

Extending the Extended Matrix with CIDOC-CRM *Paradata for Virtual Reconstruction Processes & Beyond*

Elisabetta C. Giovannini¹, Emanuel Demetrescu²

¹*Department of Architecture and Design – DAD, Politecnico di Torino* | elisabettacaterina.giovannini@polito.it

²*Institute of Heritage Science, ISPC – CNR* | emanuel.demetrescu@cnr.it

**Extending the Extended Matrix With CIDOC-CRM.
*Paradata for Virtual Reconstruction Processes & Beyond***

UNESCO Chair on Digital Cultural Heritage

*Second Webinar on Defining Paradata, Metadata & Data
for Documenting 2D/3D Digital Cultural Heritage (DCH)*

Friday 17th May 2024. 12:00-16:00 UCT. Online MS Teams



***Developed in the archaeological field
but potentially scalable with respect to the topic
of VIRTUAL RECONSTRUCTIONS at large***



Extended Matrix

For knowledge data organization

- Facilitate the discovery of archaeological datasets and support the interpretation and reuse of data by defining a semantic structure that can describe the complexity of the built environment
- Create links to all available documentation (historical sources, archival sources, maps, images, 3D etc.)

Interoperable approach

Foster data interoperability by developing an ontological model to document archaeological buildings and architectural heritage

**Extending the Extended Matrix With CIDOC-CRM.
Paradata for Virtual Reconstruction Processes & Beyond**

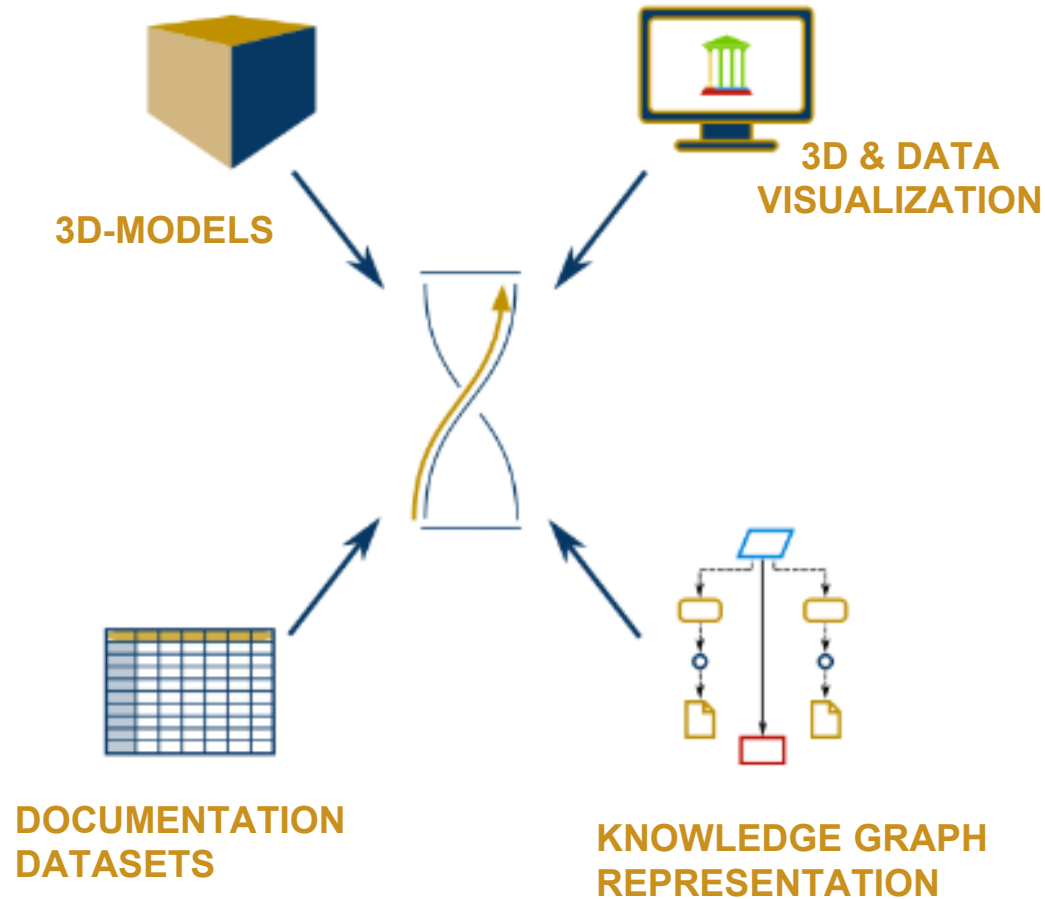
UNESCO Chair on Digital Cultural Heritage
Second Webinar on Defining Paradata, Metadata & Data
for Documenting 2D/3D Digital Cultural Heritage (DCH)

Friday 17th May 2024. 12:00-16:00 UCT. Online MS Teams





OPENSOURCE ECOSYSTEM EXTENDED MATRIX FRAMEWORK [EMF]



EM is about scientific-driven content creation,
EMF is about technological-driven solutions.

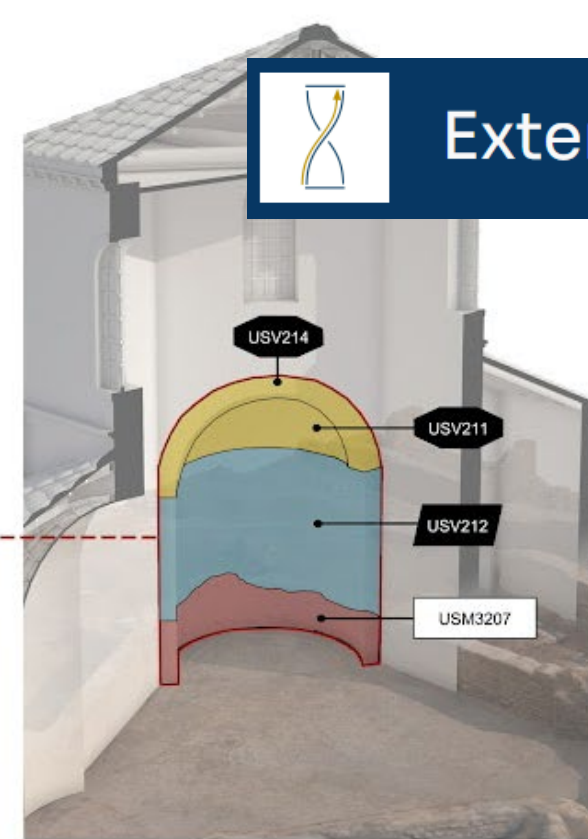
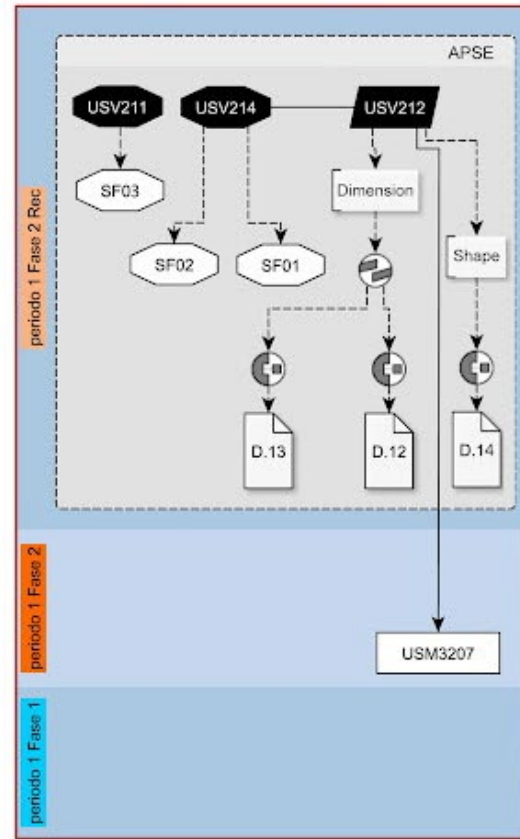
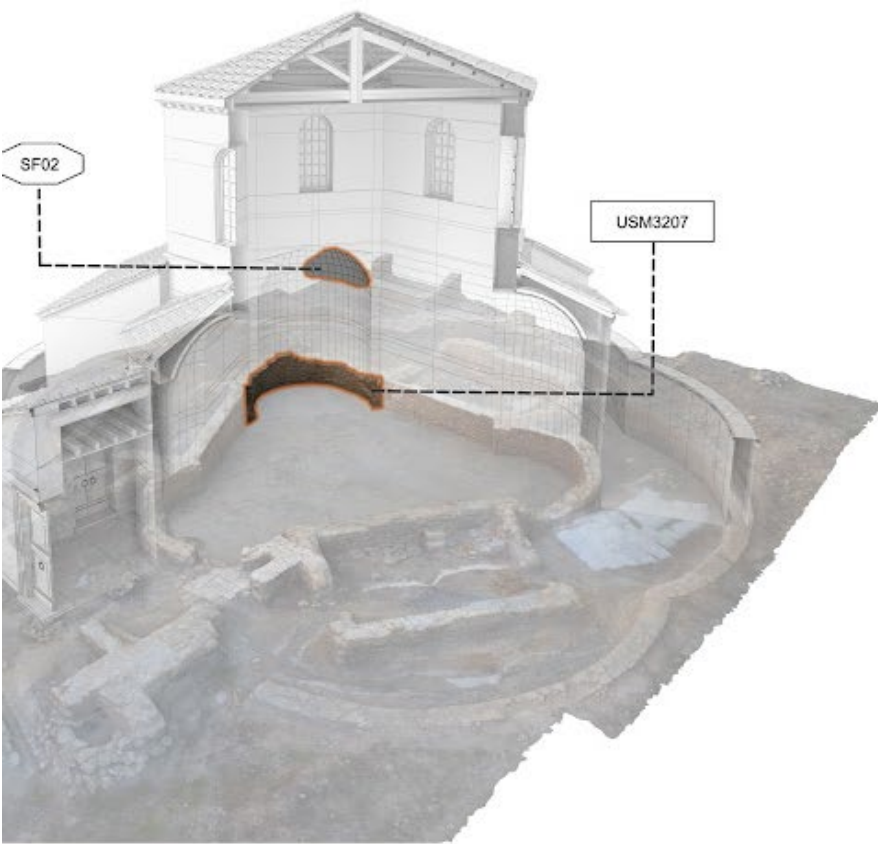
Every version of the EM has an equivalent EMF digital framework identified by the same number (at present EM 1.3 has its EMF 1.3).

Tools available in the **EMF 1.3:**

- EMviq (3DWeb-app)
- EMtools (add-on for Blender 3D)
- 3DSC (add-on for Blender 3D)



extendedmatrix.org



Extended Matrix

EXAMPLE

APSE	PROPERTIES	INFOS	INTERPRETATION	SOURCES
USV 212	EXISTENCE: SHAPE: DIMENSION: MATERIAL:	CERTAIN APSE DIAM. 16 Ft HEIGHT. 24 Ft LIMESTONE + WHITE PLASTER	EVIDENCES COMPARISONS 3D SURVEY DEDUCTION EVIDENCES	USM 3207 LATE ROMAN BUILDING (D.14) 3D MODEL (D.12) THEORY OF PROPORTION (D. 13) USM 3207 (<i>IN-SITU</i>) – EA 01 ; EA 2 (<i>NON-IN-SITU</i>)

Extending the Extended Matrix With CIDOC-CRM. Paradata for Virtual Reconstruction Processes & Beyond

UNESCO Chair on Digital Cultural Heritage
 Second Webinar on Defining Paradata, Metadata & Data for Documenting 2D/3D Digital Cultural Heritage (DCH)

Elisabetta C. Giovannini, Emanuel Demetrescu

Friday 17th May 2024. 12:00-16:00 UCT. Online MS Teams



LRM_{oo}
Library Reference Model

PRESS_{oo}
Model for publishing of periodicals

CRM_{inf}
Argumentation model

CRM_{archaeo}
Excavation Model

CRM_{sci}
Scientific observation model

CRM_{geo}
Spatiotemporal model

CRM_{dig}
Model for provenance metadata

CRM_{ba}
Model for Archaeological Buildings

CRM_{tex}
Model for the study of ancient texts

CRM_{soc}
Model for Social Phenomena

CRM_{act}
Model for Activity Plan

 **Extended Matrix**

INTEROPERABILITY

Ability of computer systems or software to exchange and make use of information



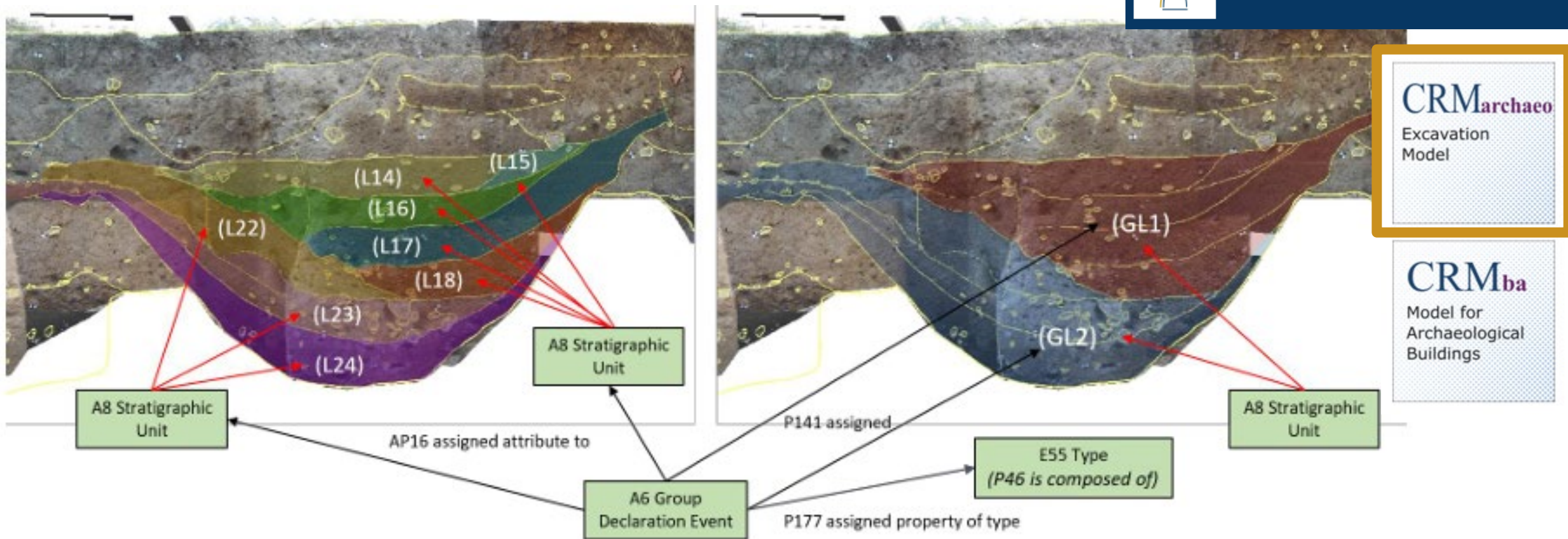
ISO 21127:2006 > ISO 21127:2014 > **ISO 21127:2023**

The CIDOC Conceptual Reference Model (CRM) is a theoretical and practical tool for information integration in the field of Cultural Heritage.





Extended Matrix



Definition of the CRM_{archaeo} - An Extension of CRM_{base} to support the archaeological excavation process, Approved by CIDOC CRM - SIG
 Editorial Status: Stable Version 2.1.1 April 2024

Extending the Extended Matrix With CIDOC-CRM.
 Paradata for Virtual Reconstruction Processes & Beyond

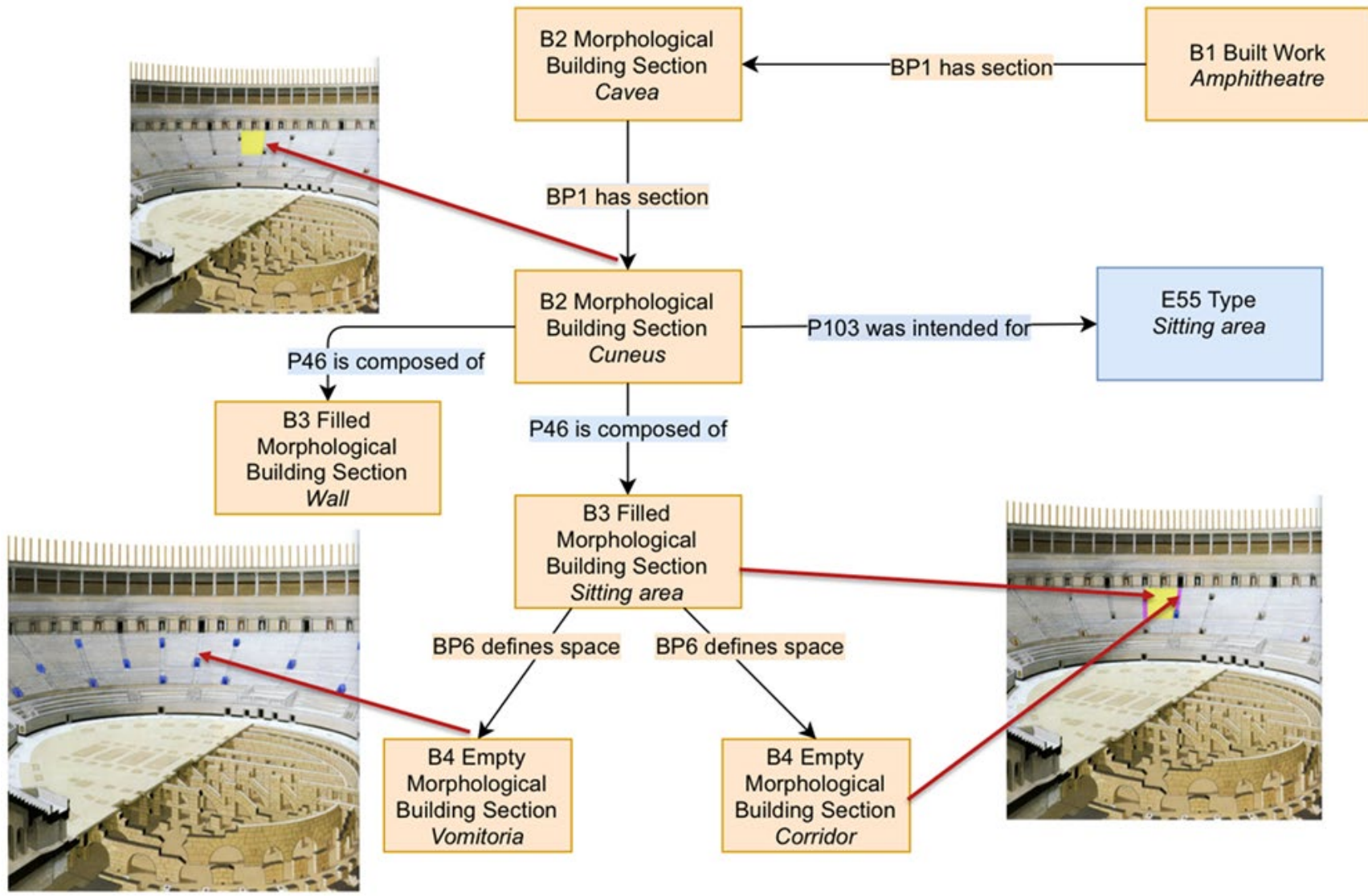
UNESCO Chair on Digital Cultural Heritage
 Second Webinar on Defining Paradata, Metadata & Data
 for Documenting 2D/3D Digital Cultural Heritage (DCH)

Friday 17th May 2024. 12:00-16:00 UCT. Online MS Teams





Extended Matrix



CRM_{archaeo}
Excavation Model

CRM_{ba}
Model for Archaeological Buildings

Paola Ronzino, Anna Toth, and Bianca Falcidieno. 2022. Documenting the Structure and Adaptive Reuse of Roman Amphitheatres through the CIDOC CRM_{ba} Model. *J. Comput. Cult. Herit.* 15, 2, Article 36 (June 2022), 23 pages. <https://doi.org/10.1145/3485466>

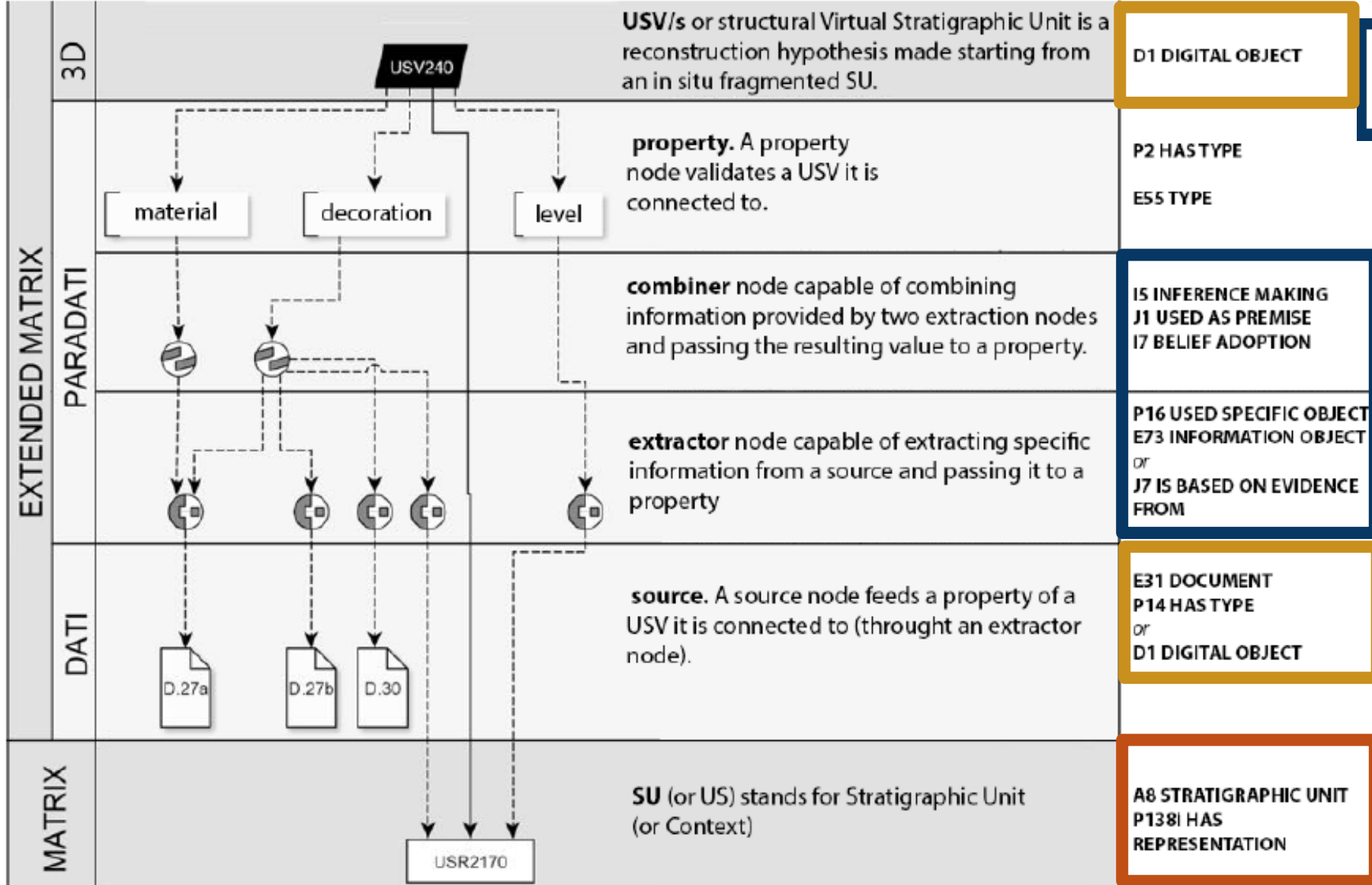
Extending the Extended Matrix With CIDOC-CRM. Paradata for Virtual Reconstruction Processes & Beyond

UNESCO Chair on Digital Cultural Heritage
Second Webinar on Defining Paradata, Metadata & Data for Documenting 2D/3D Digital Cultural Heritage (DCH)

Elisabetta C. Giovannini, Emanuel Demetrescu

Friday 17th May 2024. 12:00-16:00 UCT. Online MS Teams





D1 DIGITAL OBJECT

Extended Matrix

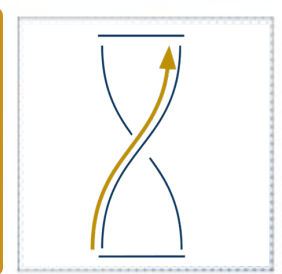
P2 HASTYPE
E55 TYPE

I5 INFERENCE MAKING
J1 USED AS PREMISE
I7 BELIEF ADOPTION

P16 USED SPECIFIC OBJECT
E73 INFORMATION OBJECT
OR
J7 IS BASED ON EVIDENCE FROM

E31 DOCUMENT
P14 HAS TYPE
OR
D1 DIGITAL OBJECT

A8 STRATIGRAPHIC UNIT
P138I HAS REPRESENTATION

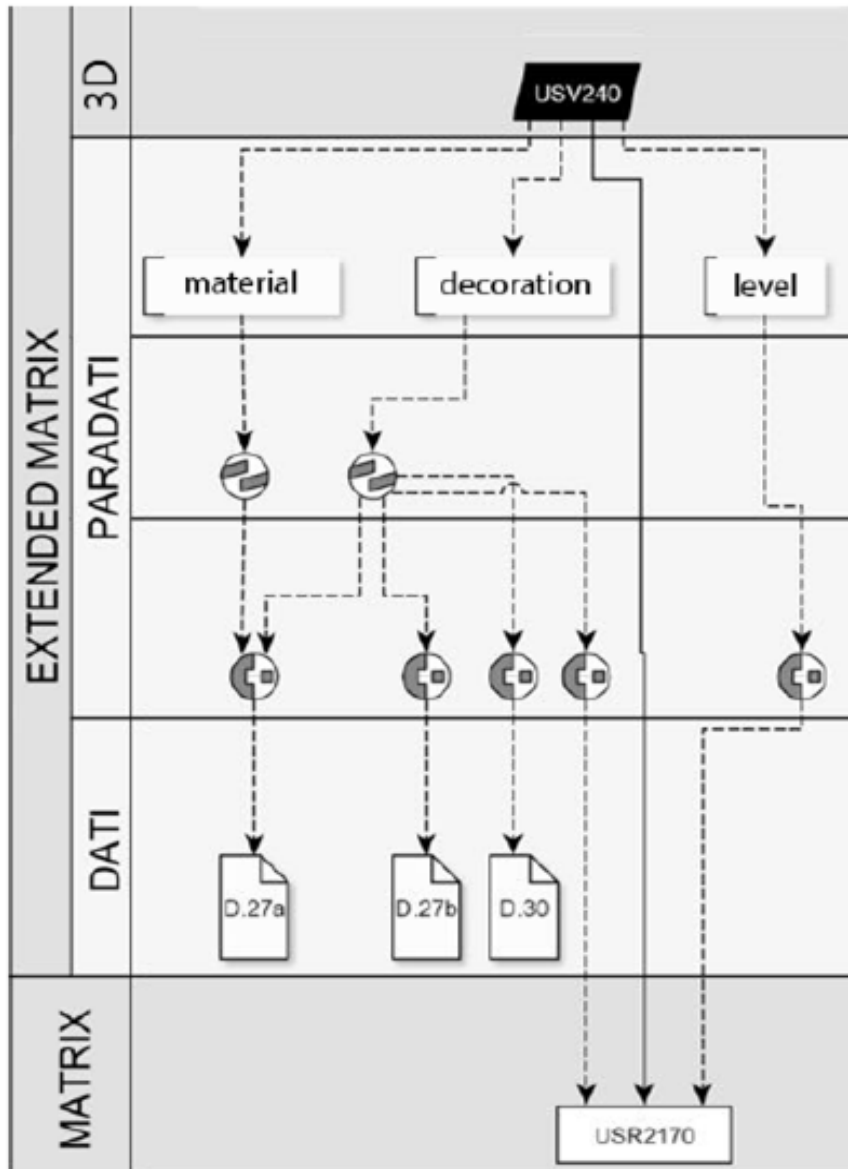


Extending the Extended Matrix With CIDOC-CRM.
Paradata for Virtual Reconstruction Processes & Beyond

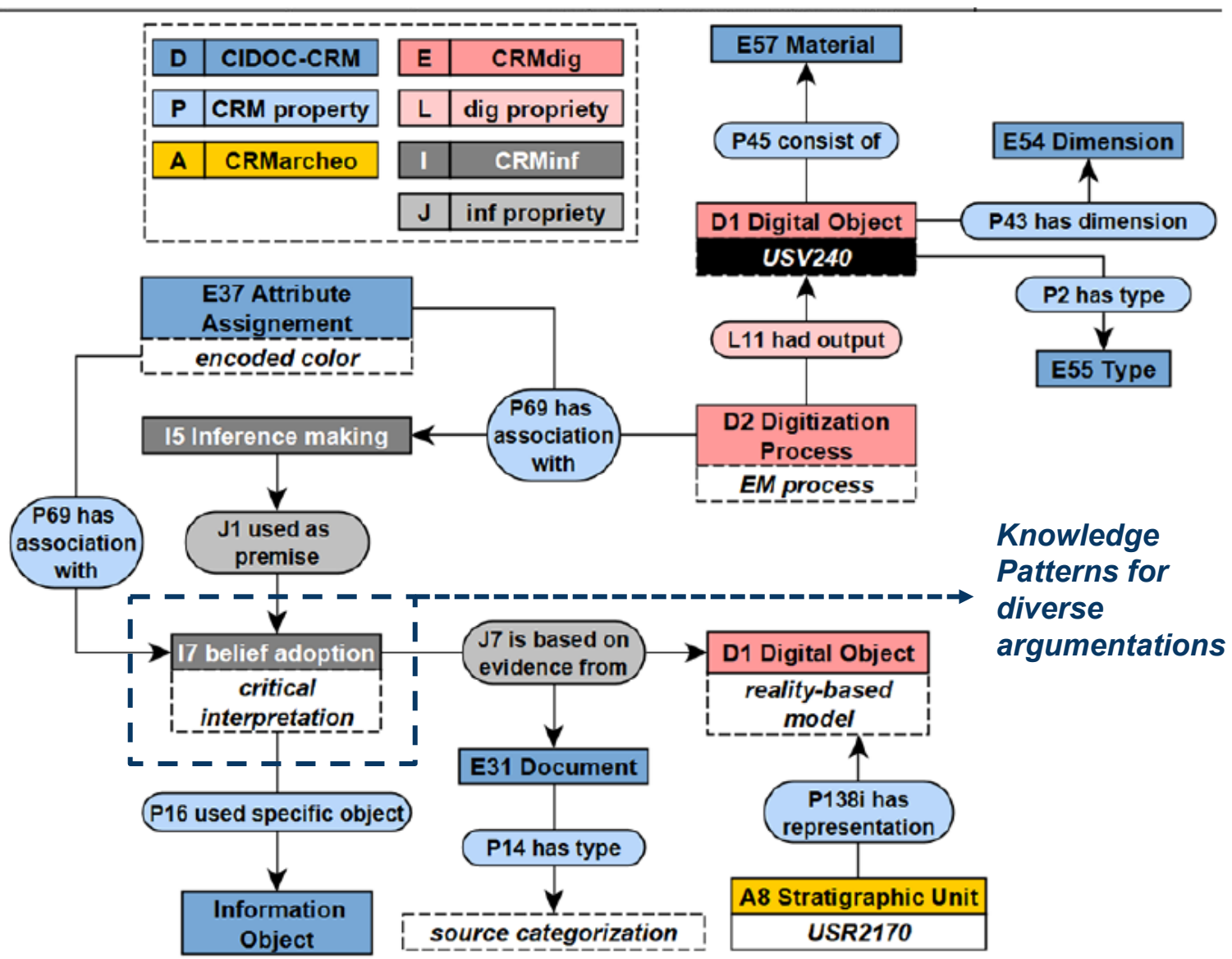
UNESCO Chair on Digital Cultural Heritage
Second Webinar on Defining Paradata, Metadata & Data
for Documenting 2D/3D Digital Cultural Heritage (DCH)

Friday 17th May 2024. 12:00-16:00 UCT. Online MS Teams





MAPPING BETWEEN EXTENDED MATRIX AND CIDOC-CRM



Knowledge Patterns for diverse argumentations

Extending the Extended Matrix With CIDOC-CRM. Paradata for Virtual Reconstruction Processes & Beyond

UNESCO Chair on Digital Cultural Heritage
Second Webinar on Defining Paradata, Metadata & Data for Documenting 2D/3D Digital Cultural Heritage (DCH)

Friday 17th May 2024. 12:00-16:00 UCT. Online MS Teams





Extended Matrix

The Extended Matrix (EM extendedmatrix.org) is an Open Science project that allows to create, visualize, explore and share online a complete 3D scene by using free and open source platforms (EMF) with the support of a community. EM allows you (expert of Cultural Heritage involved in a reconstruction process) to:

- support your reconstructive pipeline;
- organizes the complexity of your reasonings;
- map the amount of sources employed;
- declare the reliability of your final proposals;
- present your final results both with a graph and a 3D model and much more.

Copy to clipboard

Go to Tool or service

Details

CATEGORISATION

Activity Modeling Annotating Collaborating

Keyword 3D framework

Standard CIDOC CRM

CONTEXT

See also <https://doi.org/10.3390/heritage6020069>

AUTHOR

Emanuel Demetrescu
Istituto di Scienze del Patrimonio Culturale



Extended Matrix

EM SERVICE

On Social Sciences and Humanities Open Marketplace

About SSHOC

[Home](#) / [About SSHOC](#)

Accelerating Interdisciplinary Research and Collaboration in the Social Sciences and Humanities

Social Sciences & Humanities Open Cloud (SSHOC) is a project funded by the EU framework programme Horizon 2020 and unites 20 partner organisations and their 27 associates in developing the social sciences and humanities area of the **European Open Science Cloud (EOSC)**.

SSHOC partners include both developing and fully established European Research Infrastructures from the social sciences and humanities, and the association of European research libraries (LIBER). Between them, they have expertise across the entire data cycle from creation and curation to optimal re-use, training and advocacy.

During the 40-month lifespan of the project, (from January 2019 to April 2022) SSHOC will transform the current social sciences & humanities data landscape with its disciplinary silos and separate facilities into an integrated, cloud-based network of interconnected data infrastructures.

To promote synergies and open science initiatives between disciplines, and accelerate interdisciplinary research and collaboration, these data infrastructures will be supported by the **tools** and **training** which allow scholars and researchers to **access, process, analyse, enrich and compare data across the boundaries of individual repositories or institutions**.

SSHOC will continuously monitor ongoing developments in the EOSC so as to conform to the necessary technical and other requirements for making the SSHOC services sustainable beyond the duration of the project.



Extending the Extended Matrix With CIDOC-CRM. Paradata for Virtual Reconstruction Processes & Beyond

UNESCO Chair on Digital Cultural Heritage
Second Webinar on Defining Paradata, Metadata & Data for Documenting 2D/3D Digital Cultural Heritage (DCH)

Friday 17th May 2024. 12:00-16:00 UCT. Online MS Teams

Elisabetta C. Giovannini, Emanuel Demetrescu

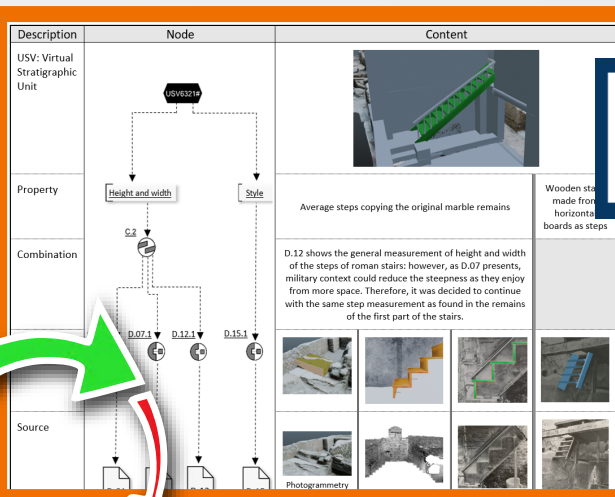


merging tangible and intangible datatables, graphs and 3D



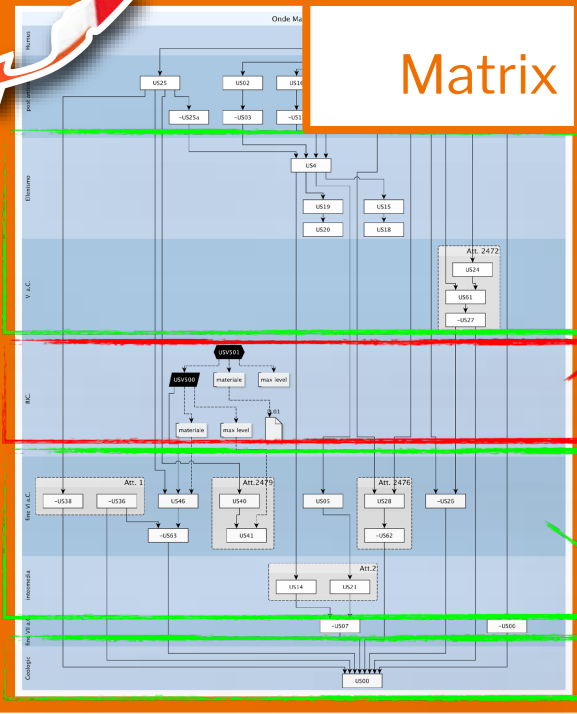
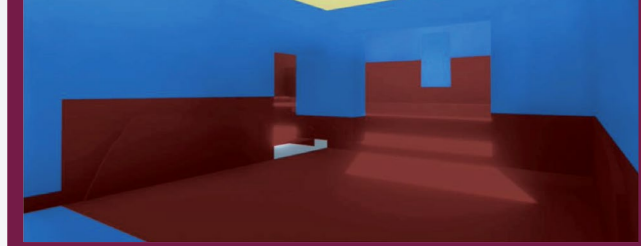
Name	Description	Uri	Property that can validate	or	
D.01	Photogrammetric model		Geometry, material		
D.02	St. Peter's Church in an engraving by E. Dodwell (1834)	F.M. CIFARELLI - M.J. STRAZZULLA (a cura di); Il Museo Archeologico di Segni. Il percorso espositivo - 2. Il suburbio, il territorio, la città medievale, Segni 2004 e ristampa 2014 (con versione in inglese), P.26	Shape and extent of the temple foundation; preservation of the cistern; three rows of blocks left cell		
D.03	Reconstructive hypothesis of the Castrum	F.M. CIFARELLI - F. COLAIACOMO - M. J. STRAZZULLA; Il Museo archeologico di Segni - Il percorso espositivo - 2. Il suburbio e il territorio, la città medievale, Segni 2004, pag. 25	Site morphology		Perspective drawing
D.04	Medieval spolia incorporated in St. Peter's Church	F.M. CIFARELLI - F. COLAIACOMO - M. J. STRAZZULLA; Il Museo archeologico di Segni - Il percorso espositivo - 2. Il suburbio e il territorio, la città medievale, Segni 2004, pp. 27-28	Architectural details		Photo
D.05	Castrum area in the early Middle Ages	F.M. CIFARELLI - F. COLAIACOMO - M. J. STRAZZULLA; Il Museo archeologico di Segni - Il percorso espositivo - 2. Il suburbio e il territorio, la città medievale, Segni 2004	Site morphology		Perspective drawing
D.06	Survey of archaeological	F.M. CIFARELLI - F. COLAIACOMO - M. J. STRAZZULLA; Il Museo archeologico di Segni	Planimetric survey		Planimetry

Sources



Extended Matrix

Visualization



Matrix

3D model

Extending the Extended Matrix With CIDOC-CRM. Paradata for Virtual Reconstruction Processes & Beyond

UNESCO Chair on Digital Cultural Heritage
Second Webinar on Defining Paradata, Metadata & Data for Documenting 2D/3D Digital Cultural Heritage (DCH)

Elisabetta C. Giovannini, Emanuel Demetrescu

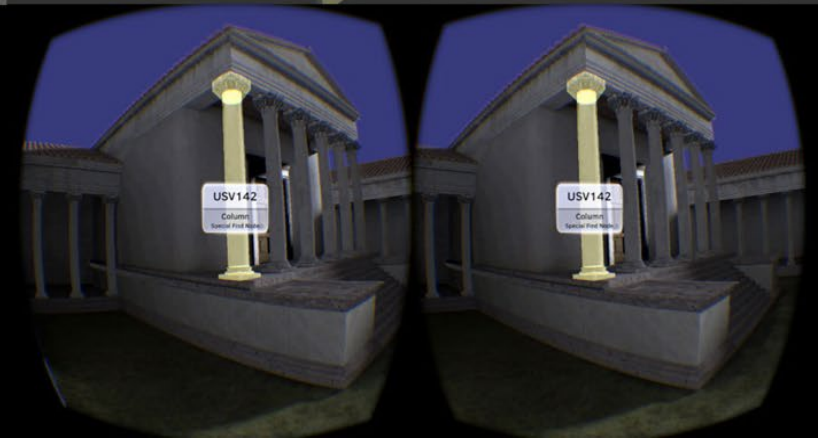
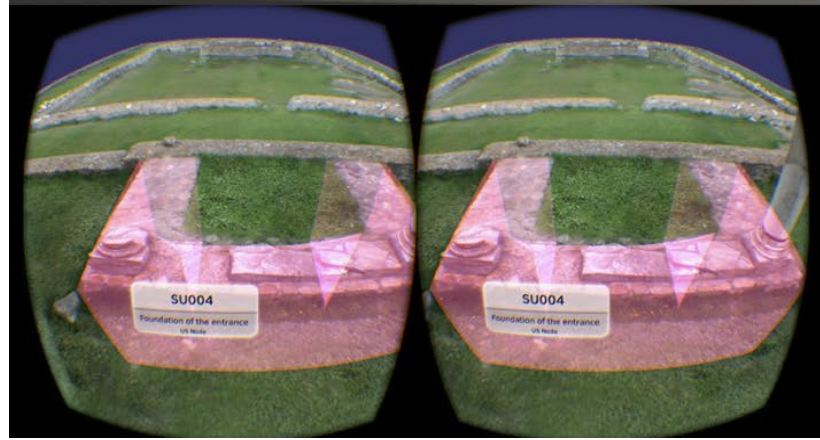
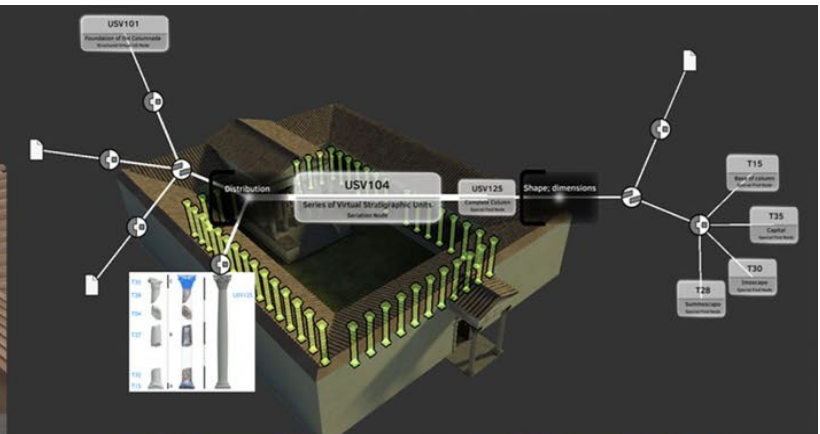
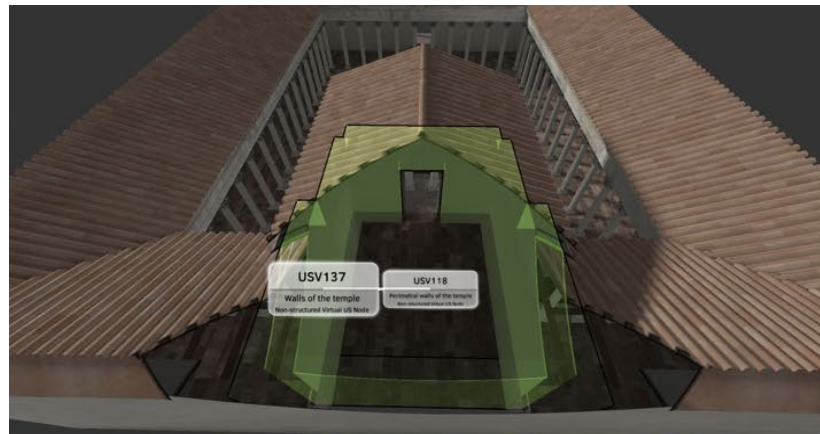
Friday 17th May 2024. 12:00-16:00 UCT. Online MS Teams





Extended Matrix

EMviq tool



EMviq

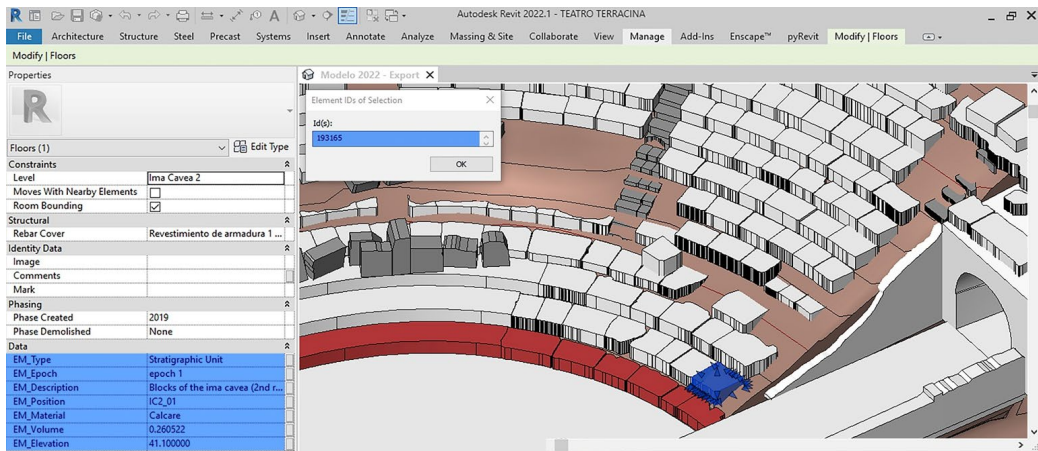
web-app, based on ATON, allowing to visualise, explore, share 3D models and 3D scenes

Extending the Extended Matrix With CIDOC-CRM. Paradata for Virtual Reconstruction Processes & Beyond

UNESCO Chair on Digital Cultural Heritage
Second Webinar on Defining Paradata, Metadata & Data for Documenting 2D/3D Digital Cultural Heritage (DCH)

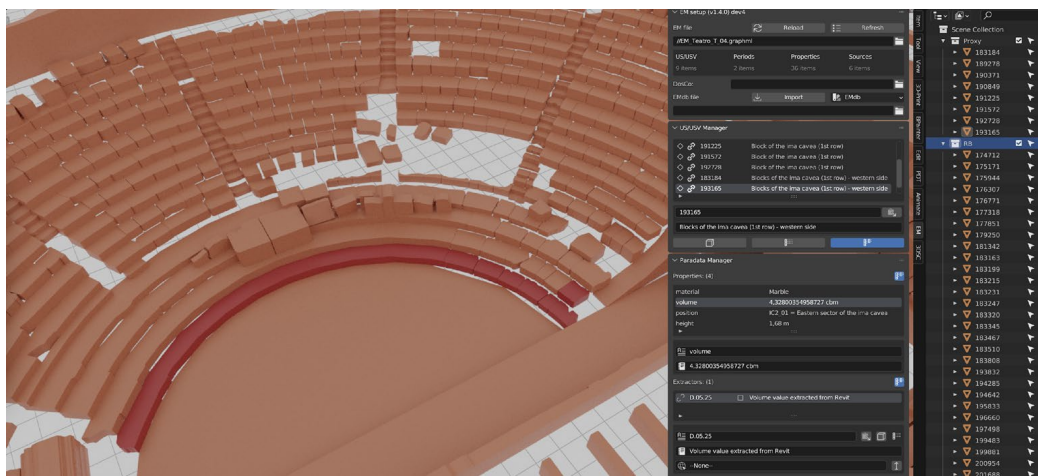
Friday 17th May 2024. 12:00-16:00 UCT. Online MS Teams





EM – BIM work in progress

- VPL scripts (data export and import) need further testing.
- HBIM and EM can be linked
- It is possible to exchange geometries and paradata from Revit to Blender and vice versa.
- The approach enables collaborative teamwork
- HBIM and EM can be linked using standards (e.g. IFC)
- Future implementation: automatic or semi-automatic procedure in Dynamo or standalone software



Extending the Extended Matrix With CIDOC-CRM. Paradata for Virtual Reconstruction Processes & Beyond

UNESCO Chair on Digital Cultural Heritage
Second Webinar on Defining Paradata, Metadata & Data for Documenting 2D/3D Digital Cultural Heritage (DCH)

Friday 17th May 2024. 12:00-16:00 UCT. Online MS Teams





Sirmione

Brescia, LOMBARDIA



Extended Matrix

Funded project



Sapienza Università di Roma
Dipartimento di Storia, Disegno e Restauro dell'Architettura



Università degli Studi di Bari Aldo Moro
Dipartimento di Ricerca e Innovazione Umanistica



Università di Bologna
Dipartimento di Storia Culture Civiltà



Università della Campania L. Vanvitelli
Dipartimento di Lettere e Beni Culturali



Università degli Studi di Foggia
Dipartimento di studi umanistici



Università degli Studi di Napoli Federico II
Dipartimento di Studi Umanistici



Università degli Studi di Padova
Dipartimento dei Beni Culturali: archeologia, storia dell'arte, del cinema e della musica



Università degli Studi della Toscana
Dipartimento di Scienze Umanistiche, della Comunicazione e del Turismo



Università di Verona
Dipartimento Culture e Civiltà



Scuola Archeologica Italiana di Atene

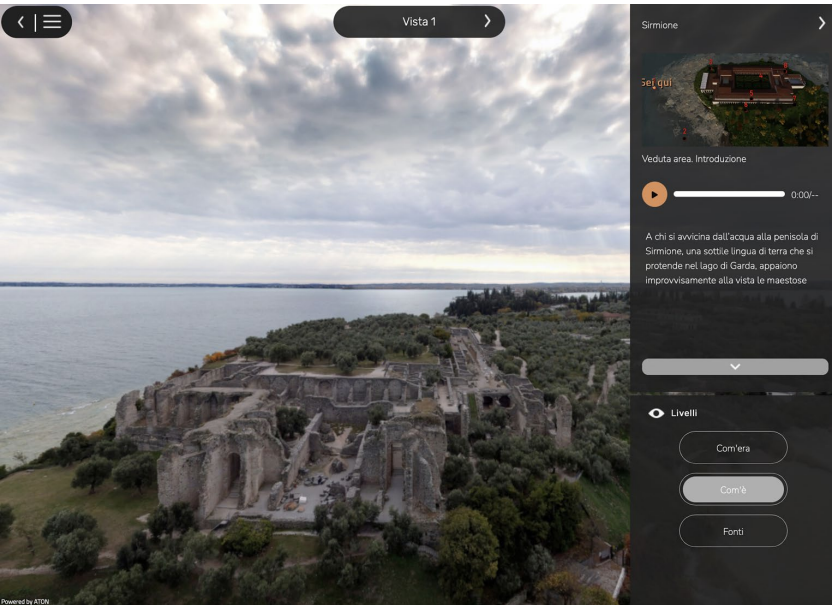
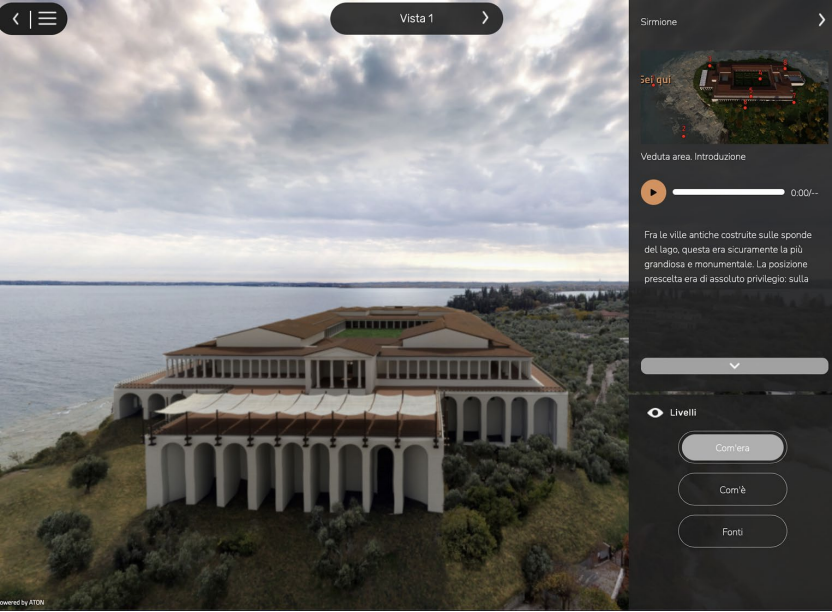


Extending the Extended Matrix With CIDOC-CRM. Paradata for Virtual Reconstruction Processes & Beyond

UNESCO Chair on Digital Cultural Heritage
Second Webinar on Defining Paradata, Metadata & Data for Documenting 2D/3D Digital Cultural Heritage (DCH)

Friday 17th May 2024. 12:00-16:00 UCT. Online MS Teams

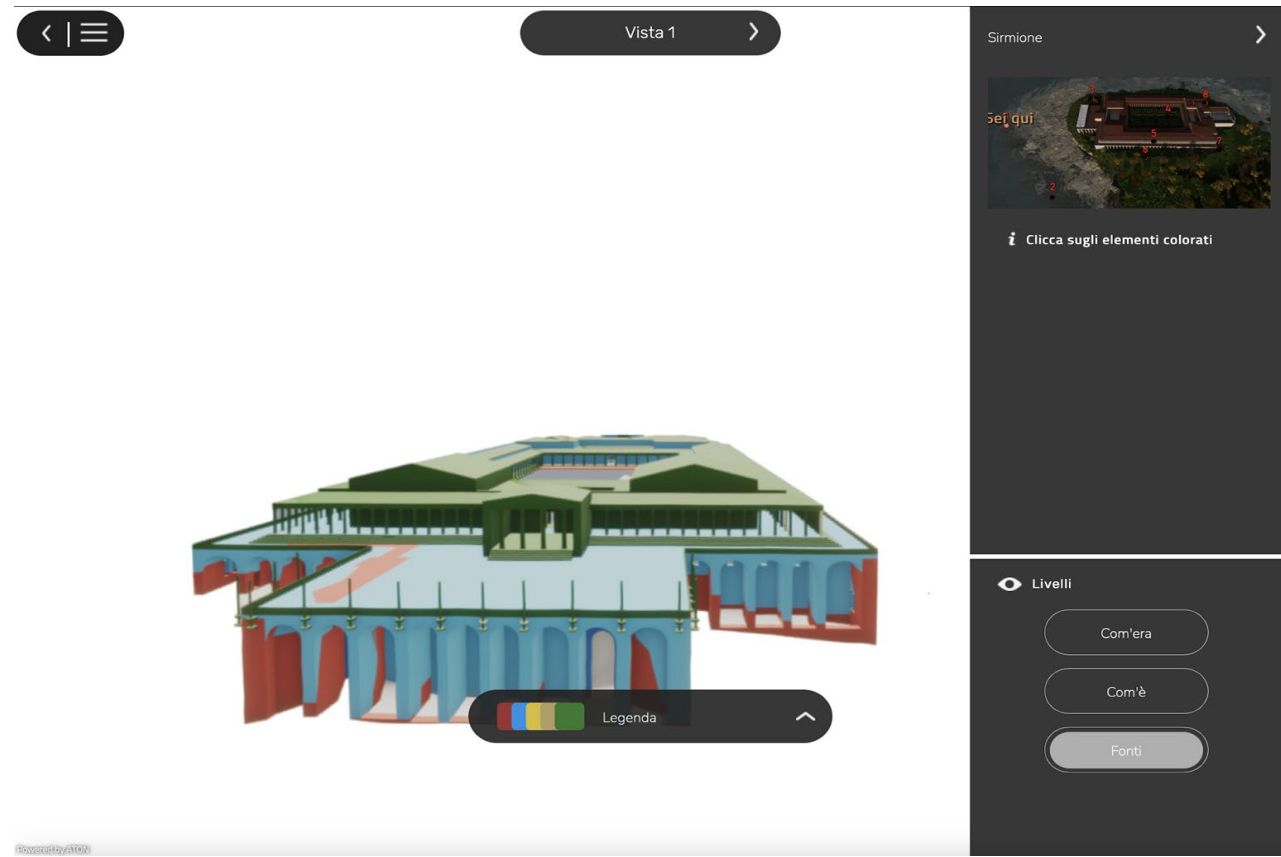
Elisabetta C. Giovannini, Emanuel Demetrescu



3d.e-archeo.it



Storytelling & Narratives



Extending the Extended Matrix With CIDOC-CRM.
Paradata for Virtual Reconstruction Processes & Beyond

UNESCO Chair on Digital Cultural Heritage
Second Webinar on Defining Paradata, Metadata & Data for Documenting 2D/3D Digital Cultural Heritage (DCH)

Friday 17th May 2024. 12:00-16:00 UCT. Online MS Teams

Elisabetta C. Giovannini, Emanuel Demetrescu



Sito internet:

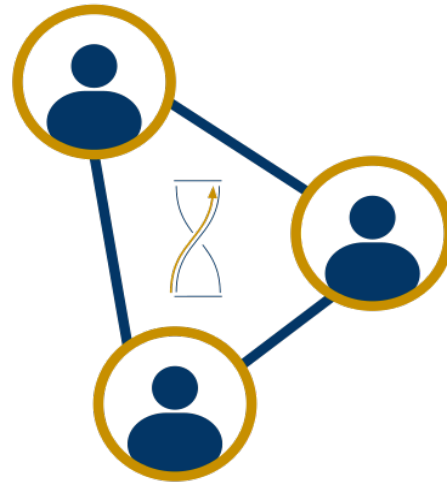
www.extendedmatrix.org

Facebook:

Extended Matrix Community

Telegram channels:

- EM User Group
- 3DSC User group
- Aton Framework - Open group



Monthly Live sessions
EM hour

1° and 3° Thursday
Every of month
14:30 CET

2022

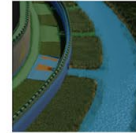


e-Archeo project

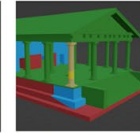


The Roman forum of Nora (Sardinia, IT)

2021



The Late Roman defensive walls of Aquileia (FVG, IT)



The Roman temple of Segni (Lazio, IT)



The Roman theatre of Catania (Sicily, IT)

2020

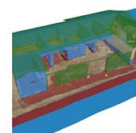


The Roman Villa of Aliano (Tuscany, IT)

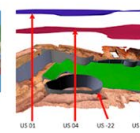


The forum of Augustus (Rome)

2019



The forgery of Montebelluna (Veneto, IT)

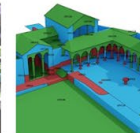


The necropolis of Banditaccia (Lazio, IT)

2018



Amba Aradam, Metro C Station (Rome)

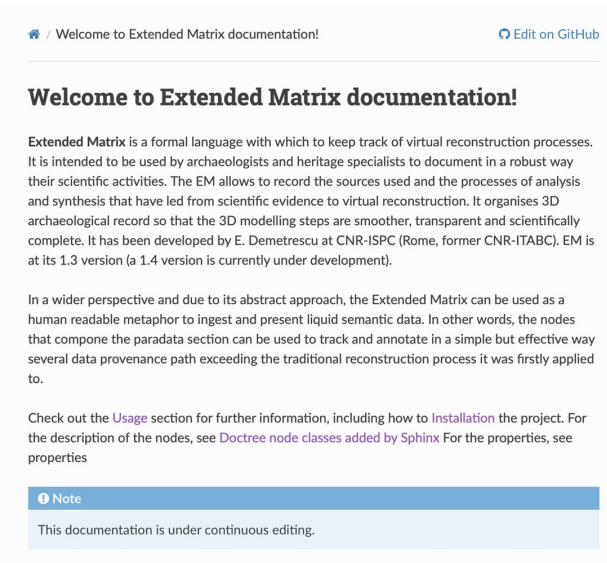
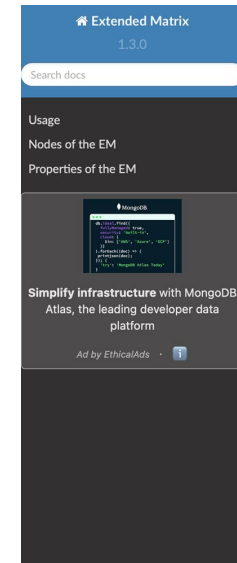


Villa fuori Porta Marina (Lazio, IT)



Extended Matrix

COMMUNITY group



Extending the Extended Matrix With CIDOC-CRM.
Paradata for Virtual Reconstruction Processes & Beyond

UNESCO Chair on Digital Cultural Heritage

Second Webinar on Defining Paradata, Metadata & Data for Documenting 2D/3D Digital Cultural Heritage (DCH)

Friday 17th May 2024. 12:00-16:00 UCT. Online MS Teams



EM 1.0

EM 1.1

EM 1.2

EM 1.3
3DSC
Emtools
EMviq



2015

2017

2021

2023

2024

Extended Matrix

Where we are

- **Managing data provenance in heterogeneous situations:** archaeological excavations, 3D surveys, geophysical investigations, analysis of degradation surfaces, sampling for invasive and non-invasive analyses
- **Produce**, manage and publish online (ATON - EMviq) scientifically validated **reconstructive hypotheses**
- Making **interpretation processes** accessible and repeatable according to **Open Science** and **FAIR** principles
- Connecting **3D and knowledge graphs** and also heterogeneous data (tables, graphs, drawings, cards, photographs, audio, video, etc.)
- **Time extension for HBIM** and GIS platforms through stratigraphic deconstruction
- Producing **information layers for digital twins**
- **Open Source** ecosystem based on **python, Blender, Aton** and extendable to other software being adopted
- **Vibrant community** of users and developers in Italy, Spain, Macedonia, Germany, Sweden, Israel, Romania
- **10+ active PhD** on the use and implementation of EM

Extending the Extended Matrix With CIDOC-CRM.
Paradata for Virtual Reconstruction Processes & Beyond

UNESCO Chair on Digital Cultural Heritage

Second Webinar on Defining Paradata, Metadata & Data
for Documenting 2D/3D Digital Cultural Heritage (DCH)

Friday 17th May 2024. 12:00-16:00 UCT. Online MS Teams



EM core

E. Demetrescu

Working on the formal language itself

EMtools

Development of the Blender add-on



Extended Matrix

Where we want to go

COMMUNITY INTEREST groups

EMviq

B. Fanini

Joining forces with the ATON community

EM TSU

Eleonora Scopinaro

EM, 3D GIS and HBIM

E. C. Giovannini
A. Sanseverino

Integration with other tools

Cristina Gonzalez Esteban

Including and sharing knowledge with the UR and other initiatives

EM and CIDOC-CRM

E. C. Giovannini

Creating compatibility mapping between EM and CIDOC-CRM

Extending the Extended Matrix With CIDOC-CRM.
Paradata for Virtual Reconstruction Processes & Beyond

UNESCO Chair on Digital Cultural Heritage

Second Webinar on Defining Paradata, Metadata & Data for Documenting 2D/3D Digital Cultural Heritage (DCH)

Friday 17th May 2024. 12:00-16:00 UCT. Online MS Teams

