



Finanziato
dall'Unione europea
NextGenerationEU



Ministero
dell'Università
e della Ricerca



Italiadomani
PIANO NAZIONALE
DI RIPRESA E RESILIENZA

CHANGES
CULTURAL HERITAGE ACTIVE INNOVATION FOR NEX-GEN SUSTAINABLE SOCIETY
EXTENDED PARTNERSHIP

Thinking Outside the Black Box: Insights from a Digital Exhibition in the Humanities

Sebastian Barzaghi¹ – sebastian.barzaghi2@unibo.it

Alice Bordignon² – alice.bordignon2@unibo.it

Bianca Gualandi² – bianca.gualandi4@unibo.it

Silvio Peroni² – silvio.peroni@unibo.it

1 Department of Cultural Heritage, University of Bologna

2 Department of Classical Philology and Italian Studies, University of Bologna,



Finanziato
dall'Unione europea
NextGenerationEU



Ministero
dell'Università
e della Ricerca



Italiadomani
PIANO NAZIONALE
DI RIPRESA E RESILIENZA

CHANGES
CULTURAL HERITAGE ACTIVE INNOVATION FOR NEX-GEN SUSTAINABLE SOCIETY
EXTENDED PARTNERSHIP

Project CHANGES Spoke 4: goals

Focus: Impact that **digital cultural heritage (DCH)** has, comparing it with the current view on (in)tangible heritage – where DCH objects are defined through the **network of interlinked relations** they have with the cultural heritage environment and their provenance context, while (in)tangible objects are the result of selective processes defined and used by cultural heritage institutions during time.

How: By experimenting with different **templates of museums and art collections**, identified analysing ISTAT data, first designing pilot studies and best practices, further adapted and reused in institutions and contexts sharing similar characteristics.

Virtual technologies: knowledge graphs, Web-based environments, eXtended Reality, gamification, serious games, edutainment, 2D/3D models and multimedia, tools for digitization and simulation, Internet of Things and sensors networks, AI-based methods and tools, location-based technologies connected to GIS, etc.



Finanziato
dall'Unione europea
NextGenerationEU



Ministero
dell'Università
e della Ricerca



Italiadomani
PIANO NAZIONALE
DI RIPRESA E RESILIENZA

CHANGE\$
CULTURAL HERITAGE ACTIVE INNOVATION FOR NEX-GEN SUSTAINABLE SOCIETY
EXTENDED PARTNERSHIP

“Core” case studies

CSAC Parma



Museo Egizio di Torino

Parco letterario «Carlo Levi»



SMA Università di
Suor Orsola Benincasa



Collezione di
Geologia “Museo
Giovanni Capellini”



Reggia di Caserta



Parco letterario
«Grazia Deledda»



SMA Università di Ferrara



SMA Università di Torino



Pilot for gathering acquisition/digitisation guidelines

Before developing final solutions for the “core” case studies, we have identified a **scenario that could serve as a common experimental ground** for a multidisciplinary group. This pilot is being used as a **baseline to define some approaches and methods**.



Obtaining a digital version of the **temporary exhibition** (ended in May 2023) **The Other Renaissance: Ulisse Aldrovandi and the wonders of the world**, starting from its **digital twin**, organised and accessible online by users, using various devices (from home computers, smartphones, to tablets and VR headsets).



The need for a replicable approach

The methodologies used in the pilot need to be **replicable** in the “core” case studies. The image on the right provides a simplified but useful definition of the terms reproducible, replicable, robust and generalisable.

However, let's keep in mind that there are **many classifications of reproducibility and replicability**, to account for contexts and disciplines where researchers lack complete control over the conditions of their studies, or the studies are of a highly interpretative nature.

		Data	
		Same	Different
Analysis	Same	Reproducible	Replicable
	Different	Robust	Generalisable

Fig. 5 How the Turing Way defines reproducible research

The Turing Way Community. (2022). The Turing Way: A handbook for reproducible, ethical and collaborative research. Zenodo. doi: [10.5281/zenodo.3233853](https://doi.org/10.5281/zenodo.3233853).



Acquisition and digitisation process

Challenges:

- **High number of institutions involved**
- **Limited time and space for data acquisition**
- **Extremely varied size, materials, and nature of the objects**
Extremely varied **exhibition setup** (objects, display cases, environmental elements to capture,...)

Solutions:

- Careful and early **planning of acquisition/processing workflows and tools implementation** (cross polarisation, setup schemas,...)
- Careful and early **planning of data and metadata models**
- Real-time and simultaneous collection of **metadata relating to processes and methodologies**

Digital Applications in Archaeology and Cultural Heritage 32 (2024) e00309



Contents lists available at ScienceDirect

Digital Applications in Archaeology and Cultural Heritage

journal homepage: www.elsevier.com/locate/daach



Saving temporary exhibitions in virtual environments: The Digital Renaissance of Ulisse Aldrovandi – Acquisition and digitisation of cultural heritage objects

Roberto Balzani^a, Sebastian Barzaghi^b, Gabriele Bitelli^c, Federica Bonifazi^d, Alice Bordignon^d, Luca Cipriani^e, Simona Colitti^e, Federica Collina^{b,*}, Marilena Daquino^d, Francesca Fabbri^b, Bruno Fanini^f, Filippo Fantini^e, Daniela Ferdani^f, Giulia Fiorini^{c,g}, Elena Formia^c, Anna Forte^c, Federica Giacomini^b, Valentina Alena Girelli^c, Bianca Gualandri^{d,h}, Ivan Heibi^d, Alessandro Iannucci^b, Rachele Manganelli Del Fà^b, Arcangelo Massari^d, Arianna Moretti^d, Silvio Peroni^d, Sofia Pescarin^b, Giulia Renda^d, Diego Ronchi^d, Mattia Sullini^e, Maria Alessandra Tini^f, Francesca Tomasi^d, Laura Travaglini^c, Luca Vittuari^c

^a Department of History and Cultures, University of Bologna, Piazza S. Giovanni in Monte, 2, 40124, Bologna, BO, Italy

^b Department of Cultural Heritage, University of Bologna, Via Degli Ariani, 1, 46121, Ravenna, RA, Italy

^c Department of Civil, Chemical, Environmental, and Materials Engineering, University of Bologna, Viale Del Risorgimento, 2, 40136, Bologna, BO, Italy

^d Department of Classical Philology and Art Studies, University of Bologna, Via Zamboni, 32, 40126, Bologna, BO, Italy

^e Department of Architecture, University of Bologna, Viale Del Risorgimento, 2, 40136, Bologna, BO, Italy

^f Digital Heritage Innovation Lab, Institute of Heritage Science, National Research Council, Via Salaria km 29, 300010, Montelibretti, Rome, RM, Italy

^g Department of Classics, Sapienza University of Rome, Piazzale Aldo Moro 5, 00185, Roma, Italy

^h Digital Heritage Innovation Lab, Institute of Heritage Science, National Research Council, Via Madonna Del Piano, 10, 50019, Sesto Fiorentino, FI, Florence, Italy

* Research Services Coordination Unit, Research Division, University of Bologna, Via Zamboni, 32, 40126, Bologna, BO, Italy

ARTICLE INFO

Keywords:
Digital cultural heritage objects
Digital twins
Photogrammetry
Preservation of temporary exhibitions
Structured light projection scanning

ABSTRACT

As per the objectives of Project CHANGES, particularly its thematic sub-project on the use of virtual technologies for museums and art collections, our goal was to obtain a digital twin of the temporary exhibition on Ulisse Aldrovandi called ‘The Other Renaissance’, and make it accessible to users online. After a preliminary study of the exhibition, focusing on acquisition constraints and related solutions, we proceeded with the digital twin creation by acquiring, processing, modelling, optimising, exporting, and metadating the exhibition. We made hybrid use of two acquisition techniques to create new digital cultural heritage objects and environments, and we used open technologies, formats, and protocols to make available the final digital product. Here, we describe the process of collecting and curating bibliographical exhibition (meta) data and the beginning of the digital twin creation to foster its findability, accessibility, interoperability, and reusability. The creation of the digital twin is currently ongoing.

1. Introduction

Several international policies support the focus on the universal use of digital data. Expressly, on Cultural Heritage (CH), both UNESCO and the EU have already provided clear guidelines for increasing the digitisation of heritage, considering aspects related to cataloguing systems as well as different ways for accessing cultural heritage objects and sites (e.g. *in situ* or decentralised). However, in the Italian context, expert

users often perceive CH as composed of tangible and intangible artefacts. In particular, Italian legislation and established and shared practices focused primarily on using material objects. To comply with current European policies and guidelines on CH, we need to go beyond this configuration and make its digital enhancement a permanent and widespread practice in museums and art collections, aiming at (a) increasing the knowledge, curation and management of artefacts in all forms, (b) expanding the involvement of the general public and

* Corresponding author.
E-mail address: federica.collina5@unibo.it (F. Collina).

<https://doi.org/10.1016/j.daach.2023.e00309>
Received 27 August 2023; Received in revised form 7 December 2023; Accepted 20 December 2023
Available online 23 December 2023
2212-0548/© 2023 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>).



Finanziato
dall'Unione europea
NextGenerationEU



Ministero
dell'Università
e della Ricerca

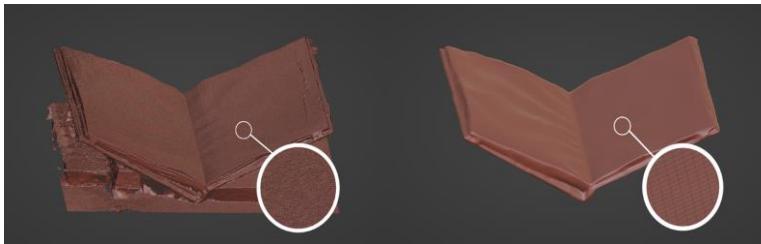
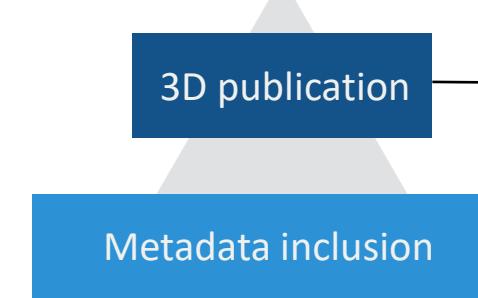


Italiadomani
PIANO NAZIONALE
DI RIPRESA E RESILIENZA

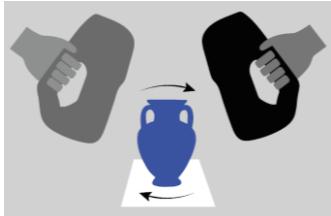
CHANGE\$
CULTURAL HERITAGE ACTIVE INNOVATION FOR NEX-GEN SUSTAINABLE SOCIETY
EXTENDED PARTNERSHIP

The workflow

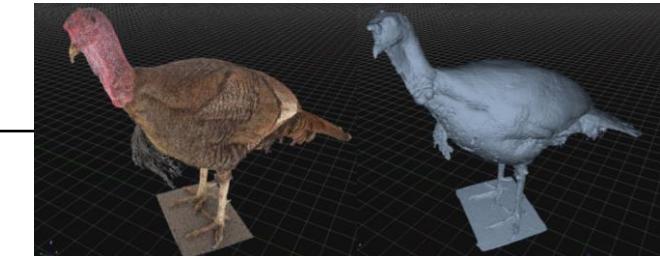
This same approach is being followed
across all phases of the project



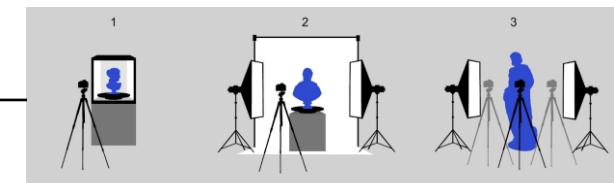
Reconstruction and retopology



Structured light projection scanner



Structure from Motion (SfM) software



Photogrammetry



Finanziato
dall'Unione europea
NextGenerationEU



Ministero
dell'Università
e della Ricerca

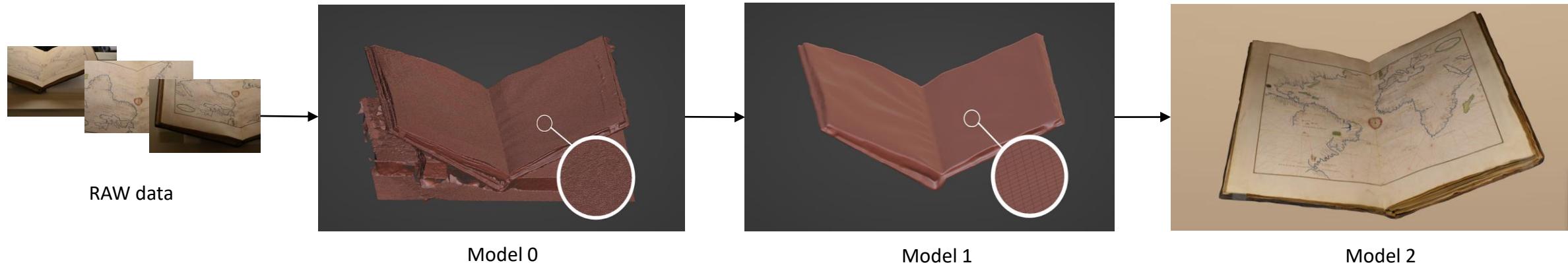


Italiadomani
PIANO NAZIONALE
DI RIPRESA E RESILIENZA

CHANGE\$
CULTURAL HERITAGE ACTIVE INNOVATION FOR NEX-GEN SUSTAINABLE SOCIETY
EXTENDED PARTNERSHIP

Data manipulation and Interpretation transparency

Storing different **derivative versions** for each 3D model:



Downloading, when possible, a **processing report** from the software used

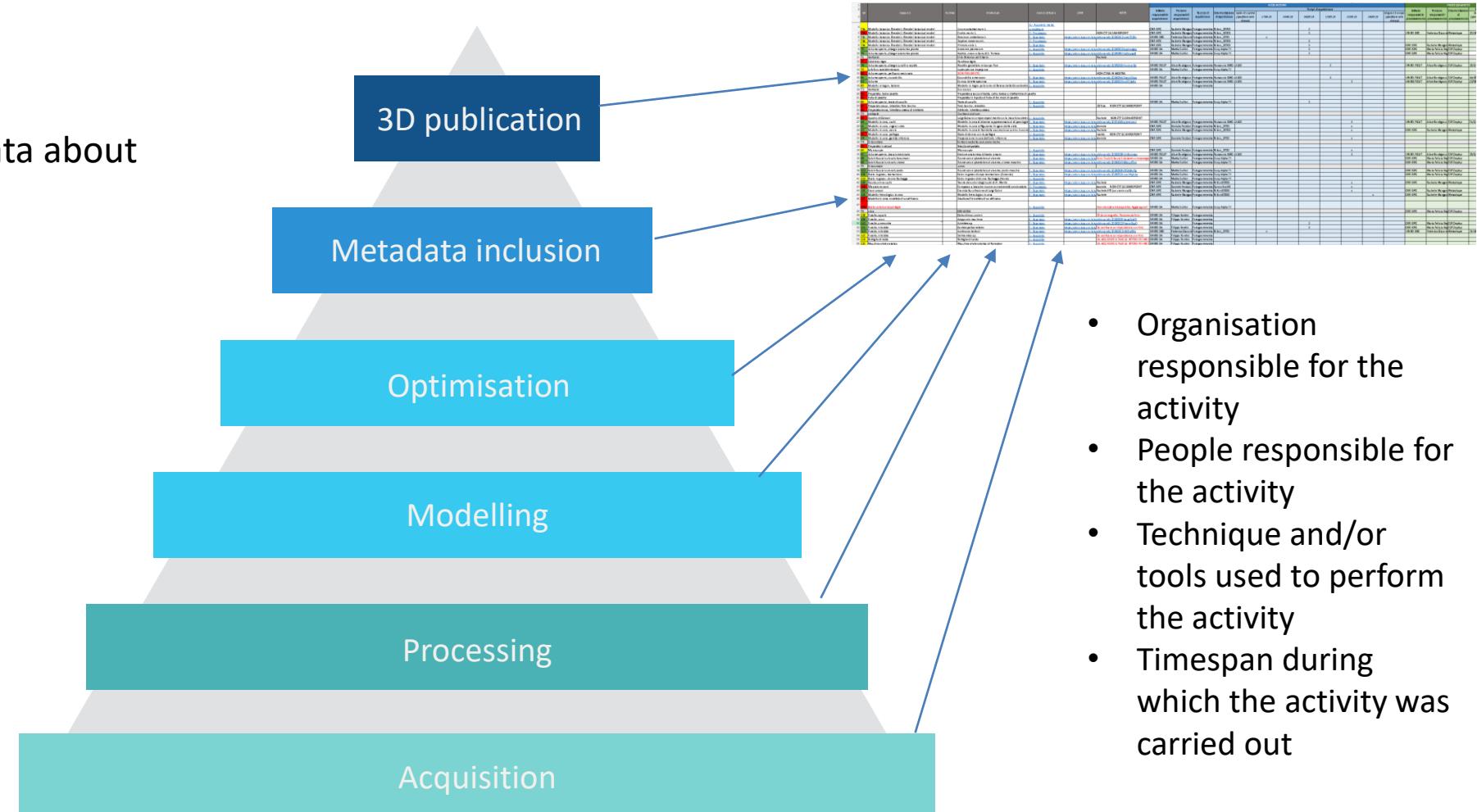
Using **interoperable formats** for each data level to allow access from different platforms



The workflow

Process Table for storing data about the digitisation process

Creation of a digitisation record for each object that includes metadata related to each step and their outputs (e.g. acquired model, processed model, optimised model, etc.)





The objects

Object Table for storing data about the physical objects

Creation of a cataloguing description for each object, based on official museum records and notes

Controlled data values aligned with existing vocabularies and authority lists

ID	Object ID	Title	Description	Type	Techniques	Materials	Dimensions	Weight	Condition	Origin	Date	Author	Curator	Collection	Keeper	Notes
1	OB1	Antique Roman Glass Vessel	A small, squat vessel made of translucent green glass.	Ceramic	Blown glass	Green glass	Height: 10 cm, Diameter: 15 cm	1.5 kg	Good condition	Rome, Italy	1st century BC	Unknown	Conservator A	Collection 1	Keeper 1	Notes 1
2	OB2	Medieval Islamic Gold Ring	A gold ring with intricate geometric patterns and a central stone.	Jewelry	Gold	Gold	Width: 2 mm, Length: 15 mm	0.5 g	Excellent condition	Iran, Middle East	10th century AD	Archaeologist B	Conservator B	Collection 2	Keeper 2	Notes 2
3	OB3	Neolithic Stone Axe	A large, polished stone axe with a straight edge and a pointed tip.	Tool	Stone	Obsidian	Length: 30 cm	2 kg	Good condition	Europe	4th millennium BC	Archaeologist C	Conservator C	Collection 3	Keeper 3	Notes 3
4	OB4	Renaissance Silver Goblet	A silver goblet with a flared base and a decorative rim.	Jewelry	Silver	Silver	Height: 15 cm, Diameter: 10 cm	1.2 kg	Very good condition	Italy, Renaissance	16th century AD	Archaeologist D	Conservator D	Collection 4	Keeper 4	Notes 4
5	OB5	Victorian Porcelain Figurine	A porcelain figurine of a seated figure, possibly a deity or a historical figure.	Ceramic	Porcelain	Porcelain	Height: 12 cm	0.8 kg	Good condition	England	19th century AD	Archaeologist E	Conservator E	Collection 5	Keeper 5	Notes 5
6	OB6	Art Deco Glass Vase	A tall, slender glass vase with a flared top and geometric patterns.	Ceramic	Blown glass	Clear glass	Height: 25 cm, Diameter: 8 cm	1.8 kg	Good condition	France	1920s	Archaeologist F	Conservator F	Collection 6	Keeper 6	Notes 6
7	OB7	Classical Greek Terracotta Figurine	A terracotta figurine of a female figure, possibly a goddess.	Ceramic	Clay	Clay	Height: 18 cm	1.2 kg	Good condition	Greece	5th century BC	Archaeologist G	Conservator G	Collection 7	Keeper 7	Notes 7
8	OB8	Medieval Islamic Gold Ring	A gold ring with intricate geometric patterns and a central stone.	Jewelry	Gold	Gold	Width: 2 mm, Length: 15 mm	0.5 g	Excellent condition	Iran, Middle East	10th century AD	Archaeologist H	Conservator H	Collection 8	Keeper 8	Notes 8
9	OB9	Neolithic Stone Axe	A large, polished stone axe with a straight edge and a pointed tip.	Tool	Stone	Obsidian	Length: 30 cm	2 kg	Good condition	Europe	4th millennium BC	Archaeologist I	Conservator I	Collection 9	Keeper 9	Notes 9
10	OB10	Renaissance Silver Goblet	A silver goblet with a flared base and a decorative rim.	Jewelry	Silver	Silver	Height: 15 cm, Diameter: 10 cm	1.2 kg	Very good condition	Italy, Renaissance	16th century AD	Archaeologist J	Conservator J	Collection 10	Keeper 10	Notes 10
11	OB11	Victorian Porcelain Figurine	A porcelain figurine of a seated figure, possibly a deity or a historical figure.	Ceramic	Porcelain	Porcelain	Height: 12 cm	0.8 kg	Good condition	England	19th century AD	Archaeologist K	Conservator K	Collection 11	Keeper 11	Notes 11
12	OB12	Art Deco Glass Vase	A tall, slender glass vase with a flared top and geometric patterns.	Ceramic	Blown glass	Clear glass	Height: 25 cm, Diameter: 8 cm	1.8 kg	Good condition	France	1920s	Archaeologist L	Conservator L	Collection 12	Keeper 12	Notes 12
13	OB13	Classical Greek Terracotta Figurine	A terracotta figurine of a female figure, possibly a goddess.	Ceramic	Clay	Clay	Height: 18 cm	1.2 kg	Good condition	Greece	5th century BC	Archaeologist M	Conservator M	Collection 13	Keeper 13	Notes 13
14	OB14	Medieval Islamic Gold Ring	A gold ring with intricate geometric patterns and a central stone.	Jewelry	Gold	Gold	Width: 2 mm, Length: 15 mm	0.5 g	Excellent condition	Iran, Middle East	10th century AD	Archaeologist N	Conservator N	Collection 14	Keeper 14	Notes 14
15	OB15	Neolithic Stone Axe	A large, polished stone axe with a straight edge and a pointed tip.	Tool	Stone	Obsidian	Length: 30 cm	2 kg	Good condition	Europe	4th millennium BC	Archaeologist O	Conservator O	Collection 15	Keeper 15	Notes 15
16	OB16	Renaissance Silver Goblet	A silver goblet with a flared base and a decorative rim.	Jewelry	Silver	Silver	Height: 15 cm, Diameter: 10 cm	1.2 kg	Very good condition	Italy, Renaissance	16th century AD	Archaeologist P	Conservator P	Collection 16	Keeper 16	Notes 16
17	OB17	Victorian Porcelain Figurine	A porcelain figurine of a seated figure, possibly a deity or a historical figure.	Ceramic	Porcelain	Porcelain	Height: 12 cm	0.8 kg	Good condition	England	19th century AD	Archaeologist Q	Conservator Q	Collection 17	Keeper 17	Notes 17
18	OB18	Art Deco Glass Vase	A tall, slender glass vase with a flared top and geometric patterns.	Ceramic	Blown glass	Clear glass	Height: 25 cm, Diameter: 8 cm	1.8 kg	Good condition	France	1920s	Archaeologist R	Conservator R	Collection 18	Keeper 18	Notes 18
19	OB19	Classical Greek Terracotta Figurine	A terracotta figurine of a female figure, possibly a goddess.	Ceramic	Clay	Clay	Height: 18 cm	1.2 kg	Good condition	Greece	5th century BC	Archaeologist S	Conservator S	Collection 19	Keeper 19	Notes 19
20	OB20	Medieval Islamic Gold Ring	A gold ring with intricate geometric patterns and a central stone.	Jewelry	Gold	Gold	Width: 2 mm, Length: 15 mm	0.5 g	Excellent condition	Iran, Middle East	10th century AD	Archaeologist T	Conservator T	Collection 20	Keeper 20	Notes 20

- Titles
- Identifiers
- Types
- Techniques
- Subjects
- Roles of people involved
- Collections
- Keepers
- ...



Finanziato
dall'Unione europea
NextGenerationEU



Ministero
dell'Università
e della Ricerca



Italiadomani
PIANO NAZIONALE
DI RIPRESA E RESILIENZA

CHANGE\$
CULTURAL HERITAGE ACTIVE INNOVATION FOR NEX-GEN SUSTAINABLE SOCIETY
EXTENDED PARTNERSHIP

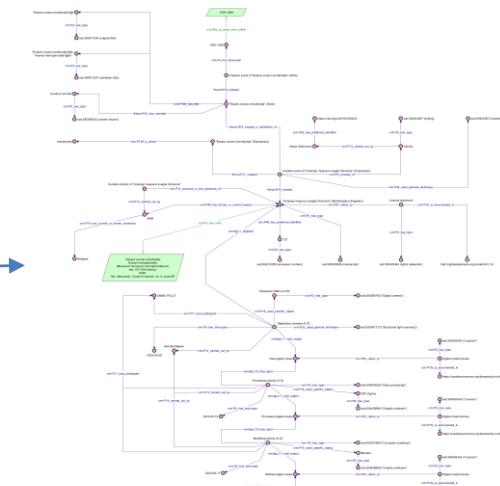
Towards transparent data publishing

RDF representation of physical objects, digital counterparts and digitisation workflow

Reuse of

- CIDOC CRM for representing objects and contextual data
- CRMdig for representing the digitisation stages

CIDOC
CRM
CRMdig





Strengths of our approach

Any reality-capture or source-based model is affected by the lens of interpretation (of a human or software) → **tracking steps for the creation of a 3D model is essential to give transparency to these interpretations**, facilitating the repeatability of the creation process.

Metadata and documentation relating to **processes** (who does what, when) and **methodologies** (how and why) need to be **collected while the research is ongoing**, or the information is lost.

Furthermore, “The Other Renaissance” was a **temporary exhibition**: objects on loan have been returned, and the rooms where the exhibition took place have changed use → the documentation of the process makes it possible to judge (at least to a certain extent) the **relationship between the digital twin and the physical collection**.

This information is crucial for scientific scrutiny but would otherwise have been lost on the day the temporary exhibition closed.



Challenges and possible solutions

Documenting the project workflow in this manner requires **careful planning, specific competencies, and it is extremely time-consuming**. Additionally, like so many other important research activities, these efforts are **not rewarded by** current academic evaluation systems → <https://coara.eu/>

Data curation practices, Data Management Plans and other Open Science practices are becoming more common but more needs to be done:

- more **explicit attention needs to be devoted to research methodologies**,
- **guidelines on how to report study protocols, methodologies and procedures** are needed, especially in the (digital) humanities.

A careful documentation of the study design, data collection, and analysis techniques help reflect and make explicit all possible influencing factors and is a fundamental tool for reliability and rigour and for opening the “black box” of research.



Finanziato
dall'Unione europea
NextGenerationEU



Ministero
dell'Università
e della Ricerca



Italiadomani
PIANO NAZIONALE
DI RIPRESA E RESILIENZA

CHANGES
CULTURAL HERITAGE ACTIVE INNOVATION FOR NEX-GEN SUSTAINABLE SOCIETY
EXTENDED PARTNERSHIP

Thank you!