A Methodology for a 3D Digitisation Project

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MNEMOSYNE

Cyprus University of Technology

THANK YOU

WELCOME

unesco

Chair

REKA3D

epic poetry

CALLIOPE.

history

CLIO.

comedy

MALIA.

astronomy

URANIA.

United Nations Educational, Scientific and Cultural Organization

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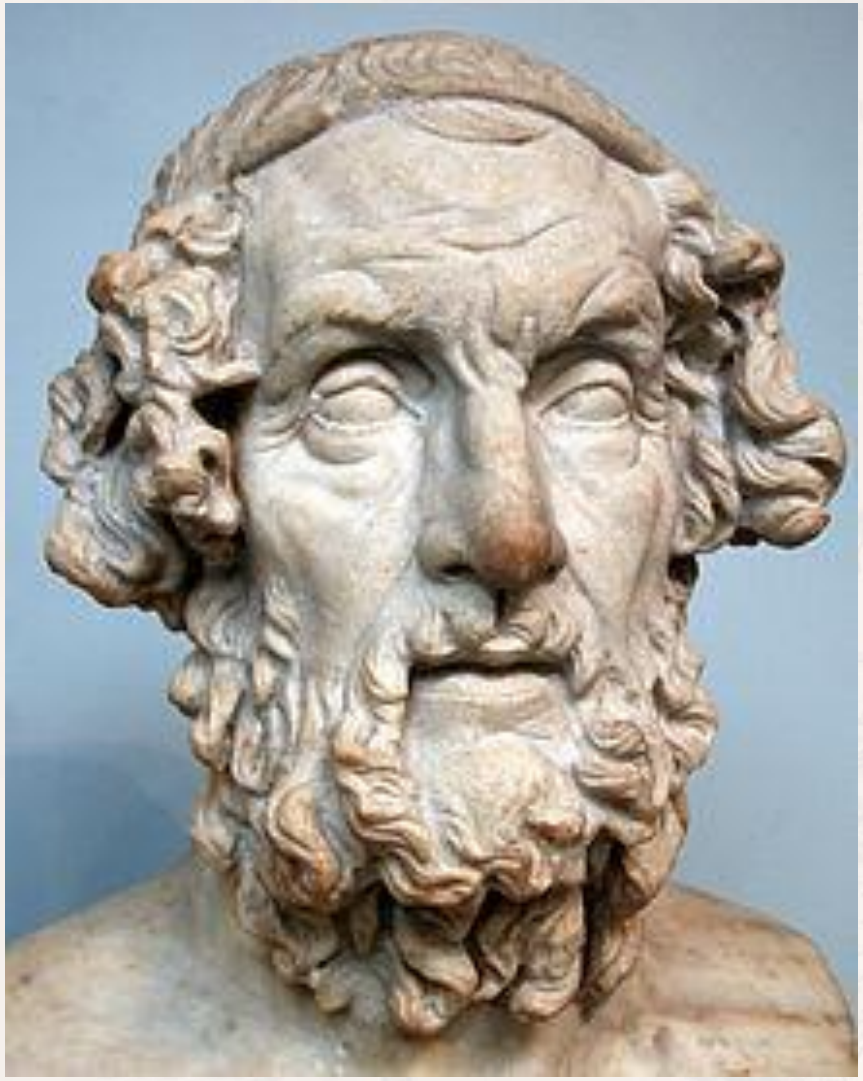
Cyprus University of Technology



Homer in his Book -The Odyssey

ἄνδρα μοι ἔννεπε, **μοῦσα,** πολύτροπον, ὃς μάλα πολλὰ λάγχθη, ἐπεὶ Τροίης ἱερὸν πτολίεθρον ἔπερσεν: πολλῶν δ᾽ ἀνθρώπων ἴδεν ἄστεα καὶ νόον ἔγνω, πολλὰ δ᾽ ὅ γ᾽ ἐν πόντῳ πάθεν ἄλγεα ὃν κατὰ θυμόν, ἀρνύμενος ἥν τε ψυχὴν καὶ νόστον ἑταίρων…

Behind us is the memory of our parents,

in front of us are the eyes of our children!

WHY to digitize Cultural Heritage content

Digitisation of cultural heritage can bring many benefits:

- Accessibility - Digital Transition,
- Research,
- Protection of VALUES and IDENTITY,
- Preservation and of
- Supporting cultural, creative innovation, Tourism, Education, etc.

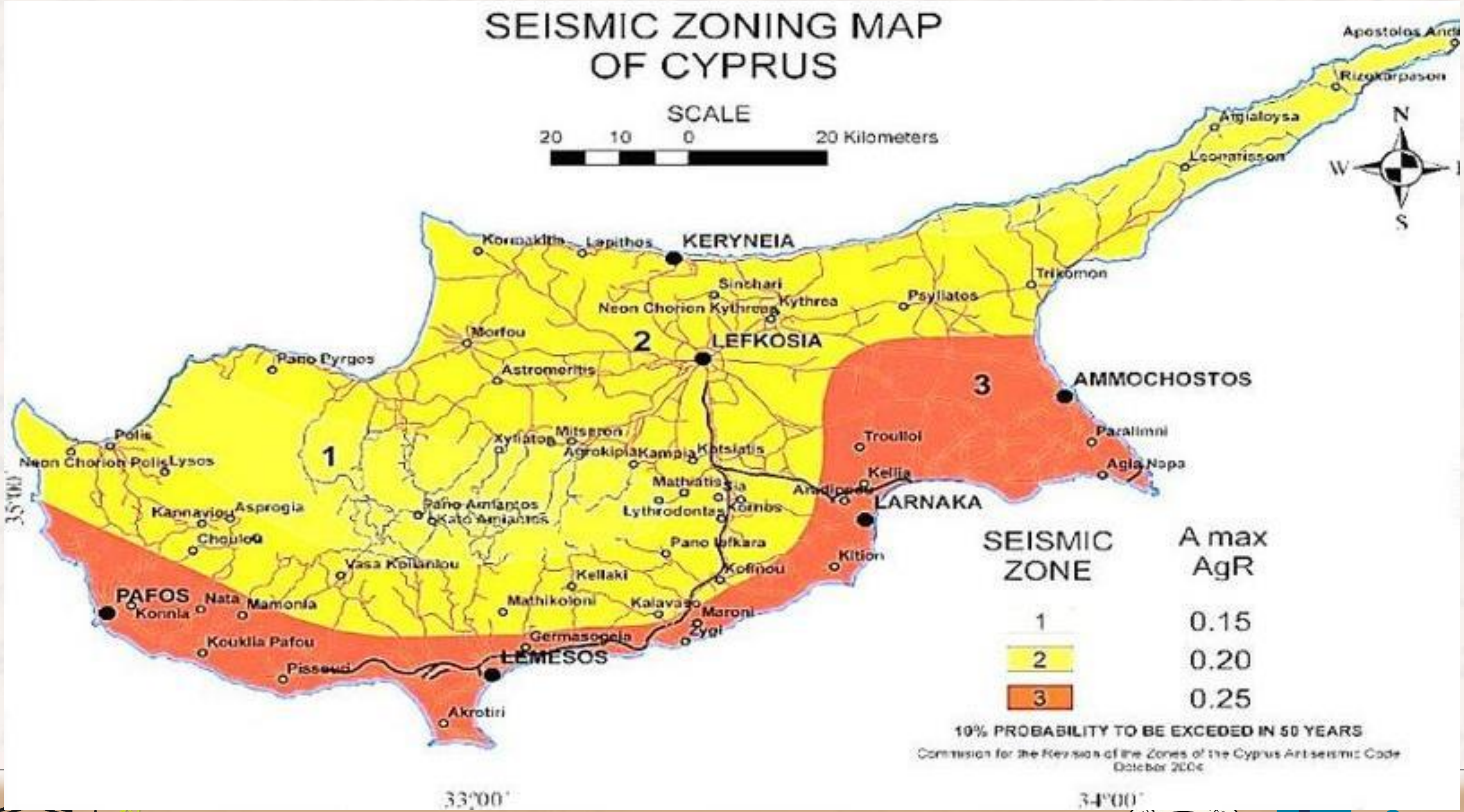
Digitized cultural heritage can be an enormous asset

Natural made destruction / Climate Change

NATURAL:

- Earthquakes,
- Landslides,
- Floods, Droughts, Air Pollution,
- Heat waves (Temperature, Infrared and Ultraviolet),
- Fires

They can seriously damage or even completely destroy monuments, historical and archaeological sites or cultural landscapes.


SEISMIC ZONING MAP
OF CYPRUS
SCALE
20 10 0 20 Kilometers
KERYNEIA
LEFKOSIA
AMMOCHOSTOS
LARNAKA
LEMESOS
PAFOS
1
2
3
SEISMIC ZONE
A max AgR
1 0.15
2 0.20
3 0.25
10% PROBABILITY TO BE EXCEDED IN 50 YEARS
33°00'
34°00'

Digitization, Preservation, Protection and Presentation of Cypriot Cultural Heritage

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The EU ERA Chair MNEMOSYNE has received funding from the European Union's Horizon 2020 Programme as Coordination and Support Action, under GA n° 810857

Human-made destruction

- War,
- Political / Religious Reasons,
- Poverty,
- Development initiatives,
- the looting and trafficking of objects that frequently arises out of those contexts (the 3rd biggest black market in the world)

IDENTITY

They can seriously damage or even completely destroy /modify monuments, historical and archaeological sites or cultural landscapes.

Difficulties , Logistics, Complexity

- Which Object(s) → Material
- How,
- When,
- Who,
- Under which conditions,
- Where to digitize?

Stakeholder Requirements

Movable

Immovable

Object(s)

Location, Environment, Lab/Site, Museum

Equipment Device

Location, Environment, Lab/Site, Museum

Deliverables

1. Geometry
2. Texture
3. Material
4. Structural Health Monitoring

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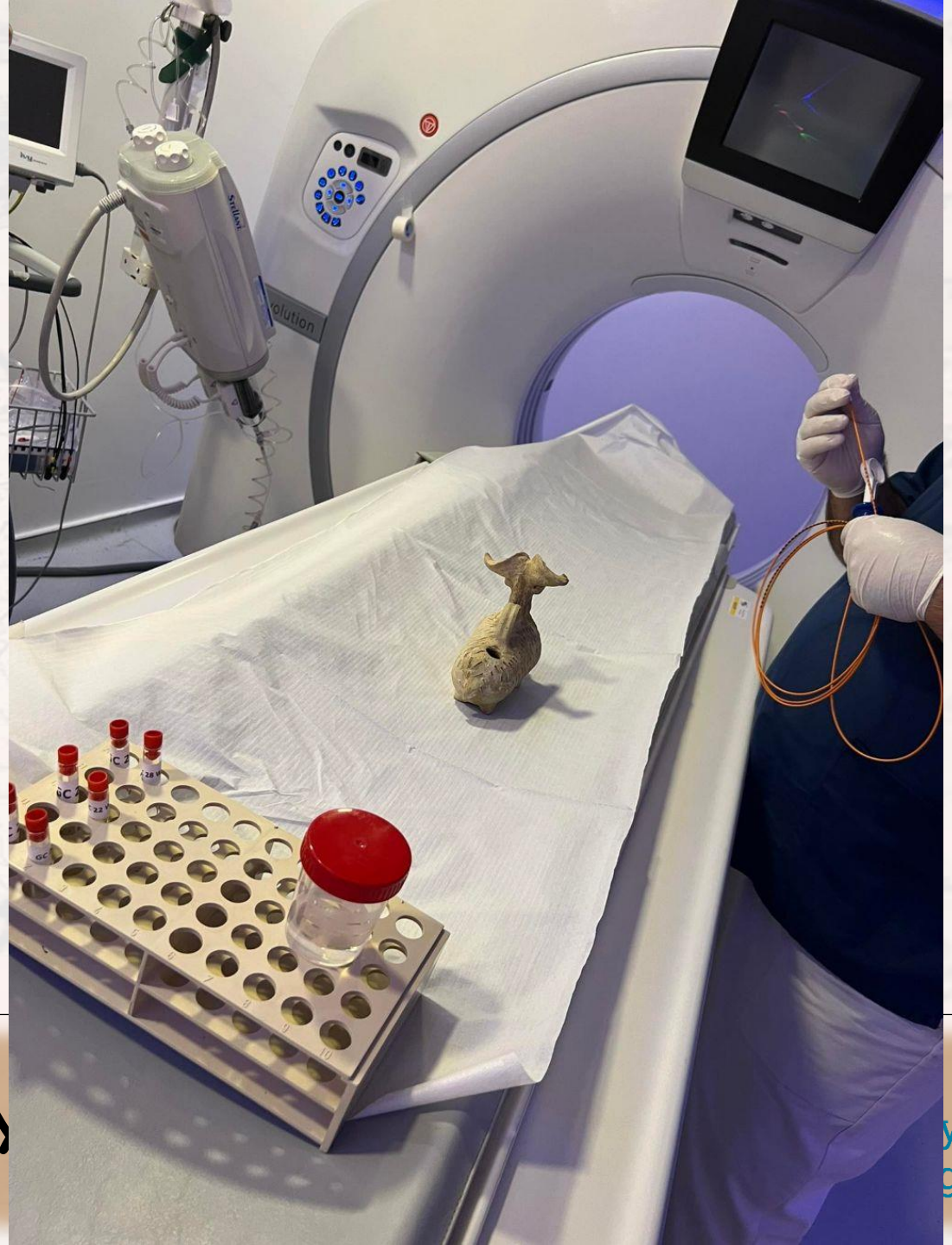
HOLISTIC DOCUMENTATION OF CYPRIOT CERAMIC ZOOMORPHIC RHYTA DATING TO THE HELLENISTIC PERIOD



EMOSY

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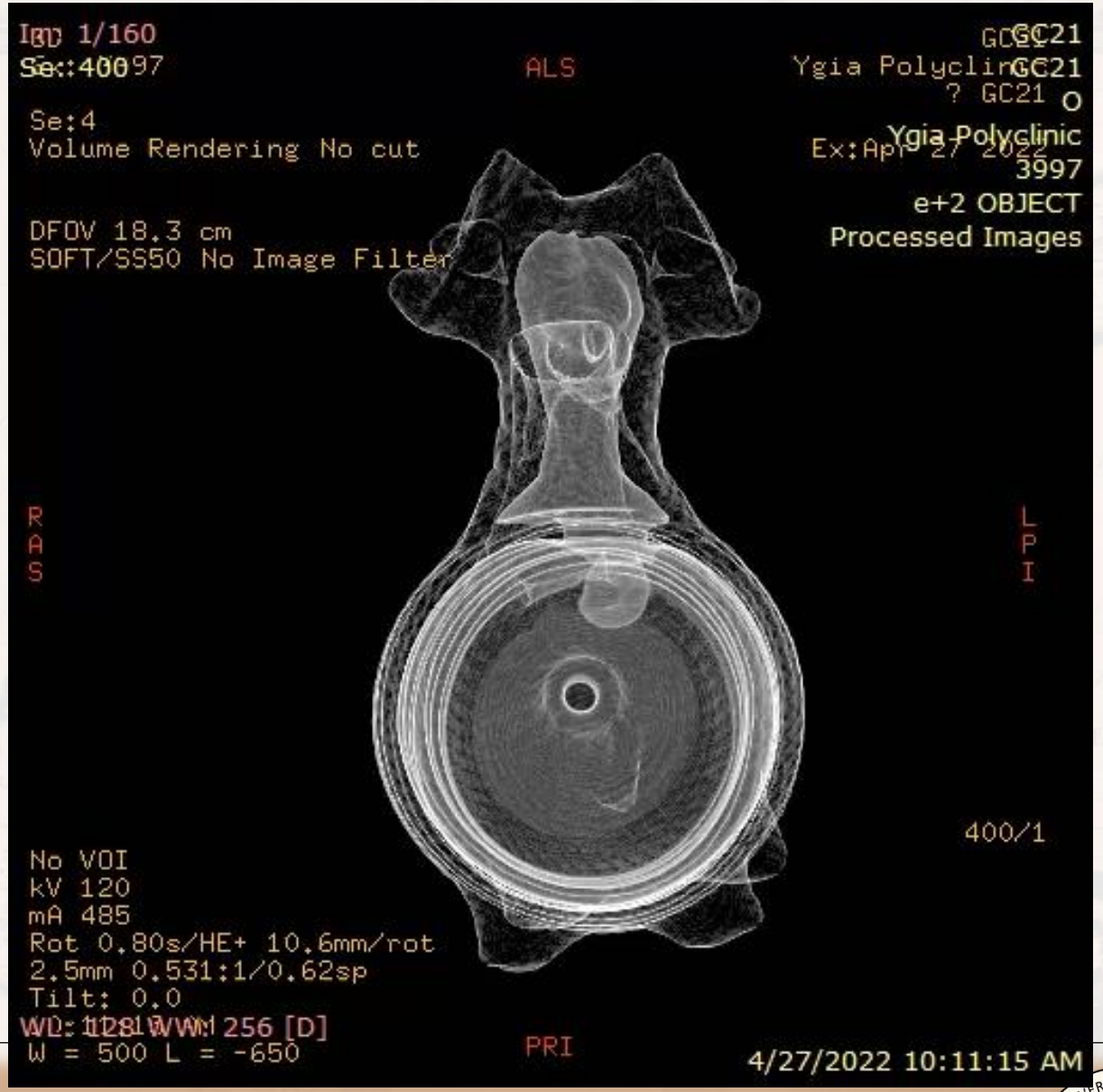
gy

GC21

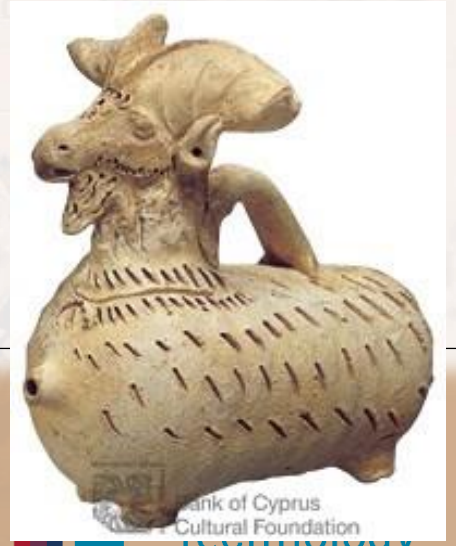


Collection of CT tomography data:

Understanding of the manufacturing technique

Collection of CT tomography data:

Understanding of the manufacturing technique

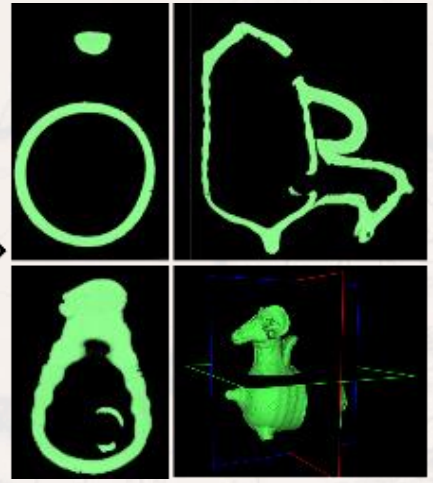


Schematic representation of the process from CT scans to 3D printing

#DigitalTwin

Data processing

3D printing



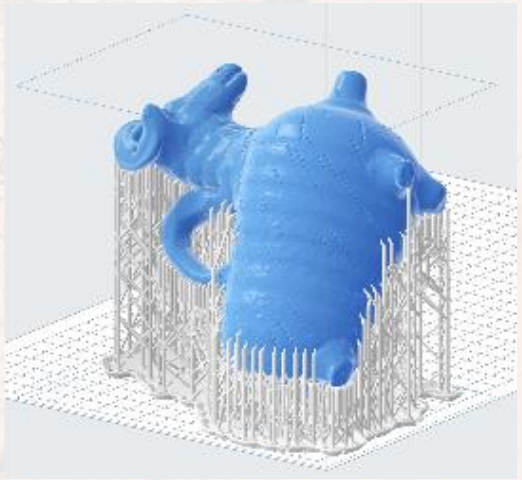


Image stack from the CT scans

3D digital geometry

Replica

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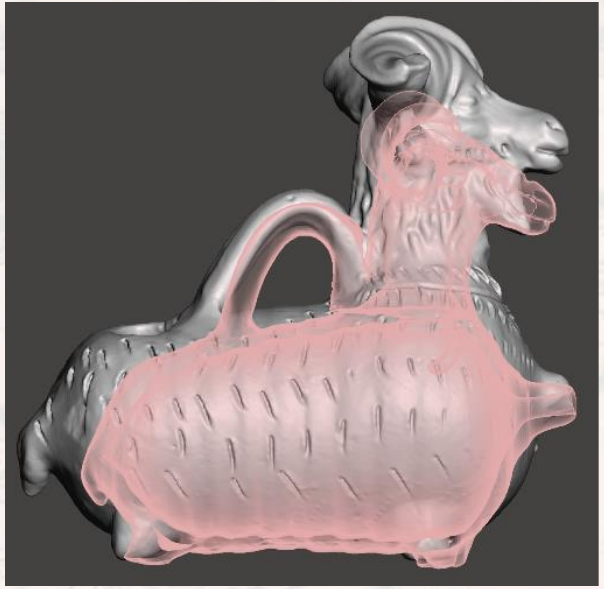
3D reconstructed rhyton with exterior decoration



Comparison of the size of rhyta C21 and C28 by superimposing the reconstructed volumes.

3D reconstructed semitransparent view of the artifact in which wall size and cavity are visible.

3D printed replica of zoomorphic rhyton C21 from CT scans.

Investigate the way the *rhyton GC28* was formed in ancient times

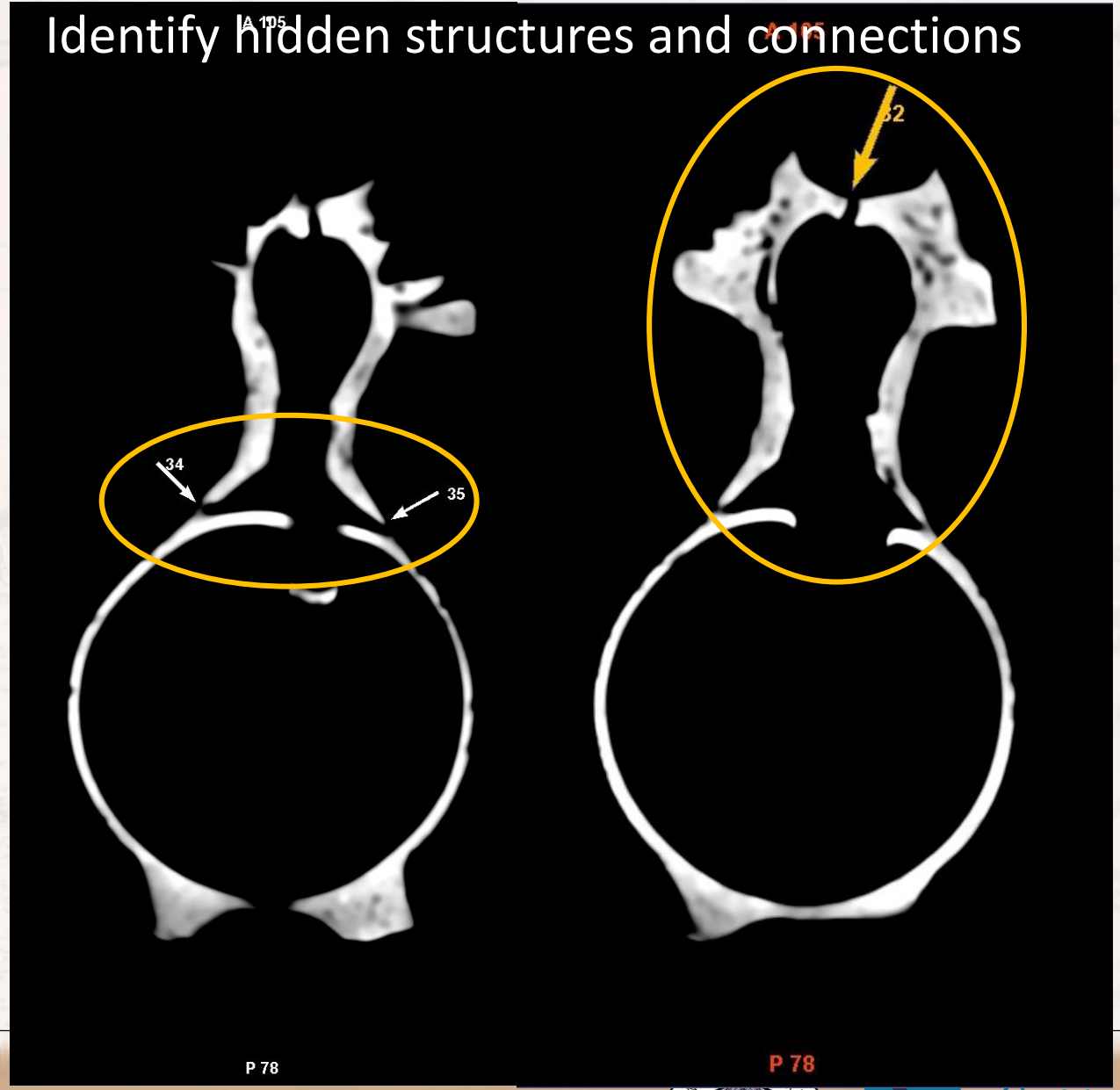
CT data of zoomorphic rhyton GC28

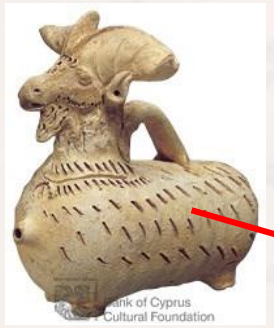
Investigate the way the *rhyton GC21* was formed in ancient times

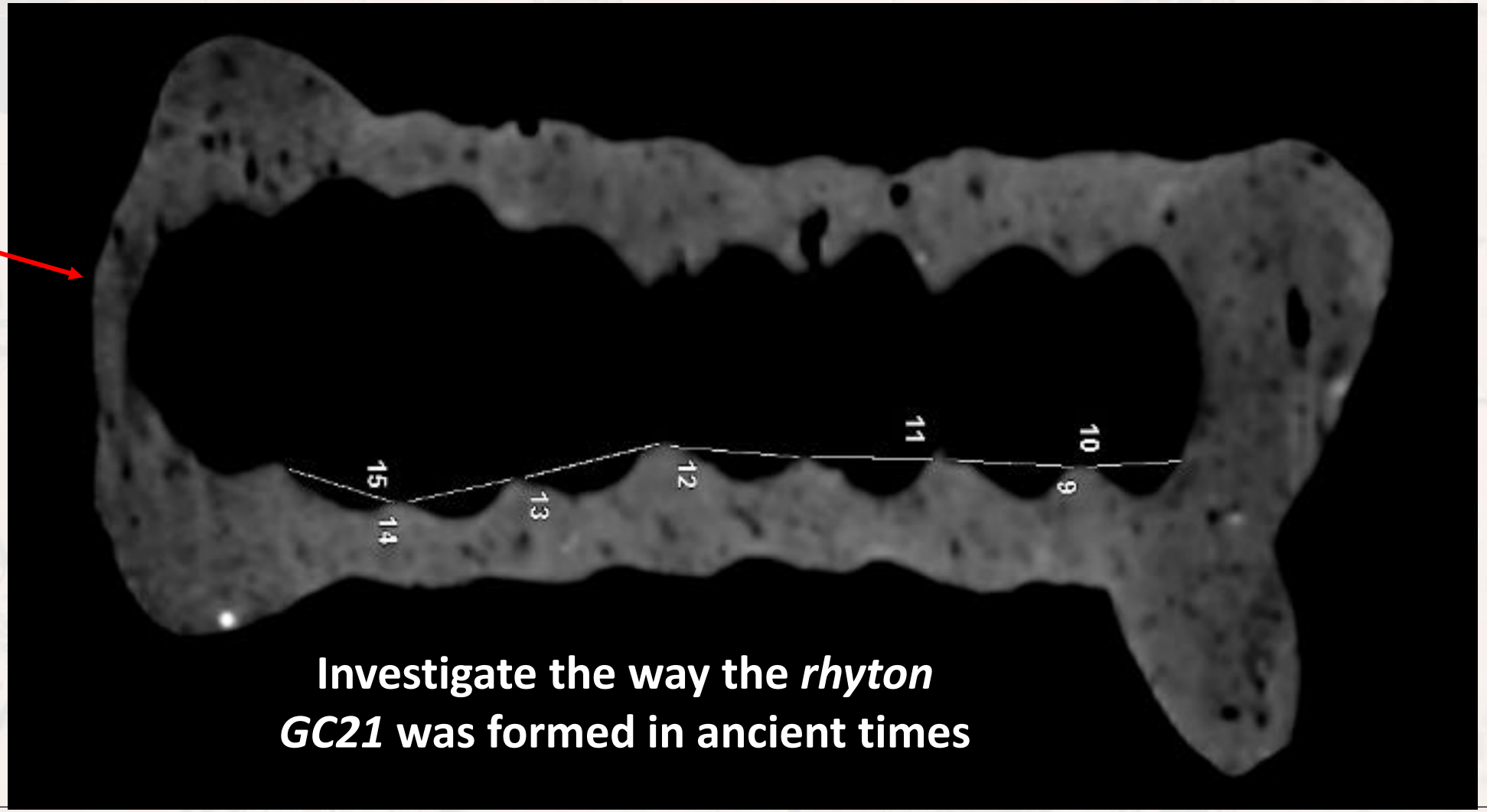
CT data
Two dimensional virtual cross sections of the zoomorphic rhyton GC21

Identify the different parts that were linked together to create the artefacts

Identify hidden structures and connections







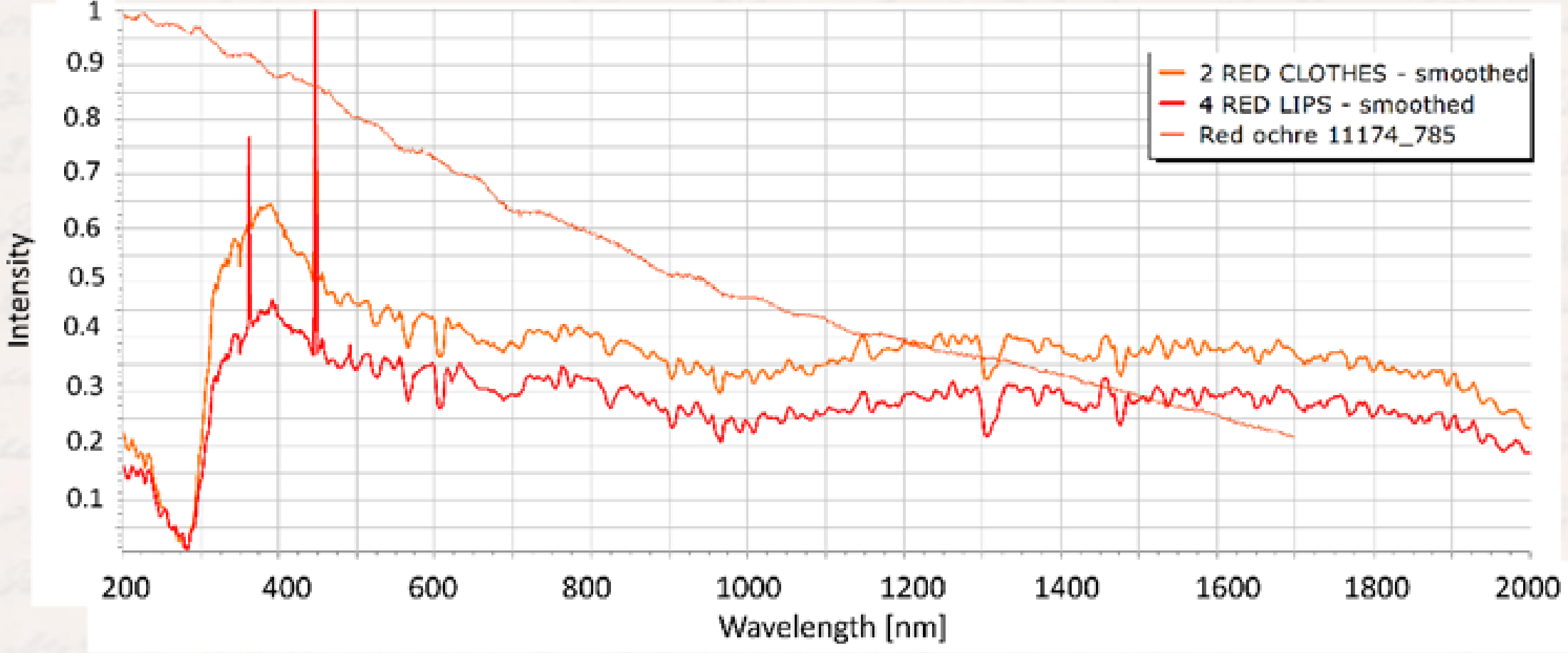
Investigate the way the *rhyton GC21* was formed in ancient times

In the XRF technique we used the Thermo Scientific portable XRF Niton XL5 spectrometer.

Identify pure metals and alloys, detect tramp elements, or obtain geochemical data.

Raman Spectroscopy

- Characterization of inclusions embedded in a geological matrix
- Identification of several minerals and other organic components within geological materials
- Molecular structure and stoichiometry studies
- Assays for inorganic and organic components in liquids.
- Classification and authentification of gemstones.

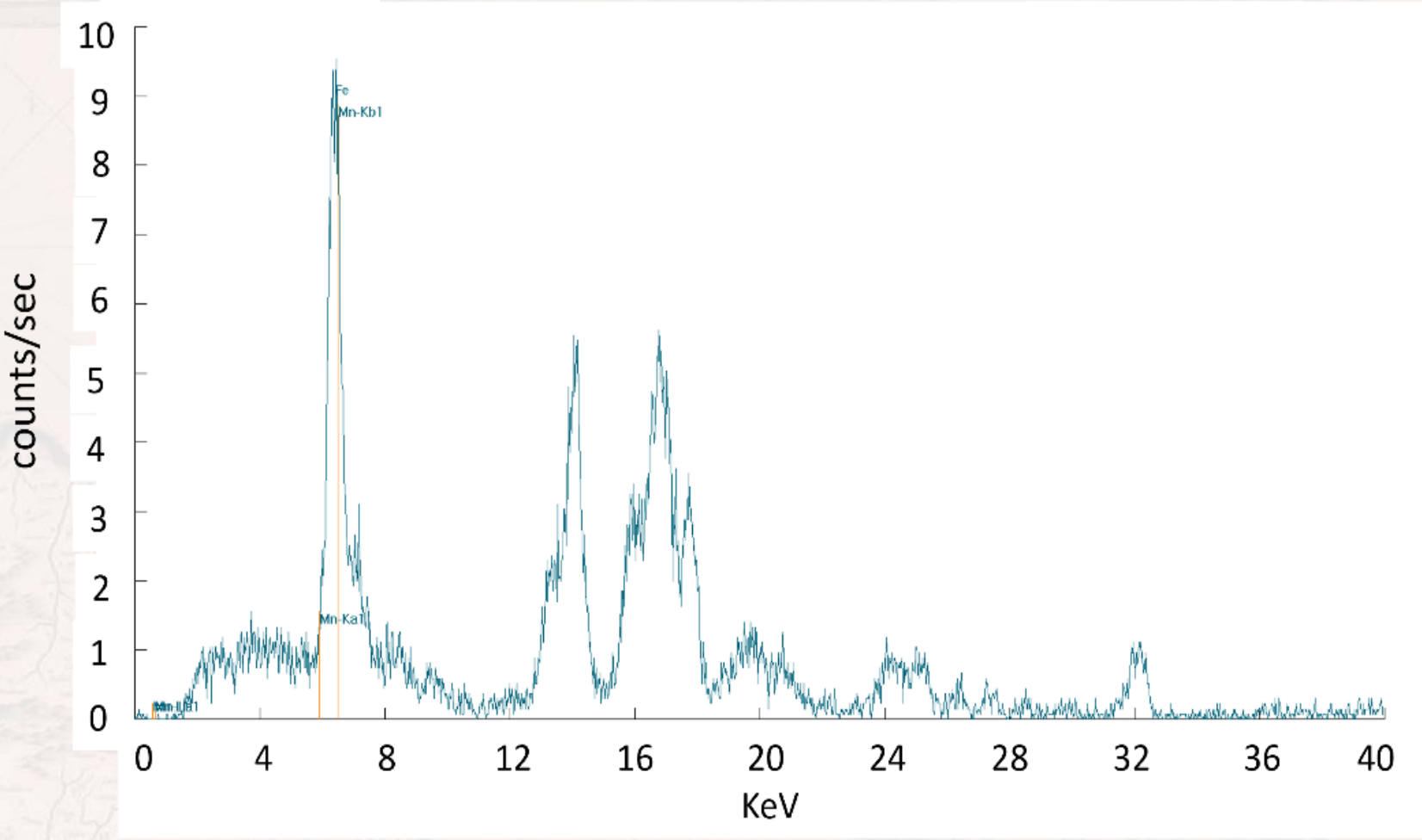


Raman spectrum collected from artefact GC28 compared with red ochre reference sample (785 nm).

XRF measurements

We made twelve (12) measurements in the same specific points.

XRF Spectra graphs analyses were carried out with the use of the scientific software Thermo Scientific NDT

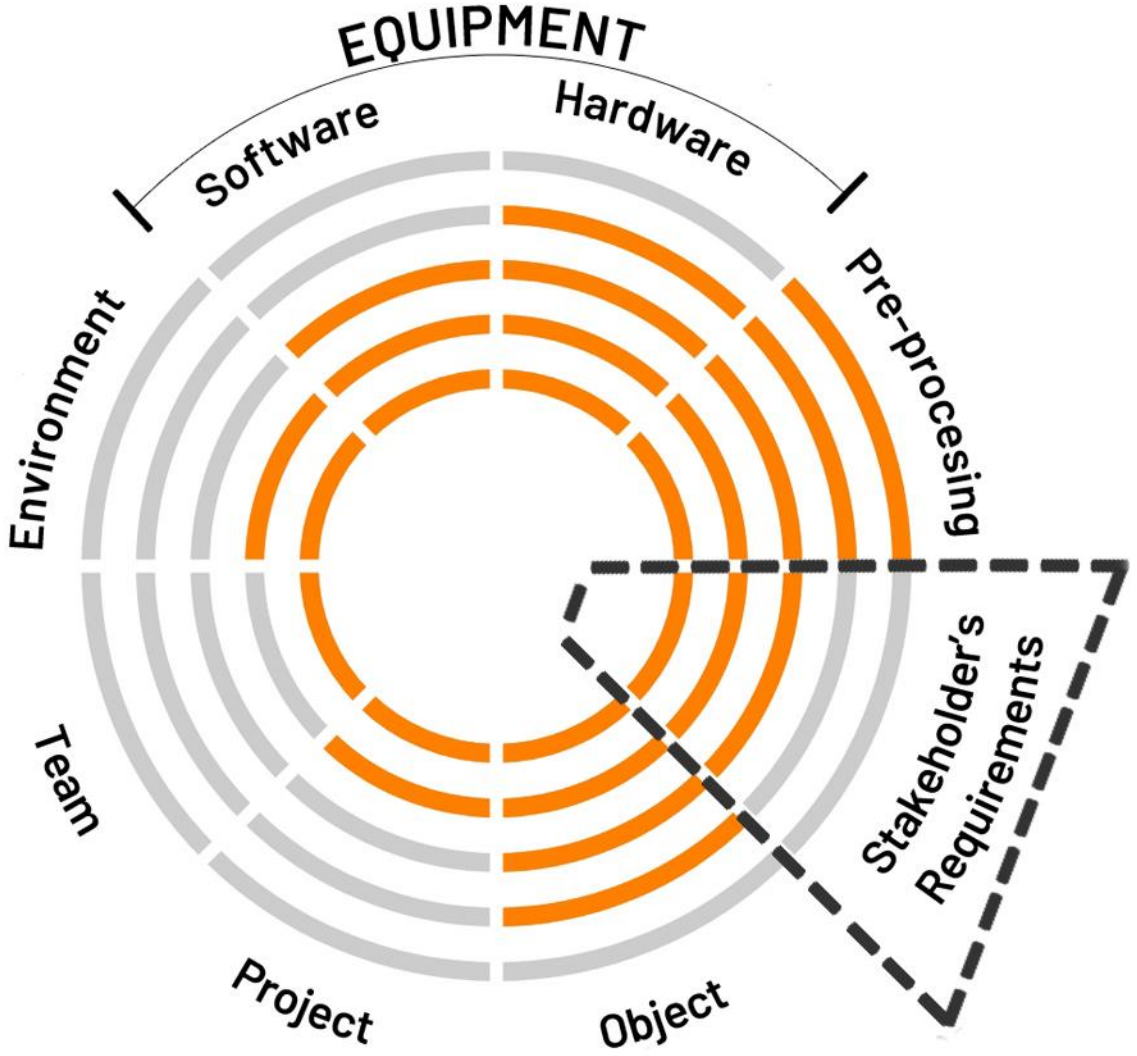


XRF spectrum collected from artefact GC21

Artefact	Colour Hue	XRF (elements)	Raman peaks (cm^{-1})	Pigment identified
GC21, GC22, GC28	**Black**	*Ca, Fe, Mn*	961m; ~ 1325vs; ~ 1580vs	Carbon black and iron-manganese
GC21, GC22, GC28	**Red**	*Fe, Ca*	220vs; 286vs; 402m; 491w; 601w	Red ochre and Hematite (Fe_2O_3 + clay + silica)

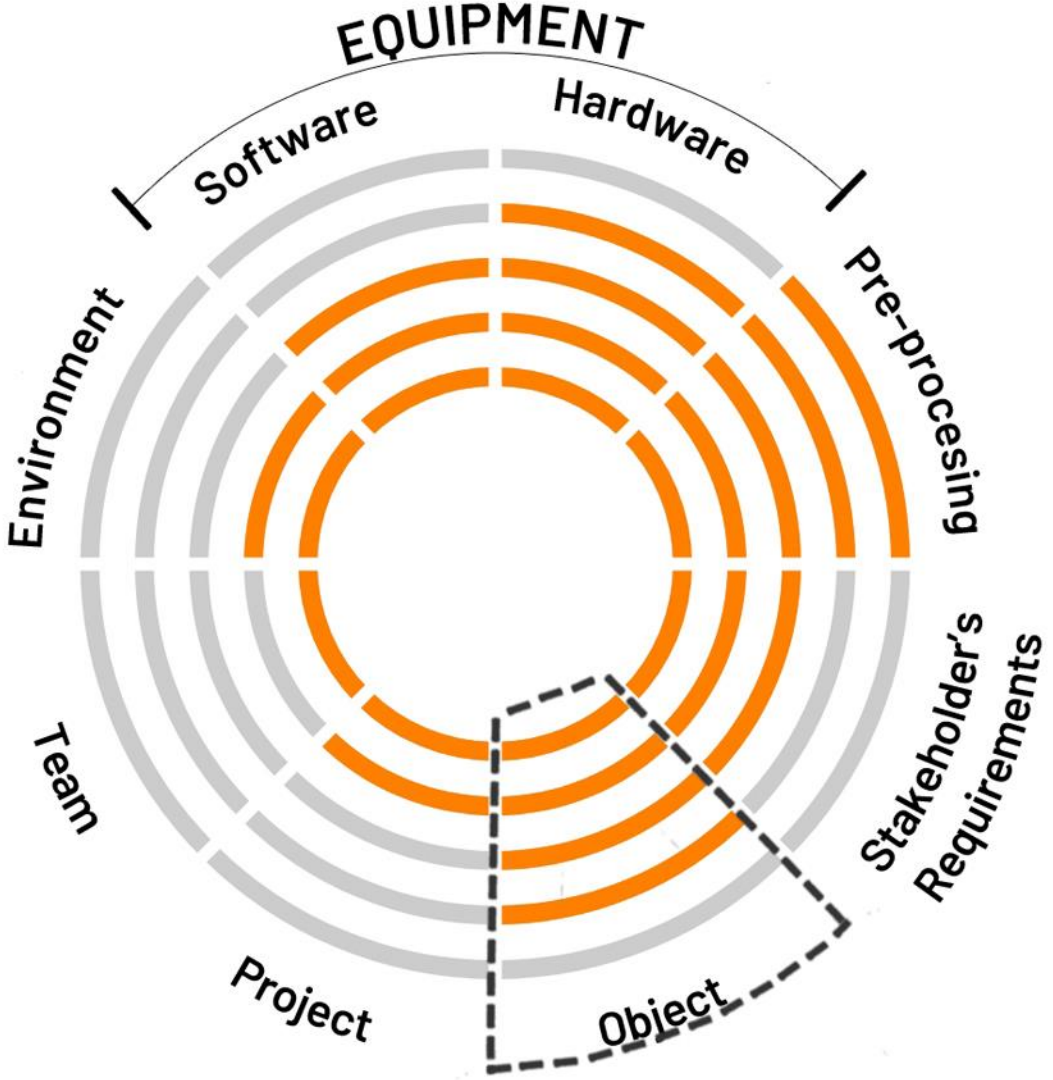
Identified pigments as a result of the complementary XRF and Raman characterization

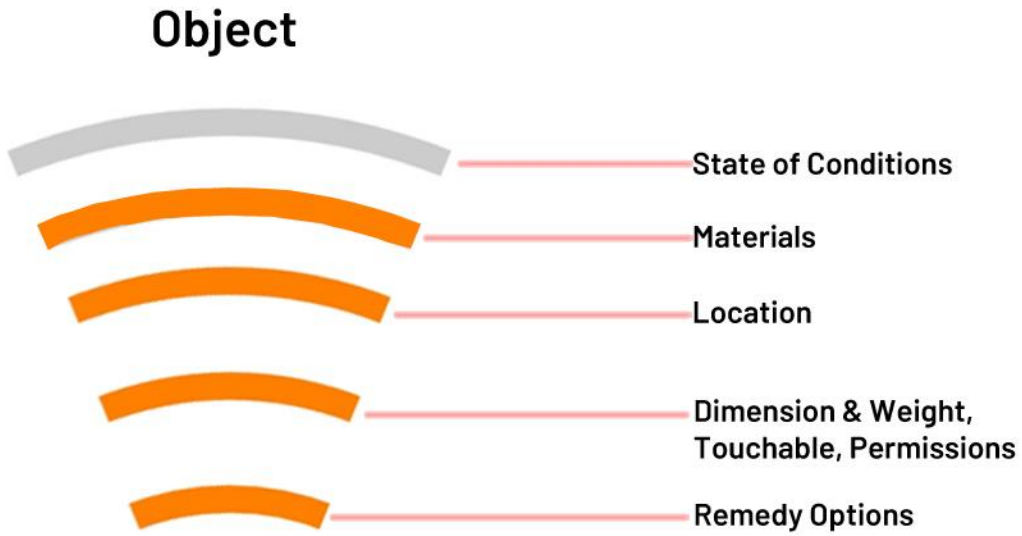
Complexity and Quality in Data Acquisition

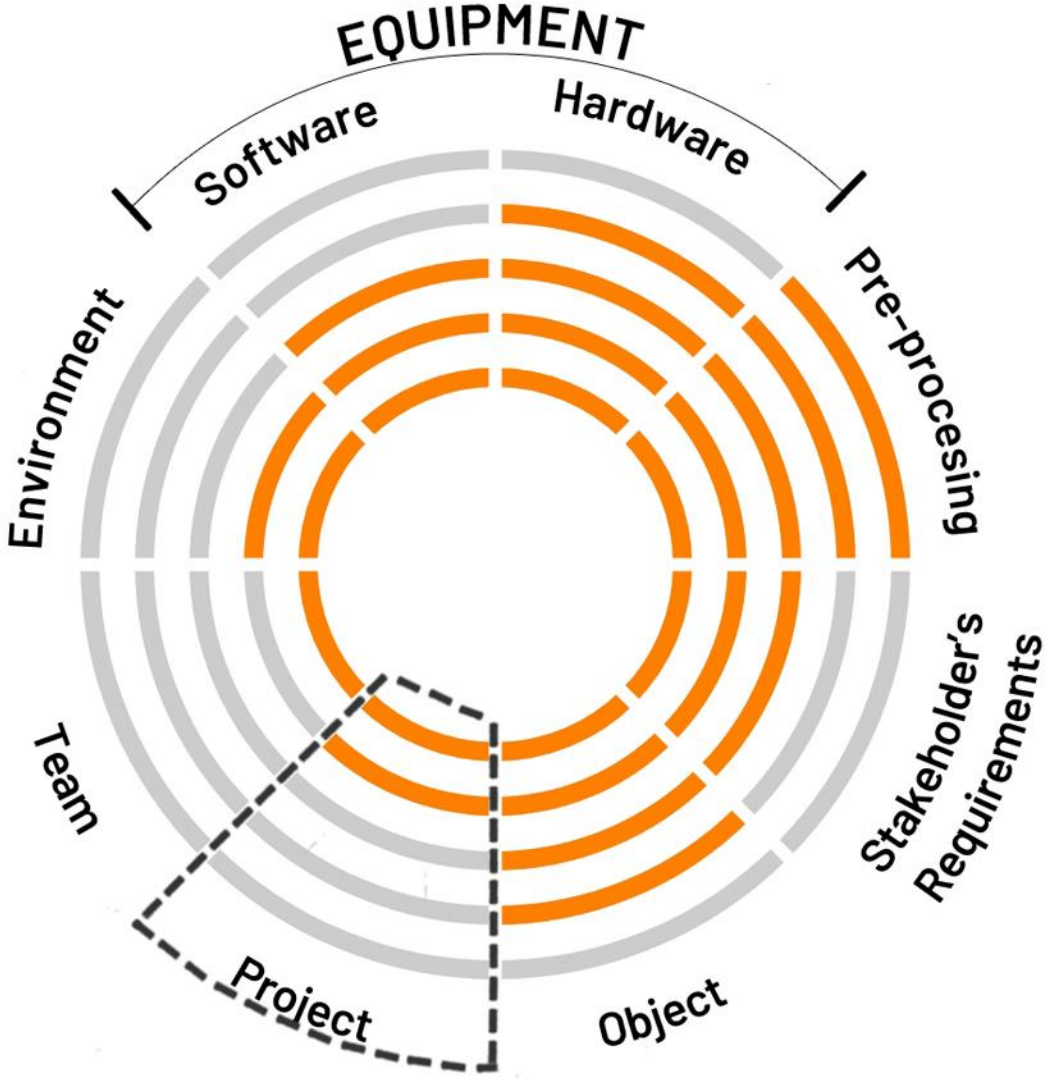


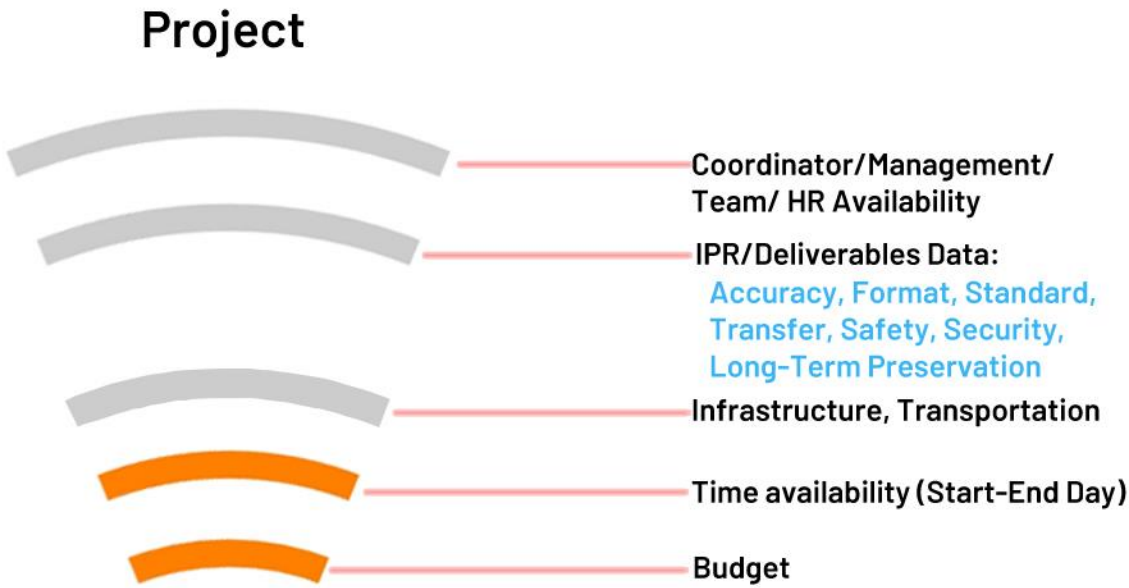
Stakeholder's Requirements

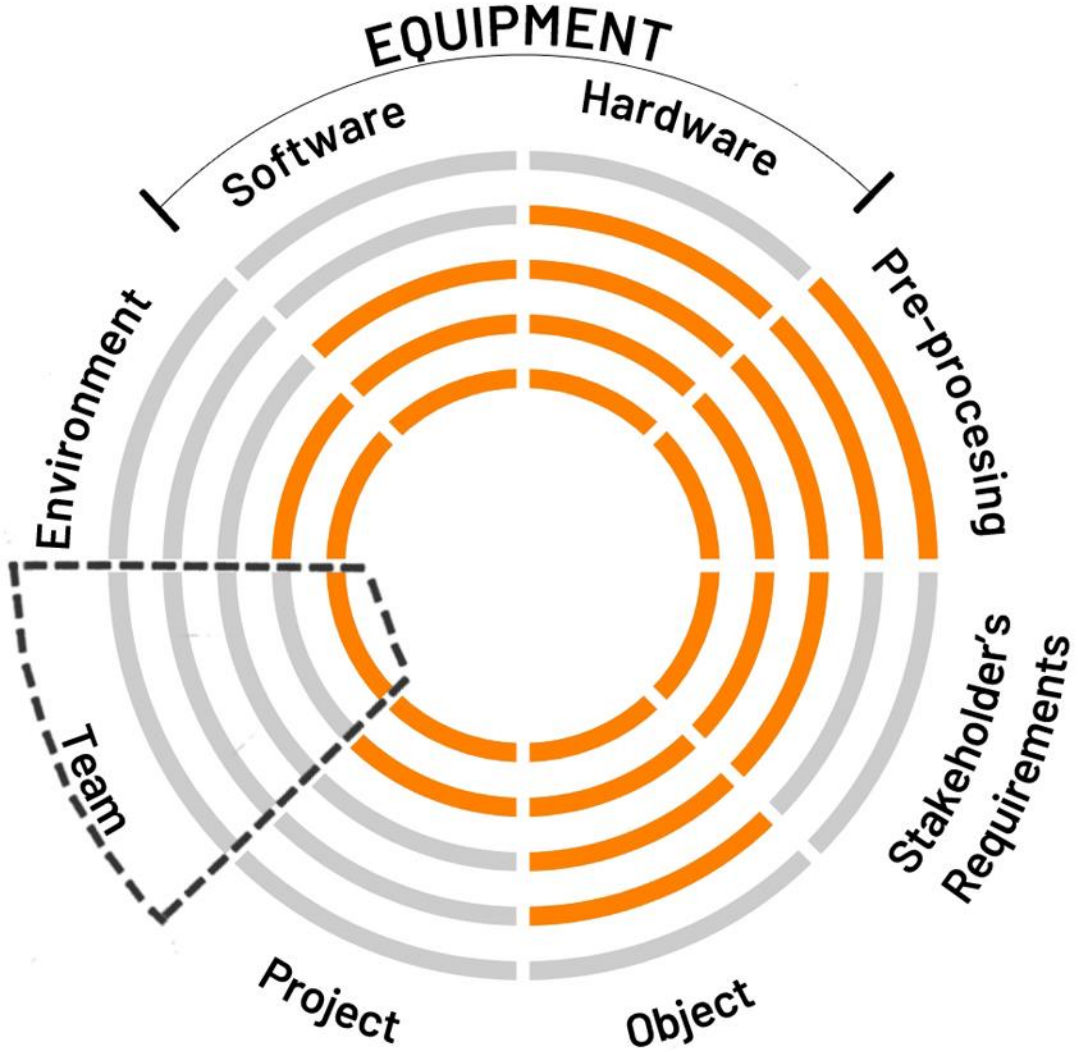
- Time (Start&End)
- Budget
- Purpose of 3D Digitisation (3D options available)
  - Reconnaissance level
  - Preliminary level
  - Detailed level
- Location:
  - Longitude
  - Latitude
- Type:
  - Terrestrial
  - Underground
  - Underwater
  - Cave
  - Museum

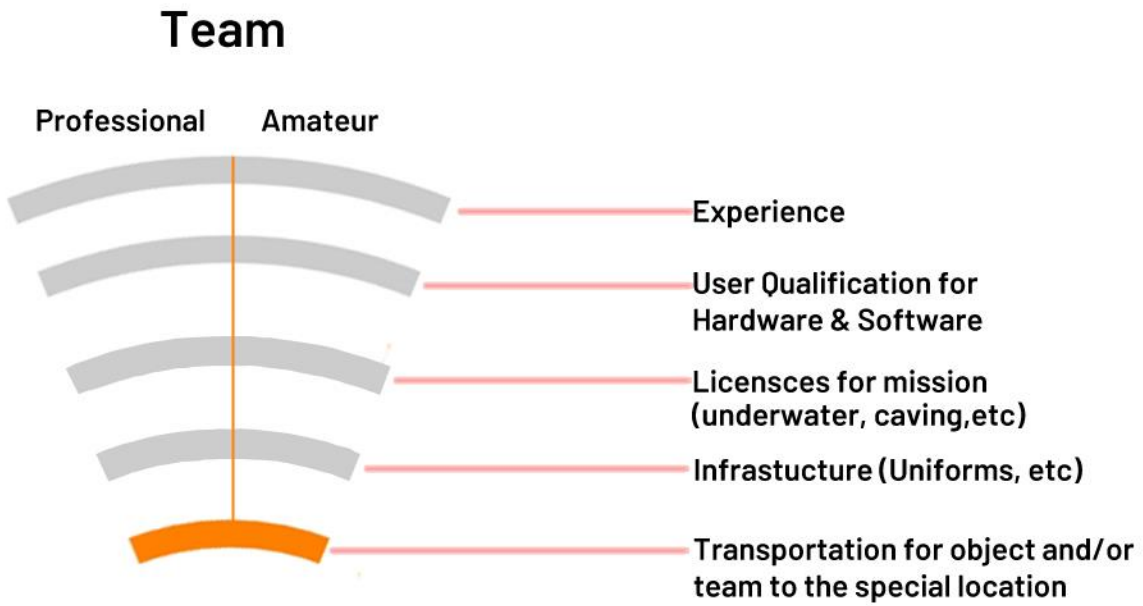

EQUIPMENT
Software
Hardware
Pre-processing
Stakeholder's Requirements
Object
Project
Team
Environment

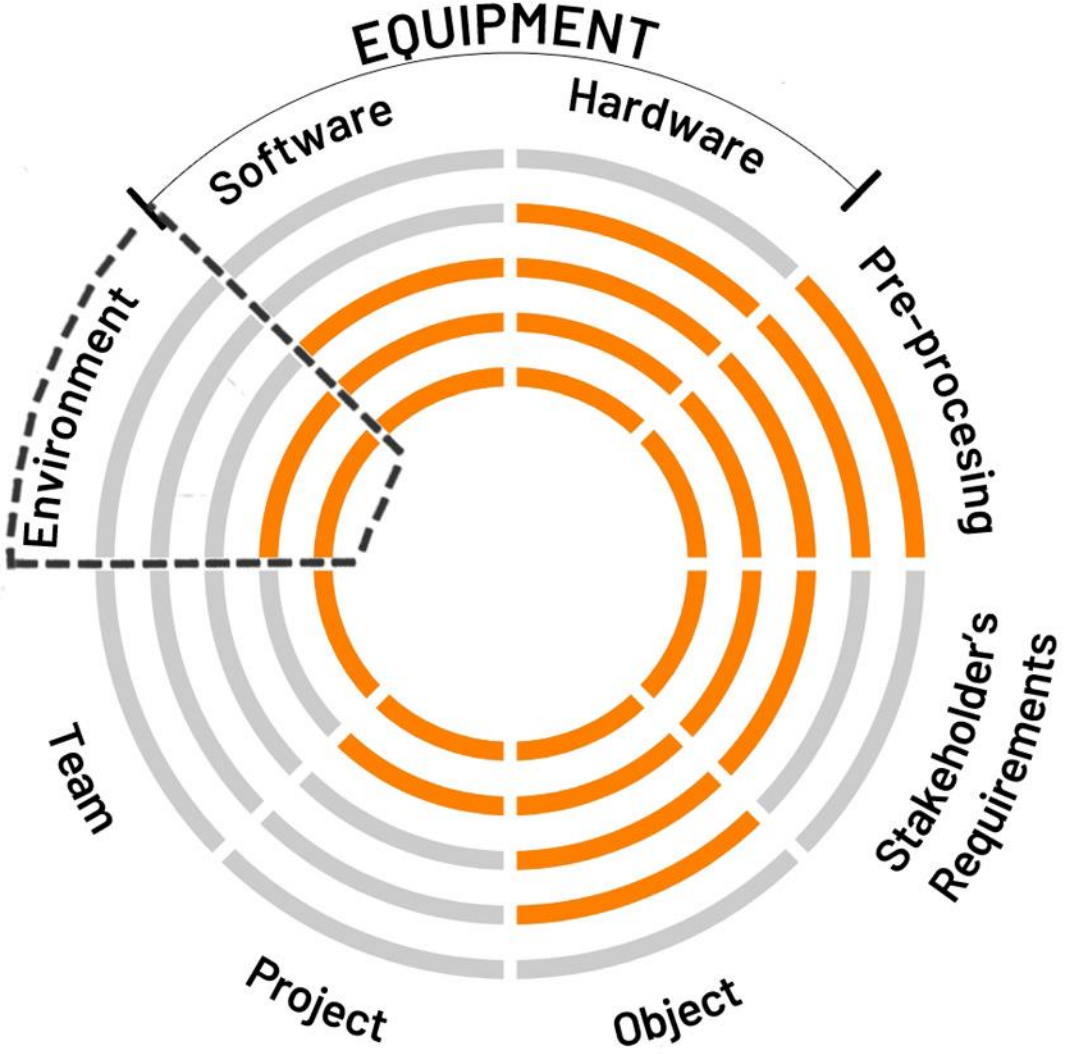

Object
State of Conditions
Materials
Location
Dimension & Weight, Touchable, Permissions
Remedy Options

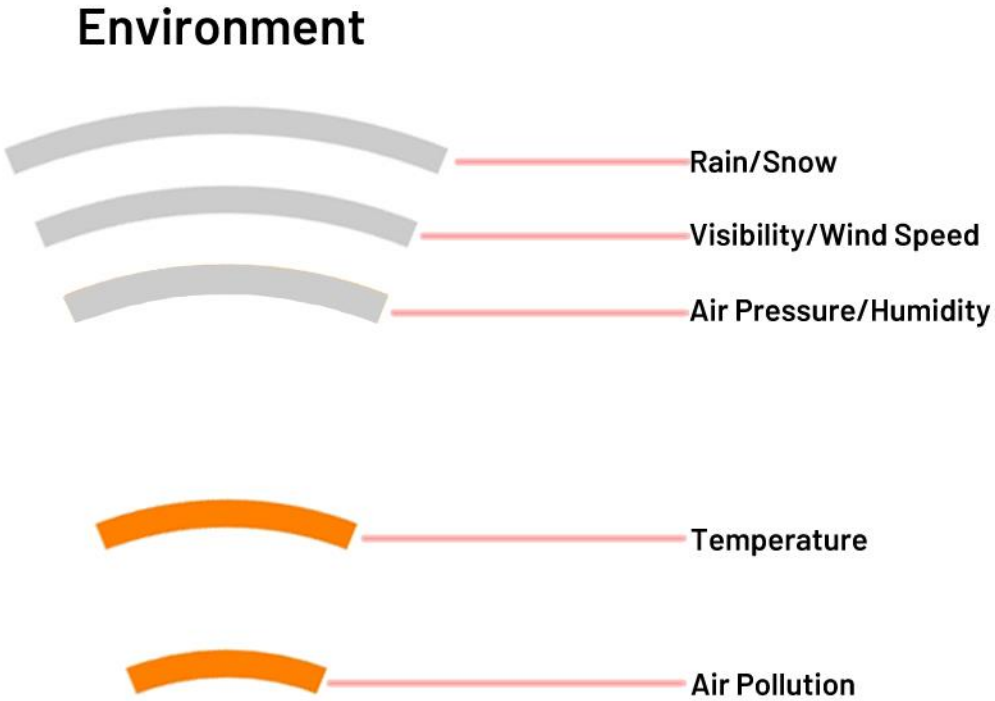

EQUIPMENT
Software
Hardware
Pre-procesing
Stakeholder's Requirements
Object
Project
Team
Environment

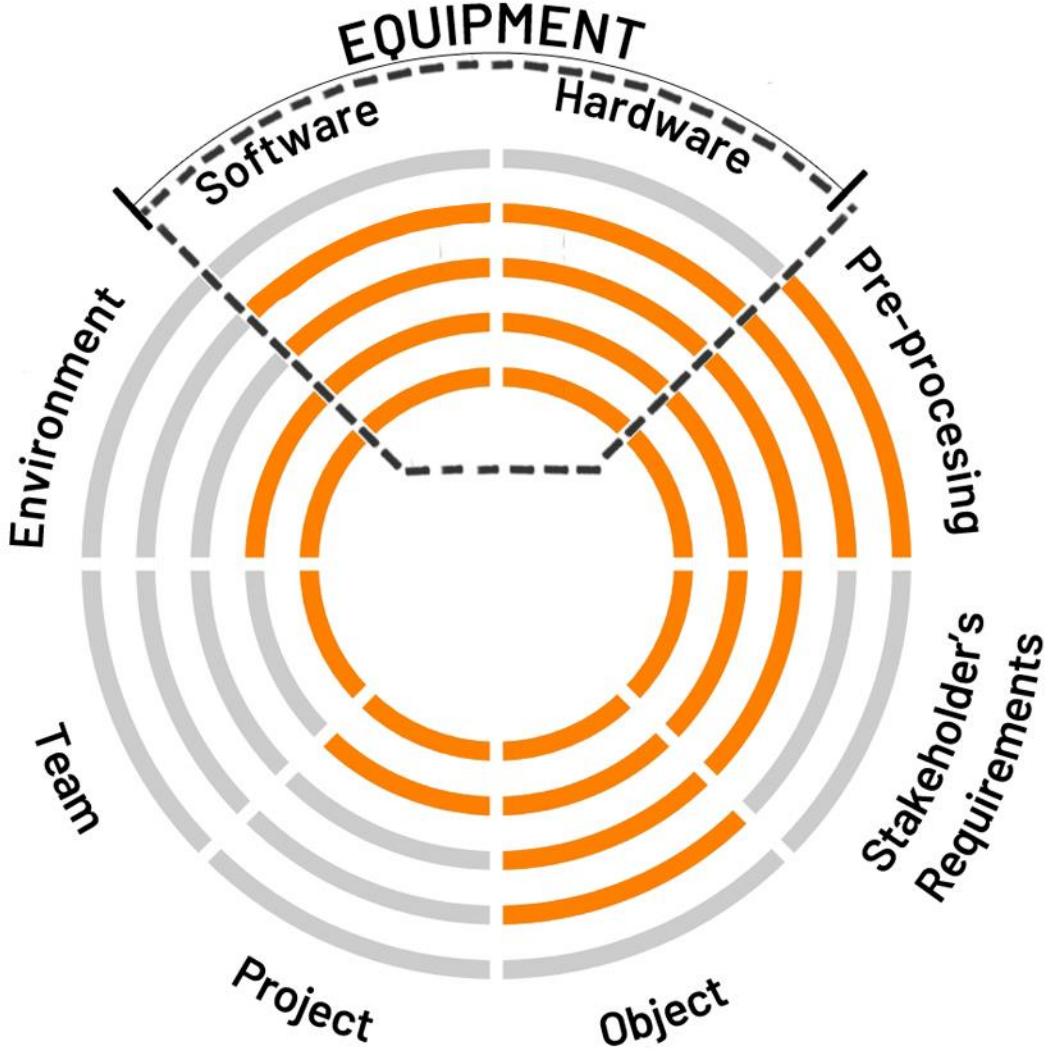

Project
Coordinator/Management/ Team/ HR Availability
IPR/Deliverables Data:
Accuracy, Format, Standard, Transfer, Safety, Security, Long-Term Preservation
Infrastructure, Transportation
Time availability (Start-End Day)
Budget


EQUIPMENT
Software
Hardware
Pre-procesing
Stakeholder's Requirements
Object
Project
Team
Environment


Team
Professional
Amateur
Experience
User Qualification for Hardware & Software
Licensces for mission (underwater, caving,etc)
Infrastucture (Uniforms, etc)
Transportation for object and/or team to the special location

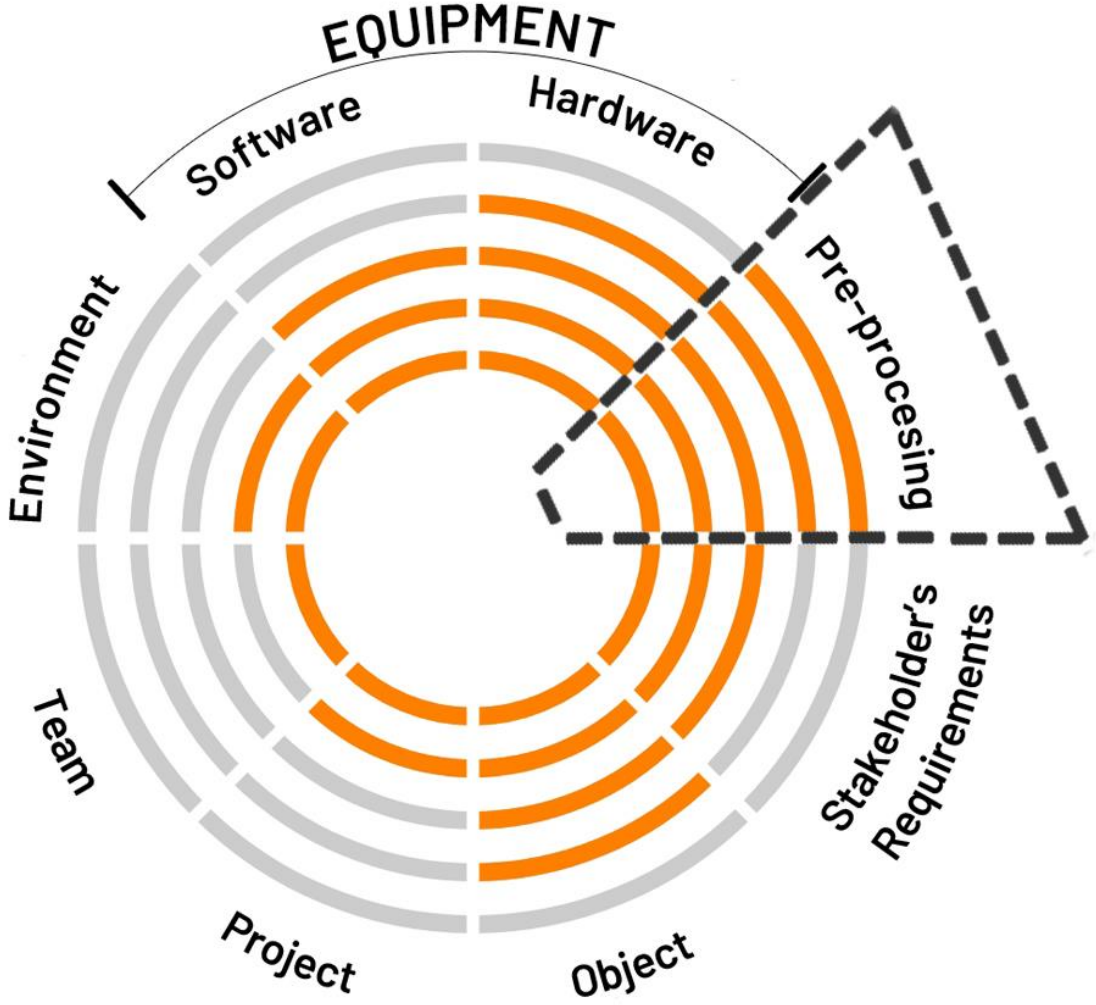

EQUIPMENT
Software
Hardware
Pre-processing
Stakeholder's Requirements
Object
Project
Team
Environment


Environment
Rain/Snow
Visibility/Wind Speed
Air Pressure/Humidity
Temperature
Air Pollution



Software & Hardware

- Licence for Hardware to be used (i.e. frequencies, interferences with other systems)
- Precision of multisensor system under different environment conditions
- Usability - Communication/Transfer of Data/ Battery/ Available Storage
- Efficiency - Speed of Data Acquisition in relation to Software & Hardware - Accuracy (Byte Resolution
- Sensor Integration

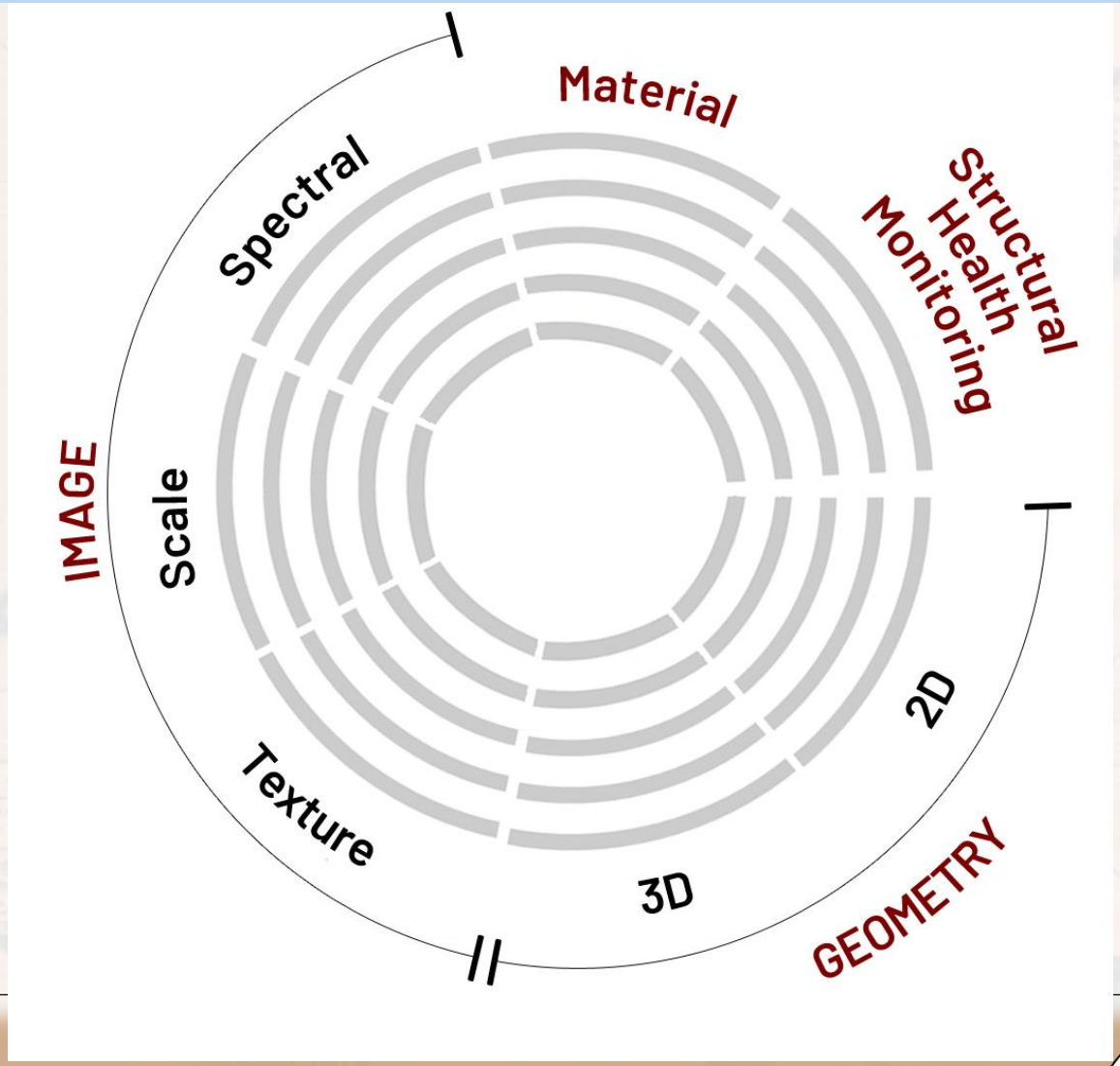


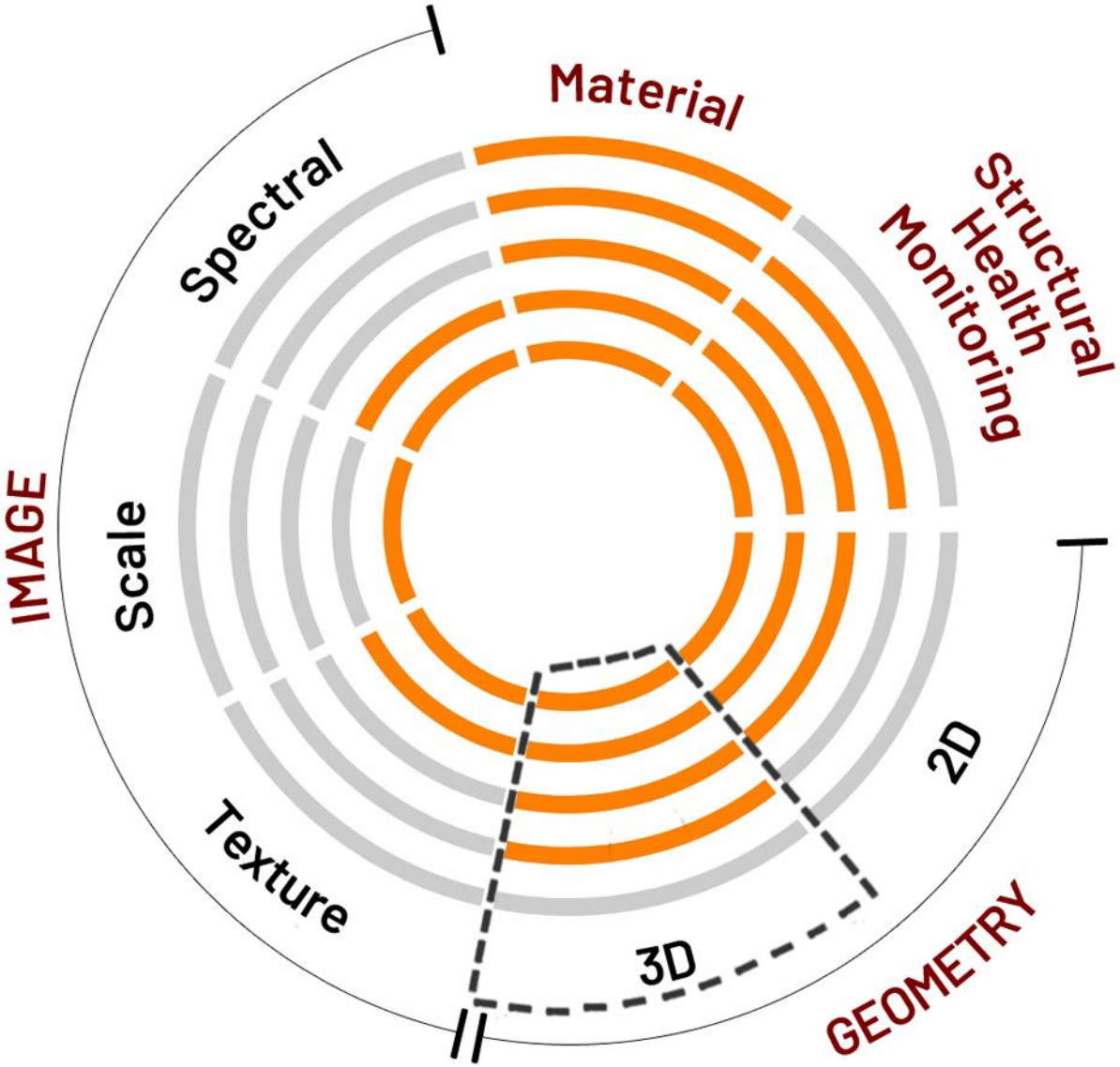
Pre-Processing

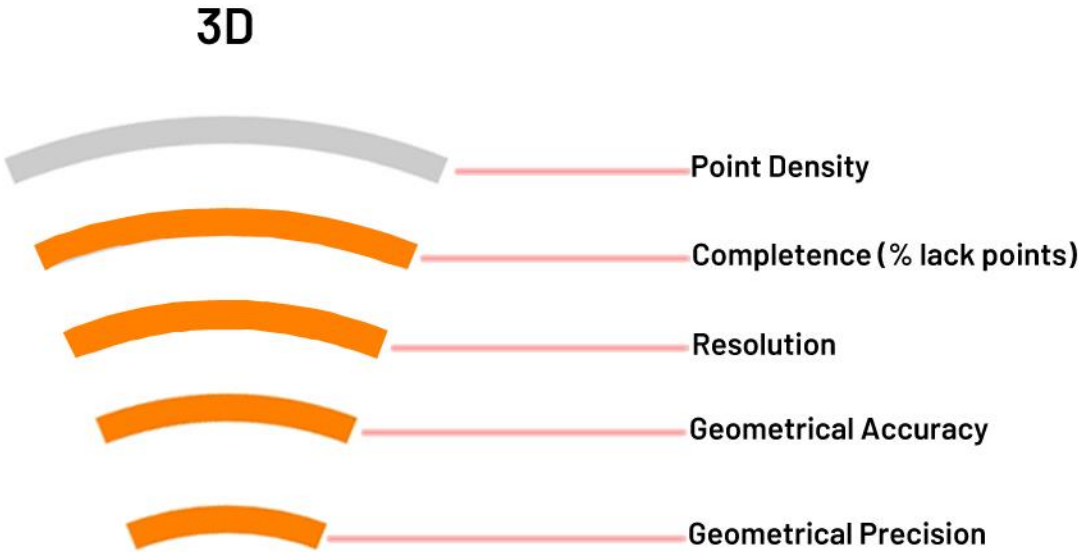
Software | Hardware

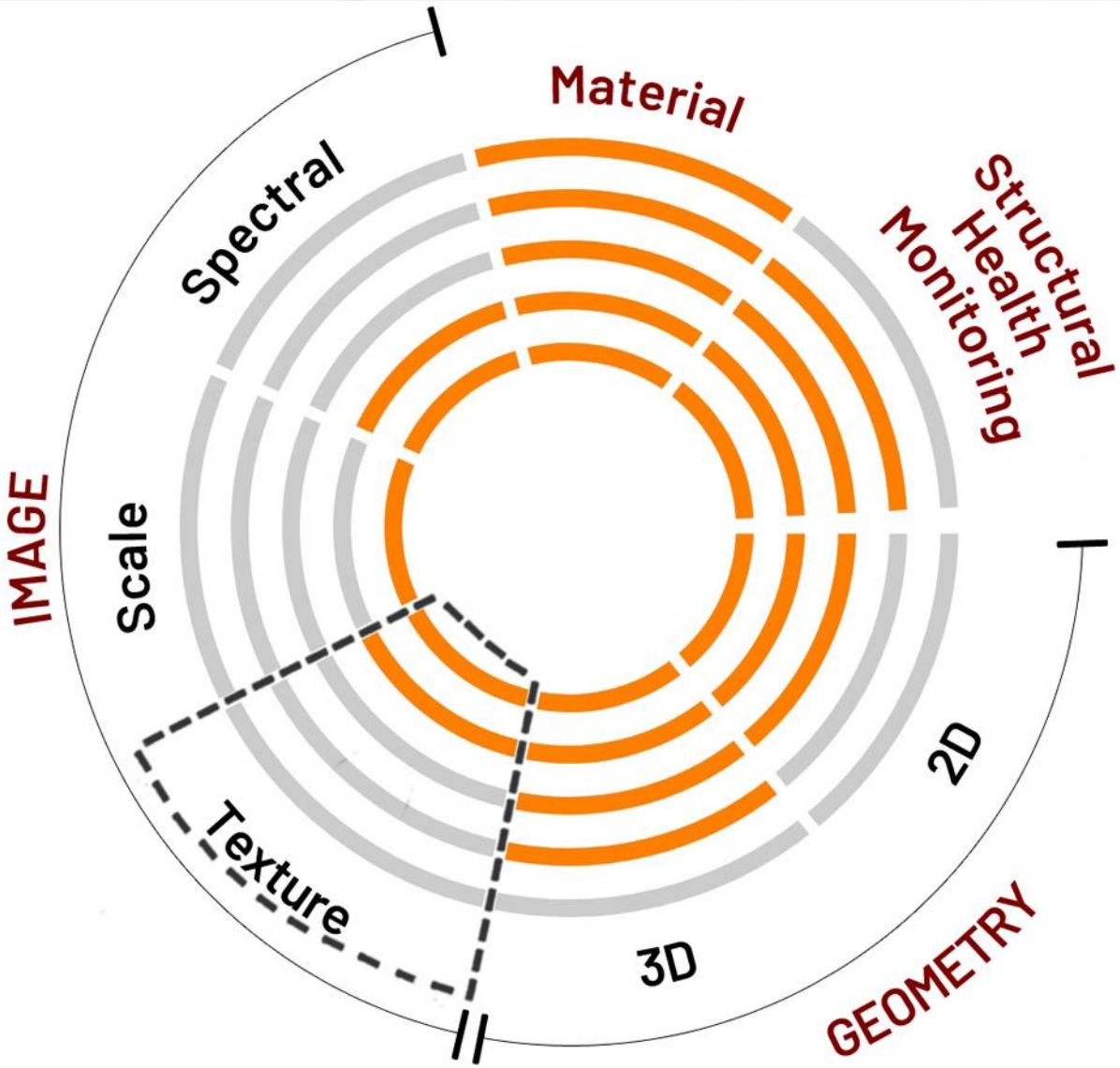
- **User:** Cloud/Workstation
- **Software:** Filtering/Distortion
- **Hardware:** CPU(s) - Power
- **Software:** Point cloud density/Standard Deviation
- **Hardware:** GPU(s)
- **Software:** Overlapping Rate
- **Hardware:** Memory (internal & external)
- **Software:** Resolution in Bytes of Software/Images or 2D/3D Points/Max. number of Images and/or Proints
- **Hardware:** Operating System (Byte Resolution)

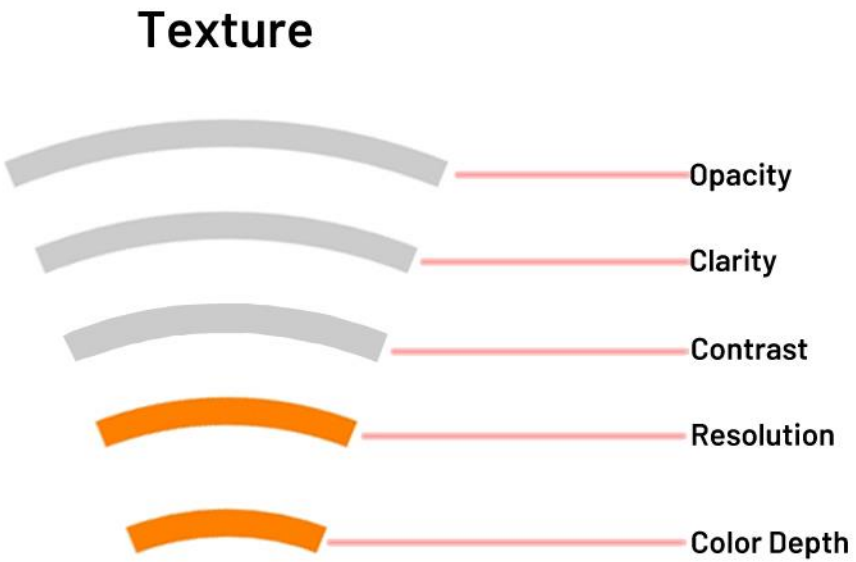
Quality

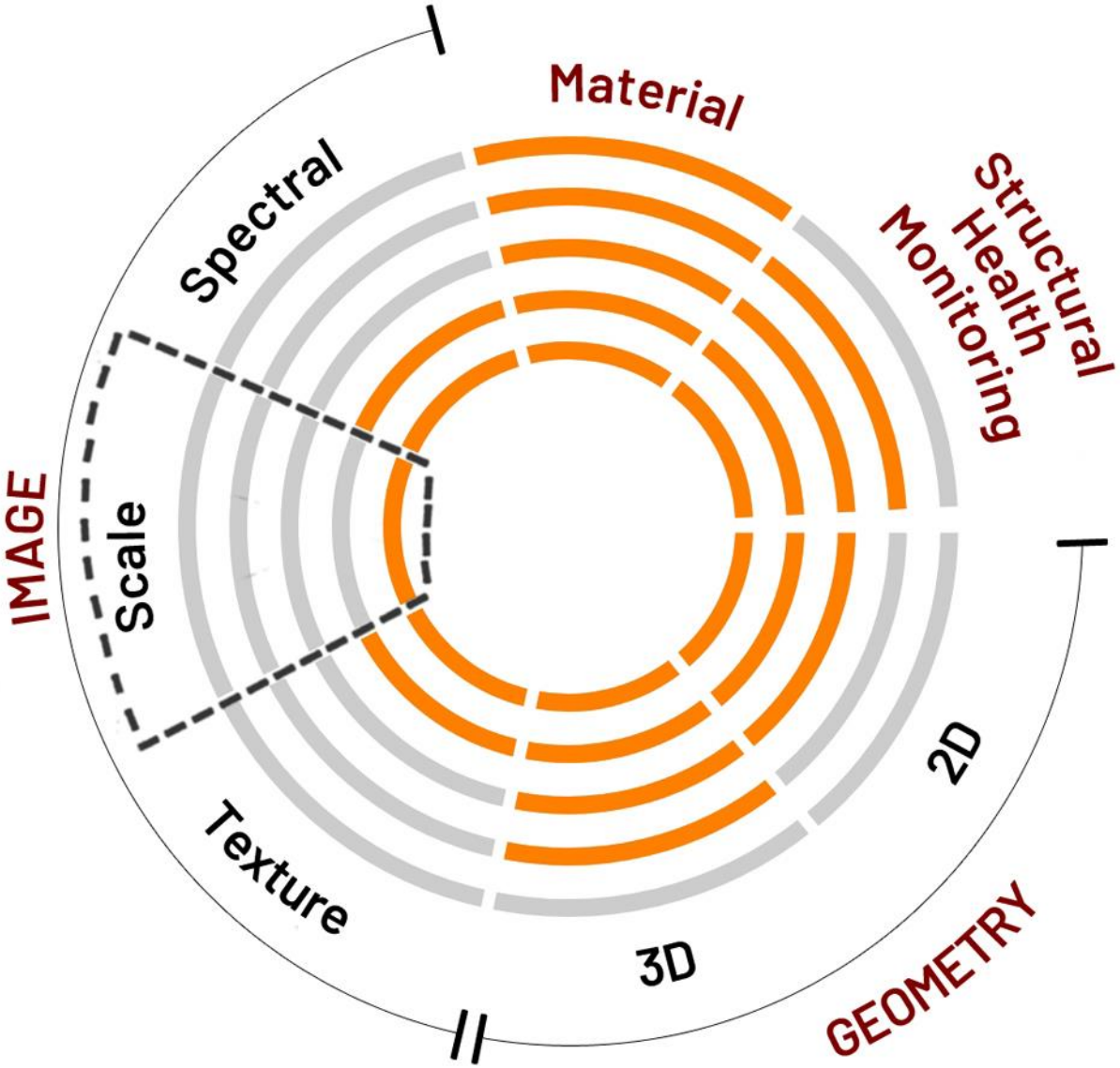

Material
Structural Health Monitoring
2D
GEOMETRY
3D
Texture
Scale
IMAGE
Spectral

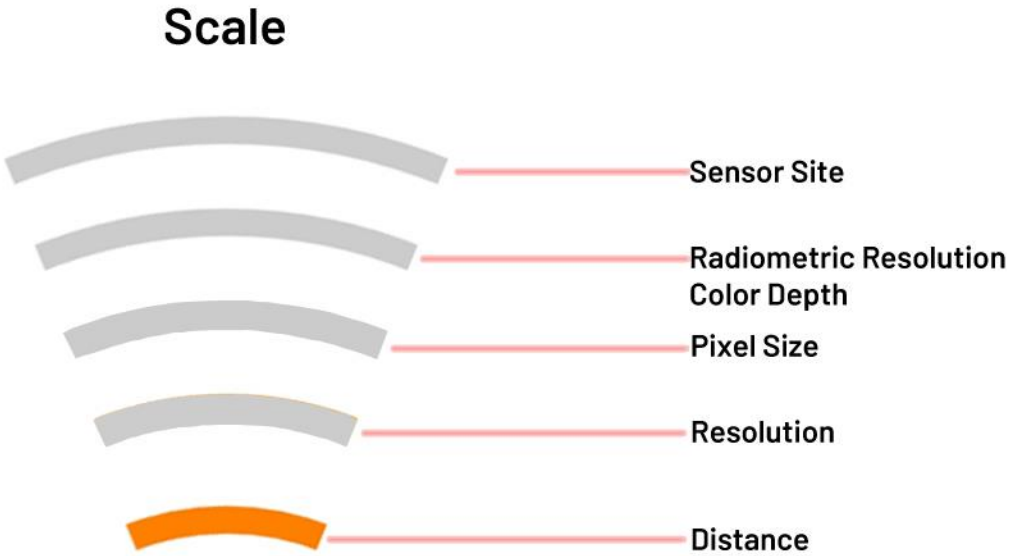

Material
Structural Health Monitoring
Spectral
IMAGE
Scale
Texture
3D
2D
GEOMETRY

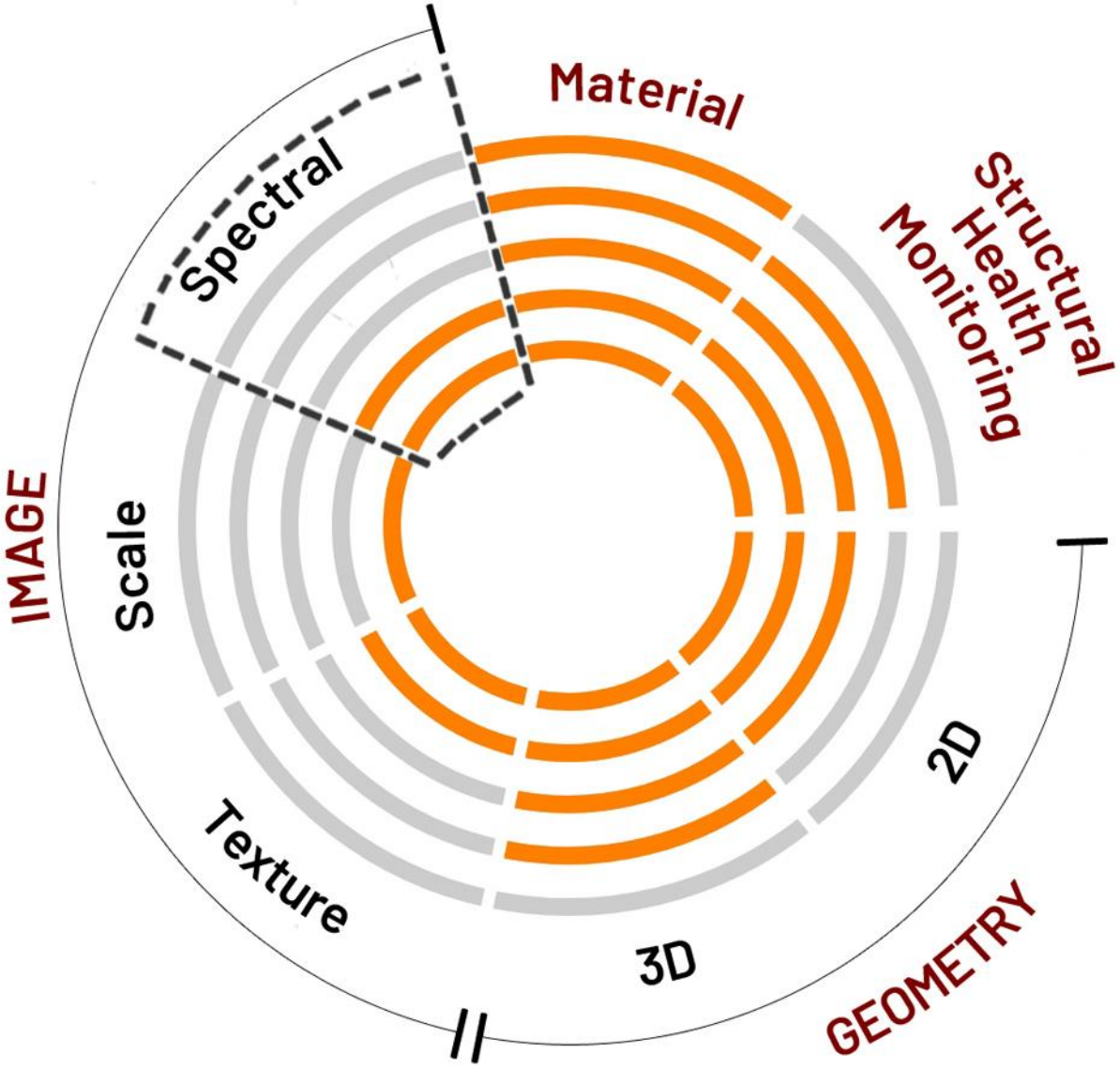

3D
Point Density
Completence (% lack points)
Resolution
Geometrical Accuracy
Geometrical Precision

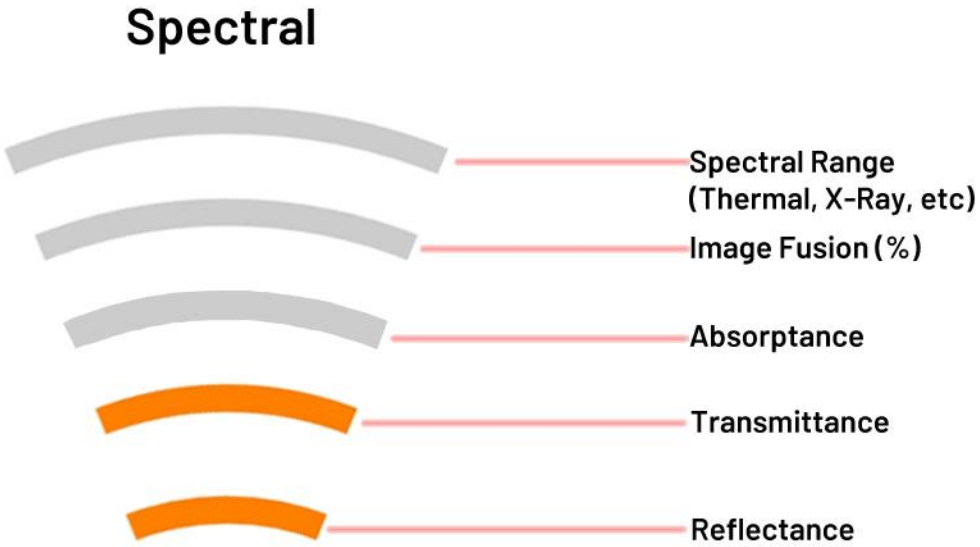

Material
Spectral
Structural Health Monitoring
IMAGE
Scale
Texture
2D
3D
GEOMETRY

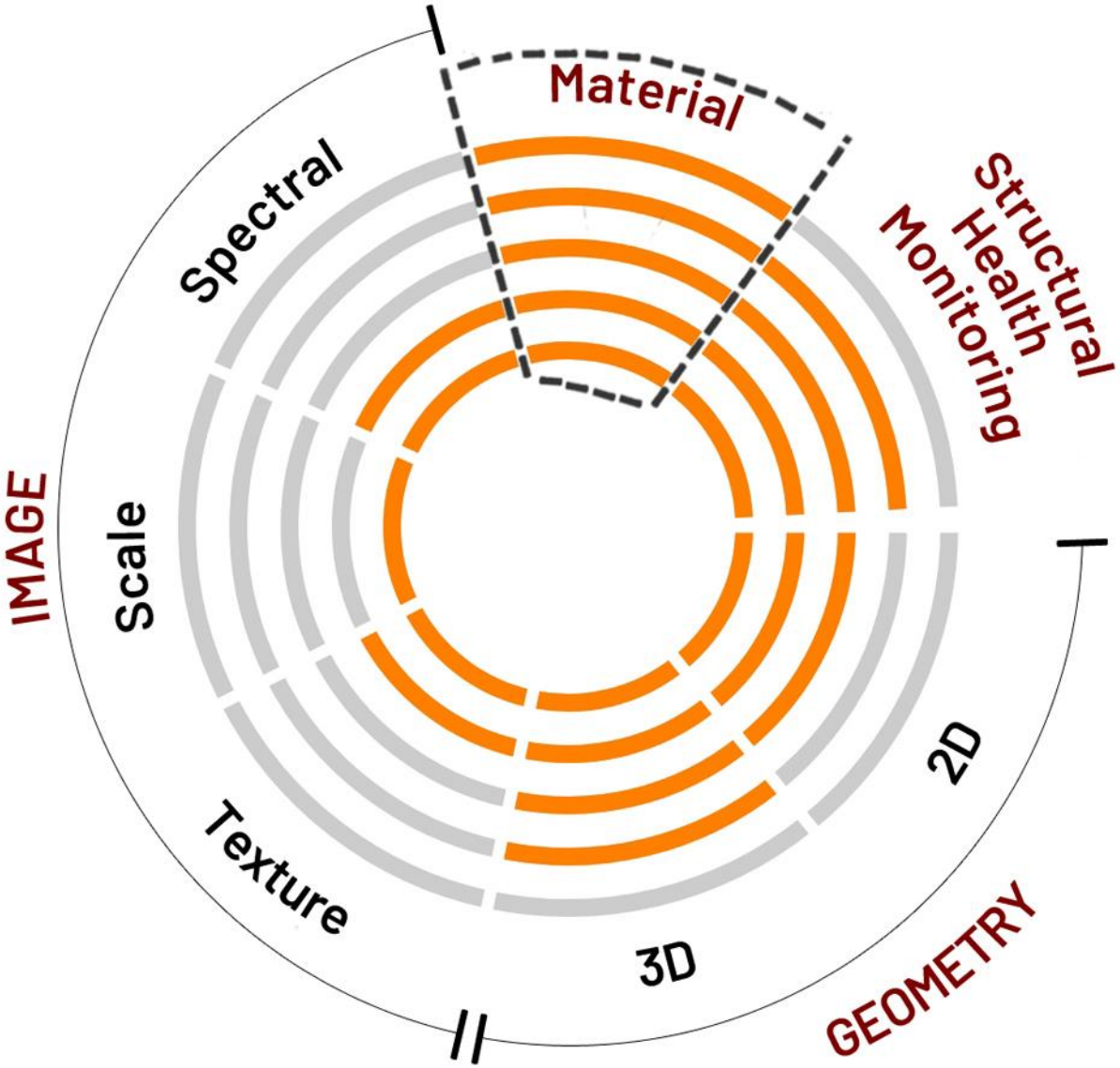

Texture
Opacity
Clarity
Contrast
Resolution
Color Depth

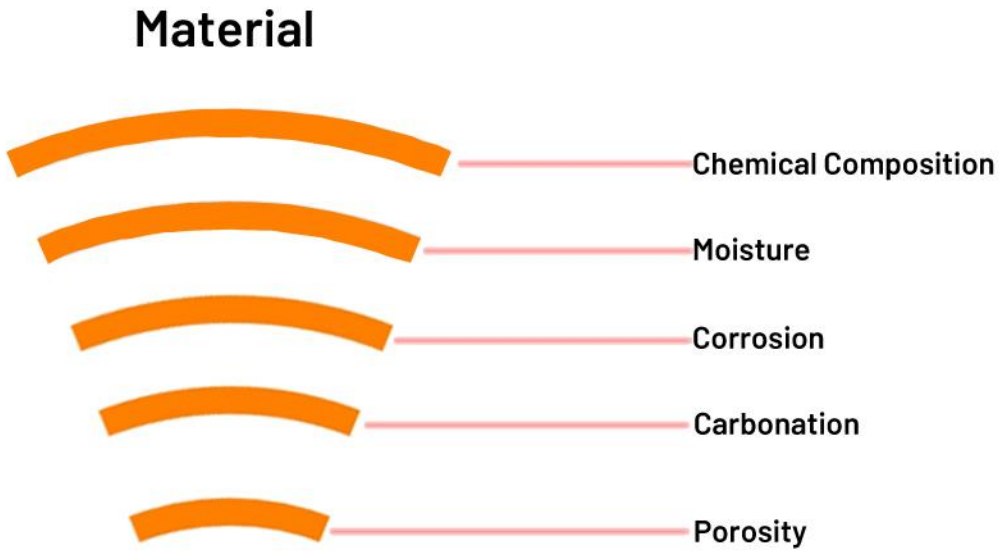

Material
Structural Health Monitoring
Spectral
IMAGE
Scale
Texture
2D
3D
GEOMETRY

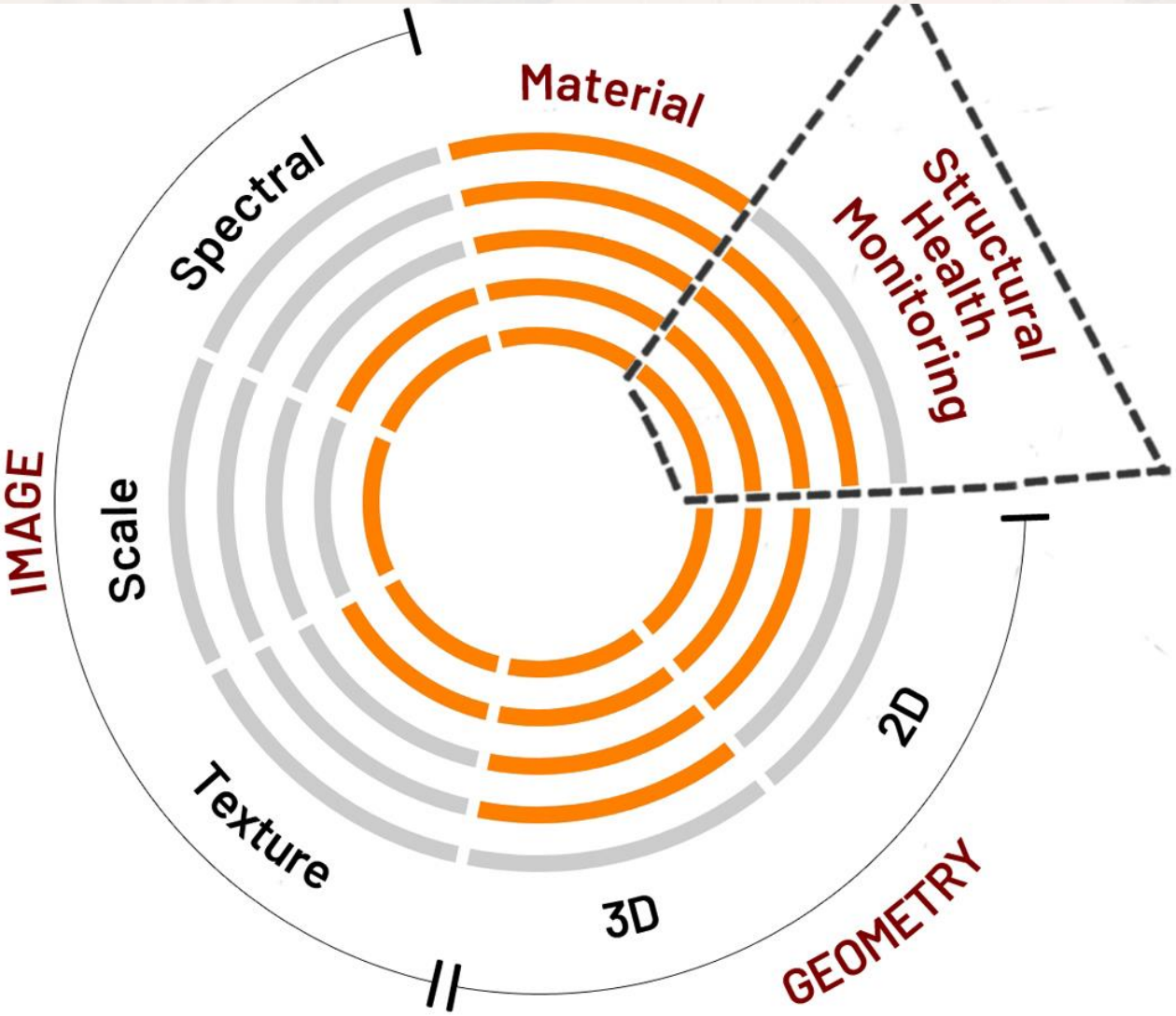

Scale
Sensor Site
Radiometric Resolution
Color Depth
Pixel Size
Resolution
Distance

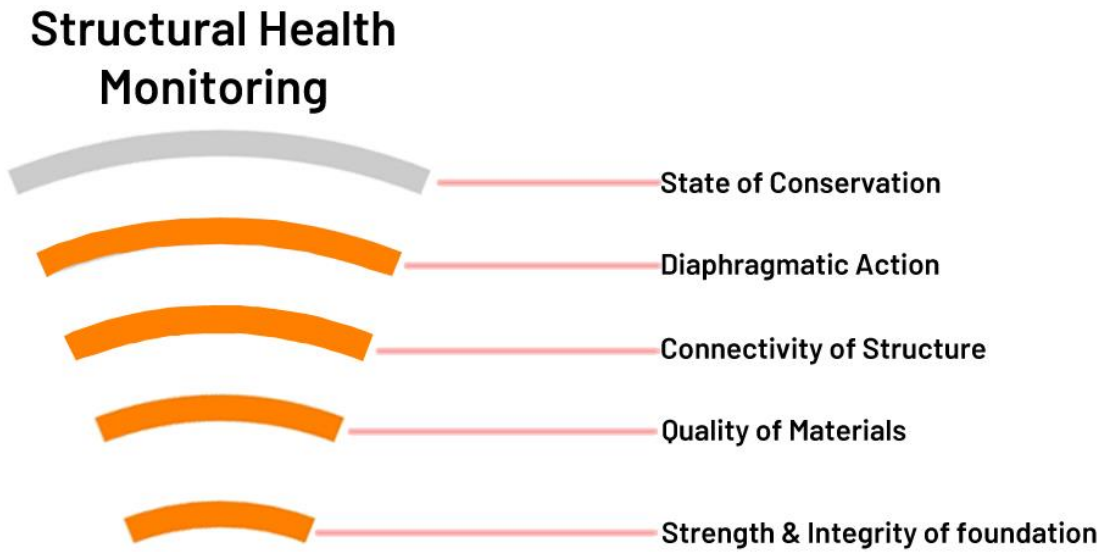

Material
Structural Health Monitoring
Spectral
IMAGE
Scale
Texture
2D
3D
GEOMETRY

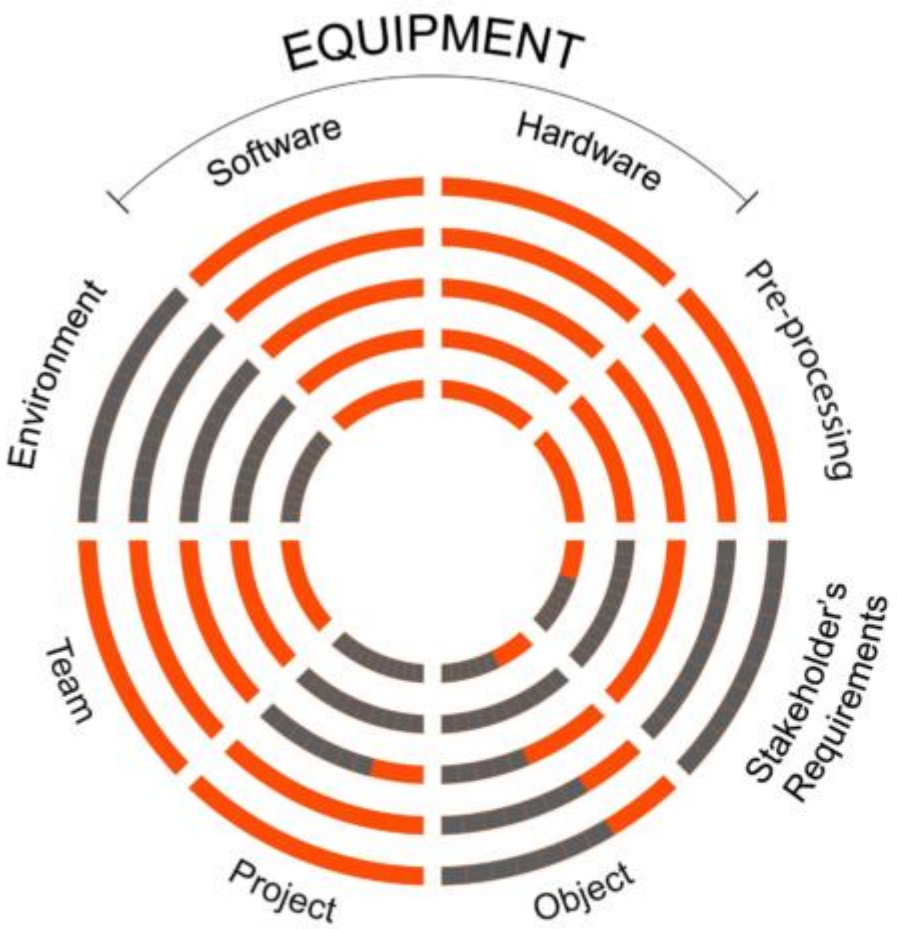

Spectral
Spectral Range (Thermal, X-Ray, etc)
Image Fusion (%)
Absorptance
Transmittance
Reflectance


Material
Spectral
Structural Health Monitoring
IMAGE
Scale
Texture
2D
3D
GEOMETRY

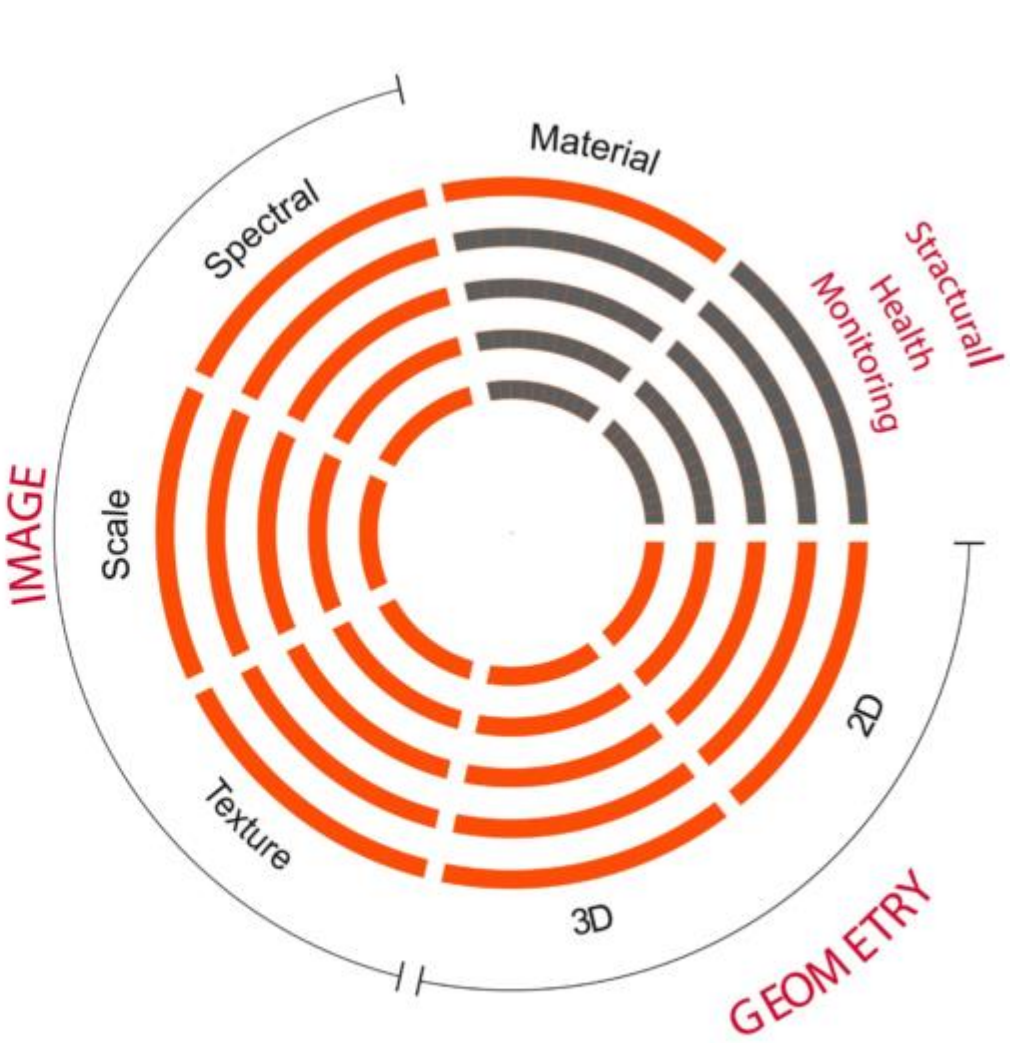

Material
Chemical Composition
Moisture
Corrosion
Carbonation
Porosity


Material
Spectral
Structural Health Monitoring
IMAGE
Scale
Texture
3D
2D
GEOMETRY


Structural Health Monitoring
State of Conservation
Diaphragmatic Action
Connectivity of Structure
Quality of Materials
Strength & Integrity of foundation



Complexity



Quality

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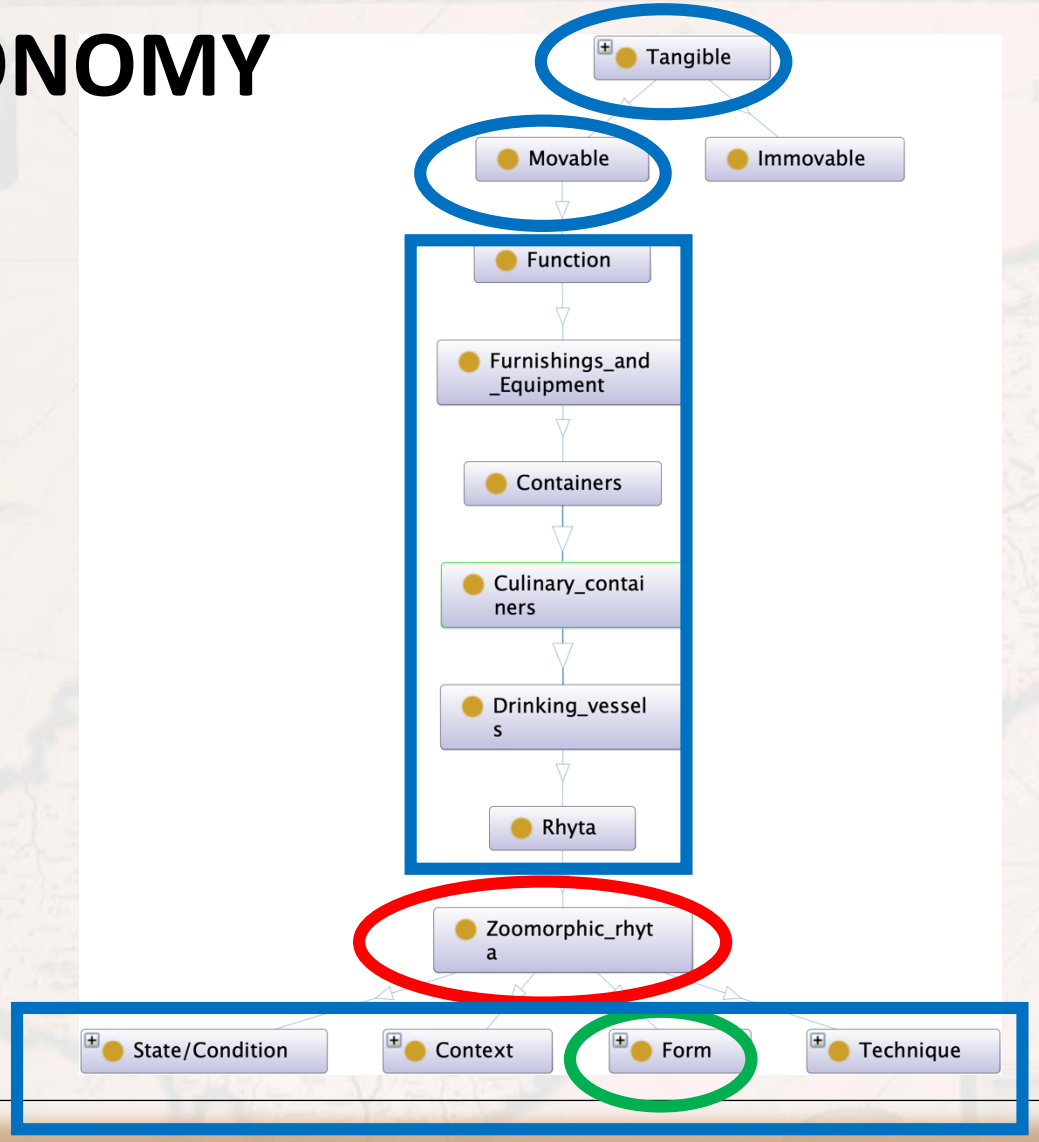
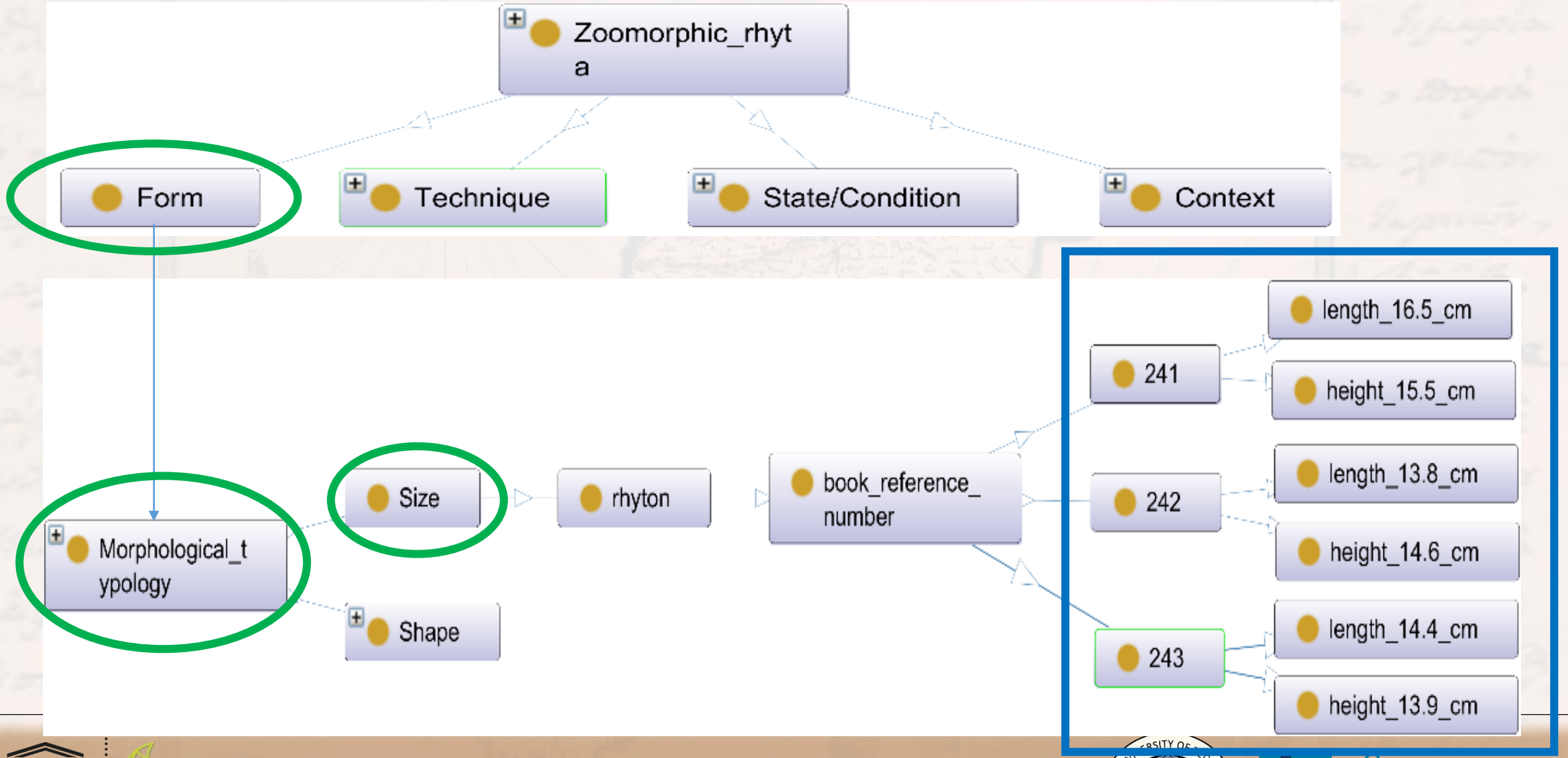
Cyprus University of Technology

TAXONOMY


Tangible
Movable
Immovable
Function
Furnishings_and _Equipment
Containers
Culinary_contai ners
Drinking_vessel s
Rhyta
Zoomorphic_rhyt a
State/Condition
Context
Form
Technique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Technique
State/Condition
Context
Morphological_typology
Size
Shape
rhyton
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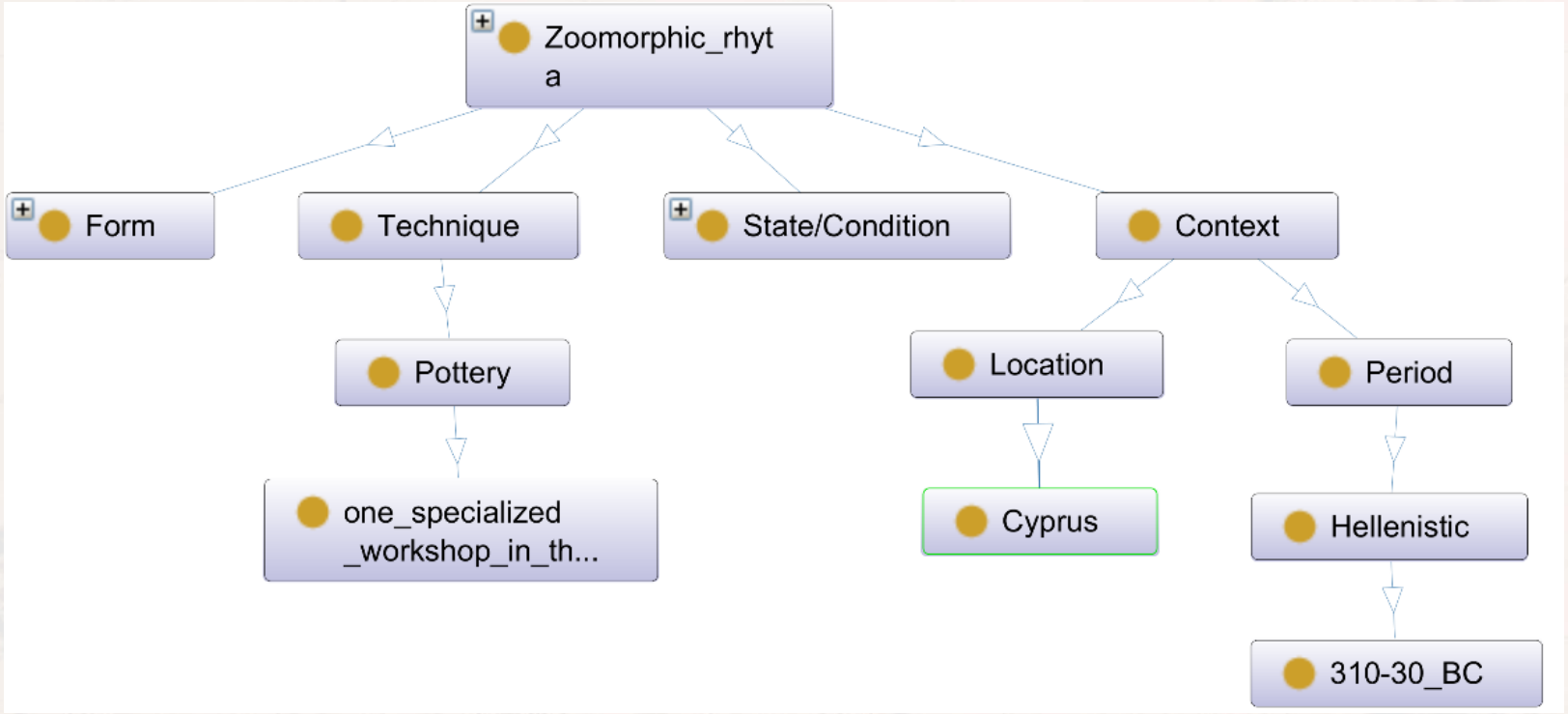
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State/Condition
Context
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Location
Period
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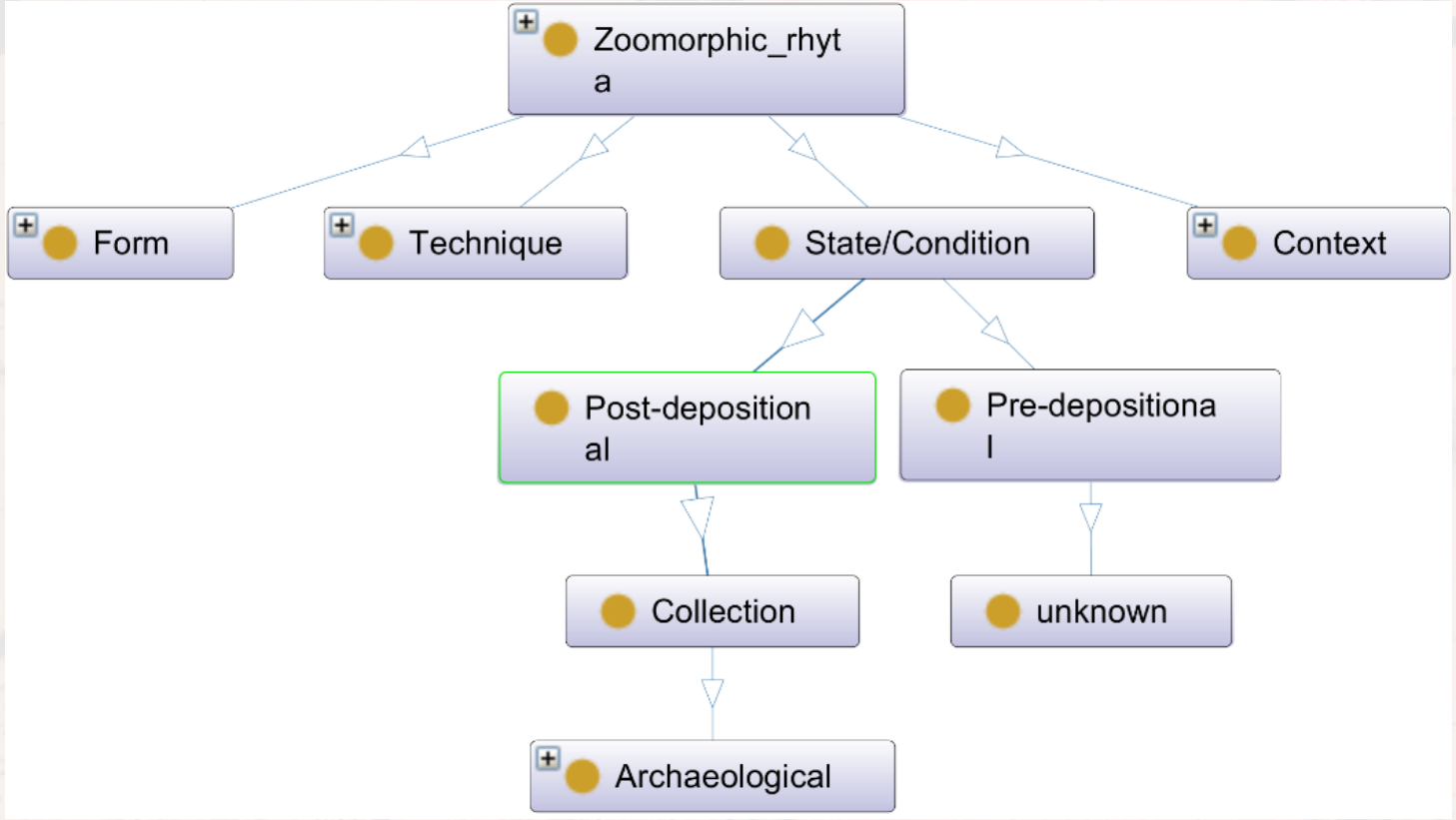
Hellenistic
310-30_BC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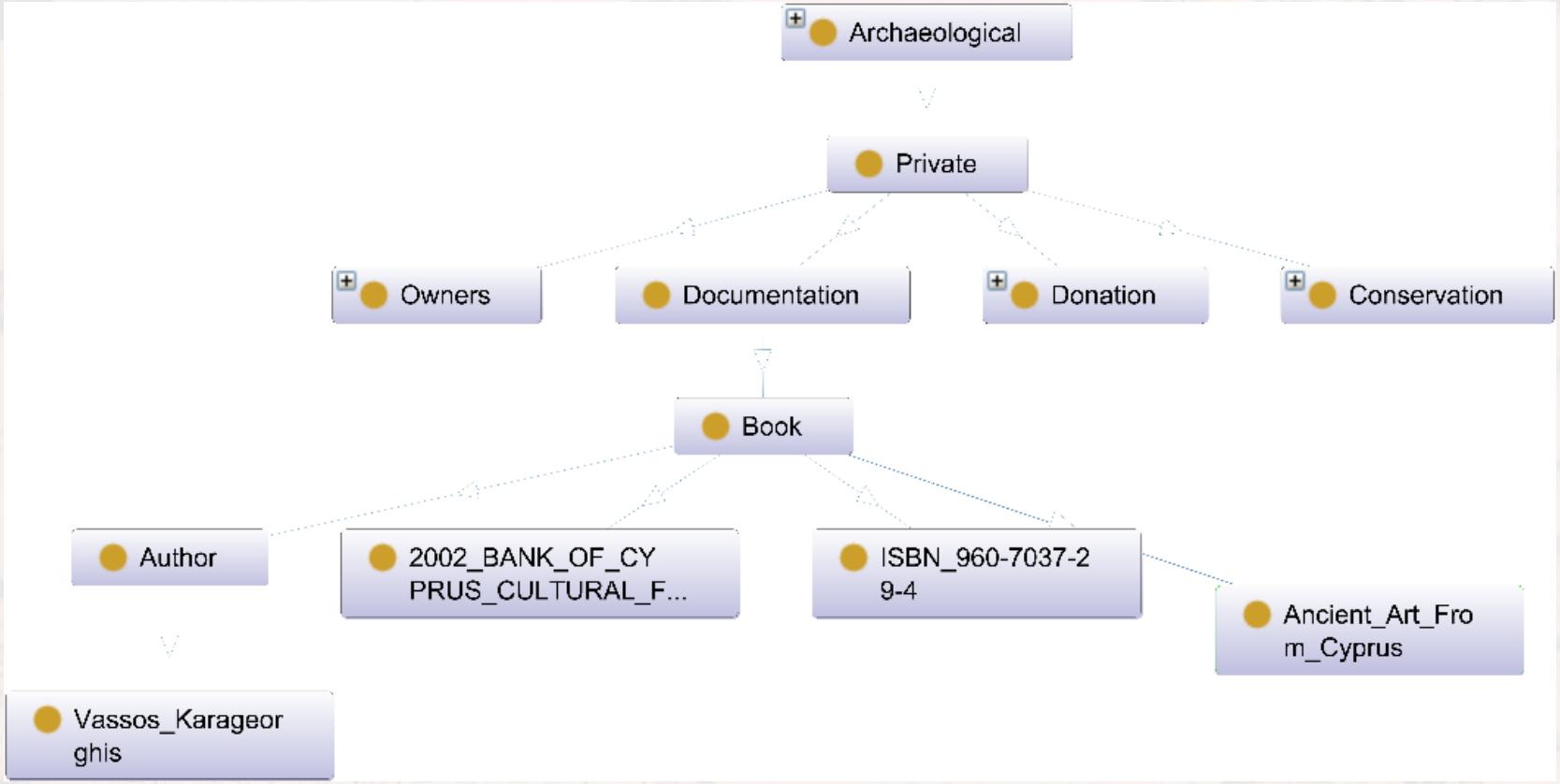
Technique
State/Condition
Context
Post-depositional
Pre-depositional
Collection
unknown
Archaeological


Archaeological
Private
Owners
Documentation
Donation
Conservation
Book
Author
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ISBN_960-7037-2 9-4
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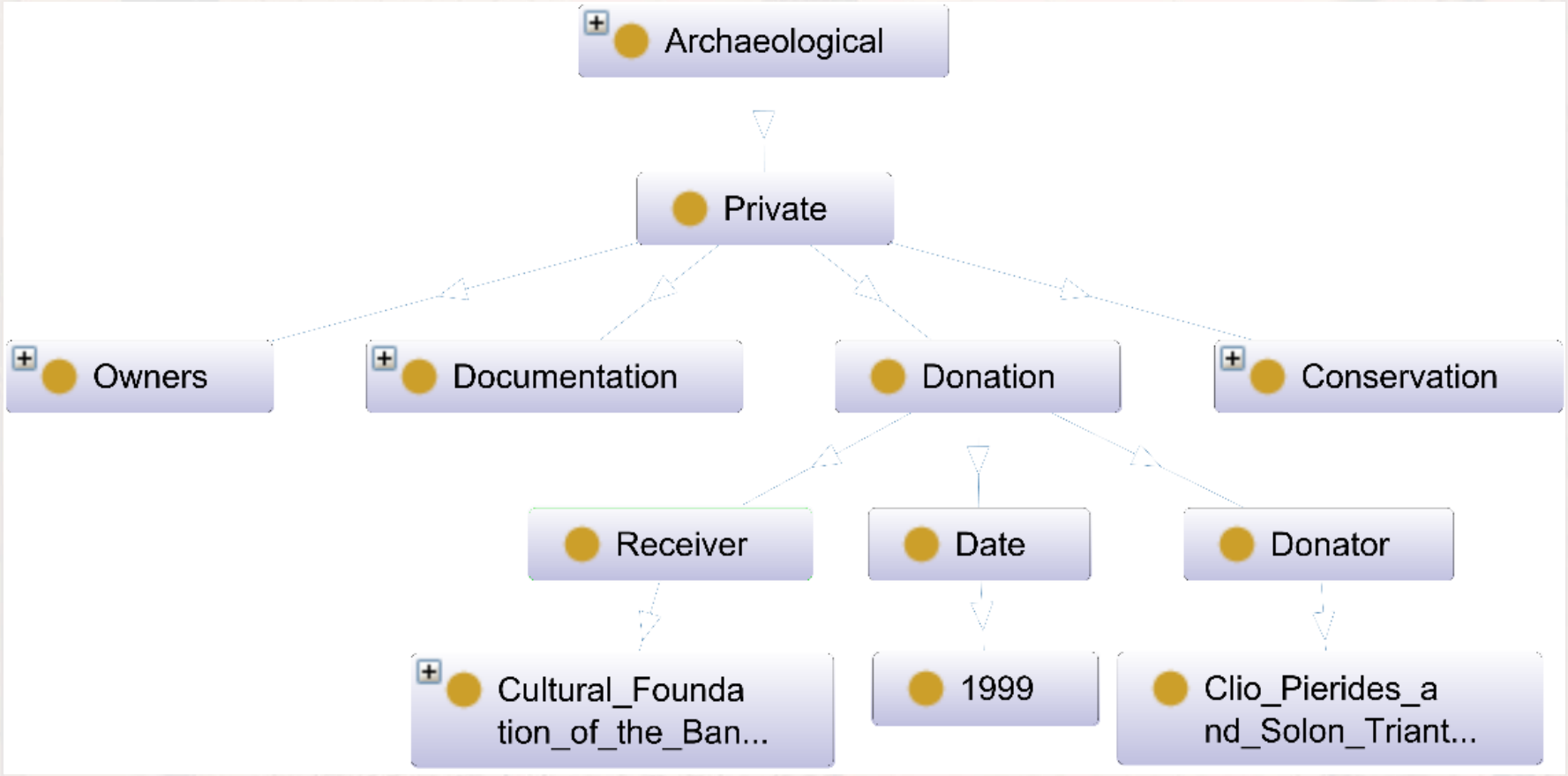
Vassos_Karageor ghis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Donator
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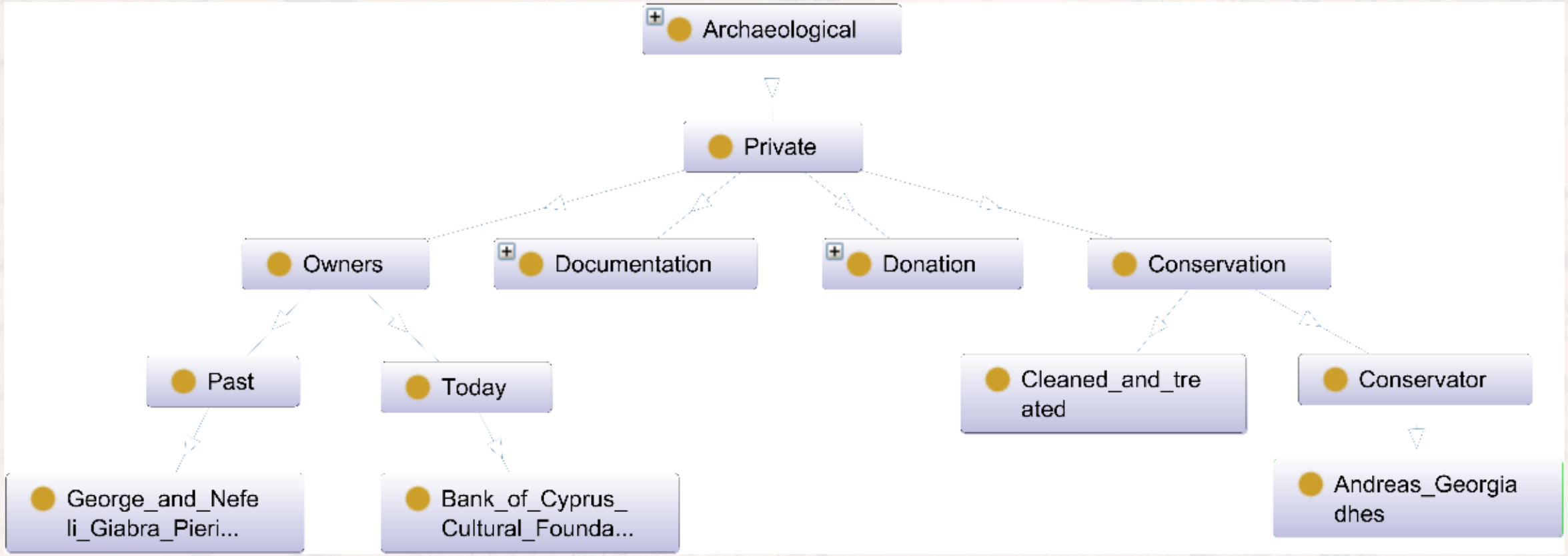
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Owners
Documentation
Donation
Conservation
Past
Today
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Conservator
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Bank_of_Cyprus_Cultural_Founda...
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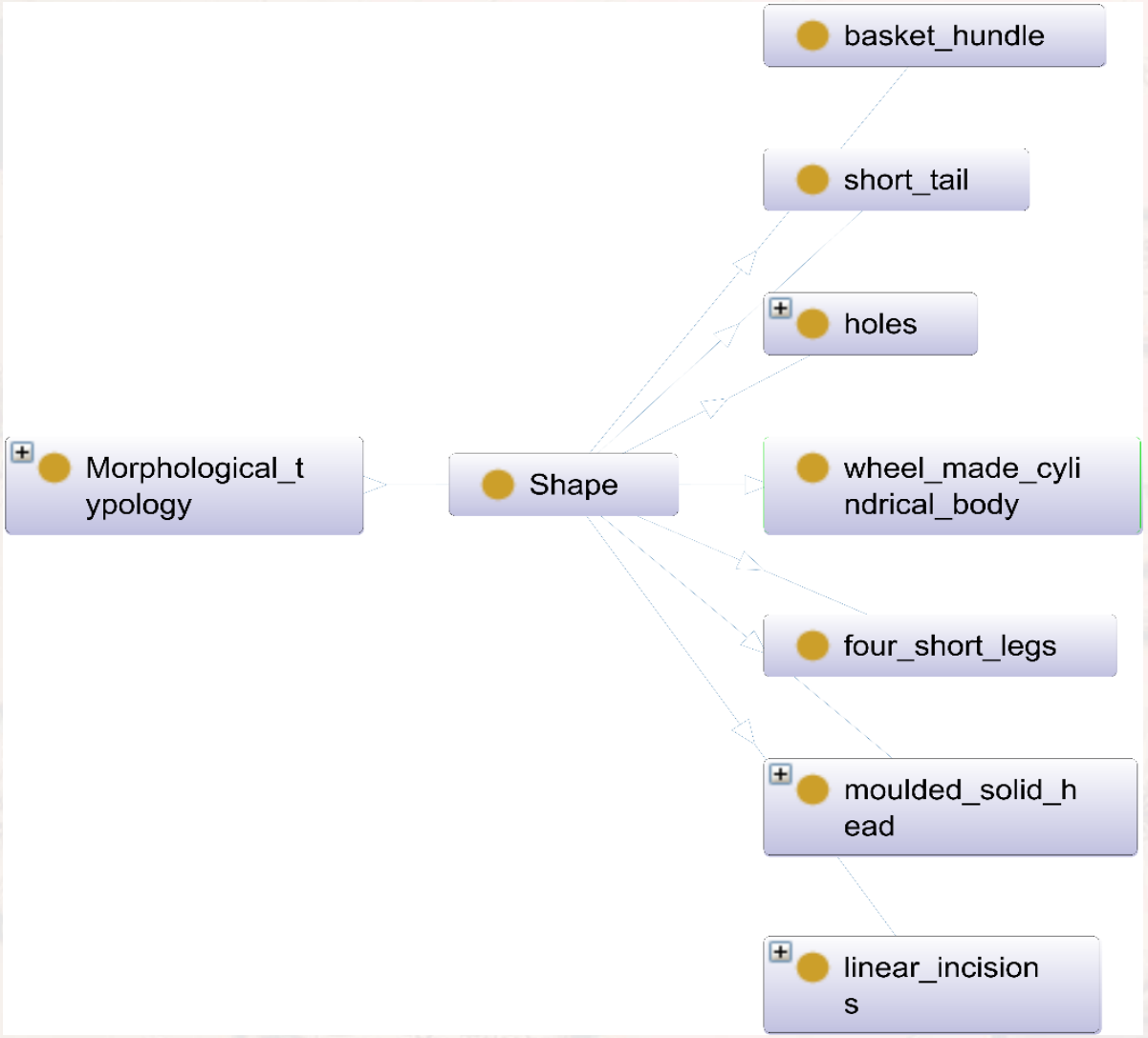
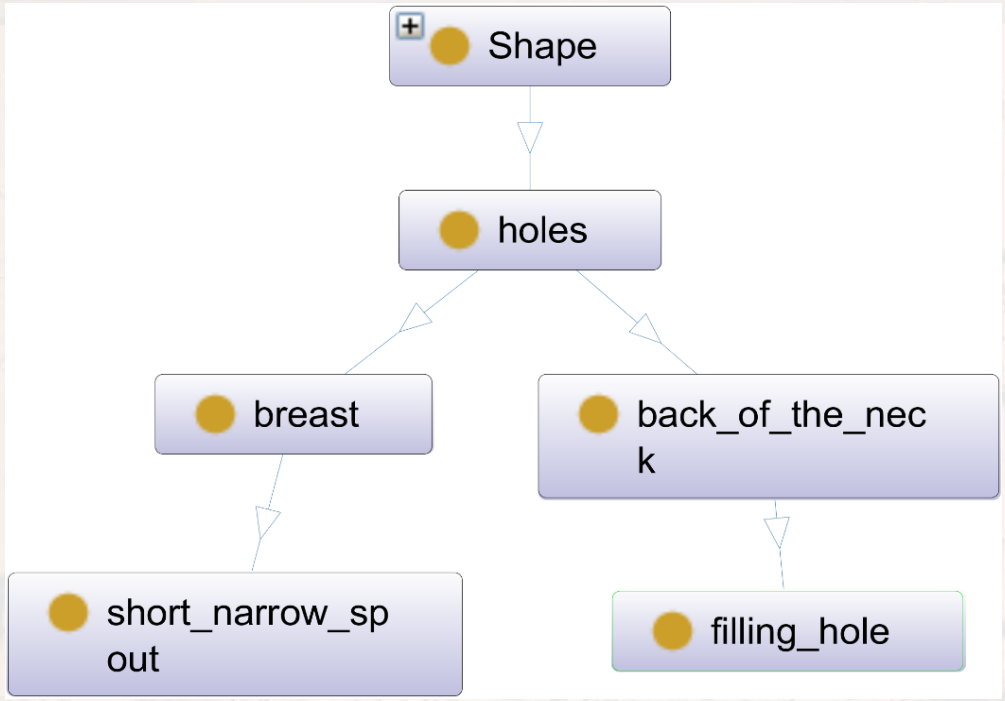
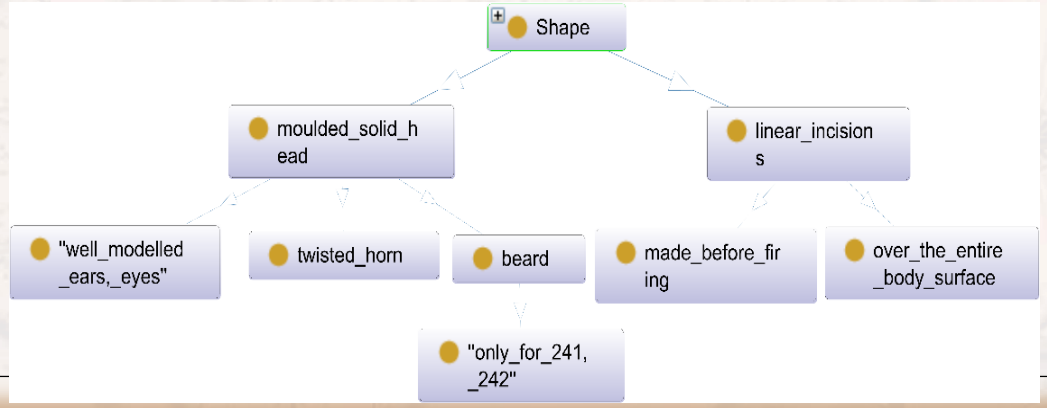

basket_hundle
short_tail
holes
Morphological_typology
Shape
wheel_made_cylindrical_body
four_short_legs
moulded_solid_head
linear_incisions


Shape
holes
breast
back_of_the_nec
k
short_narrow_sp
out
filling_hole


Shape
moulded_solid_h
ead
linear_incision
s
"well_modelled
_ears,_eyes"
twisted_horn
beard
made_before_fir
ing
over_the_entire
_body_surface
"only_for_241,
_242"

Our Monuments, Museums and Sites talk

Do we understand them ?

…and how can the Digital Era contribute to
a better understanding, access,
preservation and protection
of the history of man kind?

Information + Data == Knowledge

United Nations
Educational, Scientific and
Cultural Organization

UNESCO Chair on
Digital Cultural Heritage at
the Cyprus University of Technology

European Research Area
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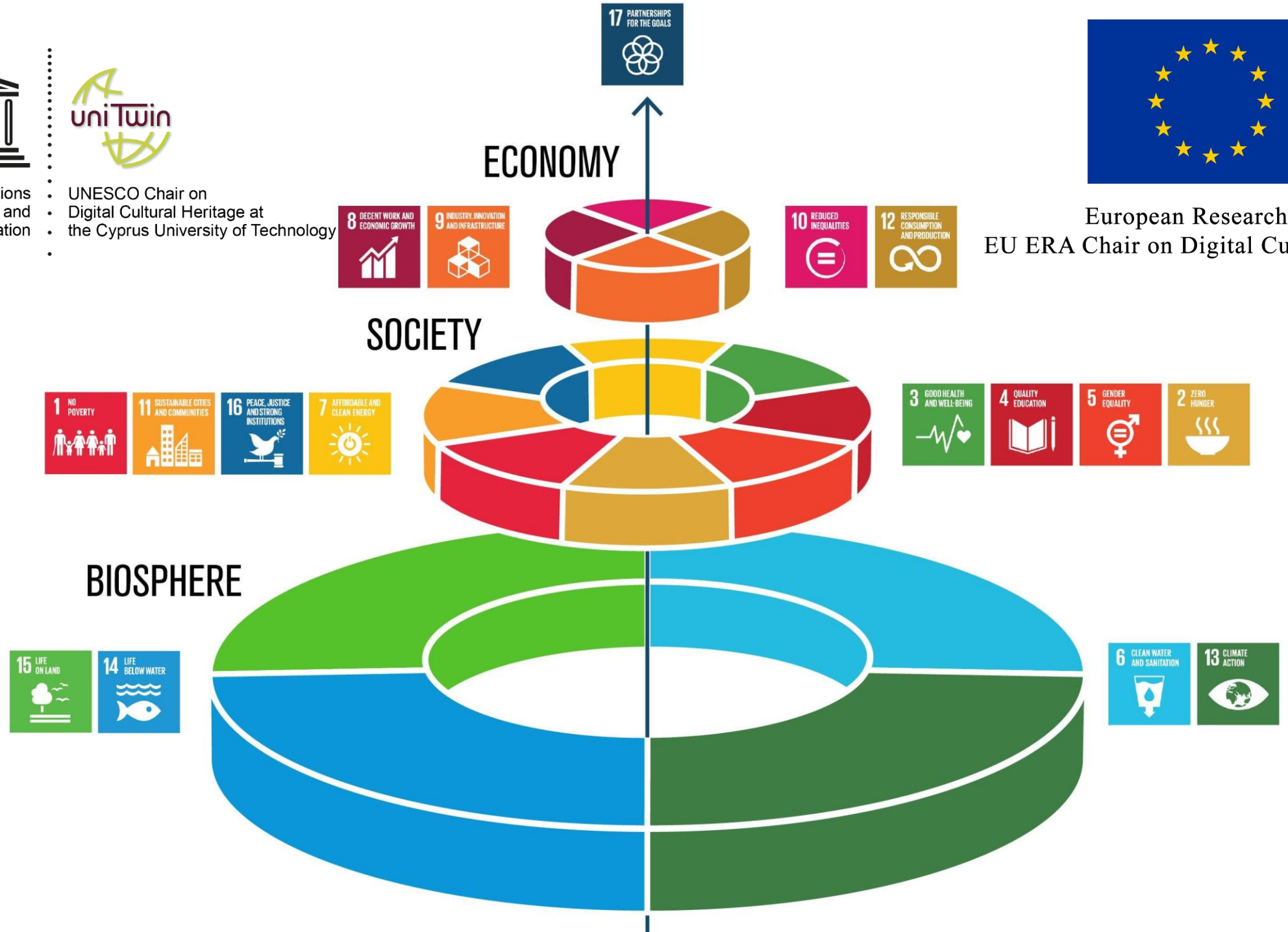

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