

# STATI GENERALI DEL PATRIMONIO INDUSTRIALE 2026

*a cura di*

Edoardo Currà, Fabio Fatiguso, Antonella Guida, Antonio Monte

Marina Docci, Graziella Bernardo, Elena Cantatore, Alessandro Mattioli, Claudio Menichelli



GANGEMI EDITORE®  
INTERNATIONAL

©

Proprietà letteraria riservata

**Gangemi Editore spa**

Via Giulia 142, Roma

[www.gangemieditore.it](http://www.gangemieditore.it)

Nessuna parte di questa pubblicazione può essere memorizzata, fotocopiata o comunque riprodotta senza le dovute autorizzazioni.

*Le nostre edizioni sono disponibili in Italia e all'estero anche in versione ebook.*

*Our publications, both as books and ebooks, are available in Italy and abroad.*

ISBN 978-88-492-5487-7



DOI: <https://cdn.gangemieditore.com/DOI/10.61020/9788849254877.pdf>

Volume Open Access pubblicato con licenza Creative Commons

Attribuzione-Non commerciale-Non opere derivate 4.0 Internazionale (CC-BY-NC-ND 4.0)

*In copertina:* © Mariano De Angelis, Ex Tabacchificio Fortunato Farina, Battipaglia (SA), 2019.

# 3° STATI GENERALI 2026 DEL PATRIMONIO INDUSTRIALE

BARI, MATERA, LECCE  
5-8 Febbraio 2026

*a cura di*

Edoardo Currà, Fabio Fatiguso, Antonella Guida, Antonio Monte  
Marina Docci, Graziella Bernardo, Elena Cantatore,  
Alessandro Mattioli, Claudio Menichelli

GANGEMI EDITORE®  
INTERNATIONAL

## 3° Stati Generali del Patrimonio Industriale

Bari - Matera - Lecce  
5-8 febbraio 2026

### Congresso promosso e organizzato da:



### In collaborazione con:



### Curatori degli atti

Edoardo Currà, Fabio Fatiguso, Antonella Guida, Antonio Monte  
Marina Docci, Graziella Bernardo, Elena Cantatore, Alessandro Mattioli, Claudio Menichelli

### Comitato d'onore

Helmuth Albrecht | Consiglio Direttivo TICCIH and ICOMOS  
Antonello Alici | Presidente DoCoMoMo Italia  
Clementina Barucci | Centro studi Giorgio Muratore  
Marco Bertilorenzi | Master Erasmus Mundus TPTI – Università di Padova  
Carlo Bianchini | Prorettore per il Patrimonio arch. - Sapienza Università di Roma  
Ana Cardoso de Matos | Board member AIHC – Università di Évora  
Eusebi Casanelles | Life president TICCIH - Spagna  
Mariela Ceva | Iniciativa de Archivos - UCA Argentina  
Maurizio Di Stefano | Presidente ICOMOS  
Marco Doria | Presidente SISE – Società italiana degli storici economici  
Fabio Fatiguso | Presidente ArTec – Società Scientifica dell'Architettura Tecnica  
Giovanni Luigi Fontana | Presidente Accademia Olimpica di Vicenza  
Walter Hauser | Presidente ERIH - Germania  
Mario Losasso | Presidente SITdA – Società Italia della Tecnologia dell'Architettura  
Luis Müller | Universidad Nacional del Litoral UNL - Argentina  
Valeriè Nègre | Coordinatore Master Erasmus Mundus TPTI - Francia  
Spartaco Paris | Direttore CITERA - Sapienza Università di Roma  
Renata Picone | Presidente SIRA – Società Italiana per il Restauro dell'Architettura  
Amerigo Restucci | Presidente Istituto Regionale Ville Venete  
Giorgio Rocco | Presidente del Centro di Studi per la Storia dell'Architettura  
Antonello Sanna | Università di Cagliari  
Claudia Schimdt | Universidad Torcuato Di Tella Buenos Aires - Argentina  
Elisabetta Scungio | Direttrice Istituto Aut. Villa Adriana e Villa d'Este - MiC  
Vicente Julian Sobrino Simal | TICCIH-Spagna  
Marion Steiner | Presidente TICCIH  
Guido Zucconi | IUAV Venezia

## Comitato scientifico

### Consiglio direttivo AIPAI

Presidente AIPAI

Edoardo Currà

Vicepresidenti AIPAI

Marina Docci

Antonio Monte

Manuel Ramello

Past president AIPAI

Renato Covino

Giovanni Luigi Fontana

Former national repr. TICCIH

Massimo Preite

Laura Severi | Segretario AIPAI

Martina Russo | Tesoriere AIPAI

Franco Mancuso | S. Benemerito AIPAI

Augusto Vitale | S. Benemerito AIPAI

Massimo Bottini | Consigliere AIPAI

Maria Elena Castore | Consigliere AIPAI

David Celetti | Consigliere AIPAI

Sara De Maestri | Consigliere AIPAI

Antonella Guida | Consigliere AIPAI

Jacopo Ibello | Consigliere AIPAI

Amedeo Lepore | Consigliere AIPAI

Carolina Lussana | Consigliere AIPAI

Rossella Maspoli | Consigliere AIPAI

Claudio Menichelli | Consigliere AIPAI

Cristina Natoli | Consigliere AIPAI

Cesira Paolini | Consigliere AIPAI

Giorgio Ravasio | Consigliere AIPAI

Laura Severi | Consigliere AIPAI

Silvia Tardella | Consigliere AIPAI

Rita Vecchiattini | Consigliere AIPAI

Luca Zan | Consigliere AIPAI

Elena Paudice | Delegata AIPAI

Palmina Trabocchi | Delegata AIPAI

### Comitato scientifico di riferimento

Matteo Abita (UnivAQ)

Marta Acierno (UniRM)

Jose Ramon Albiol Ibanez (UPV)

Francesco Antoniol (TICCIH)

Elena Antonioli (IUAV)

Carlo Atzeni (UniCA)

Cristiana Bartolomei (UniBO)

Alberto Bassi (IUAV)

Iacopo Benincampi (UniRM1)

Laura Bernardi (Ist. Aut. VaVe MiC)

Marco Bertilorenzi (UniPD)

Angelo Bertolazzi (UniPD)

Andrea Billi (UniRM1)

Alberto Bologna (UniRM1)

Gianluca Capurso (UniRM2)

Viviana Carbonara (Ist. Aut. VaVe MiC)

Ugo Carughi (ICOMOS)

Santi Maria Cascone (UniCT)

Niccolò Casiddu (UniGE)  
Agostino Catalano (ecampus)  
Alessandra Cirafici (UniCAM)  
Angelo Ciribini (UniBS)  
Rossella Corrao (UniPA)  
Silvia Cutarelli (UniRM1)  
Alessandro D'Amico (UniRM1)  
Giorgio Danesi (IUAV)  
Luciano De Bonis (UniMOL)  
Fabrizio Di Marco (UniRM1)  
Elisabetta Doria (UniPV)  
Elena Eramo (UniRM2)  
Ruggero Ermini (UniBAS)  
Antonella Falzetti (UniRM2)  
Laura Farroni (UniRM3)  
Carmen Fattore (UniBAS)  
Annarita Ferrante (UniBO)  
Paolo Ferri (UniBO)  
Francesca Fino (UniBO)  
Pierfrancesco Fiore (UniSA)  
Angela Fiorelli (UniRM2)  
Anna Frangipane (UniUD)  
Alessia Franzese (IUAV)  
Francesco Gabellone (CNR-Nanotec)  
Emilia Garda (PoliTO)  
Giuseppe Gerace (UniRM1)  
Ilaria Giannetti (UniRM2)  
Manuela Grecchi (PoliMI)  
Laura Greco (UniCAL)  
Luca Guardigli (UniBO)  
Riccardo Gulli (UniBO)  
Stefania Landi (UniMI)  
Maria Lusiani (UniBO)  
Marika Mangosio (PoliTO)  
Marzia Marandola (IUAV)  
Alessandra Marcon (IUAV)  
Elisabetta Mangiotta Nervi (PLN-Project)  
Marco Mari (Ongreening Ltd)  
Francesco Marino (UniBAS)  
Valentina Martino (UniRM1)  
Nicola Masini (CNR-ISPC)  
Manuela Mattone (PoliTO)  
Cecilia Mazzoli (UniBO)  
Ippolita Mecca (UniPegaso)  
Mariavaleria Mininni (UniBAS)  
Fabio Minutoli (UniME)  
Giovanni Minutoli (UniFI)  
Renato Morganti (UnivAQ)  
Stefania Mornati (UniRM2)  
Michele Munafò (ISPRA MASE)  
Antonello Pagliuca (UniBAS)  
Stefano Palermo (UniRM1)  
Luis Palmero Iglesias (UPV-Valencia)  
Andrea Pane (UniNA)  
Rosaria Parente (UniMERCATORUM)  
Roberto Parisi (UniMOL)  
Valentina Pintus (UniCA)  
Marco Pistolesi (UniRM1)  
Daniela Pittaluga (UniGE)

Elena Paudice (UniRM1)  
Tiziana Poli (PoliMI)  
Franco Polverino (UniNA)  
Salvatore Polverino (UniGE)  
Federica Pompejano (UniGE)  
Marina Pugnaletto (UniRM1)  
Chiara Rizzi (UniBAS)  
Mauro Saito (DoCoMoMo)  
Cristian Sammarco (UniRM1)  
Giovanni Santi (UniPI)  
Marco Santillo (UniSA)  
Luca Scappin (IUAV)  
Albina Sciotti (UniPegaso)  
Nino Sulfaro (UniRC)  
Maria Pia Testa (UniNA)  
Barbara Tetti (UniRM1)  
Damiana Treccozi (MiC-SABAP)  
Francesco Trovò (IUAV)  
Maria Grazia Turco (UniRM1)  
Denise Ulivieri (UniPI)  
Margherita Vanore (IUAV)  
Elena Vigliocco (PoliTO)  
Maria Vitiello (UniRM1)

#### **Presidenti del Congresso**

Fabio Fatiguso, Antonella Guida, Antonio Monte

#### **Presidente Stati Generali del Patrimonio Industriale di AIPAI**

Edoardo Currà

#### **Comitato di coordinamento**

Graziella Bernardo, Elena Cantatore, Mariella De Fino, Marina Docci, Claudio Menichelli, Vito Porcari, Martina Russo, Laura Severi

#### **Comitato e segreteria organizzativi**

Daniele Altamura, Luca Borghini, Silvana Bruno, Andrea Califano, Maria Elena Castore, Daiana Dall'Arche, Cassia De Lian Cui, Ilaria Giannetti Valeria Giannuzzi, Margherita Lasorella, Mario Mariani, Alessandro Mattioli, Caterina Mosca, Cesira Paolini, Sara Porcari, Arcangelo Priore, Marina Pugnaletto, Maria Felicia Rondinelli, Albina Sciotti, Silvia Tardella, Palmina Trabocchi

Giuseppe Andrisani, Arianna Baccaro, Michele Buldo, Federica Cassano, Teresa Fortunato, Enrico Lamacchia, Angela Rosa Manicone

#### **Comitato grafica e sito**

Referenti: Luca Borghini, Ilaria Giannetti, Martina Russo

Michele Buldo, Daiana Dall'Arche, Alessandro Depaoli, Enrico Lamacchia, Angela Rosa Manicone, Mario Mariani, Laviero Pepe

#### **Comitato media e comunicazione**

Referenti: Francesco Granese, Manuel Ramello

Luca Borghini, Federica Cassano, Maria Elena Castore, Arianna Mazza, Sara Porcari, Silvia Tardella, Palmina Trabocchi

*I contributi sono stati sottoposti a referaggio (blind peer review)*

**Il convegno è stato realizzato con il contributo concesso dalla Direzione Generale Educazione, ricerca e istituti culturali. Annualità 2026.**

# Con il patrocinio di:

## Autorità istituzionali



## Parchi e siti patrimoniali



## Associazioni scientifico-disciplinari



## Associazioni culturali e di ricerca



## Ordini professionali



## Fondazioni



## Con la partecipazione di:



## Con il contributo di:



Le autorizzazioni alla pubblicazione delle immagini e dei documenti di archivio sono in possesso dei singoli autori. È fatto divieto di ulteriore riproduzione e/o duplicazione con qualsiasi mezzo.

Quest'opera è protetta dalla Legge sul diritto d'autore.  
È vietata ogni duplicazione, anche parziale, non autorizzata.

# Sommario

---

Gli Stati Generali del Patrimonio Industriale a Bari, Matera e Lecce <i>Fabio Fatiguso, Antonella Guida, Antonio Monte</i>	36
Introduzione ai Terzi Stati Generali del Patrimonio Industriale <i>Edoardo Currà</i>	40
I valori della storia e il soft power delle imprese italiane per affrontare le sfide della nuova competitività The Values of History and the Soft Power of Italian Companies in Facing the Challenges of New Competitiveness <i>Antonio Calabrò</i>	50

## **AREA 1 MACCHINE, BREVETTI E CICLI PRODUTTIVI STORICI DEL PATRIMONIO INDUSTRIALE** **MACHINES, PATENTS AND HISTORICAL PRODUCTION CYCLES OF THE INDUSTRIAL HERITAGE**

*a cura di: Renato Covino, Antonio Monte, Laura Severi, Marco Venanzi*

Introduzione	54
<b>1.1. Macchine, brevetti e cicli produttivi storici del patrimonio industriale</b> <i>Renato Covino, Antonio Monte, Laura Severi</i>	55
<ul style="list-style-type: none"><li>• La carta tra Fabriano e l'Appennino umbro-marchigiano The Paper Between Fabriano and the Umbria-Marche Apennines <i>Renato Covino</i></li></ul>	56
<ul style="list-style-type: none"><li>• La tradizione olearia nel Mezzogiorno d'Italia tra innovazione e trasformazione. Abruzzo, Basilicata, Calabria e Puglia: casi studio a confronto The Olive Oil Tradition in Southern Italy between Innovation and Transformation. Abruzzo, Basilicata, Calabria and Puglia: Comparative Case Studies <i>Antonio Monte, Palmira Trabocchi</i></li></ul>	62
<ul style="list-style-type: none"><li>• Evoluzione e stabilità del processo saccarifero. Macchine e brevetti nella produzione dello zucchero Evolution and Stability of the Sugar Production Process. Machinery and Patents in Sugar Production <i>Laura Severi</i></li></ul>	70
<ul style="list-style-type: none"><li>• L'industria italiana del sorgo zuccherino (1937-1948) The Italian Sweet Sorghum Industry (1937-1948) <i>Lorenzo Aldini, Alessandro Valente</i></li></ul>	78
<ul style="list-style-type: none"><li>• From Tinsplate to Galvanization: the Birth of a Metal-Coating Industry in Liège (1845-1905) Dalla banda stagnata alla zincatura: la nascita dell'industria dei rivestimenti metallici a Liegi (1845-1905) <i>James Deboeur</i></li></ul>	86
<ul style="list-style-type: none"><li>• L'innovazione e il trasferimento tecnologico nell'industria mondiale dell'ammoniaca sintetica negli Anni Venti del Novecento: il caso del processo Casale Innovation and Technology Transfer in the Global Synthetic Ammonia Industry in the 1920s: The Case of the Casale Process <i>Lorenzo Francisci</i></li></ul>	94
<ul style="list-style-type: none"><li>• Dall'artigianato all'archeologia industriale: il Panificio-Pasticceria Ilvento Vignola a Grassano From Craftsmanship to Industrial Archaeology: The Ilvento Vignola Bakery and Pastry Shop in Grassano <i>Porzia Ilvento, Mariagrazia Decuzzi</i></li></ul>	101

## **AREA 2 CITTÀ E PAESAGGI DELL'INDUSTRIA E DEL LAVORO** **CITIES AND LANDSCAPES OF INDUSTRY AND LABOR**

*a cura di: David Celetti, Giovanni Luigi Fontana, Elena Paudice, Massimo Preite, Silvia Tardella*

Introduzione	109
<b>2.1. Paesaggi dell'industria, UNESCO e patrimonio della comunità</b> <i>Giovanni Luigi Fontana, Massimo Preite</i>	110
<ul style="list-style-type: none"><li>• I poli della prima industrializzazione tessile tra Europa e America latina Between Europe and Latin America: The Centres of Early Textile Industrialisation <i>Giovanni Luigi Fontana</i></li></ul>	111

• Emigrazione e industrializzazione in una città operaia in Argentina: il caso di Villa Flandria (1910-1945) Emigration and Industrialisation in a Working-Class Town in Argentina: The Case of Villa Flandria (1910-1945) <i>Mariela Ceva</i>	119
• Paesaggi produttivi e patrimonio UNESCO: le riserve MaB come infrastrutture di riferimento identitario lungo la Valle del fiume Po Productive Landscapes and UNESCO World Heritage: MaB Reserves as Infrastructures of Identity along the Po River Valley <i>Andrea Rolando</i>	126
• Dal fiume alla fabbrica, dal paesaggio al racconto: la costruzione, la crisi e la rinascita del distretto laniero biellese From the River to the Factory, from the Landscape to the Story: The Construction, Crisis and Rebirth of the Biella Wool District <i>Cristina Natoli, Giovanni Vachino</i>	135
• Tra rimozione e recupero del cemento: un approccio antropologico alla patrimonializzazione del paesaggio di Casale Monferrato Between Removal and Recovery of Cement: An Anthropological Approach to the Heritage of the Landscape of Casale Monferrato <i>Michele Filippo Fontefrancesco</i>	144
• Cinque paesaggi stradali del Veneto Five Roadscapes of the Veneto Region <i>Remi Wacogne, Mersida Ndrevaaj</i>	153
• Object-based Learning and the Preservation of Industrial Heritage: the Study and Inventory of Foundry Moulds Object-based Learning e conservazione del patrimonio industriale: studio e inventario degli stampi di fonderia <i>Maria da Luz Sampaio, Paulo Moura</i>	161
<b>2.2. Architetture del paesaggio urbano e industriale</b> <i>Elena Paudice, Federica Pompejano</i>	170
• “Costruire” il paesaggio industriale: l’eredità dell’impresa Sugliani & Tissoni nella Valle Bormida “Building” the Industrial Landscape: The Legacy of the Sugliani&Tissoni Company in the Bormida Valley <i>Cecilia Moggia, Federica Pompejano</i>	171
• Milano, ferro e acqua. La tutela dei ponti sui navigli, tracce del passato industriale della città Milan, Iron and Water. Protecting the Bridges over the Navigli Canals, Traces of the City’s Industrial Past <i>Elena Rizzico, Morena Scaglia</i>	179
• Arredo in ghisa per la città ottocentesca. Percorsi progettuali e imprenditoriali tra Francia e Italia Cast Iron Furniture for the Nineteenth-Century City. Design and Entrepreneurial Journeys between France and Italy <i>Giovanna Rosso Del Brenna, Chiara Quartero</i>	188
• Terre di sale. Le saline come modelli di coesistenza tra produzione e ambiente Lands of salt. Saltworks as Models of Coexistence between Production and the Environment <i>Marta Martinelli</i>	195
<b>2.3. Paesaggi dell’industria e del lavoro del Meridione</b> <i>Elena Paudice, Silvia Tardella</i>	203
• Costellazioni produttive in Calabria. Tracce materiali e processi di patrimonializzazione Productive Constellations in Calabria. Material Traces and Processes of Patrimonialization <i>Nino Sulfaro, Martina La Mela</i>	204
• La manifattura tabacchi di Catania: dalle origini alla trasformazione in area museale The Catania Tobacco Manufacturing Plant: From its Origins to its Transformation into a Museum Area <i>Isabella Frescura</i>	212
• Il calzificio Torrieri a Lanciano: strategie di recupero di un opificio urbano The Torrieri Hosiery Factory in Lanciano: Strategies for the Regeneration of an Urban Factory <i>Alessandra Tosone, Matteo Abita, Danilo Di Donato, Renato Morganti</i>	220
• Il paesaggio produttivo della contrada Targia: un’oasi nel territorio industriale della costa siracusana The Productive Landscape of the Targia District: An Oasis in the Industrial Area of the Syracuse Coast <i>Serena Volterra</i>	228

<b>2.4. Company Towns, villaggi e quartieri operai</b>	236
<i>David Celetti, Giovanni Luigi Fontana, Silvia Tardella</i>	
• Giovanni Muzio e il progetto per il “Villaggio Saffa” a Pontenuovo di Magenta (MI), 1954-1962 Giovanni Muzio and the Project for the “Saffa Village” in Pontenuovo di Magenta (MI), 1954-1962 <i>Leone Carlo Ghoddousi, Luca Placci</i>	237
• Paesaggi della memoria: il caso Thyssenkrupp a Torino Landscapes of Memory: the Thyssenkrupp Case in Turin <i>Michela Comba, Paola Gregory</i>	245
• Aspetti dell’industrializzazione ad Aosta: il quartiere Ansaldo-Cogne Aspects of Industrialisation in Aosta: the Ansaldo-Cogne District <i>Monica Resmini, Giulio Mirabella Roberti</i>	254

## AREA 3 INFRASTRUTTURE TERRITORIALI E URBANE SPATIAL AND URBAN INFRASTRUCTURE

*a cura di: Massimo Bottini, Franco Mancuso, Stefania Mornati, Palmira Trabocchi*

Introduzione	264
<b>3.1. Nuovi paesaggi industriali: quale futuro tra tutela e transizione ecologica?</b>	265
<i>Massimo Bottini, Cristina Natoli</i>	
• Pianificazione energetica e paesaggio: criticità e prospettive per una governance multilivello Energy Planning and Landscape: Critical Issues and Prospects for Multilevel Governance <i>Cristina Natoli, Paolo Cagnoli, Giuseppe De Natale</i>	266
• L’infrastruttura elettrica nel paesaggio: conflitto, integrazione o progetto? Electrical Infrastructure in the Landscape: Conflict, Integration, or Design? <i>Gabriella Rago, Roberto Bardari</i>	274
• Eolico offshore, la sfida paesaggistica e i nuovi paesaggi costiero-marini Offshore Wind Power, the Landscape Challenge and New Coastal and Marine Landscapes <i>Gabriella Rago, Roberto Bardari</i>	283
• I dati oltre le macchine? Una ricognizione dell’insediamento dei Data Center nell’area milanese Data Beyond Machines? A Survey Data Center Locations in the Milan Area <i>Remi Wacogne, Andrea Cairati</i>	291
• Le Colline Metallifere un terzo paesaggio culturale. Fragilità e potenzialità di una storia millenaria The Metalliferous Hills: A Third Cultural Landscape. The Fragility and Potential of a Thousand-Year History <i>Barbara Catalani</i>	298
<b>3.2. L’acqua, l’industria, la città</b>	306
<i>Franco Mancuso, Stefania Mornati</i>	
• Un acquedotto per Roma Capitale: alle origini dell’Acqua Pia Marcia An Aqueduct for the Capital City of Rome: the Origins of the Acqua Pia Marcia <i>Paolo Buonora</i>	307
• Aggiornamenti tecnologici per l’acquedotto storico di Genova: il caso del Ponte Sifone sul Geirato Technological Upgrades for Genoa’s Historic Aqueduct: the Case of the Syphon Bridge over the Geirato <i>Matilde Ridella</i>	315
• Urban Water Infrastructures of the 20th Century in Historical Contexts: the Case Study of the Grabiglioni in the Sassi of Matera, Italy Le infrastrutture idriche urbane del XX secolo nei contesti storici: il caso di studio dei Grabiglioni nei Sassi di Matera, Italia <i>Enrico Lamacchia, Daniele Altamura, Ruggero Ermini, Nicola Masini, Antonella Guida</i>	324
• Canal-related Industrial Built Heritage in Italy: Current Conditions and Challenges Il patrimonio industriale legato ai canali in Italia: condizioni attuali e sfide <i>Sun Lei, Luca Guardigli</i>	332

<b>3.3. Il ruolo delle infrastrutture ferroviarie dismesse</b>	341
<i>Massimo Bottini, Palma Trabocchi</i>	
• Il masterplan della Costa dei Trabocchi attraverso il riuso del vecchio sedime ferroviario adriatico Ortona / Vasto	
The Master Plan for the Trabocchi Coast through the Reuse of the Old Adriatic Ortona/Vasto Railway Line	342
<i>Massimo Bottini</i>	
• Tracciati costieri. Il progetto delle infrastrutture ferroviarie dismesse	
Coastal Routes. The Project for Disused Railway Infrastructure	349
<i>Giulio Minuto</i>	
• La ferrovia Civitavecchia-Orte: un patrimonio in bilico tra abbandono e progetti irrealizzati	
The Civitavecchia-Orte Railway: a Heritage Caught between Abandonment and Unrealised Projects	356
<i>Marina Dozzi, Ludovica Funari</i>	
• Recupero e valorizzazione dei depositi ferroviari circolari	
Recovery and Enhancement of Circular Railway Depots	365
<i>Andrea Cenci, Giulia Formato, Sabato Gargiulo, Manuela Mattone</i>	

## **AREA 4 PROGETTO E COSTRUZIONE PER L'INDUSTRIA**

### **DESIGN AND CONSTRUCTION FOR THE INDUSTRY**

*a cura di: Edoardo Currà, Ilaria Giannetti, Antonella Guida, Cesira Paolini, Martina Russo, Augusto Vitale*

Introduzione	375
<b>4.1. La machine à fabriquer: una narrazione attraverso i brevetti del Novecento</b>	376
<i>Ilaria Giannetti, Martina Russo</i>	
• Industrializzazione delle coperture sottili autoportanti: coppi, tegoli e volte prismatiche nel secondo Novecento in Italia	
Industrialization of Self-Supporting Thin Roofing: Tiles, Slate, And Prismatic Vaults in Second Half of the 20th Century in Italy	377
<i>Ilaria Giannetti, Martina Russo</i>	
• I brevetti per la costruzione dei silos da grano quale strumento per la conoscenza e la conservazione della tipologia	
Patents for the Construction of Grain Silos as a Tool for Knowledge and Preservation of the Typology	385
<i>Stefania Landi</i>	
• L'eredità del moderno industriale. La forma della fabbrica nella sperimentazione di Pier Luigi Nervi	
The Legacy of Modern Industrialism. The Shape of the Factory in Pier Luigi Nervi's Experimentation	393
<i>Lorenzo Bagnoli</i>	
• Reuse of Structural Steel Components in Industrial Heritage: Towards an Operational Protocol with a Circular Approach	
Riuso dei componenti strutturali in acciaio nel patrimonio industriale: verso un protocollo operativo con un approccio circolare	400
<i>Giulio Basileo, Danilo Di Donato, Renato Morganti, Alessandra Tosone, Viorel Ungureanu</i>	
• Il lanificio Tiberghien a Verona e l'impiego del calcestruzzo armato	
The Tiberghien Wool Mill in Verona and the Use of Reinforced Concrete	408
<i>Angelo Bertolazzi, Michele De Mori</i>	
• Come mare increspato da piccole onde: le coperture a volta sottile di Felice Bertone per l'architettura industriale	
Like the Sea Ripple with Small Waves: Felice Bertone's Slim Vaulted Roofs for Industrial Architecture	416
<i>Marika Mangosio</i>	
• Un alfabeto costruttivo in cemento armato per l'industria. Il brevetto del coppone prefabbricato AL.FA di Aldo Favini (1967)	
A Constructive Alphabet in Reinforced Concrete for Industry. The Patent for The AL.Fa Prefabricated Coppone by Aldo Favini (1967)	425
<i>Vito Quadrato</i>	

<b>4.2. Costruzione e architettura per l'industria e la città</b>	433
<i>Antonella Guida, Cesira Paolini</i>	
• I mercati coperti del Governatorato a Roma The Covered Markets of the Governorate in Rome <i>Cesira Paolini, Marina Pugnaletto</i>	434
• Il progetto di Alziro Bergonzo per la Reggiani: aspetti innovativi e prospettive di tutela Alziro Bergonzo's Project for Reggiani: Innovative Aspects and Prospects for Protection <i>Eleonora Caggiati, Giulio Mirabella Roberti</i>	443
• Industrial Heritage and Architectural Technology: a Critical Study of the Ferrania-3M "Nuova Direzione" Office Building (1953-1955) Patrimonio industriale e tecnologia architettonica: uno studio critico dell'edificio per uffici Ferrania-3M "Nuova Direzione" (1953-1955) <i>Federica Pompejano, Marta Casanova, Lisa Guglielmi</i>	451
• Il complesso Olivetti a Massa. Una storia di sperimentazione costruttiva (1940-1970) The Olivetti Complex in Massa. A History of Constructive Experimentation (1940-1970) <i>Francesco Spada, Teresa Casale, Giuliana Di Mari, Emilia Garda, Laura Greco, Alessandra Renzulli</i>	460
• Le torri di raffreddamento della raffineria S.A.R.O.M. a Ravenna The Cooling Towers of the S.A.R.O.M. Refinery in Ravenna <i>Francesca Santarella</i>	468
• Nature, Architecture and Industrial Heritage: the Water Mills of Banyeres de Mariola, Alacant, Spain Natura, architettura e patrimonio industriale: i mulini ad acqua di Banyeres de Mariola, Alacant, Spagna <i>Miguel Valero-Mateu, Javier Benlloch-Marco, Vicente Lopez-Mateu, Teresa M. Pellicer</i>	476

## **AREA 5 STORIA, CULTURA E MEMORIA DELL'INDUSTRIA E DEL LAVORO: RICERCHE, ARCHIVI, MUSEI E PRATICHE DI VALORIZZAZIONE**

### **HISTORY, CULTURE AND MEMORY OF INDUSTRY AND LABOR: RESEARCH, ARCHIVES, MUSEUMS, AND ENHANCEMENT PRACTICE**

*a cura di: Marco Bertilorenzi, David Celetti, Amedeo Lepore, Roberto Lorenzetti, Carolina Lussana, Massimo Negri, Luca Zan*

Introduzione	486
<b>5.1. Archivi, architetture, storie industriali</b>	487
<i>Paolo Buonora, Carolina Lussana</i>	
• Una storia industriale: la Ditta Barbieri di Castel Maggiore (BO) An Industrial History: The Barbieri Company of Castel Maggiore (BO) <i>Vincenzo Petrillo</i>	488
• Tra spiriti, essenze e spazi distillati. Lettura e conoscenza tecnica dell'ex distilleria di Barletta Among Spirits, Essences and Distilled Spaces. Reading and Technical Knowledge of the Former Distillery in Barletta <i>Antonella Guida, Antonio Monte, Vito Domenico Porcari, Martina Pisani</i>	497
• Emilio Sernagiotto l'"architetto" del vino a cento anni dalla sua nascita Emilio Sernagiotto, the "Architect" of Wine, one Hundred Years after his Birth <i>Antonio Monte, Palmina Trabocchi</i>	506
• Architettura per l'industria: lo Studio Corsini e Wiskemann Architecture for Industry: The Corsini and Wiskemann Studio <i>Carolina Lussana, Silvia Giugno</i>	514
• Tra armi e archivi, donne e fucili, i 150 anni della fabbrica d'armi di Terni Between Weapons and Archives, Women and Rifles, the 150 Years of the Terni Weapons Factory <i>Daniele Scopigno</i>	522

<b>5.2. Cultura e memoria dell'industria: casi studio e buone pratiche</b>	530
<i>David Celetti, Luca Zan</i>	
<ul style="list-style-type: none"> <li>• Conservare la cultura della memoria. Opifici e vie d'acqua. La cartiera di Scauri (LT) Preserving the Culture of Memory. Factories and Waterways. The Scauri Paper Mill (LT) <i>Cesare Crova</i></li> </ul>	531
<ul style="list-style-type: none"> <li>• Añana Salt Valley: a Case of Crisis and Recovery of an Industrial Heritage Site Añana Salt Valley: dalla crisi al recupero di un sito del patrimonio industriale <i>Luca Zan</i></li> </ul>	540
<ul style="list-style-type: none"> <li>• Tecnologia, produzione e patrimonio: i cantieri Tosi di Taranto come paradigma di archeologia industriale Technology, Production and Heritage: The Tosi Shipyards in Taranto as a Paradigm of Industrial Archaeology <i>Antonella Guida, Antonio Monte, Carmen Fattore</i></li> </ul>	548
<ul style="list-style-type: none"> <li>• La ex cartiera Latina sull'Appia Antica a Roma: dalla memoria alla valorizzazione The ex-Cartiera Latina on the Appia Antica in Rome: From Memory to Valorisation <i>Caterina Rossetti</i></li> </ul>	557
<ul style="list-style-type: none"> <li>• L'ex zuccherificio di Policoro tra passato, presente e futuro: una proposta di valorizzazione patrimoniale The ex-Sugar Factory in Policoro Between Past, Present and Future: a Proposal for Heritage Enhancement <i>Chiara Benedetto</i></li> </ul>	565
<b>5.3. Organizzazione del lavoro e iniziative di inclusione sociale</b>	573
<i>Maria Gabriella Rienzo, Marco Santillo</i>	
<ul style="list-style-type: none"> <li>• L'esperienza di R.I.Stor.A.M.I. Per la conoscenza e la valorizzazione degli archivi e dei musei d'impresa R.I.Stor.A.M.I.'s Experience in Promoting the Awareness and Appreciation of Corporate Archives and Museums <i>Amedeo Lepore</i></li> </ul>	574
<ul style="list-style-type: none"> <li>• Il sistema integrato "Museo-Scuole-Officine" di Filangieri: un'esperienza <i>ante litteram</i> di placement Filangieri's Integrated "Museum-Schools-Workshops" System: A Pioneering Experience in Work Placement <i>Marco Santillo</i></li> </ul>	579
<ul style="list-style-type: none"> <li>• Architetture dell'assistenza: il modello proto-industriale del Real Albergo dei Poveri Architecture of Assistance: The Proto-Industrial Model of the Real Albergo dei Poveri <i>Gerardo Cringoli, Serena Potito</i></li> </ul>	587
<ul style="list-style-type: none"> <li>• Il lavoro femminile e minorile nella tessitura delle manifatture cotoniere meridionali a Fratte di Salerno Women's and Children's Labour in the Weaving of Southern Cotton Manufacturers in Fratte di Salerno <i>Maria Gabriella Rienzo</i></li> </ul>	596
<ul style="list-style-type: none"> <li>• L'Organizzazione del lavoro negli arsenali militari marittimi italiani nei primi anni del Novecento The Organisation of Work in Italian Naval Arsenals in the Early 20th Century <i>Paola Nardone, Dario Dell'Osa</i></li> </ul>	602
<b>5.4. Esperienze imprenditoriali paradigmatiche in età contemporanea</b>	610
<i>Angelina Marcelli, Giuseppe Moricola</i>	
<ul style="list-style-type: none"> <li>• La navigazione a vapore e la costruzione di macchine a vapore nel Regno delle Due Sicilie (1818-1861) Steam Navigation and Steam Engine Construction in the Kingdom of the Two Sicilies (1818-1861) <i>Maria Sirago</i></li> </ul>	611
<ul style="list-style-type: none"> <li>• Mangiatorella: visione imprenditoriale e archivio d'impresa Mangiatorella: Entrepreneurial Vision and Company Archive <i>Angelina Marcelli</i></li> </ul>	619
<ul style="list-style-type: none"> <li>• L'industria aeronautica in Campania: archeologia industriale e storia economica di un ecosistema produttivo The Aeronautical Industry in Campania: Industrial Archaeology and Economic History of a Productive Ecosystem <i>Andrea Pomella, Giacomo Zanibelli</i></li> </ul>	625
<ul style="list-style-type: none"> <li>• Dall'Archivio Ford. Gli uomini di Detroit: testimonianze e racconti da dentro il Fordismo From the Ford Archive. The Men of Detroit: Testimonies and Stories from within Fordism <i>Giuseppe Moricola</i></li> </ul>	634

<b>5.5. Cultura, industria e sviluppo nel dopoguerra: casi specifici e forme di intervento territoriale</b>	641
<i>Amedeo Lepore, Giovanni Serreli</i>	
<ul style="list-style-type: none"> <li>• La memoria come risorsa generativa per abilitare nuovi futuri From the Ford Archive. The Men of Detroit: Testimonies and Stories from within Fordism <i>Ludovico Solima</i></li> </ul>	642
<ul style="list-style-type: none"> <li>• Saline demaniali nel Sud Sardegna: un progetto per la valorizzazione storico-culturale del Parco naturale regionale Molentargius-Saline State-owned Saltworks in Southern Sardinia: A Project for the Historical and Cultural Enhancement of the Molentargius-Saline Regional Natural Park <i>Stefania Ecchia, Sabrina Sabiu, Giovanni Serreli</i></li> </ul>	648
<ul style="list-style-type: none"> <li>• Le fonti grafiche per la storia del movimento operaio di Terra di Lavoro Graphic Sources for the History of the Labour Movement in Terra di Lavoro <i>Paola Broccoli</i></li> </ul>	655
<ul style="list-style-type: none"> <li>• Il primo stabilimento Del Monte in Europa. Dalla chiusura a una nuova prospettiva di rinascita: un'iniziativa dal basso per salvare una presenza identitaria The First Del Monte Factory in Europe. From Closure to a New Prospect of Rebirth: A Bottom-Up Initiative to Save an Iconic Presence <i>Davide Calanca</i></li> </ul>	663
<b>5.6. Valorizzazione del patrimonio archivistico nelle sue articolazioni settoriali e territoriali</b>	671
<i>Amedeo Lepore, Potito Quercia</i>	
<ul style="list-style-type: none"> <li>• Gli Archivi camerali abruzzesi: fonti per una storia industriale tra Ottocento e Novecento The Abruzzo Chambers of Commerce Archives: Sources for Industrial History between the Nineteenth and Twentieth Centuries <i>Natascia Ridolfi, Ada Di Nucci, Dario Dell'Osa</i></li> </ul>	672
<ul style="list-style-type: none"> <li>• Le miniere di Pazzano: archeologia industriale e patrimonio archivistico The Mines of Pazzano: Industrial Archaeology and Archival Heritage <i>Elia Fiorenza, Renato Ghezzi</i></li> </ul>	680
<ul style="list-style-type: none"> <li>• Il Canale del Sarno e la Fabbrica d'armi: il patrimonio industriale Torrese in attesa di valorizzazione The Sarno Canal and the Arms Factory: Torre's Industrial Heritage Waiting to Be Enhanced <i>Franca Pirolo, Michele Cuomo</i></li> </ul>	690
<ul style="list-style-type: none"> <li>• Un lavoro corale: conservazione e restauro dei lucidi architettonici dell'Archivio Storico MAIRE A Team Effort: Conservation and Restoration of the Architectural Drawings in the MAIRE Historical Archive <i>Paola Fagnola</i></li> </ul>	697
<ul style="list-style-type: none"> <li>• L'Associazione Archivio Storico Olivetti, dai documenti al territorio The Olivetti Historical Archive Association, from Documents to the Territory <i>Marcella Turchetti</i></li> </ul>	704
<b>5.7. Testimonianze e storia del lavoro</b>	711
<i>Palmira Trabocchi, Marco Bertilorenzi</i>	
<ul style="list-style-type: none"> <li>• Work and Resistance. Intangible Heritage Of The Textile Industry Lavoro e resistenza. Il patrimonio immateriale dell'industria tessile <i>Ana Rajković Pejić, Kosjenka Laszlo Klemar</i></li> </ul>	712
<ul style="list-style-type: none"> <li>• Il V Congresso della Società Chimica Italiana del 1935 in Sardegna: tra fervore patriottico e paesaggio industriale The 5th Congress of the Italian Chemical Society in 1935 in Sardinia: Between Patriotic Fervour and Industrial Landscape <i>Stefania Bagella, Federico Berretta, Sergio Stoccoro</i></li> </ul>	720
<ul style="list-style-type: none"> <li>• Valorizzare le testimonianze del primo quartiere industriale di Modena Enhancing the Heritage of Modena's First Industrial District <i>Elena Corradini, Angelo Marcello Tarantino</i></li> </ul>	729
<ul style="list-style-type: none"> <li>• La ferrovia Sangritana, un viaggio italiano tra memoria, lavoro e conservazione The Sangritana Railway, an Italian Journey through Memory, Work and Conservation <i>Caterina Serafini, Palmira Trabocchi</i></li> </ul>	737

<b>5.8. Between History and Heritization. The Transformation of European Historical Shipyards</b>	745
<i>Pegram Harrison, Luca Zan</i>	
• Costruzioni navali e patrimonio industriale. Il caso dell'arsenale di Brest Shipbuilding and Industrial Heritage. The Case of the Brest Arsenal	746
<i>David Celetti</i>	
• The Transformation of European Historical Shipyards: a Preliminary View La trasformazione dei cantieri navali storici europei: un esame preliminare	755
<i>Luca Zan, Pegram Harrison</i>	
<b>5.9. Musei industriali e comunità patrimoniale</b>	763
<i>Renè Capovin, Massimo Preite</i>	
• Reinventing Industrial Museums for a New Image of Italy Reinventare i Musei industriali per una nuova immagine dell'Italia	764
<i>Laura Genovese, Alessandro Rizzi, Angela Quattrocchi</i>	
• Il Museo del Cristallo di Colle di Val d'Elsa: esempio di Comunità patrimoniale The Crystal Museum in Colle di Val D'Elsa: an Example of a Heritage Community	772
<i>Giacomo Baldini, Filippo Fornai, Leonardo Giovanni Terreni</i>	
• Musei per la fruizione di complessi industriali dismessi. Design per la valorizzazione di sistemi produttivi, territori culturali e comunità Museums for the Use of Disused Industrial Complexes. Design for the Enhancement of Production Systems, Cultural Territories and Communities	781
<i>Serena Del Puglia</i>	
• I minerali identitari delle miniere metallifere della Sardegna nella "Collezione Antonio Manunta" del parco geominerario storico e ambientale della Sardegna. Patrimonio materiale e immateriale identitario dell'eredità industriale mineraria della Sardegna The Minerals that Define the Identity of Sardinia's Metalliferous Mines in the "Antonio Manunta Collection" of the Sardinia Historical and Environmental Geomining Park. Tangible and Intangible Heritage that Defines the Identity of Sardinia's Mining Industrial Heritage	790
<i>Roberto Rizzo, Fabrizio Atzori</i>	
<b>AREA 6 DIGITALIZZAZIONE E AI DEL PATRIMONIO INDUSTRIALE: CONOSCENZA, PROGETTO, GESTIONE E FRUIZIONE</b>	
<b>DIGITIZATION AND AI OF INDUSTRIAL HERITAGE: KNOWLEDGE, DESIGN, MANAGEMENT AND FRUITION</b>	
<i>a cura di: Silvana Bruno, Elena Cantatore, Cassia De Lian Cui, Edoardo Currà, Fabio Fatiguso, Mariella De Fino</i>	
Introduzione	799
<b>6.1. Digitalizzazione e AI del patrimonio industriale: conoscenza, progetto, gestione e fruizione</b>	800
<i>Silvana Bruno, Elena Cantatore, Cassia De Lian Cui, Edoardo Currà, Fabio Fatiguso, Mariella De Fino</i>	
• Combined 3D Survey and AI Techniques for Enhancing Fortified Heritage Tecniche combinate di rilevamento 3D e intelligenza artificiale per valorizzare il patrimonio fortificato	801
<i>Antonia Spanò, Zhiguo Wu, Giacomo Patrucco</i>	
• Enhancing Datacenter Integration in the Built Environment through Digital Twins Migliorare l'integrazione dei Data Center nell'ambiente costruito attraverso i Digital Twin	810
<i>Lavinia Chiara Tagliabue, Marco Aldinucci, Viviana Vaccaro, Silvia Meschini, Robert Birke</i>	
• Neural Representation and 3D Digital Survey for Industrial Heritage Valorisation: the Corradini Foundry Case Study (Naples) Rappresentazione neurale e rilievo 3D per la valorizzazione del patrimonio industriale: il caso dell'ex fonderia Corradini a Napoli	818
<i>Riccardo Tavolare, Mara Capone, Valeria Cera, Cesare Verdoscia</i>	
• Evaluating Digital Twin Software and Services for Industrial Construction. A Comparative Assessment of ORUR-CUS Sheds and Building Valutazione di software e servizi Digital Twin per l'edilizia industriale. Valutazione comparativa di capannoni e edifici ORUR-CUS	827
<i>Andrea Alagia, Cassia De Lian Cui, Edoardo Currà, Yangyang Yuan</i>	

## EVALUATING DIGITAL TWIN SOFTWARE AND SERVICES FOR INDUSTRIAL CONSTRUCTION. A COMPARATIVE ASSESSMENT OF ORUR-CUS SHEDS AND BUILDING

Valutazione di software e servizi Digital Twin per l'edilizia industriale.  
Valutazione comparativa di capannoni e edifici ORUR-CUS

Andrea Alagia<sup>1</sup>, Cassia De Lian Cui<sup>1</sup>, Edoardo Currà<sup>1</sup>, Yangyang Yuan<sup>2</sup>

1: Department of Civil, Building and Environmental Engineering, Sapienza University of Rome

2: Department of Landscape Architecture, Southeast University

### Keyword

Digital Twin; Industrial Construction; Tools Evaluation; Comparative Analysis.  
Digital Twin; edilizia industriale; valutazione degli strumenti; analisi comparativa.

**Abstract** Nowadays, the integration of advanced digital technologies into heritage practices has transformed both methodologies and approaches for built heritage management. Among these innovations, Digital Twin technology represents a promising tool for enabling dynamic, data-driven workflows that support recovery and valorization activities. However, their implementation within the industrial heritage context is currently limited, and challenges arise in determining the suitability of the available solutions for specific project requirements.

This study offers a comparative evaluation of ten software and services, Dalux, Trimble Connect, Autodesk Viewer, Speckle, Cesium JS, Autodesk Tandem, Azure Digital Twins, Matterport, Fuzor, and Twinmotion, applied to the former Roman University Representative Board (ORUR) and the University Sports Complex (CUS) in Rome. Each solution is assessed based on criteria such as accessibility, interoperability, functionality performance, IoT integration, and collaborative features. The results aim to provide an evaluation of the different features, supporting users in selecting the most appropriate option according to the objectives of the application and specific requirements of the heritage context.

## 1. INTRODUCTION

The rapid digital transition in heritage practice has brought growing attention to Digital Twins (DTs). Widely adopted in manufacturing, process industries, healthcare, transportation, and energy<sup>1</sup>, DTs pair a physical asset with a virtual one through bidirectional data flows to support monitoring, analysis, and decision-making. In the cultural heritage context, recent studies demonstrate diverse applications: Marra et al.<sup>2</sup> integrate an information system with a DT by modeling each artwork as container content sensors, enabling conservation-oriented monitoring and structural assessment of museum objects; Angjeliu et al.<sup>3</sup> develop a DT of Milan Cathedral using nonlinear finite-element modeling and hierarchical geometry to support inspection, damage prediction, and maintenance

<sup>1</sup> A. RASHEED, O. SAN, T. KVAMSDAL, *Digital twin: Values, challenges and enablers from a modeling perspective*, IEEE Access 8, 2020, 21980–22012. doi:10.1109/ACCESS.2020.2970143.

<sup>2</sup> A. MARRA, S. GERBINO, A. GRECO, G. FABBROCINO, *Combining integrated informative system and historical digital twin for maintenance and preservation of artistic assets*, Sensors 21, 2021, 5956. URL: <http://dx.doi.org/10.3390/s21175956>. doi:10.3390/s21175956. (October '25)

<sup>3</sup> G. ANGJELIU, D. CORONELLI, G. CARDANI, *Development of the simulation model for digital twin applications in historical masonry buildings: The integration between numerical and experimental reality*, Computers Structures 238, 2020, 106282. doi:10.1016/j.compstruc.2020.106282

planning, with prospects for virtual sensors and environmental effects. Other work explores energy and operations: a cloud–edge architecture (Azure Digital Twins) leverages sensor data and machine-learning forecasts for energy efficiency and smart maintenance in historic buildings<sup>4</sup>. At the urban and participatory scale, the ROCK platform connects physical and virtual heritage and enhances citizen participation to support regeneration of historic centers<sup>5</sup>. Even more, mixed-reality pipelines show promise for interpretation and access, with AR workflows combining historical/spatial data, dense surface models, and HBIM for in-situ visualization of heritage buildings<sup>6</sup>.

Across these examples, DTs are generally characterized by high fidelity representations, dynamic state synchronization, identifiability of physical–digital assets, and adaptive behavior through feedback; they are often multi-scale, multidisciplinary, and hierarchically structured to align analyses and interventions with the complexity of heritage assets<sup>7</sup>.

Despite all these applications, there is a lack of comparative evaluations of DT solutions expressly tailored to the requirements of industrial heritage use cases.

To address this gap, this paper presents a comparative assessment of ten software/services applied to a sports-related industrial architecture case (the ORUR–CUS complex in Rome), to identify the strengths, limitations, and overall performance in this specific context.

## 2. THE FORMER ROMAN UNIVERSITY REPRESENTATIVE BOARD (ORUR) AND THE UNIVERSITY SPORTS COMPLEX (CUS) IN ROME

The ORUR-CUS represents a modern architectural solution for an industrial sports complex. It was designed in 1967 by Enrico Mandolesi, one of the most prominent and influential professors of the Sapienza University in Rome, to achieve a fast, inexpensive, and reliable structure through the use of experimentation and new building techniques, mainly revolving around prefabrication<sup>8</sup>.

Located beside the main Sapienza campus, near Piazzale del Verano and the Monumental Cemetery of Verano, the connection between these areas is interrupted by the presence of the Via Tiburtina. This high-speed road connects the district of San Lorenzo to the Tiburtina station, further isolating the ORUR-CUS from the western side of the city center.

The structure consists of two independent volumes, one with a prevailing horizontal development, utilizing a spatial tubular truss beam and load-bearing bare reinforced concrete walls, where the CUS is located. The other asset, with a vertical development, houses the offices of the former ORUR (now DiSCO Lazio), built with the standardization of three steel beam profiles.

These features make the complex an exemplary case for digital documentation and management, combining the study of modern technological solutions with the need to support condition tracking toward reuse (fig. 1-2).

<sup>4</sup> Z. NI, P. ERIKSSON, Y. LIU, M. KARLSSON, S. GONG, *Improving energy efficiency while preserving historic buildings with digital twins and artificial intelligence*, *IOP Conference Series: Earth and Environmental Science* 863, 2021, 012041. URL: <https://doi.org/10.1088/1755-1315/863/1/012041>. doi:10.1088/1755-1315/863/1/012041. (October '25)

<sup>5</sup> B. TURILLAZZI, G. LEONI, J. GASPARI, M. MASSARI, S. BOULANGER, *Cultural heritage and digital tools: the rock interoperable platform*, *International Journal of Environmental Impacts: Management, Mitigation and Recovery* 4, 2021, 276–288. doi:10.2495/EI-V4-N3-276-288.

<sup>6</sup> E. DEZEN-KEMPTER, D. L. MEZENCIO, E. D. M. MIRANDA, D. P. DE SÁ, U. DIAS, *Towards a digital twin for heritage interpretation-from bbim to ar visualization*, 2020, URL: [http://papers.cumincad.org/cgi-/works/paper/caadria2020\\_141](http://papers.cumincad.org/cgi-/works/paper/caadria2020_141). (October '25)

<sup>7</sup> M. SINGH, E. FUENMAYOR, E. P. HINCHY, Y. QIAO, N. MURRAY, D. DEVINE, *Digital twin: Origin to future*, *Applied System Innovation* 4, 2020 doi:10.3390/asi4020036.

<sup>8</sup> A. STAZI, *La sede dell'ORUR-CUS a Roma*, in *L'Industria delle Costruzioni*, n°43, 1974, pp. 3-18, (Progetto: E. Mandolesi).



Fig. 1-2. The ORUR-CUS in Rome.

Excessive heat gain, driven by the metal roofing and the translucent skylight, produces temperatures that are incompatible with safe athletic activity, a condition exacerbated under peak occupancy when the combined presence of spectators and athletes compounds internal loads. In light of these findings, optimizing the lighting and HVAC systems emerges as the most impactful pathway to reduce emissions and improve occupant comfort simultaneously. To operationalize this objective, the project proposes a digital twin, initially focused on the primary weight room and gym area, which enables real-time monitoring of equipment utilization, detection of anomalies, and prompt feedback to building systems. This one-to-one linkage between the physical asset and its virtual counterpart is intended to support data-driven control, continuous commissioning, and informed decision-making across both public and private use patterns.

Within this broader research perspective, the specific aim of the present paper is to assess existing software and services, summarized in the comparative matrix, and identify the environments best suited for implementing the proposed digital twin.

### 3. FRAMEWORK AND APPLICATION OF THE COMPARATIVE ANALYSIS

#### 3.1. Methodological approach

Given these architectural and urban characteristics, this research adopts a structured evaluation workflow that creates a clear digital record of the ORUR-CUS (fig. 3) and tests lightweight, browser-based viewers on core tasks, such as view, navigate, section, measure, annotate, and share, while keeping the option to attach simple environmental data (e.g., temperature, humidity). The setup relies on portable, widely supported formats, plug-in-free web access on laptops and phones, simple link sharing, and consistent test conditions to keep results comparable. Functional and technical requirements, as interoperability, real-time monitoring, and multi-user collaboration, are further taken into account in order to define the criteria for the tool selection.

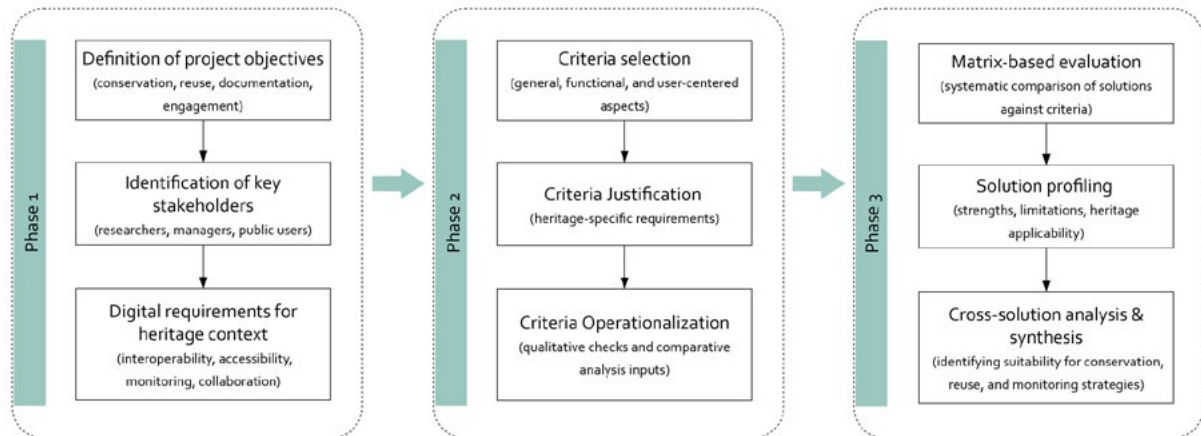


Fig. 3. Three-phase framework for the ORUR–CUS software and services assessment.

Building on Phase 1, seven criteria were chosen to cover the full user journey from first open to collaborative use and, when needed, basic monitoring<sup>9-10</sup>:

- **Accessibility:** it should be easy to open and use: plug-in-free browser access on desktop and mobile, simple link sharing for view-only access, and a free/education tier for testing.
- **Compatibility:** it has to read and export widely supported formats for models and point clouds (e.g., RVT, OBJ, FBX, GLTF, E57/LAZ) and exchange tabular data (e.g., CSV/JSON). Preference is given to stable identifiers and basic APIs/SDKs so information can move across tools without lock-in.
- **Web-based performance** requires the viewer to run via WebGL/WebGPU in a standard browser, load a medium model in a reasonable time, and remain smooth during navigation and sectioning on ordinary laptops and phones. This criterion captures the practical limits of front-end compatibility and back-end performance.
- **IoT / real-time monitoring:** where available, the tool should ingest simple time-series (e.g., CSV uploads or basic REST/MQTT feeds), bind them to rooms or elements, and provide clear history/threshold views with optional alerts and data export.
- **Functionality:** core tools needed for the study must be present and reliable: view and navigate, section and measure, walk/orbit, property query, explode/cutaway, notes/markup with images, saved views, and export of annotations.
- **Sharing:** it has to be straightforward to share the model through a link, ideally without forcing viewers to create an account. Basic permission control (public, invite-only, role levels) and exportable comment/issue records are evaluated.
- **Learnability:** it should be usable with minimal onboarding. Time-to-first-task (publish → measure → share), number of steps/clicks for common actions, clarity of the UI/help, and error feedback are observed to assign a score.

Once the criteria are defined, the next step regards the application to the case study on the ten selected solutions in order to evaluate the performance.

<sup>9</sup> D. M. BOTÍN-SANABRIA, S. MIHAIȚA, R. E. PEIMBERT-GARCÍA, M. A. RAMÍREZ-MORENO, R. A. RAMÍREZ-MENDOZA, AND J. DE J. LOZOYA-SANTOS, “Digital Twin Technology Challenges and Applications: A Comprehensive Review,” *Remote Sens.*, vol. 14, no. 6, 2022, pp. 1–25, doi: 10.3390/rs14061335.

<sup>10</sup> D. JONES, C. SNIDER, A. NASSEHI, J. YON, AND B. HICKS, “Characterising the Digital Twin: A systematic literature review,” *CIRP J. Manuf. Sci. Technol.*, vol. 29, no. 2019, pp. 36–52, doi: 10.1016/j.cirpj.2020.02.002.

### 3.2. Results and Discussion

The results of the application can first be summarized as an overview of the solution features (fig. 4). Dalux, thanks to its simplified graphics, is a high-speed cloud viewer. It features a Revit plug-in that allows for multiple updates to the model, directly replacing the old one. Although it is not open-source software, it offers a free personal plan that allows users to utilize the software to its full potential. It enables project sharing via web links, and it does not allow native integration of IoT products.

Trimble Connect is a cloud coordination platform that integrates with Revit and loads, updates, and displays 3D models on the web extremely quickly, thanks to a plug-in that—unlike other software—is highly customizable. Connect is compatible with almost all 3D formats, including the IFC standard. Even if it is not open source, it offers a free plan. The platform natively integrates IoT products within the model.

Autodesk Viewer is an excellent starting point for understanding how to integrate a Revit model into the cloud, as both are Autodesk software. It does not have a native plug-in in Revit; the user needs to upload the .rvt file directly to the site, which will generate a web visualization of the BIM. It allows sharing of the project link without an Autodesk account and is the only web viewer under consideration capable of rendering 3D views.

Speckle's user experience is unrivalled, with a highly well-designed user interface and graphics. It is the fastest open-source interoperability service (with web viewer) among those reviewed and offers new features such as light and shadow customization. Thanks to its open-source nature, Speckle offers 28 plug-ins that connect it to all major 3D modeling software.

Cesium.js is a geospatial framework designed for digital twins of cities. It offers several features that differ from those of the other software under review, such as placing the model directly in a 3D basemap using the geolocation of the point cloud. Like Speckle, it is open source and based on the same core technology, three.js, a library capable of performing 3D rendering with relatively little computational power.

Autodesk Tandem is the most comprehensive DT operations platform among those under consideration. It is equipped with all the basic features for 3D visualization, is native to IoT devices, and allows the creation of an integrated dashboard with all data, which can be used directly as a front-end user interface. Although it is not open-source, it offers a free plan with essential features.

Fuzor is an excellent 3D renderer. It has proprietary software that must be purchased, with no option to try the program through a free trial or student account.

Twinmotion is built on Unreal Engine, a software capable of creating very fast 3D renders, which is why it is often used for creating 3D games by its parent company, Epic Games.

Azure Digital Twins is a compelling PaaS service for DT graphs and IoT integration. It is not open source, and even the free version requires credit card details, which the user can use to purchase additional computing power or cloud storage space.

Matterport is an innovative capture-hosting service for digital twins. It is based on the creation of digital spaces, captured using cameras sold by Matterport itself, or produced via a 3D scan from the Matterport app on a smartphone. It does not support importing BIM models into a space that has not been scanned using a phone. The software can serve as a basis for BIM creation by importing the digital space into Revit using a plug-in.

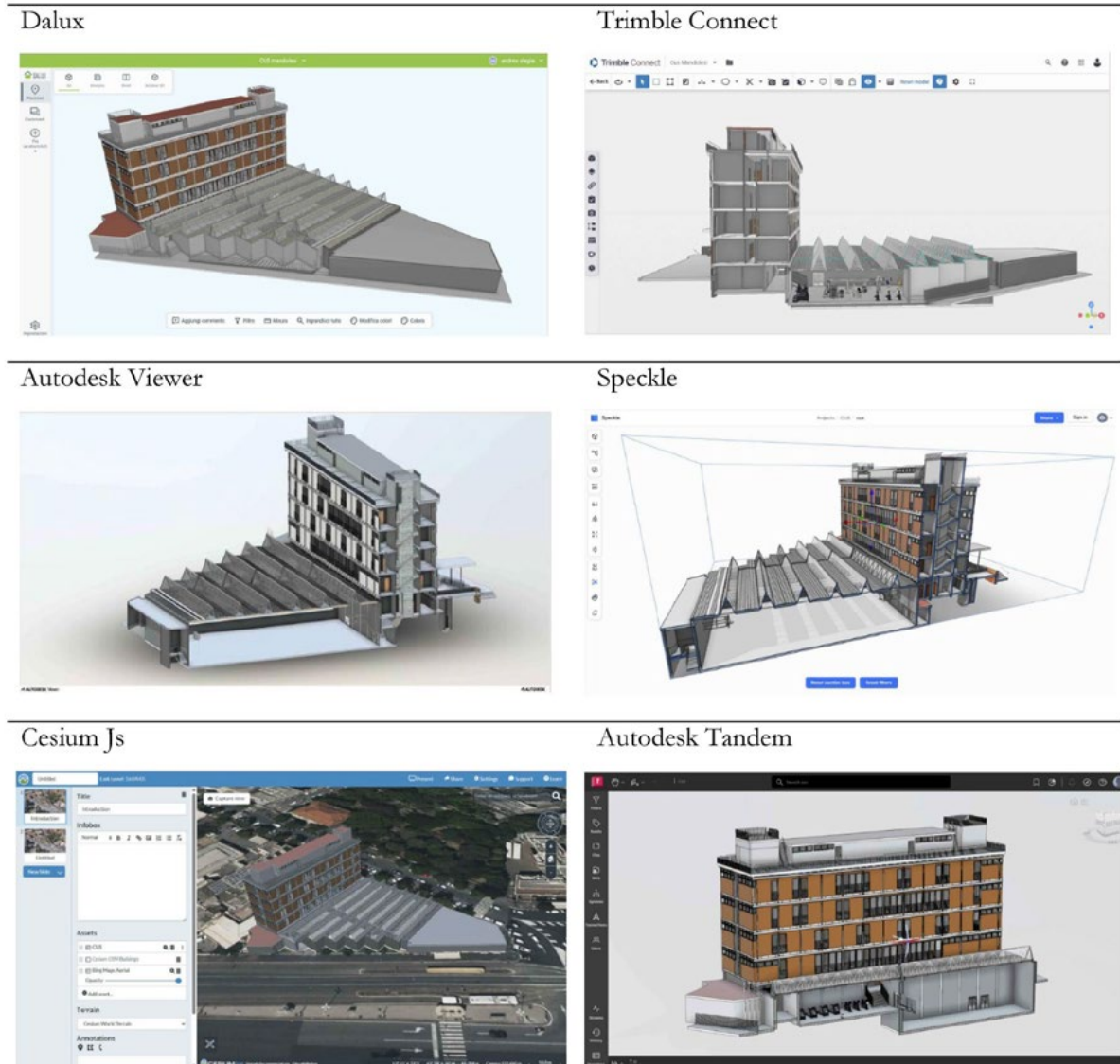


Fig. 4. Comparative visualization of the ORUR-CUS model in a selection of solutions: Dalux, Trimble Connect, Autodesk Viewer, Speckle, Cesium.js, and Autodesk Tandem (clockwise from top left).

Following the solution-by-solution analysis, the comparative matrix (fig. 5) identifies cross-patterns in accessibility, compatibility, and integration. Open-sources options such as Speckle and Cesium.js contrast with proprietary ecosystems, where free tiers are common but with different scopes. Native support for .rvt and IFC from Autodesk Viewer, Trimble Connect, and Fuzor handle both workflows directly or via dedicated plug-ins, while others rely on intermediate formats or constrained pipelines. Web-based access is provided natively by operations-oriented solutions (e.g., Trimble Connect, Autodesk Tandem, Azure Digital Twins, and, where applicable, Fuzor/Cesium), and missing in tools focused on model exchange or rendering.

		Autodesk Viewer	Dalux	Fuzor	Trimble Connect	Speckle (Three.js)	Twin Motion	Cesium Js	Autodesk Tandem	Azure Digital Twins	Matter Port
A c c e s s i b i l i t y	Open source	X	X	X	X	✓	X	✓	X	X	X
	Free Plan	✓	✓	X	✓	✓	✓	✓	✓	Need credit card info	✓
	Paid Plan	10 €/month	X	110 €/month base	13 €/month base	9 €/month base	505€/year + tax	149 €/month base	3400 \$/year base	Account based on credits	11 €/month base
C o m p a t i b i l i t y	.Rvt	✓	✓	X	✓	✓	✓	✓	✓	X	X
	.Ifc	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Others	Native with all the majors 3D formats: .3ds .fbx .obj .glTF .skp .dwg	A plugin in Revit enables automatic upload in Dalux	A plugin in Rhino 3D enables upload in Fuzor Native with .fbx .skp	A plugin in Revit enables automatic upload in Trimble Connect	A plugin in Revit enables automatic upload in Speckle	A plugin in Revit enables automatic upload in twinmotion	Native with .obj .fbx .glTF	Compatible only with .Rvt and .ifc	Native with .glTF	A plugin enables upload from Matterport to Revit
W e b b a s e d		✓	✓	X	✓	✓	X	✓	✓	✓	✓
I O T		X	X	✓	✓	X	X	✓	✓	✓	✓
F u n c t i o n a l i t y	Measure	✓	✓	X	✓	✓	X	✓	✓	X	✓
	Cut	✓	✓	X	✓	✓	X	X	✓	X	X
	Orbit	✓	✓	X	✓	✓	✓	✓	✓	X	✓
	Digital Walk	✓	Native support of Dalux 360° Camera SiteWalk	X	✓	X	X	X	✓	X	Native support of Matterport 360° Camera Guided Tour
	Explode	✓	X	X	X	✓	X	X	X	X	X
	Notes	✓	✓	X	✓	✓	X	✓	✓	X	✓
S h a r i n g		✓ Web-based Url No Account needed	✓ Web-based Url. Dalux account needed	X	✓ Web based Url No Account needed	✓ Web based Url No Account needed	X	✓ Web based Url No Account needed	✓ Web based Url Autodesk account needed	X	✓ Web-based Url Matterport account needed
L e a r n a b i l i t y		4/5	4/5	0/5	5/5	5/5	0/5	2/5	5/5	0/5	3/5

Fig. 5. Comparative matrix of the ten solutions summarizing accessibility, file compatibility (RVT/IFC), web/IoT support, core functions, sharing, and learnability.

From a functional point of view, the majority of the software and services cover essential review actions (measure/orbit/notes), but advanced interactions (section/cut, walk-through, explode) and dashboarding capabilities are concentrated in solutions designed for coordination or operations.

Overall, the matrix positions Trimble Connect and Autodesk Tandem as the most balanced for multi-stakeholder projects (sharing + IoT + lifecycle features), Speckle as the most agile and extensible for open workflows, and Autodesk Viewer as a low-friction baseline for faithful BIM publication.

#### 4. CONCLUSIONS

This research explored and evaluated ten digital-twin solutions of a sports-related industrial architecture, the ORUR-CUS complex in Rome, through a use-case-driven comparison. The results of this analysis are the first step towards implementing real-time tracking of humidity, temperature, illuminance, and air quality. Autodesk Tandem, thanks to its features, will be employed to host the BIM and gather data from the sensors. Afterwards, this data will be processed in the environment and compared to the different thresholds set within the building<sup>11</sup>.

For the gym area, the threshold will be set to give a warning for temperature and humidity outside the predefined ranges. This warning will activate an automation or send a notification to the users, allowing them to address the issue and change the real-time parameters in the physical world. As a result, it restores the link between the real model and the digital one.

Ultimately, future work will focus on enhancing comfort and operational oversight in a facility not initially designed to contemporary sustainability standards, with the primary goal of deploying the pilot, validating alert logic and response workflows, and evaluating the long-term impacts on comfort and energy performance.

---

<sup>11</sup> H. WANG, Y. QIAN, Y. KUANG, *ET AL.* *How occupant positioning systems can be applied to help historic residences manage energy consumption: a case study in China Build*, *Environ.*, 249, 2024, Article 111110, 10.1016/j.buildenv.2023.111110

GANGEMI EDITORE®  
INTERNATIONAL

FEBBRAIO 2026

[www.gangemeditore.it](http://www.gangemeditore.it)

