of the three-dimensional models. New visualization and communication modes for the geometrical and measurement information have to be conceived and developed in step with the development and application of three-dimensional surveys.

## Acknowledgements

The project is under development by a consortium of fourteen partners from ten European countries led by the Department of Architecture of the University of Ferrara. Academic partners of the Consortium, in addition to the Department of Architecture of the University of Ferrara, include the University of Ljubljana (Slovenia), the National Technical University of Athens (Greece), the Cyprus University of Technology (Cyprus), the University of Zagreb (Croatia), the research centres Consorzio Futuro in Ricerca (Italy) and Cartif (Spain). The clustering of small medium enterprises includes: DEMO Consultants BV (The Netherlands), 3L Architects (Germany), Nemoris (Italy), RDF (Bulgaria), 13BIS Consulting (France), Z + F (Germany), Vision and Business Consultants (Greece).

The INCEPTION project has been applied under the Work Programme Europe in a changing world – inclusive, innovative and reflective Societies (Call - Reflective Societies: Cultural Heritage and European Identities, Reflective-7-2014, Advanced 3D modelling for accessing and understanding European cultural assets).

This research project has received funding from the European Union's H2020 Framework Programme for research and innovation under Grant agreement no 665220.

## Bibliographical References

[1] DI GIULIO, Roberto; MAIETTI, Federica; PIAIA, Emanuele. 3D documentation and semantic aware representation of cultural heritage: the INCEPTION project. In: *Proceedings of the 14th Eurographics Workshop on Graphics and Cultural Heritage*. Eurographics Association, 2016. p. 195-198.

[2] REMONDINO, Fabio. *3D recording, documentation and management of cultural heritage*. Whittles Publishing, 2016.

[3] MAIETTI, Federica, et al. Digital Memory and Integrated Data Capturing: Innovations for an Inclusive Cultural Heritage in Europe Through 3D Semantic Modelling. In: *Mixed Reality and Gamification for Cultural Heritage*. Springer, Cham, 2017. p. 225-244.

- [4] JENNINGS, Edel; DOBREVA, Milena; DEVRENI-KOUTSOUKI, Anna. Towards user engagement models for citizen science: initiatives in the digital cultural heritage domain. In: *Cultural Heritage Communities*. Routledge, 2017. p. 98-115.
- [5] EPPICH, Rand; GRINDA, JL Garcia. Management Documentation: Indicators & Good Practice at Cultural Heritage Places. *The International Archives of Photogrammetry, Remote Sensing and Spatial Information Sciences*, 2015, 40.5: 133.
- [6] QUATTRINI, Ramona, et al. From TLS to HBIM. High quality semantically-aware 3D modeling of complex architecture. *The International Archives of Photogrammetry, Remote Sensing and Spatial Information Sciences*, 2015, 40.5: 367.
- [7] DI GIULIO, Roberto, et al. Integrated Data Capturing Requirements for 3D Semantic Modelling of Cultural Heritage: The INCEPTION Protocol. *The International Archives of Photogrammetry, Remote Sensing and Spatial Information Sciences*, 2017, 42: 251.
- [8] PAUWELS, Pieter, et al. Integrating building information modelling and semantic web technologies for the management of built heritage information. In: *Digital Heritage International Congress (DigitalHeritage), 2013*. IEEE, 2013. p. 481-488.
- [9] ARAYICI, Yusuf, et al. (ed.). *Heritage Building Information Modelling*. Taylor & Francis, 2017.
- [10] ACHILLE, Cristiana; LOMBARDINI, Nora; TOMMASI, Cinzia. BIM and Cultural Heritage: Compatibility Tests in an Archaeological Site. *International Journal of 3-D Information Modeling (IJ3DIM)*, 2016, 5.1: 29-44.
- [11] LOGOTHETIS, S.; DELINASIOU, A.; STYLIANIDIS, E. Building information modelling for cultural heritage: a review. *ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, 2015, 2.5: 177.
- [12] BONSMMA, Peter, et al. Roadmap for IT Research on a Heritage-BIM Interoperable Platform within INCEPTION. In: *SBE Malta-Sustainable Built Environment*. Gutenberg Press, 2016. p. 283-290.
- [13] CHENG, Hung-Ming; YANG, Wun-Bin; YEN, Ya-Ning. BIM applied in historical building documentation and refurbishing. *The International Archives of Photogrammetry, Remote Sensing and Spatial Information Sciences*, 2015, 40.5: 85.
- [14] NOH, Zakiah; SUNAR, Mohd Shahrizal; PAN, Zhigeng. A review on augmented reality for virtual heritage system. In: *International Conference on Technologies for E-Learning and Digital Entertainment*. Springer, Berlin, Heidelberg, 2009. p. 50-61.



- UNESCO Chair on Landscape, Cultural Heritage and Territorial Governance
- BENECON Research Centre of Competence of the Campania Region for Cultural Heritage, Ecology and Economy, Naples, Italy



## PATRONED BY



**UNIVERSITÀ DEGLI STUDI DELLA CAMPANIA  
LUIGI VANVITELLI**

---

**SCUOLA POLITECNICA E DELLE SCIENZE DI BASE**

---

**DIPARTIMENTO DI ARCHITETTURA  
E DISEGNO INDUSTRIALE**



UNIVERSITAT  
POLITÈCNICA  
DE VALÈNCIA



Organizzazione  
delle Nazioni Unite  
per l'Educazione,  
la Scienza e la Cultura



Commissione Nazionale  
Italiana per l'UNESCO



THE US - ITALY FULBRIGHT COMMISSION  
Linking Minds Across Cultures



UNIFARCO

DOLOMIA  
LUCE, VITALITÀ, RESPIRO

