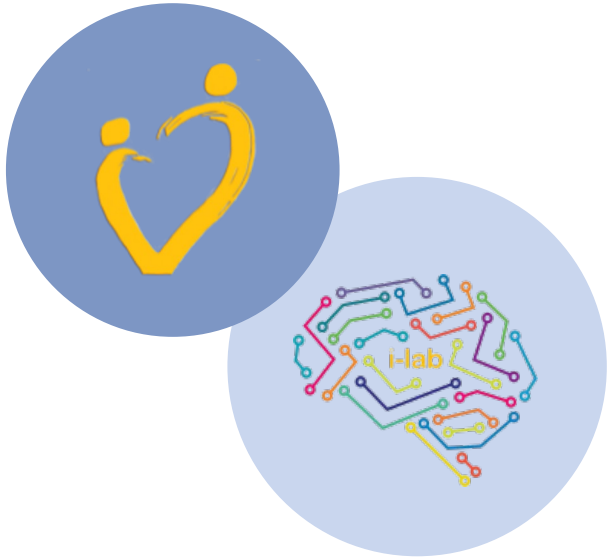
UNIVERSITY OF THE AEGEAN
SCHOOL OF SOCIAL SCIENCES
DEPARTMENT OF CULTURAL TECHNOLOGY AND COMMUNICATION

An Ontology to Support **Decision-making** in **Conservation and Restoration Interventions** of Cultural Heritage

SWODCH Workshop
07/11/2023

Efthymia Moraitou,
Yannis Christodoulou,
Konstantinos Kotis,
and George Caridakis



Intelligent Interaction Research Group

(ii Research Group)

Intelligent Systems Laboratory (iLab)

Founded on June 2016, under the aegis of the Department of Cultural Technology and Communication of the University of the Aegean (Greece) research work.

II research work mainly focus on:

- Human Computer Interaction
- Intelligent Systems
- Cultural Information Management

Conservation and Restoration of CH

Preserve and safeguard tangible CH

Decide **if and how** to intervene

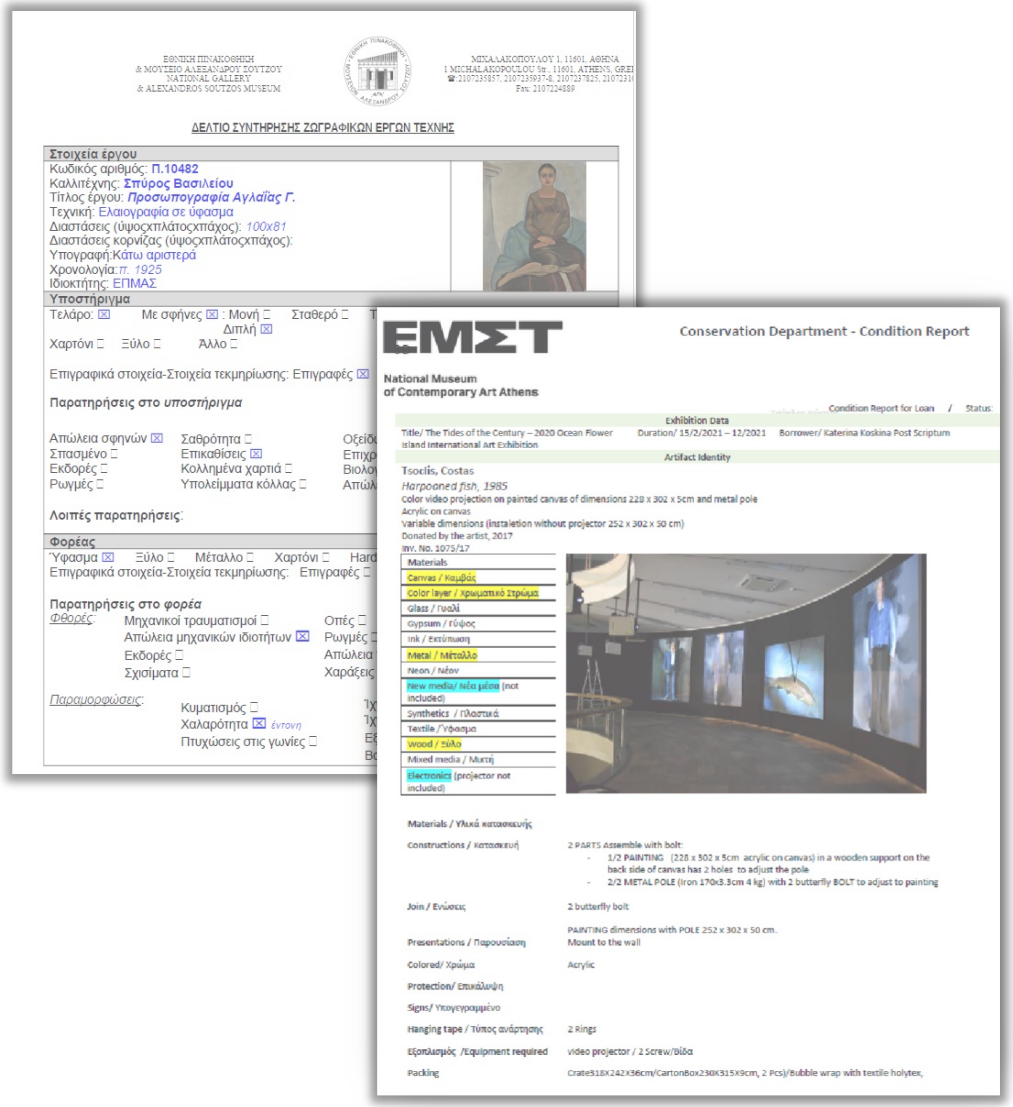
Understand **original and present** state

Decision-making process

documentation

CnR data & interoperability issues

- Fragmentation of the data
- Heterogeneity of the data
  - various forms
  - terminology inconsistencies



ΕΘΝΙΚΗ ΠΙΝΑΚΟΘΗΚΗ
& ΜΟΥΣΕΙΟ ΑΛΕΞΑΝΔΡΟΥ ΣΟΥΤΖΟΥ
NATIONAL GALLERY
& ALEXANDROS SOUTZOS MUSEUM

ΔΕΛΤΙΟ ΣΥΝΤΗΡΗΣΗΣ ΖΩΓΡΑΦΙΚΩΝ ΕΡΓΩΝ ΤΕΧΝΗΣ

Στοιχεία έργου
Κωδικός αριθμός: Π.10482
Καλλιτέχνης: Σπύρος Βασιλείου
Τίτλος έργου: Προσωπογραφία Αγλαΐας Γ.
Τεχνική: Ελαιογραφία σε ύφασμα
Διαστάσεις (ύψοςxπλάτοςxπάχος): 100x81
Διαστάσεις κορνίζας (ύψοςxπλάτοςxπάχος):
Υπογραφή:Κάτω αριστερά
Χρονολογία:π. 1925
Ιδιοκτήτης: ΕΠΜΑΣ

Υποστήριγμα
Τελάρο: ☒ Με σφήνες ☒ : Μονή ☐ Σταθερό ☐ Διπλή ☒
Χαρτόνι ☐ Ξύλο ☐ Άλλο ☐
Επιγραφικά στοιχεία-Στοιχεία τεκμηρίωσης: Επιγραφές ☒
Παρατηρήσεις στο υποστήριγμα
Απώλεια σφηνών ☒ Σαθρότητα ☐
Στασμένο ☐ Επικαθίσεις ☒
Εκδορές ☐ Κολλημένα χαρτιά ☐
Ρωγμές ☐ Υπολείμματα κόλλας ☐
Λοιπές παρατηρήσεις:

Φορέας
Ύφασμα ☒ Ξύλο ☐ Μέταλλο ☐ Χαρτόνι ☐
Επιγραφικά στοιχεία-Στοιχεία τεκμηρίωσης: Επιγραφές ☐
Παρατηρήσεις στο φορέα
Φθορές: Μηχανικοί τραυματισμοί ☐ Οπές ☐
Απώλεια μηχανικών ιδιοτήτων ☒ Ρωγμές ☐
Εκδορές ☐ Απώλεια
Σχισίματα ☐ Χαράξεις
Παραμορφώσεις: Κυματισμός ☐
Χαλαρότητα ☒ έντονη
Πτυχώσεις στις γωνίες ☐

ΕΜΣΤ
Conservation Department - Condition Report
National Museum
of Contemporary Art Athens
Condition Report for Loan / Status:
Exhibition Data
Title/ The Tides of the Century – 2020 Ocean Flower Island International Art Exhibition
Duration/ 15/2/2021 – 12/2021
Borrower/ Katerina Koskina Post Scriptum
Artifact Identity
Tsoclis, Costas
Harpooned fish, 1985
Color video projection on painted canvas of dimensions 228 x 302 x 5cm and metal pole
Acrylic on canvas
Variable dimensions (instaletion without projector 252 x 302 x 50 cm)
Donated by the artist, 2017
INV. No. 1075/17
Materials
Canvas / Καμβάς
Color layer / Χρωματικό Στρώμα
Glass / Γυαλί
Gypsum / Γύψος
Ink / Εκτύπωση
Metal / Μέταλλο
Neon / Νέον
New media/ Νέα μέσα (not included)
Synthetics / Πλαστικά
Textile /Ύφασμα
Wood / Ξύλο
Mixed media / Μικτή
Electronics (projector not included)
Materials / Υλικά κατασκευής
Constructions / Κατασκευή: 2 PARTS Assemble with bolt:
- 1/2 PAINTING (228 x 302 x 5cm acrylic on canvas) in a wooden support on the back side of canvas has 2 holes to adjust the pole
- 2/2 METAL POLE (iron 170x3.3cm 4 kg) with 2 butterfly BOLT to adjust to painting
Join / Ενώσεις: 2 butterfly bolt
Presentations / Παρουσίαση: PAINTING dimensions with POLE 252 x 302 x 50 cm. Mount to the wall
Colored/ Χρώμα: Acrylic
Protection/ Επικάλυψη
Signs/ Υπογεγραμμένο
Hanging tape / Τύπος ανάρτησης: 2 Rings
Εξοπλισμός /Equipment required: video projector / 2 Screw/Βίδα
Packing: Crate518X242X36cm/Carton80x230X315X9cm, 2 Pcs)/Bubble wrap with textile holytex,

Semantic models & Ontologies for CnR - aspects

- **Administration**
- **Materials and technology**
- **Alteration**
- **Investigation**
- **Intervention**

Semantic models & Ontologies for CnR - services

- **Unified access & information retrieval**
- **Data visualization**
- **Problem identification**
- **Recommendation of digitization/analysis methods**

Exploitation of ontologies

Conceptualization of CnR intervention decision-making process

Support of the option selection in an assistive way

Assistance of conservators to

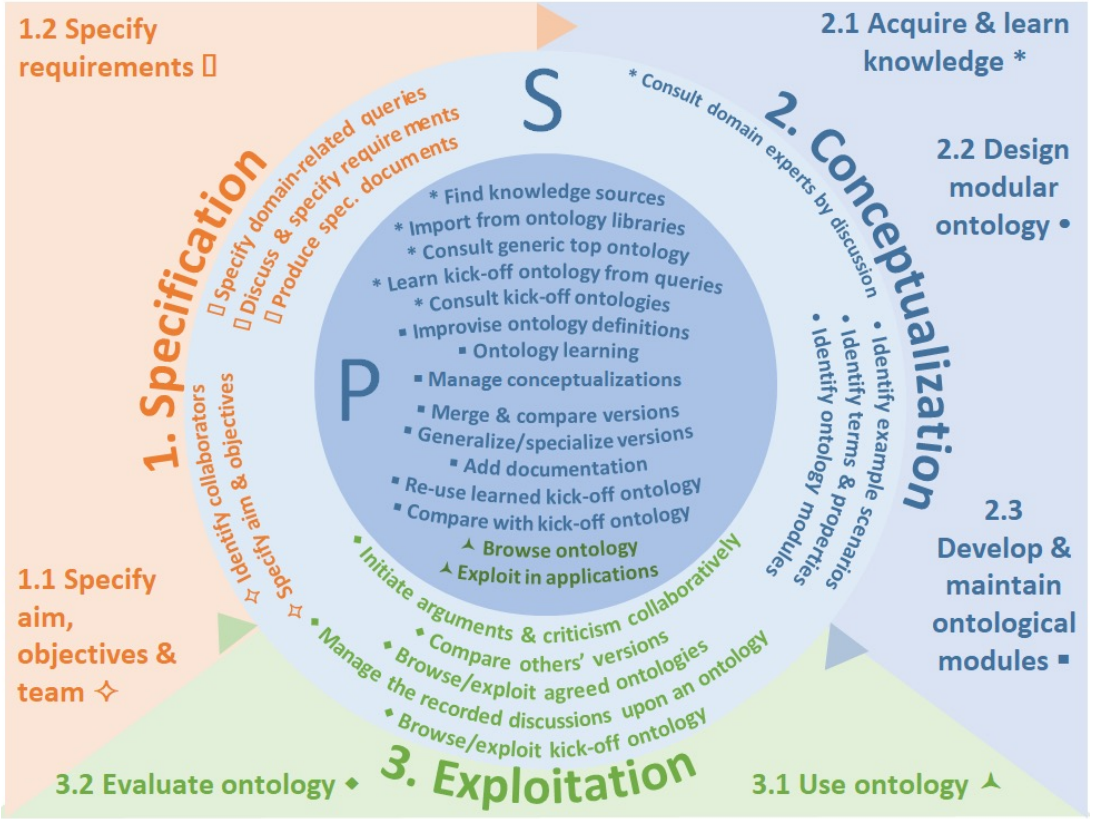
1. organize their thoughts and determine requirements (extrinsic and intrinsic) and criteria over a case at hand

2. validate and enrich the documentation of the input data, which are taken into account for the final decision

3. automatically receive a set of specific suitable intervention options based on the specific parameters, requirements and criteria of the case at hand

HCOME methodology

- Human-Centered Collaborative Ontology Engineering Methodology
- Cooperation with conservators from National Museum of Contemporary Art Athens and National Gallery Alexandros Soutsos Museum
- Structure meetings
- Asynchronous communication through shared documents



Data

- *the **characteristics** of the conservation object, its environment, and any planned CnR intervention,*
- *the **CnR intervention options**, including any techniques, supplies and requirements involved (**intrinsic requirements**)*
- *the **external factors**, such as budget and location requirements (**extrinsic requirements**)*
- *the **criteria** of selection between suitable options*

Data

- **cleaning of superficial deposits**, refers to the reduction of superficial soil, dust, grime, insect droppings, accretions, or other surface deposits of conservation objects - *very common intervention, applied in a variety of different conservation objects*
- **consolidation of flaking gouache** refers to the stabilization of flaked areas of gouache painting layers by introducing materials - *more specialized intervention, applied only on the painting layers of artworks that are made with the gouache technique*

Inferences

- *An option **is considered***
- *An intrinsic requirement **is stipulated***
- *A requirement **is not satisfied***
- *Terminology inferences (**broader-narrower terms**)*

Competency questions

Simpler

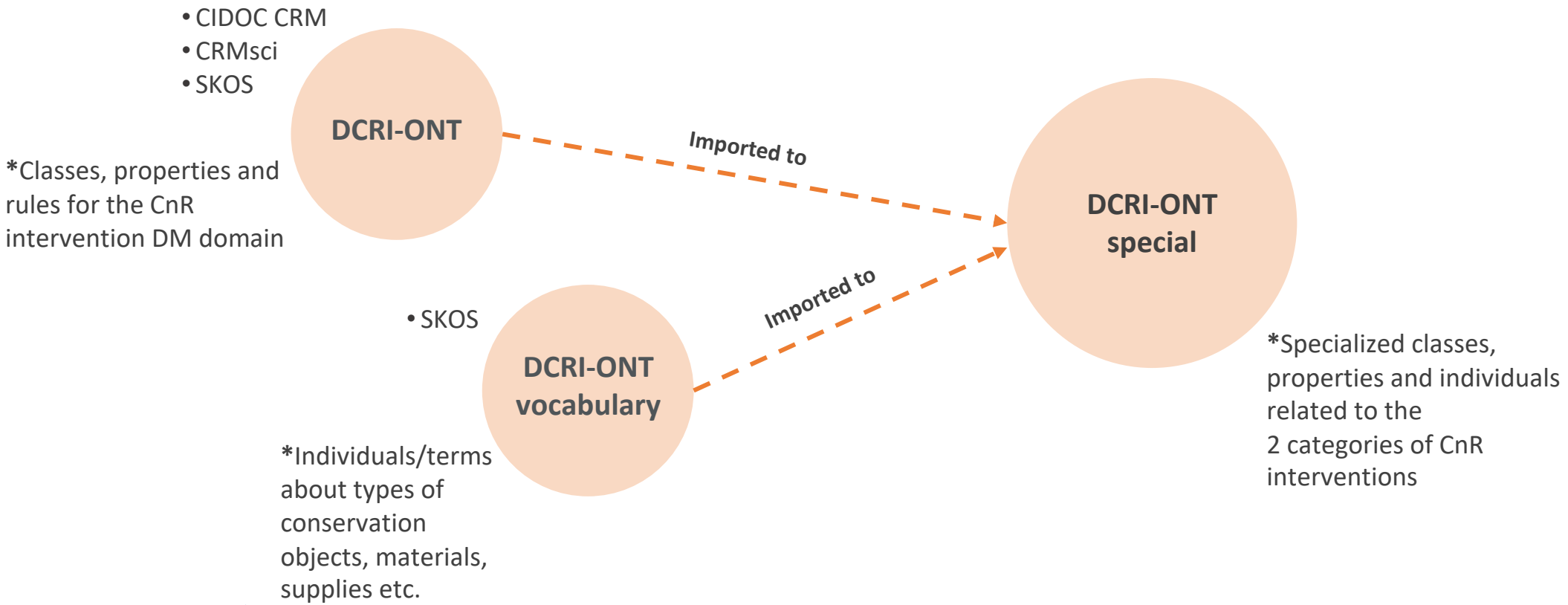
- What are the characteristics of the conservation object?
- What are the options considered for an issue?
- Which is the criterion of a decision-making process?

Competency questions

More sophisticated

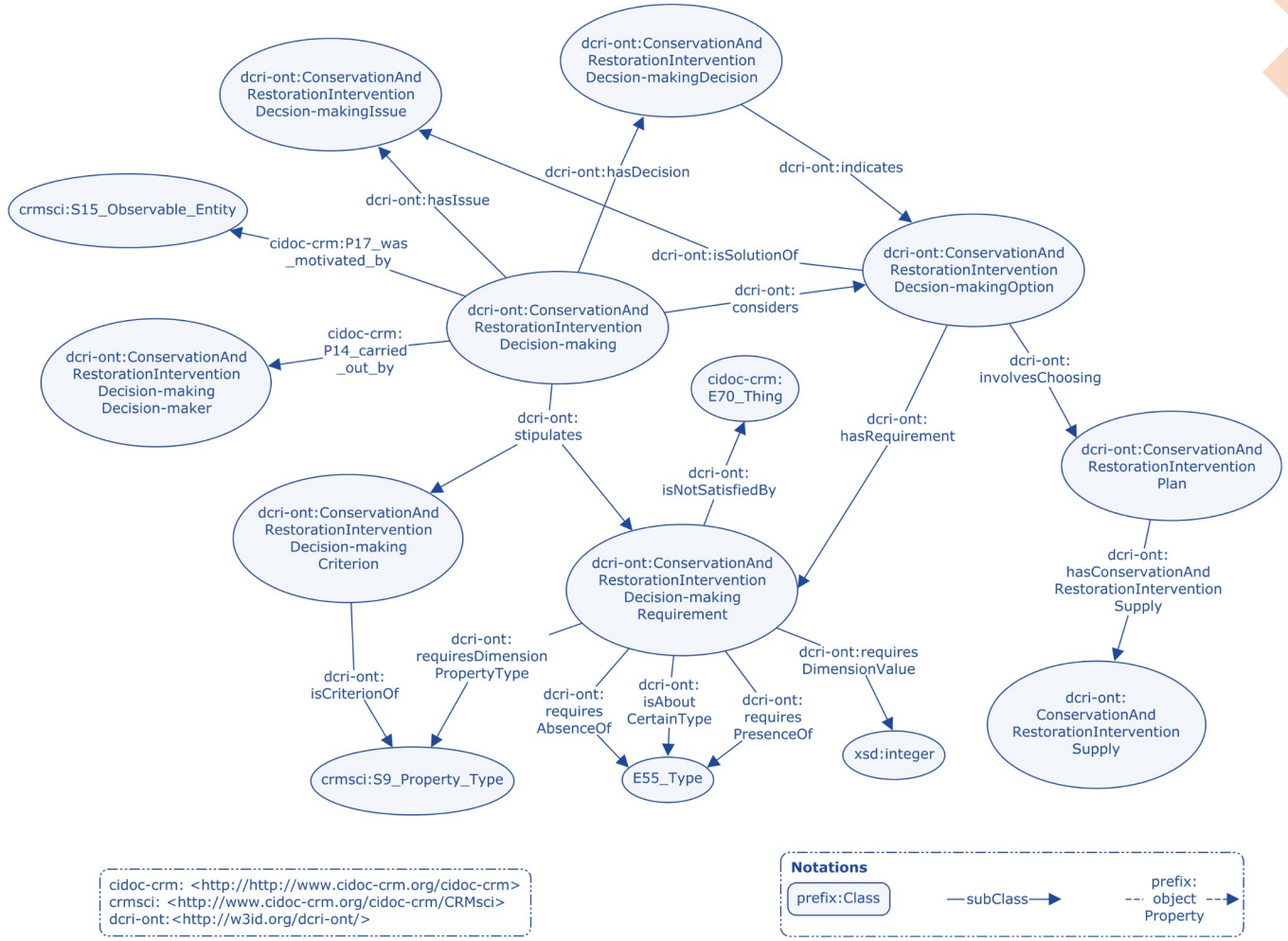
- What are the characteristics of the conservation object about which an intrinsic requirement requires their absence/presence and there is no relation of their presence/absence?
- Which of the considered options have not even one intrinsic requirement which is not satisfied?
- What's the order of the suitable options according to the criterion defined by the decision-making, along with the qualitative values of the criterion?

Technical choices



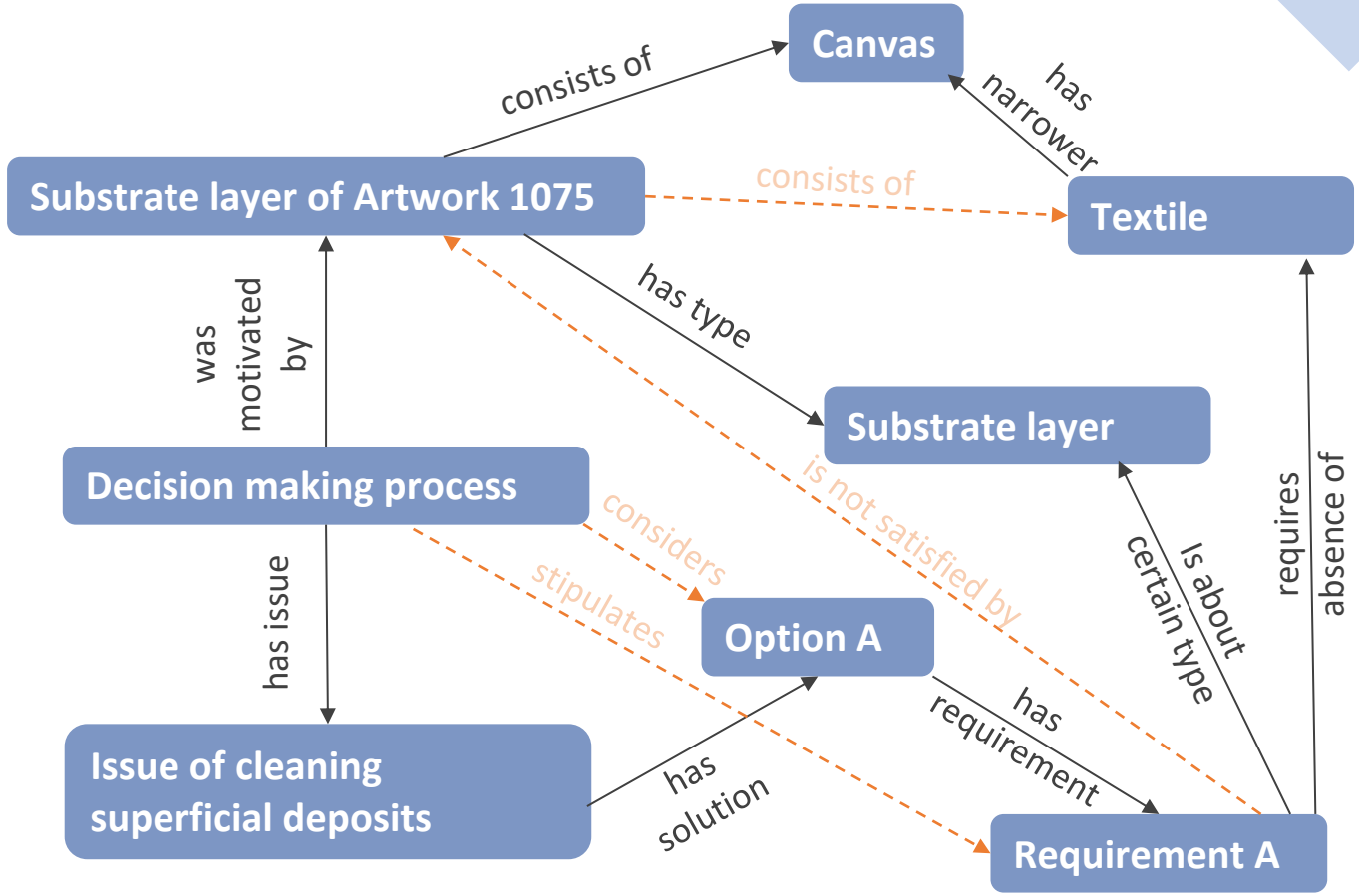
Thematic clusters

- **CnR-DM-I process** - *process, issues, actors, options, requirements, criteria*
- **Conservation object** – *administrative information, materials and technology, features, alteration*
- **Conservation object's environment** – *location, quantitative and qualitative characteristics*
- **CnR intervention plans** – *plans, techniques, supplies*

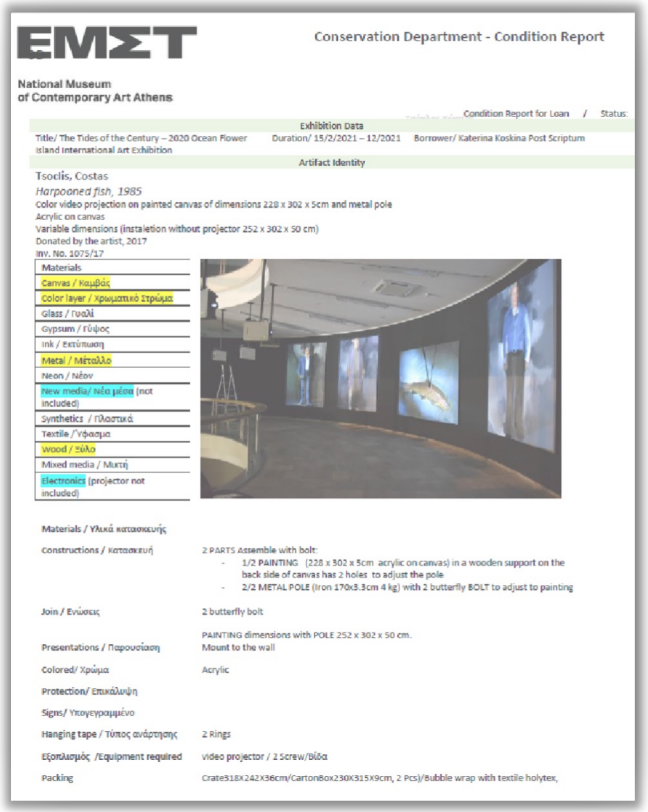


Semantic rules (SWRL)

- Options and intrinsic requirements
- Satisfaction of requirements regarding the absence/presence of characteristics
- Satisfaction of requirements regarding maximum/minimum value of a dimension of a parameter
- Relations of terms which describe different CnR-DM-I parameters as well as broader/narrower terms of the CnR domain



Evaluation



EMΣT

Conservation Department - Condition Report

National Museum
of Contemporary Art Athens

Condition Report for Loan / Status:

Exhibition Data

Title/ The Tides of the Century – 2020 Ocean Flower Island International Art Exhibition

Duration/ 15/2/2021 – 12/2021

Borrower/ Katerina Koskina Post Scriptum

Artifact Identity

Tsoclis, Costas

Harpooned fish, 1985

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Acrylic on canvas
Variable dimensions (instaletion without projector 252 x 302 x 50 cm)
Donated by the artist, 2017
INV. No. 1075/17

Materials
Canvas / Καμβάς
Color layer / Χρωματικό στρώμα
Glass / Γυαλί
Gypsum / Γύψος
Ink / Εκτύπωση
Metal / Μέταλλο
Neon / Νέον
New media/ Νέα μέσα (not included)
Synthetics / Πλαστικά
Textile /Ύφασμα
Wood / Ξύλο
Mixed media / Μικτή
Electronics (projector not included)

Materials / Υλικά κατασκευής

Constructions / Κατασκευή: 2 PARTS Assemble with bolt:
- 1/2 PAINTING (228 x 302 x 5cm acrylic on canvas) in a wooden support on the back side of canvas has 2 holes to adjust the pole
- 2/2 METAL POLE (Iron 170x3.3cm 4 kg) with 2 butterfly BOLT to adjust to painting

Join / Ενώσεις: 2 butterfly bolt

Presentations / Παρουσίαση: PAINTING dimensions with POLE 252 x 302 x 50 cm. Mount to the wall

Colored/ Χρώμα: Acrylic

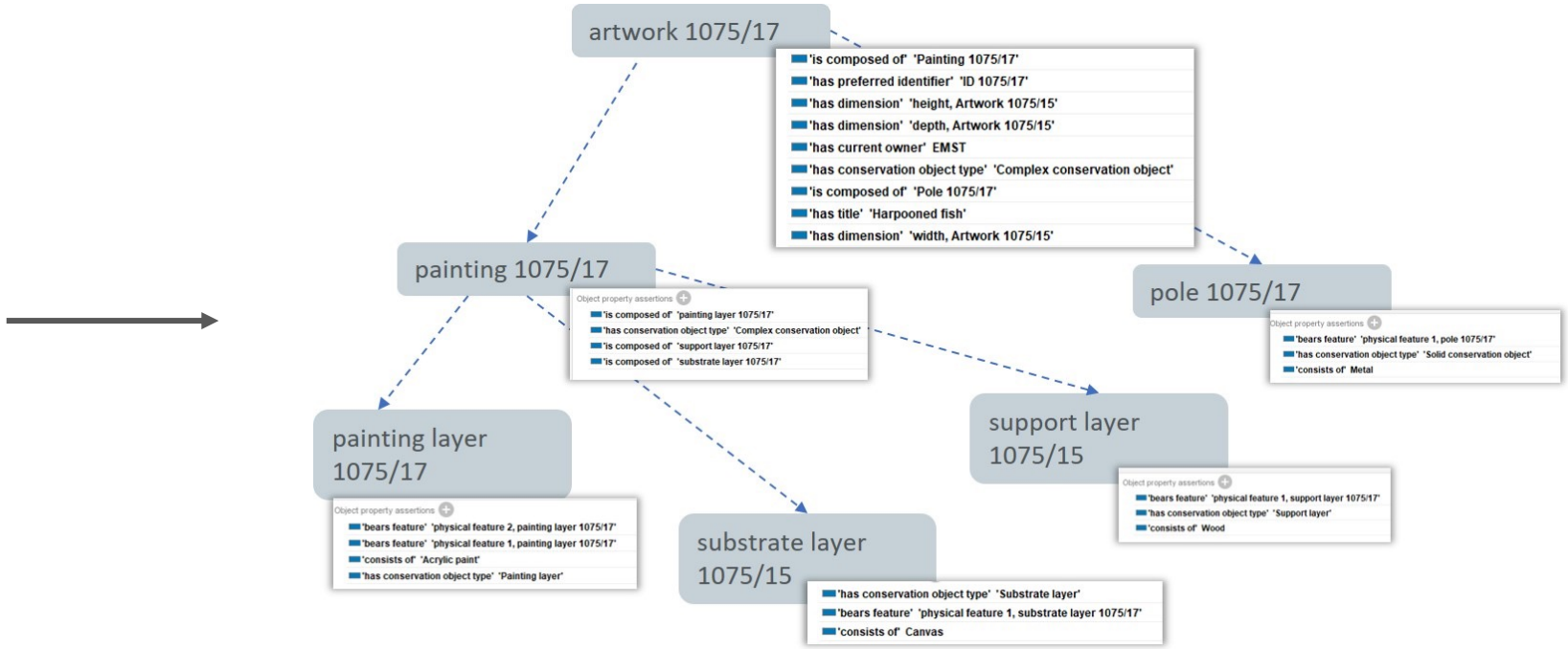
Protection/ Επικάλυψη

Signs/ Υπογεγραμμένο

Hanging tape / Τύπος ανάρτησης: 2 Rings

Εξοπλισμός /Equipment required: video projector / 2 Screw/Βίδα

Packing: Crate318X242X36cm/Carton80x230X315X9cm, 2 Pcs)/Bubble wrap with textile holytex,



SPARQL Queries

Snap SPARQL Query:

```
?dm rdf:type dcri-ont:ConservationAndRestorationInterventionDecision-making .
?dm dcri-ont:stipulates ?ir.
?ir rdf:type dcri-ont:ConservationAndRestorationInterventionDecision-makingIntrinsicRequirementAboutConservationObject.
?dm cidoc-crm:P17_was_motivated_by ?obj.
?obj rdf:type cidoc-crm:E22_Man-Made_Object.
?ir dcri-ont:isAboutCertainType ?type.
?obj cidoc-crm:P2_has_type ?type.
?ir rdfs:label ?labelRequirement.
{?ir dcri-ont:requiresAbsenceOf ?ch.}
MINUS
{{?obj dcri-ont:hasCharacteristicOfType ?ch}
UNION
{?obj dcri-ont:hasNotCharacteristicOfType ?ch}}
?ch rdfs:label ?labelCharacteristic.
FILTER (LANG(?labelRequirement) = "en")
FILTER (LANG(?labelCharacteristic) = "en")
}
```

Execute

?labelRequirement	
requirement for conservation object about friability absence@en	Friability@en
requirement for conservation object about roughness absence@en	Roughness@en
requirement for conservation object about stickiness absence@en	Stickiness@en
requirement for conservation object about relief absence@en	Relief@en
requirement for conservation object about flaking absence@en	Flaking@en
requirement for conservation object about uplifted crack edge absence@en	Uplifted crack edge@en
requirement for conservation object about powdering absence@en	Powdering@en

"What are the characteristics of the conservation object about which an intrinsic requirement requires their absence and there is no relation of their presence/absence?"

Snap SPARQL Query:

```
PREFIX cidoc-crm: <http://www.cidoc-crm.org/cidoc-crm/>
PREFIX emst: <http://www.semanticweb.org/emst/>

SELECT ?optionLabel ?rqLabel ?entityLabel  WHERE {
 ?dm dcri-ont:stipulates ?rq.
 ?rq rdf:type dcri-ont:ConservationAndRestorationInterventionDecision-makingIntrinsicRequirement.
 ?rq dcri-ont:isNotSatisfiedBy ?entity.
 ?dm dcri-ont:considers ?option.
 ?option rdf:type dcri-ont:ConservationAndRestorationInterventionDecision-makingOption.
 ?option dcri-ont:hasRequirement ?rq.
          ?rq rdfs:label ?rqLabel.
          ?entity rdfs:label ?entityLabel.
          ?option rdfs:label ?optionLabel
 FILTER (LANG(?optionLabel)="en")
 FILTER (LANG(?entityLabel) = "en")
 FILTER (LANG(?rqLabel) = "en")
 }
```

Execute

?optionLabel	?rqLabel	
option of physicochemical cleaning of superficial deposits with dust cloth and ethanol in window cleaner at 0.5@en	requirement for conservation object about painting media absence@en	Painting layer 1075/17@en
option of physicochemical cleaning of superficial deposits with dust cloth and ethanol in water at 0.5 around flakin...	requirement for conservation object about painting media absence@en	Painting layer 1075/17@en
option of physicochemical cleaning of superficial deposits with dust cloth and ethanol in water at 0.5@en	requirement for conservation object about painting media absence@en	Painting layer 1075/17@en
option of physicochemical cleaning of superficial deposits with absorbent paper and ethanol in window cleaner at ...	requirement for conservation object about painting media absence@en	Painting layer 1075/17@en
option of mechanical cleaning of superficial deposits with eraser crumbs@en	requirement for adjacent layer about paper presence@en	Substrate layer 1075/17@en
option of mechanical cleaning of superficial deposits with professional vacuum cleaner and dusting brush@en	requirement for conservation object about very big size@en	Painting layer 1075/17@en
option of mechanical cleaning of superficial deposits with professional vacuum cleaner@en	requirement for conservation object about very big size@en	Painting layer 1075/17@en
option of mechanical cleaning of superficial deposits with leaf blower and dusting brush@en	requirement for conservation object about very big size@en	Painting layer 1075/17@en
option of mechanical cleaning of superficial deposits with leaf blower@en	requirement for conservation object about very big size@en	Painting layer 1075/17@en
option of mechanical cleaning of superficial deposits with dusting brush around flaking areas@en	requirement for conservation object about flaking presence@en	Painting layer 1075/17@en
option of mechanical cleaning of superficial deposits with smoke sponge around flaking areas@en	requirement for conservation object about flaking presence@en	Painting layer 1075/17@en
option of mechanical cleaning of superficial deposits with dust bulb and dusting brush aroung flaking areas@en	requirement for conservation object about flaking presence@en	Painting layer 1075/17@en
option of physicochemical cleaning of superficial deposits with dust cloth and ethanol in water at 0.5 around flakin...	requirement for conservation object about flaking presence@en	Painting layer 1075/17@en
option of mechanical cleaning of superficial deposits with museum vacuum cleaner (blowing/suction) and dusting...	requirement for conservation object about flaking presence@en	Painting layer 1075/17@en
option of mechanical cleaning of superficial deposits with museum vacuum cleaner (blowing/suction) around flaki...	requirement for conservation object about flaking presence@en	Painting layer 1075/17@en
option of mechanical cleaning of superficial deposits with smoke sponge around friability areas@en	requirement for conservation object about friability presence@en	Painting layer 1075/17@en
option of mechanical cleaning of superficial deposits with dusting brush around friability areas@en	requirement for conservation object about friability presence@en	Painting layer 1075/17@en
option of mechanical cleaning of superficial deposits with dust bulb and dusting brush aroung friability areas@en	requirement for conservation object about friability presence@en	Painting layer 1075/17@en

"What are the intrinsic requirements which are not satisfied, along with the options that have them and the entities that do not satisfy them?"

SPARQL Queries

Snap SPARQL Query:

```
?option rdf:type dcri-ont:ConservationAndRestorationInterventionDecision-makingOption.
{{?dm dcri-ont:considers ?option.}
MINUS
{?option dcri-ont:hasRequirement ?rq.
?rq dcri-ont:isNotSatisfiedBy ?entity}}
MINUS
{{?dm dcri-ont:considers ?option.
?option dcri-ont:involvesChoosing ?plan.
?plan dcri-ont:specifiesConservationAndRestorationInterventionSupply ?supply.
?eir dcri-ont:isNotSatisfiedBy ?supply.}
UNION
{?dm dcri-ont:considers ?option.
?option dcri-ont:involvesChoosing ?plan.
?eir dcri-ont:isNotSatisfiedBy ?plan.}}
?option rdfs:label ?optionLabel.
FILTER (LANG(?optionLabel) = "en").
}
```

Execute

option of mechanical cleaning of superficial deposits with battery air blower and dusting brush@en
option of mechanical cleaning of superficial deposits with battery vacuum cleaner and dusting brush@en
option of mechanical cleaning of superficial deposits with battery air blower@en
option of mechanical cleaning of superficial deposits with swiffer duster@en
option of mechanical cleaning of superficial deposits with smoke sponge@en
option of mechanical cleaning of superficial deposits with feather duster@en
option of mechanical cleaning of superficial deposits with dust bulb and dusting brush@en
option of mechanical cleaning of superficial deposits with dust cloth@en
option of mechanical cleaning of superficial deposits with dusting brush@en
option of mechanical cleaning of superficial deposits with battery vacuum cleaner@en
option of mechanical cleaning of superficial deposits with dust bulb@en

"Which of the considered options i) have not even one intrinsic requirement which is not satisfied and ii) there is not even one extrinsic requirement which is not satisfied by them?"

Snap SPARQL Query:

```
{?dm dcri-ont:considers ?option.
?option dcri-ont:involvesChoosing ?plan.
?eir dcri-ont:isNotSatisfiedBy ?plan.}}
?dm dcri-ont:stipulates ?cr.
?cr rdf:type dcri-ont:ConservationAndRestorationInterventionDecision-makingCriterionAboutPlan.
?cr dcri-ont:isCriterionOf ?ch.
?dm dcri-ont:considers ?option.
?option dcri-ont:involvesChoosing ?plan.
?plan dcri-ont:hasQualitativeValue ?qv.
?qv dcri-ont:refersToPropertyType ?ch.
?qv dcri-ont:hasPriorityIndex ?index.
?qv rdfs:label ?qvLabel.
?option rdfs:label ?optionLabel.
FILTER (LANG(?optionLabel) = "en").
FILTER (LANG(?qvLabel)= "en")
}
ORDER BY DESC (?index)
```

Execute

?optionLabel	
option of mechanical cleaning of superficial deposits with swiffer duster@en	very fast performance@en
option of mechanical cleaning of superficial deposits with battery vacuum cleaner@en	fast performance@en
option of mechanical cleaning of superficial deposits with battery air blower and dusting brush@en	fast performance@en
option of mechanical cleaning of superficial deposits with battery air blower@en	fast performance@en
option of mechanical cleaning of superficial deposits with battery vacuum cleaner and dusting brush@en	fast performance@en
option of mechanical cleaning of superficial deposits with smoke sponge@en	very slow performance@en
option of mechanical cleaning of superficial deposits with dust cloth@en	very slow performance@en
option of mechanical cleaning of superficial deposits with dust bulb and dusting brush@en	very slow performance@en
option of mechanical cleaning of superficial deposits with dust bulb@en	very slow performance@en
option of mechanical cleaning of superficial deposits with feather duster@en	very slow performance@en
option of mechanical cleaning of superficial deposits with dusting brush@en	very slow performance@en

"What's the order of the suitable options according to the criterion defined by the decision-making, along with the qualitative values of the criterion?"

Conclusions

- *The ontology efficiently represents the domain of interest,*
- *The conservators can determine requirements and criteria*
- *The description of the case at hand can be enriched with further characteristics or dimensions which are important and must be taken into account for the final decision*
- *It is possible to receive a set of suitable options for the case at hand, as well as explanation for the rejection of options*

Future work

Further exploitation of the ontology in the context of the framework for the explicit assistance of the conservator

More categories of interventions can be added

Thank you!