



## D2.3

# Upper-level Cultural Heritage Ontology

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This deliverable presents the CrossCult upper-level ontology, which captures the concepts that are used in the project pilots. It consists of two documents: a report describing the design of the ontology and an OWL file containing the ontology code in XML syntax. The ontology will be refined until M25 (March 2018); the final version of this deliverable will describe the final version of the ontology.



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# 1. Introduction

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The report presents a collaborative effort from the project partners, which took place in months M2-M8 of the project and focused on the delivery of a generic upper-level conceptual structure that captures common concepts and relationships across the four pilots. The deliverable focused on i) reviewing the upper-level ontology requirements, ii) investigating ontology standards relevant to the project, iii) defining the ontological arrangements of the upper-level ontology, and iv) creating mappings between the project pilots' metadata and the ontology. The deliverable is organised in such a way as to provide a clear and explicit definition of the upper-level ontology. It begins with an overview of the upper-level ontology requirements and highlighting relevant ontology standards. It then provides the rationale leading to the definition of the upper-level ontology entities. It concludes with a set of example mappings drawn from pilots' scenarios as discussed in the deliverable D2.1.

## 1.1. Upper-level Ontology Requirements and Standards

The CrossCult ontology is defined as a generic upper-level conceptual structure that captures common concepts and relationships across the four pilots of the project. As such, the ontology delivers formalisms that describe the “world” of CrossCult, which accommodates common conceptual arrangements and enables augmentation, linking, semantic-based reasoning and retrieval across disparate data resources. The CrossCult ontology requirements are summarised as follows:

- a single and generic upper-level structure that acts as a semantic layer of common concepts and relationships across pilots,
- a robust ontological definition that enables efficient semantic-based reasoning and retrieval,
- a scalable structure that can be formally extended to support specialised conceptual needs when required,
- a knowledge representation model that builds on standard semantic web technologies facilitating interoperability and linking with Linked Data resources,
- a knowledge representation model that makes maximum reuse of established semantic web resources and standards.

With respect to the above requirements, the project has concluded to use OWL 2 (<https://www.w3.org/TR/owl2-syntax/>) as the underlying language for the CrossCult ontology (the specific subset of OWL 2 will be determined during the refinement process based on the performance of the CrossCult platform and the apps that will be developed on top of the ontology). The project has also decided to adopt elements from the following standard Semantic Web ontologies that support the aims of the upper-level CrossCult ontology.

## 1.2. CIDOC-CRM

The Conceptual Reference Model (CRM) of the International Council of Museums (ICOM) – International Committee for Documentation (CIDOC), is a well established ISO standard (ISO 21127:2006) in the modelling of cultural heritage information. CIDOC-CRM provides an extensible semantic framework that any cultural heritage information can be mapped to. It provides a framework for matching instances of people, places, things, events and periods using

the information and context around these entities. In addition, it provides a "semantic glue" needed to mediate between different sources of cultural heritage information. The applicability of the CIDOC-CRM in information systems of the broader cultural heritage domain is evident in the literature on numerous large-scale projects [[http://www.cidoc-crm.org/uses\\_applications.html](http://www.cidoc-crm.org/uses_applications.html)]. For the needs of our project we will adopt the OWL version of CIDOC-CRM as defined by the Erlangen implementation of the model (<http://erlangen-crm.org/>).

Adopting CIDOC-CRM as the core conceptual layer of the CrossCult upper-level ontology guarantees the use of well-defined and interoperable semantics, which support the generic aims of the upper-level structure whilst providing specialisations that can benefit the individual needs of pilots. On the other hand, CIDOC-CRM as a formal and generic structure of concepts and relationships is not tied to any particular vocabulary of types, terms and individuals. This level of abstraction, albeit useful for the semantics of the broader cultural heritage domain, does not cover the need for a finer definition of types, terms and appellations. The need for an additional level of vocabulary semantics is addressed by connecting thesauri and glossary concepts with CIDOC-CRM.

### 1.3. SKOS

Simple Knowledge Organization System (SKOS) is a W3C recommendation designed for representation of thesauri, classification schemes, taxonomies, or any other type of structured controlled vocabulary. It builds upon RDF and RDFS, and its main objective is to enable easy publication and use of such vocabularies as linked data [<https://www.w3.org/2004/02/skos/>]. SKOS structures can be linked with CIDOC-CRM concepts to provide a specialised vocabulary to instances of the ontology. It is an established approach that has been followed by numerous projects in the domain of cultural heritage. In its most common form, individuals of CIDOC-CRM concepts are connected via the **E55.Type** entity to SKOS thesauri concepts that provide further semantic relationships (e.g. broader / narrower term).

The upper-level ontology incorporates the SKOS semantics, specifically the SKOS **Concept** and **Concept Scheme** classes and their associated properties, to provide access to specialised vocabularies. A range of specialised vocabularies has been identified as relevant to the needs of the ontology. Such thesauri are primarily relevant to the broader cultural heritage domain but also span to less domain dependent vocabularies of geographic and chronological terms and include:

- The Art & Architecture Thesaurus: a structured vocabulary of approximately 44,000 concepts of art, architecture and culture items.  
<http://www.getty.edu/research/tools/vocabularies/aat/>
- PeriodO: a gazetteer of scholarly definitions of historical, art-historical, and archaeological periods.  
<http://perio.do/>
- Heritage Data Vocabularies: A set of heritage thesauri maintained by the Forum on Information Standards in Heritage (FISH).  
<http://www.heritagedata.org/blog/>
- GeoNames: A geographical resource containing millions of place-names.  
<http://www.geonames.org/>

#### 1.4. FOAF and other Semantic Web Ontologies

The upper-level ontology also mediates and enables connections to additional semantics from specialised ontologies. For example, the FOAF (Friend-Of-A-Friend) ontology (<http://xmlns.com/foaf/spec/>) is a machine-readable ontology describing persons and their activities, and is suitable for linking to a specialised user ontology. The connection is enabled through a cherry-picked selection of useful ontology constructs (classes and properties) that participate in the upper-level ontology. Currently, the ontology adopts the FOAF **Person** class and the **interest\_topic** property. Further refinements could reveal the need to adopt additional entities and properties from the same or other known semantic web ontologies such as Geonames.



## 2. Ontology Abstractions and Rationale

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The project reviewed the pilots' datasets as they are discussed in the deliverable D2.1 and engaged in a series of meetings before concluding to a set of common entities across the four pilots. The set of common entities is discussed below:

### 2.1. Reflective Topic

This is a central concept to the CrossCult experience that carries the semantics of all those subjects and topics of interest that drive the reflection and reinterpretation qualities of the application. The notion of Reflective Topic acts as a hub that could connect under a common theme physical items, multimedia content and users. Specialisations of the class can be topics like Immigration, Women in Society, Healing, Painting Style, etc. The Reflective Topic could be related a range of ontology classes via properties which will realise relationships of interest. For example, the topic of Healing could be linked to a Place (Spa), a Physical Item (fountain), a Date (1st Century BC), a Multimedia Content (image) and a User Interest (Healthcare).

### 2.2. Physical Item

A Physical item is any museum artefact, painting, venue item or landmark that has some relation to the reflection topics and can be associated with one or more MM Contents. Specialisations of the class can be things like a painting, a public square, a museum exhibit, etc. Several other non-top level classes will be related to the class such as material, title, dimension, etc.

### 2.3. Digital MM Content

Any MM (Multi-Media) content could relate to one or more Physical Items. Subclasses can be realised as Image, Text, Video, etc. Some existing metadata such as copyright, title, creator, etc., can be accommodated by specialised classes.

### 2.4. Place

Places in the ontology have a spatial focus, which could refer to the location of an object in space, a place of artefact production, a place of item display, a depicted place on a painting, etc. The properties of a Place and its relationships to the ontology classes dictate the type of a Place, for example, the location of an object, place of origin, place depicted on artwork, etc.

### 2.5. Actor

An Actor can be any person or organisation that relates to one or more ontology classes. The properties of an Actor and its relationships to the ontology classes describe its type; for example, creator of a painting, a historic person related with an artefact, a user interested in an exhibit and an institution owning an artwork.

### 2.6. Temporal Entity

Any form of temporal definition such as date and period that relates to one or more ontology classes. The properties of a Temporal entity and its relationships to the ontology classes describe its type; for example, the date of an artist's birth, the production date of an artefact, the historic period of an exhibit, the date of a visit, etc.

### 3. Upper-level Ontology Structure

The version of the upper-level ontology is a subset of CIDOC-CRM enhanced with additional semantics from the SKOS and FOAF ontology. The structure maintains full compatibility with CIDOC-CRM containing the least minimum set of CRM concepts as described in the latest specification document version 6.2.1<sup>1</sup>. In addition, the structure contains SKOS and FOAF concepts and introduces the project specific entity Reflective Topic. The specific entity addresses the issue of relating topics for reflection to a broader range of entities beyond the scope of CIDOC-CRM. It provides the required flexibility to relate a Reflective Topic with CRM entities, SKOS concepts and a FOAF person.

Figure 1 presents the core entities of the upper-level ontology and their respective relationships. It has a particular focus on the relations of a physical thing (man-made or physical feature) with ontology classes of interest and does not attempt to model the full complexity of the ontology structure. The full structure of the ontology including the range of classes and properties of the upper-level ontology is shown in tables 1 and 2 respectively. The code of the ontology in XML syntax is contained in the accompanying OWL file (Crosscult-ontology-D2.3.owl).

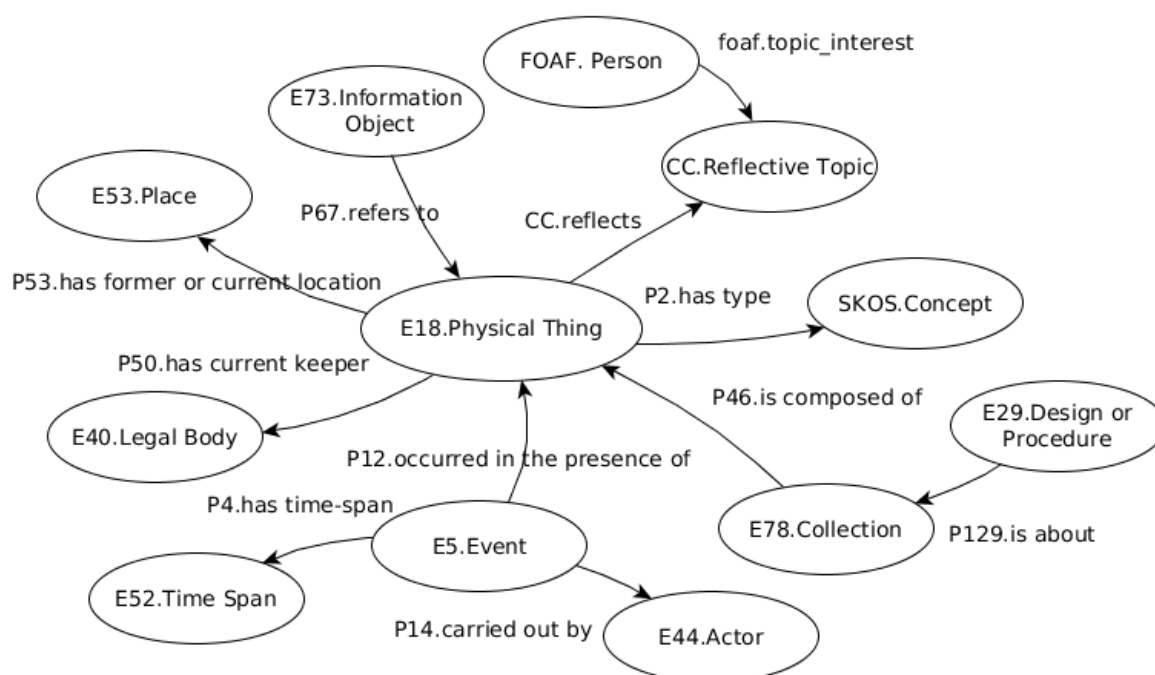


Figure 1: The core entities of the upper-level Ontology with focus on the relations of E18.Physical Thing

<sup>1</sup> [http://www.cidoc-crm.org/docs/cidoc\\_crm\\_version\\_6.2.1.pdf](http://www.cidoc-crm.org/docs/cidoc_crm_version_6.2.1.pdf)

### 3.1. Entity Structure

Table 1 depicts the hierarchy of a subset of the classes of the CrossCult ontology, specifically those that we regard as more important for the needs of the project. A list of all classes is available in the appendix. Definitions for all classes are contained in the accompanying owl file.

**Table 1: Crosscult Ontology Entity Structure**

owl:Thing									
-	Reflective Topic								
-	skos:Concept								
-	skos:Concept Scheme								
-	foaf:Person								
-	E1 CRM Entity								
-	-	E2 Temporal Entity							
-	-	-	E4 Period						
-	-	-	-	E5 Event					
-	-	-	-	-	E7 Activity				
-	-	-	-	-	-	E11 Modification			
-	-	-	-	-	-	-	E12 Production		
-	-	-	-	-	-	E13 Attribute Assignment			
-	-	-	-	-	-	E65 Creation			
-	-	-	-	-	E63 Beginning of Existence				
-	-	-	-	-	-	E12 Production			
-	-	-	-	-	-	E65 Creation			
-	-	-	-	-	-	E67 Birth			
-	-	-	-	-	E64 End of Existence				
-	-	-	-	-	-	E6 Destruction			
-	-	-	-	-	-	E68 Dissolution			
-	-	-	-	-	-	E69 Death			
-	-	E77 Persistent Item							
-	-	-	E70 Thing						
-	-	-	-	E72 Legal Object					
-	-	-	-	-	E18 Physical Thing				
-	-	-	-	-	-	E19 Physical Object			
-	-	-	-	-	-	-	E20 Biological Object		
-	-	-	-	-	-	-	-	E21 Person	
-	-	-	-	-	-	-	E22 Man Made Object		
-	-	-	-	-	-	-	-	E84 Information Carrier	
-	-	-	-	-	-	E24 Physical Man-Made Thing			
-	-	-	-	-	-	-	E22 Man Made Object		
-	-	-	-	-	-	-	-	E84 Information Carrier	
-	-	-	-	-	-	-	E25 Man Made Feature		
-	-	-	-	-	-	-	E76 Collection		
-	-	-	-	-	-	E26 Physical Feature			
-	-	-	-	-	-	-	E25 Man Made Feature		
-	-	-	-	-	-	-	E27 Site		
-	-	-	-	-	E90 Symbolic Object				
-	-	-	-	E71 Man-Made Thing					

-	-	-	-	-	-	E24 Physical Man-Made Thing
-	-	-	-	-	-	E22 Man Made Object
-	-	-	-	-	-	E84 Information Carrier
-	-	-	-	-	-	E25 Man Made Feature
-	-	-	-	-	-	E76 Collection
-	-	-	-	-	-	E28 Conceptual Object
-	-	-	-	-	-	E89 Propositional Object
-	-	-	-	-	-	E30 Right
-	-	-	-	-	-	E73 Information Object
-	-	-	-	-	-	E90 Symbolic Object
-	-	-	-	-	-	E41 Appellation
-	-	-	-	-	-	E73 Information Object
-	-	-	-	-	-	E55 Type
-	-	-	-	-	-	E39 Actor
-	-	-	-	-	-	Group
-	-	-	-	-	-	E52 Time-Span
-	-	-	-	-	-	E53 Place
-	-	-	-	-	-	E54 Dimension

### 3.2. Ontology Properties

Table 2 depicts the hierarchy of a subset of the properties of the CrossCult ontology, specifically those that we regard as more important for the needs of the project. A list of all properties is available in the appendix and their definitions are contained in the accompanying owl file.

**Table 2: Crosscult Ontology Property Structure**

Property Name	Domain	Range
reflects	Reflective Topic	owl:Thing
skos:has member	skos:Concept	skos:Concept
skos:has member list	skos:Concept	skos:Concept
skos:has top concept	skos:Concept	skos:Concept
skos:is in scheme	skos:Concept	skos:Concept Scheme
-   skos:is top concept of scheme	skos:Concept	skos:Concept Scheme
skos:is in semantic relation	skos:Concept	skos:Concept
-   skos:has broader transitive	skos:Concept	skos:Concept
-   -   skos:has broader	skos:Concept	skos:Concept
-   skos:has narrower transitive	skos:Concept	skos:Concept
-   -   skos:has narrower	skos:Concept	skos:Concept
-   skos:has related	skos:Concept	skos:Concept
-   skos:is in mapping relation with	skos:Concept	skos:Concept
foaf:topic interest	foaf:Person	owl:Thing
P1 is identified by (identifies)	E1 CRM Entity	E41 Appellation
P2 has type (is type of)	E1 CRM Entity	E55 Type
P4 has time-span (is time-span of)	E2 Temporal Entity	E52 Time-Span
P7 took place at (witnessed)	E4 Period	E53 Place

Property Name	Domain	Range
P12 occurred in the presence of (was present at)	E5 Event	E77 Persistent Item
- P11 had participant (participated in)	E5 Event	E39 Actor
- - P14 carried out (performed) by	E7 Activity	E39 Actor
- P16 used specific object (was used for)	E7 Activity	E70 Thing
- P31 has modified (was modified by)	E11 Modification	E24 Physical Man-Made Th.
- - P108 has produced (was produced by)	E12 Production	E24 Physical Man-Made Th.
- P92 brought into existence (was brought into existence by)	E63 Beginning of Existence	E77 Persistent Item
- - P108 has produced (was produced by)	E12 Production	E24 Physical Man-Made
- - P94 has created (was created by)	E65 Creation	E28 Conceptual Object
- P93 took out of existence (was taken out of existence by)	E64 End of Existence	E77 Persistent Item
P15 was influenced by (influenced)	E7 Activity	E1 CRM Entity
- P16 used specific object (was used for)	E7 Activity	E70 Thing
P20 had specific purpose (was purpose of)	E7 Activity	E5 Event
P43 has dimension (is dimension of)	E70 Thing	E54 Dimension
P46 is composed of (forms part of)	E18 Physical Thing	E18 Physical Thing
P59 has section (is located on or within)	E18 Physical Thing	E53 Place
P67 refers to ( is referred to by)	E89 Prop. Object	E1 CRM Entity
P75 possesses (is possessed by)	E39 Actor	E30 Right
P89 falls within (contains)	E53 Place	E53 Place
P104 is subject to (applies to)	E72 Legal Object	E30 Right
P106 is composed of (forms part of)	E90 Symbolic Object	E90 Symbolic Object
P107 has current or former member (is current or former member of)	E74 Group	E39 Actor
P127 has broader term (has narrower term)	E55 Type	E55 Type
P128 carries (is carried by)	E18 Physical Thing	E90 Symbolic Object
P130 shows features of (features are also found on)	E70 Thing	E70 Thing
P140 assigned attribute to (was attributed by)	E13 Attribute	E1 CRM Entity
P141 assigned (was assigned by)	E13 Attribute	E1 CRM Entity
P148 has component (is component of)	E89 Prop. Object	E89 Propositional Object

## 4. Data Mapping Examples

The following examples are based on the scenarios of the four pilots described in the deliverable D2.1 and present mapping definitions of data drawn from the abstract scenario descriptions with classes of the upper-level ontology. The entities and relationships of interest are extracted from the descriptions (underlined) and then mapped to ontology classes and properties.

## 4.1. Pilot 1

The user is located at The National Gallery, in Room 30 where she looks at the painting ‘The Toilet of Venus’ or ‘The Rokeby Venus’ made by Velázquez, Diego (1599 - 1660) as part of her route. The date of artwork is between 1647 and 1951 and the painting is connected to the Reflection point of Colour and Materials as it provides a notable example of colour change and material degradation. In order to retrieve more information about the Reflection Topic the user reads a textual description and she views an image, a digital reconstruction of the painting.

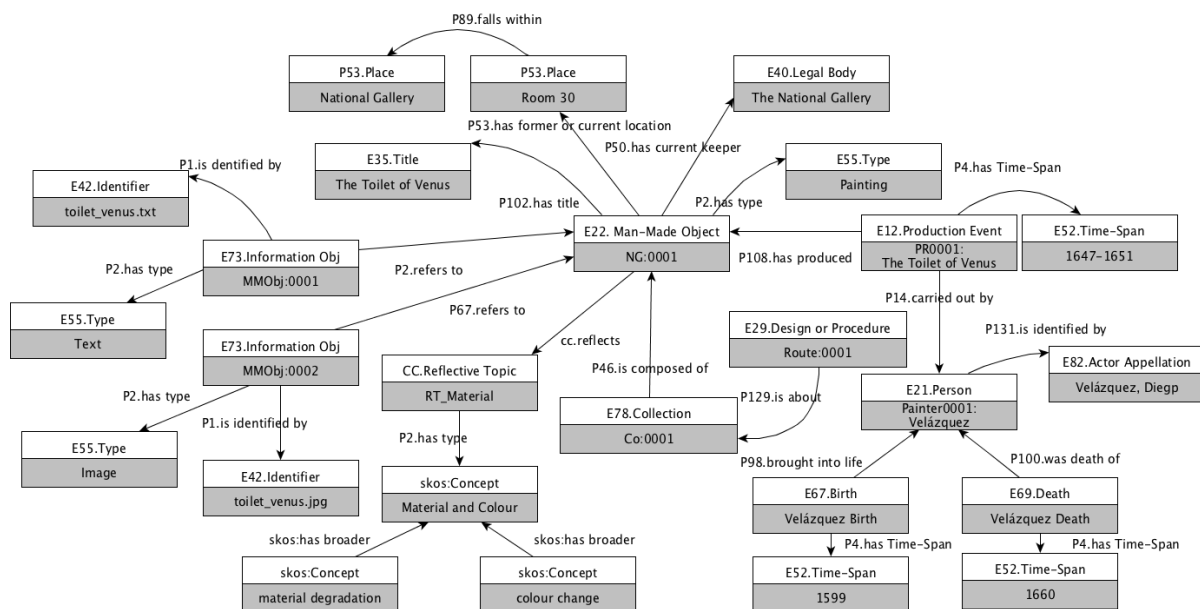


Figure 2: Data Mapping Example from Pilot 1

## 4.2. Pilot 2

The visitors play a question-based game in the archaeology site of Montegrotto Terme, probably involving associations to other archaeological sites also including Lugo, Chaves, and Epidauros. In the site's location, they discover the existence of archaeological remains dating back to the Roman period, and pictures of objects from similar archaeological sites connecting to the people's traditions and way of living. During the visit, they discover several facts that spur their reflections with the help of the CrossCult app: all the archaeological sites were part of the Roman Empire at some time, the first three are connected to the topic of healing spas, and Montegrotto Terme and Epidauros received Roman emperors as visitors.

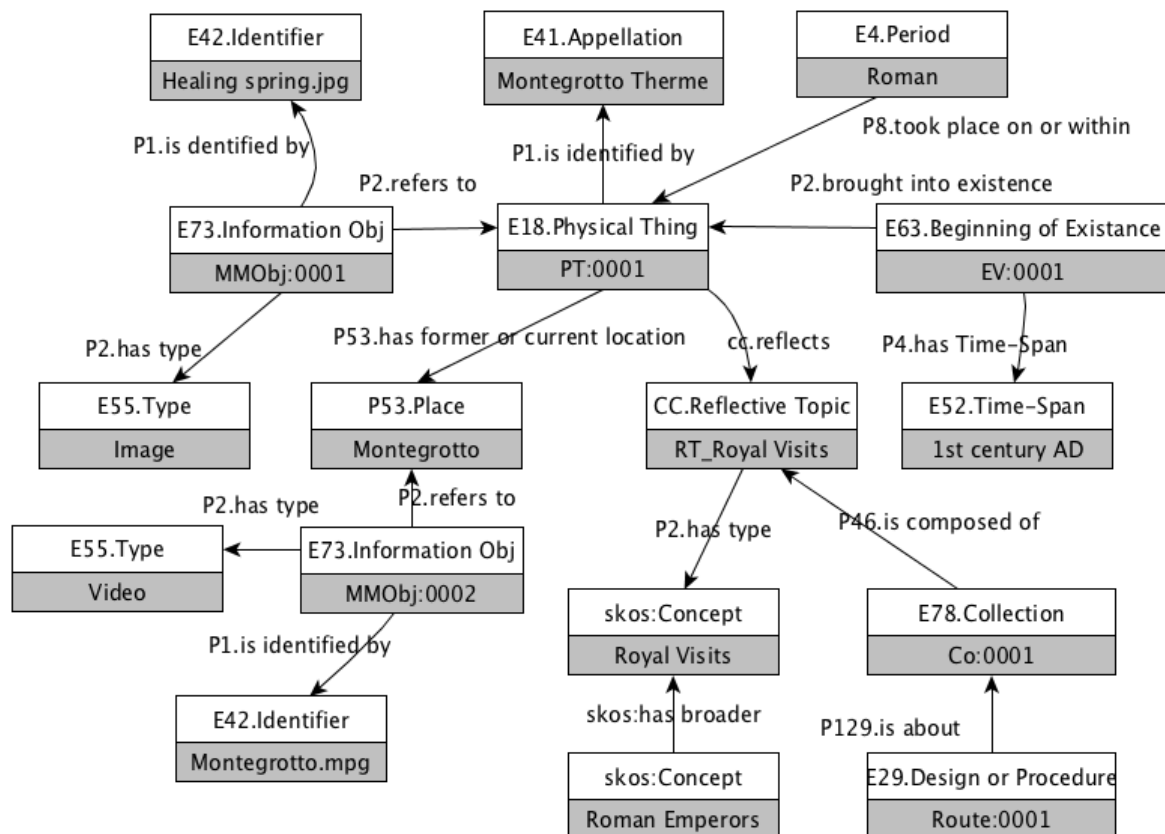


Figure 3: Data Mapping Example from Pilot 2

### 4.3. Pilot 3

The visitor is located at the Archaeological Museum of Tripolis. She looks at a statue that depicts the relief of a woman, child and man. She listens to an historical overview of the way women dressed in antiquity and the significance of the dress code they used. The object is part of the itinerary on the reflection topic of Appearance. Some artefacts from other European museums showing women's and girls' dresses also appear on her screen.

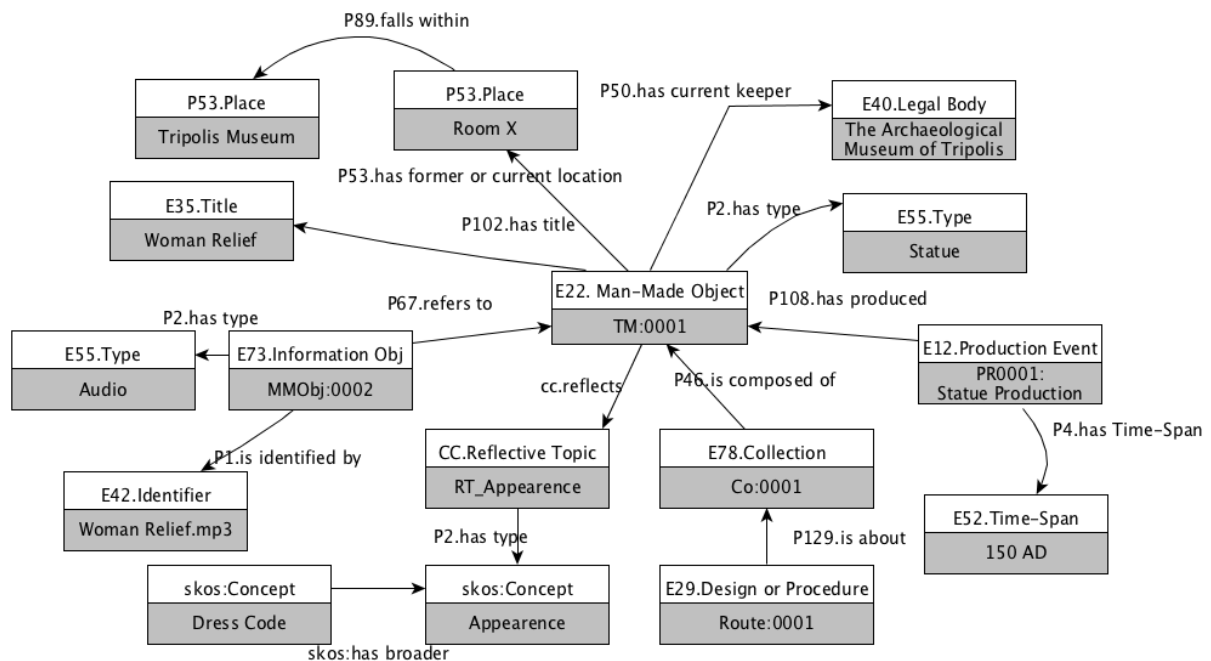


Figure 4: Data Mapping Example from Pilot 3



#### 4.4. Pilot 4

Max plays a treasure-hunt game in Luxembourg. He got interested in the statue of Tall Banker. He found its location on the map of Kirchberg together with a group of objects, all related to the thread of cross-border worker.

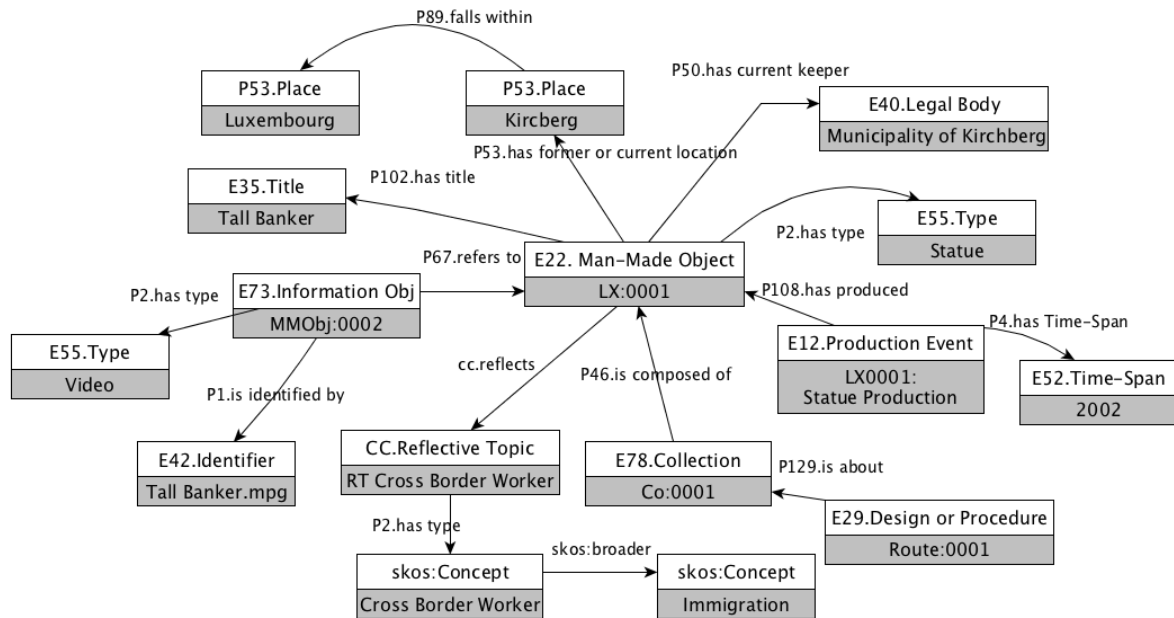


Figure 5: Data Mapping Example from Pilot 4

## 5. Summary

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This deliverable describes the current status of the upper-level CrossCult ontology, which has been defined based on the requirements of the four pilots described in D2.1. It also provides ontology-based modelling examples from the four pilots. The CrossCult ontology will be further refined until M25 based on the needs of the apps that the project will develop for the four pilots. The final version of the ontology will be described in the refined version of this deliverable at M25.

## Appendix

Table 3: A list of all classes of the CrossCult upper-level Ontology

CrossCult Ontology Classes	
E11_Modification	E4_Period
E12_Production	E50_Date
E13_Attribute_Assignment	E52_Time-Span
E18_Physical_Thing	E53_Place
E19_Physical_Object	E54_Dimension
E1_CRM_Entity	E55_Type
E20_Biological_Object	E56_Language
E21_Person	E57_Material
E22_Man-Made_Object	E58_Measurement_Unit
E24_Physical_Man-Made_Thing	E5_Event
E25_Man-Made_Feature	E63_Beginning_of_Existence
E26_Physical_Feature	E64_End_of_Existence
E27_Site	E65_Creation
E28_Conceptual_Object	E67_Birth
E29_Design_or_Procedure	E68_Dissolution
E2_Temporal_Entity	E69_Death
E30_Right	E6_Destruction
E31_Document	E70_Thing
E32_Authority_Document	E71_Man-Made_Thing
E33_Linguistic_Object	E72_Legal_Object
E34_Inscription	E73_Information_Object
E35_Title	E74_Group
E36_Visual_Item	E75_Conceptual_Object_Appellation
E37_Mark	E77_Persistent_Item
E38_Image	E78_Collection
E39_Actor	E7_Activity
E40_Legal_Body	E82_Actor_Appellation
E41_Appellation	E84_Information_Carrier
E42_Identifier	E89_Propositional_Object
E44_Place_Appellation	E90_Symbolic_Object
E46_Section_Definition	Reflective_Topic
E47_Spatial_Coordinates	skos:Concept
E48_Place_Name	skos:ConceptScheme
E49_Time_Appellation	foaf:Person

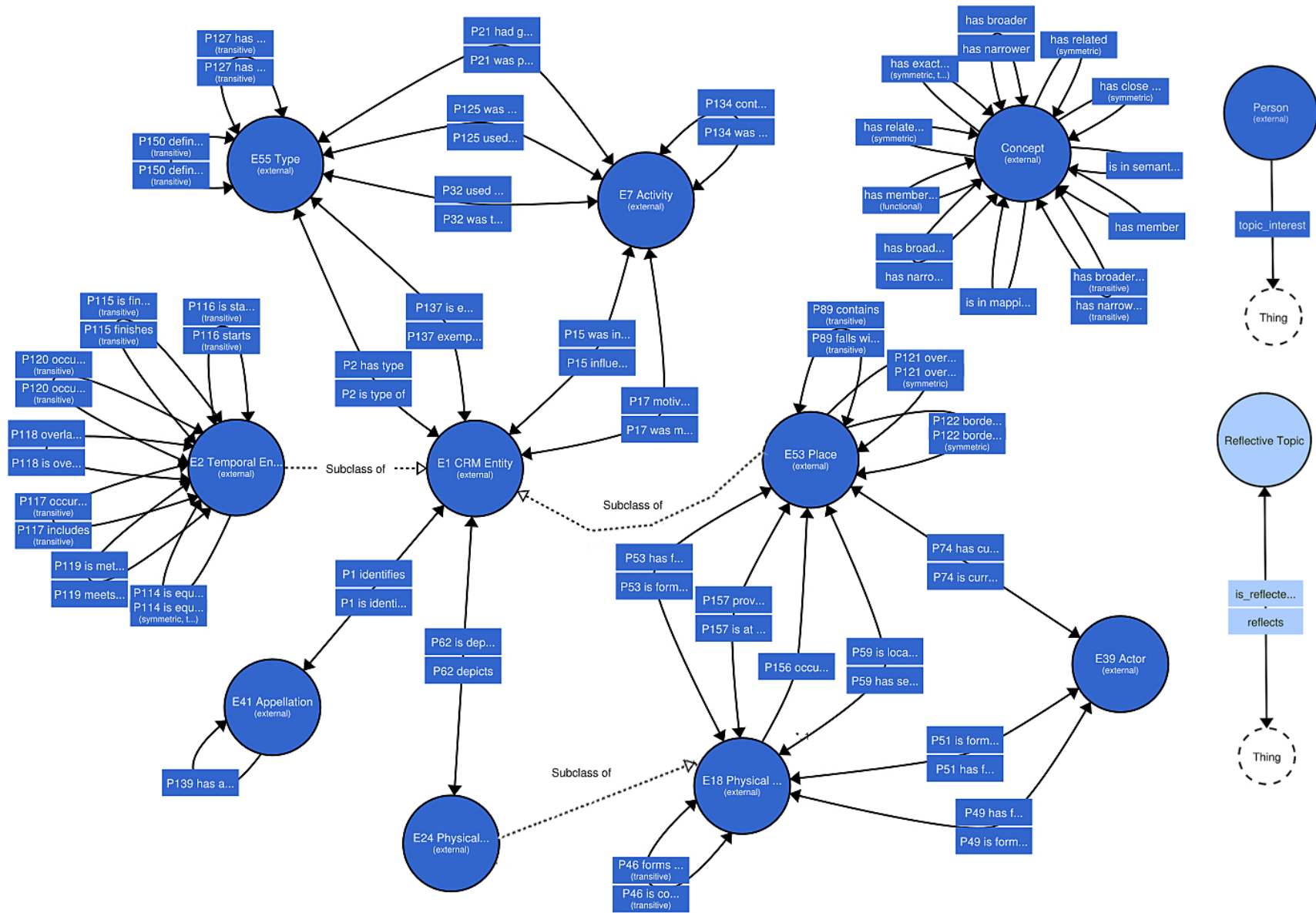
Table 4: A list of all properties of the CrossCult upper-level Ontology

Property	Domain	Range
P100_was_death_of	E69_Death	E21_Person
P100i_died_in	E21_Person	E69_Death
P101_had_as_general_use	E70_Thing	E55_Type
P101i_was_use_of	E55_Type	E70_Thing
P102_has_title	E71_Man-Made_Thing	E35_Title
P102i_is_title_of	E35_Title	E71_Man-Made_Thing
P103_was_intended_for	E71_Man-Made_Thing	E55_Type
P103i_was_intention_of	E55_Type	E71_Man-Made_Thing
P104_is_subject_to	E72_Legal_Object	E30_Right
P104i_applies_to	E30_Right	E72_Legal_Object
P105_right_held_by	E72_Legal_Object	E39_Actor
P105i_has_right_on	E39_Actor	E72_Legal_Object
P106_is_composed_of	E90_Symbolic_Object	E90_Symbolic_Object
P106i_forms_part_of	E90_Symbolic_Object	E90_Symbolic_Object
P107_has_current_or_former_membe	E74_Group	E39_Actor
P107i_is_current_or_former_member	E39_Actor	E74_Group
P108_has_produced	E12_Production	E24_Physical_Man-Made_Thing
P108i_was_produced_by	E24_Physical_Man-Made_Thing	E12_Production
P109_has_current_or_former_curator	E78_Collection	E39_Actor
P109i_is_current_or_former_curator_	E39_Actor	E78_Collection
P114_is_equal_in_time_to	E2_Temporal_Entity	E2_Temporal_Entity
P115_finishes	E2_Temporal_Entity	E2_Temporal_Entity
P115i_is_finished_by	E2_Temporal_Entity	E2_Temporal_Entity
P116_starts	E2_Temporal_Entity	E2_Temporal_Entity
P116i_is_started_by	E2_Temporal_Entity	E2_Temporal_Entity
P117_occurs_during	E2_Temporal_Entity	E2_Temporal_Entity
P117i_includes	E2_Temporal_Entity	E2_Temporal_Entity
P118_overlaps_in_time_with	E2_Temporal_Entity	E2_Temporal_Entity
P118i_is_overlapped_in_time_by	E2_Temporal_Entity	E2_Temporal_Entity
P119_meets_in_time_with	E2_Temporal_Entity	E2_Temporal_Entity
P119i_is_met_in_time_by	E2_Temporal_Entity	E2_Temporal_Entity
P11_had_participant	E5_Event	E39_Actor
P11i_participated_in	E39_Actor	E5_Event
P120_occurs_before	E2_Temporal_Entity	E2_Temporal_Entity
P120i_occurs_after	E2_Temporal_Entity	E2_Temporal_Entity
P121_overlaps_with	E53_Place	E53_Place
P122_borders_with	E53_Place	E53_Place
P125_used_object_of_type	E7_Activity	E55_Type
P125i_was_type_of_object_used_in	E55_Type	E7_Activity
P126_employed	E11_Modification	E57_Material
P126i_was_employed_in	E57_Material	E11_Modification
P127_has_broader_term	E55_Type	E55_Type
P127i_has_narrower_term	E55_Type	E55_Type
P128_carries	E18_Physical_Thing	E90_Symbolic_Object
P128i_is_carried_by	E90_Symbolic_Object	E24_Physical_Man-Made_Thing
P129_is_about	E89_Propositional_Object	E1_CRM_Entity
P129i_is_subject_of	E1_CRM_Entity	E89_Propositional_Object
P12_occurred_in_the_presence_of	E5_Event	E77_Persistent_Item
P12i_was_present_at	E77_Persistent_Item	E5_Event
P130_shows_features_of	E70_Thing	E70_Thing
P130i_features_are_also_found_on	E70_Thing	E70_Thing

<b>P131_is_identified_by</b>	E39_Actor	E82_Actor_Appellation
<b>P131i_identifies</b>	E82_Actor_Appellation	E39_Actor
<b>P134_continued</b>	E7_Activity	E7_Activity
<b>P134i_was_continued_by</b>	E7_Activity	E7_Activity
<b>P137_exemplifies</b>	E1_CRM_Entity	E55_Type
<b>P137i_is_exemplified_by</b>	E55_Type	E1_CRM_Entity
<b>P138_represents</b>	E36_Visual_Item	E1_CRM_Entity
<b>P138i_has_representation</b>	E1_CRM_Entity	E36_Visual_Item
<b>P139_has_alternative_form</b>	E41_Appellation	E41_Appellation
<b>P13_destroyed</b>	E6_Destruction	E18_Physical_Thing
<b>P13i_was_destroyed_by</b>	E18_Physical_Thing	E6_Destruction
<b>P140_assigned_attribute_to</b>	E13_Attribute_Assignment	E1_CRM_Entity
<b>P140i_was_attributed_by</b>	E1_CRM_Entity	E13_Attribute_Assignment
<b>P141_assigned</b>	E13_Attribute_Assignment	E1_CRM_Entity
<b>P141i_was_assigned_by</b>	E1_CRM_Entity	E13_Attribute_Assignment
<b>P148_has_component</b>	E89_Propositional_Object	E89_Propositional_Object
<b>P148i_is_component_of</b>	E89_Propositional_Object	E89_Propositional_Object
<b>P149_is_identified_by</b>	E28_Conceptual_Object	E75_Conceptual_Object_Appellat
<b>P149i_identifies</b>	E75_Conceptual_Object_Appellat	E28_Conceptual_Object
<b>P14_carried_out_by</b>	(inherits domain and range restrictions from P11_had_participant)	
<b>P14i_performed</b>	(inherits domain and range restrictions from P11i_participated_in)	
<b>P150_defines_typical_parts_of</b>	E55_Type	E55_Type
<b>P150i_defines_typical_wholes_for</b>	E55_Type	E55_Type
<b>P152_has_parent</b>	E21_Person	E21_Person
<b>P152i_is_parent_of</b>	E21_Person	E21_Person
<b>P156_occupies</b>	E18_Physical_Thing	E53_Place
<b>P157_is_at_rest_relative_to</b>	E53_Place	E18_Physical_Thing
<b>P157i_provides_reference_space_for</b>	E18_Physical_Thing	E53_Place
<b>P15_was_influenced_by</b>	E7_Activity	E1_CRM_Entity
<b>P15i_influenced</b>	E1_CRM_Entity	E7_Activity
<b>P165_incorporates</b>	E73_Information_Object	E90_Symbolic_Object
<b>P165i_is_incorporated_in</b>	(inherits domain and range restrictions from P106i_forms_part_of)	
<b>P16_used_specific_object</b>	E7_Activity	E70_Thing
<b>P16i_was_used_for</b>	E70_Thing	E7_Activity
<b>P17_was_motivated_by</b>	E7_Activity	E1_CRM_Entity
<b>P17i_motivated</b>	E1_CRM_Entity	E7_Activity
<b>P19_was_intended_use_of</b>	E7_Activity	E71_Man-Made_Thing
<b>P19i_was_made_for</b>	E71_Man-Made_Thing	E7_Activity
<b>P1_is_identified_by</b>	E1_CRM_Entity	E41_Appellation
<b>P1i_identifies</b>	E41_Appellation	E1_CRM_Entity
<b>P20_had_specific_purpose</b>	E7_Activity	E5_Event
<b>P20i_was_purpose_of</b>	E5_Event	E7_Activity
<b>P21_had_general_purpose</b>	E7_Activity	E55_Type
<b>P21i_was_purpose_of</b>	E55_Type	E7_Activity
<b>P2_has_type</b>	E1_CRM_Entity	E55_Type
<b>P2i_is_type_of</b>	E55_Type	E1_CRM_Entity
<b>P31_has_modified</b>	E11_Modification	E24_Physical_Man-Made_Thing
<b>P31i_was_modified_by</b>	E24_Physical_Man-Made_Thing	E11_Modification
<b>P32_used_general_technique</b>	E7_Activity	E55_Type
<b>P32i_was_technique_of</b>	E55_Type	E7_Activity
<b>P33_used_specific_technique</b>	E7_Activity	E29_Design_or_Procedure
<b>P33i_was_used_by</b>	E29_Design_or_Procedure	E7_Activity
<b>P43_has_dimension</b>	E70_Thing	E54_Dimension
<b>P43i_is_dimension_of</b>	E54_Dimension	E70_Thing

<b>P45_consists_of</b>	E18_Physical_Thing	E57_Material
<b>P45i_is_incorporated_in</b>	E57_Material	E18_Physical_Thing
<b>P46_is_composed_of</b>	E18_Physical_Thing	E18_Physical_Thing
<b>P46i_forms_part_of</b>	E18_Physical_Thing	E18_Physical_Thing
<b>P48_has_preferred_identifier</b>	E1_CRM_Entity	E42_Identifier
<b>P48i_is_preferred_identifier_of</b>	E42_Identifier	E1_CRM_Entity
<b>P49_has_former_or_current_keeper</b>	E18_Physical_Thing	E39_Actor
<b>P49i_is_former_or_current_keeper_o</b>	E39_Actor	E18_Physical_Thing
<b>P4_has_time-span</b>	E2_Temporal_Entity	E52_Time-Span
<b>P4i_is_time-span_of</b>	E52_Time-Span	E2_Temporal_Entity
<b>P50_has_current_keeper</b>	(inherits domain and range restrictions from P49)	
<b>P50i_is_current_keeper_of</b>	(inherits domain and range restrictions from P49i)	
<b>P51_has_former_or_current_owner</b>	E18_Physical_Thing	E39_Actor
<b>P51i_is_former_or_current_owner_of</b>	E39_Actor	E18_Physical_Thing
<b>P52_has_current_owner</b>	(inherits domain and range restrictions from P51)	
<b>P52i_is_current_owner_of</b>	(inherits domain and range restrictions from P51i)	
<b>P53_has_former_or_current_location</b>	E18_Physical_Thing	E53_Place
<b>P53i_is_former_or_current_location_</b>	E53_Place	E18_Physical_Thing
<b>P54_has_current_permanent_locatio</b>	E19_Physical_Object	E53_Place
<b>P54i_is_current_permanent_location</b>	E53_Place	E19_Physical_Object
<b>P55_has_current_location</b>	E19_Physical_Object	E53_Place
<b>P55i_currently_holds</b>	E53_Place	E19_Physical_Object
<b>P56_bears_feature</b>	E19_Physical_Object	E26_Physical_Feature
<b>P56i_is_found_on</b>	E26_Physical_Feature	E19_Physical_Object
<b>P58_has_section_definition</b>	E18_Physical_Thing	E46_Section_Definition
<b>P58i_defines_section</b>	E46_Section_Definition	E18_Physical_Thing
<b>P59_has_section</b>	E18_Physical_Thing	E53_Place
<b>P59i_is_located_on_or_within</b>	E53_Place	E18_Physical_Thing
<b>P62_depicts</b>	E24_Physical_Man-Made_Thing	E1_CRM_Entity
<b>P62i_is_depicted_by</b>	E1_CRM_Entity	E24_Physical_Man-Made_Thing
<b>P65_shows_visual_item</b>	E24_Physical_Man-Made_Thing	E36_Visual_Item
<b>P65i_is_shown_by</b>	E36_Visual_Item	E24_Physical_Man-Made_Thing
<b>P67_refers_to</b>	E89_Propositional_Object	E1_CRM_Entity
<b>P67i_is_referred_to_by</b>	E1_CRM_Entity	E89_Propositional_Object
<b>P68_foresees_use_of</b>	E29_Design_or_Procedure	E57_Material
<b>P68i_use_foreseen_by</b>	E57_Material	E29_Design_or_Procedure
<b>P69_has_association_with</b>	E29_Design_or_Procedure	E29_Design_or_Procedure
<b>P69i_is_associated_with</b>	E29_Design_or_Procedure	E29_Design_or_Procedure
<b>P70_documents</b>	E31_Document	E1_CRM_Entity
<b>P70i_is_documented_in</b>	E1_CRM_Entity	E31_Document
<b>P71_lists</b>	E32_Authority_Document	E1_CRM_Entity
<b>P71i_is_listed_in</b>	E1_CRM_Entity	E32_Authority_Document
<b>P72_has_language</b>	E33_Linguistic_Object	E56_Language
<b>P72i_is_language_of</b>	E56_Language	E33_Linguistic_Object
<b>P73_has_translation</b>	E33_Linguistic_Object	E33_Linguistic_Object
<b>P73i_is_translation_of</b>	E33_Linguistic_Object	E33_Linguistic_Object
<b>P74_has_current_or_former_residenc</b>	E39_Actor	E53_Place
<b>P74i_is_current_or_former_residence</b>	E53_Place	E39_Actor
<b>P75_possesses</b>	E39_Actor	E30_Right
<b>P75i_is_posessed_by</b>	E30_Right	E39_Actor
<b>P78_is_identified_by</b>	E52_Time-Span	E49_Time_Appellation
<b>P78i_identifies</b>	E49_Time_Appellation	E52_Time-Span
<b>P7_took_place_at</b>	E4_Period	E53_Place
<b>P7i_witnessed</b>	E53_Place	E4_Period

<b>P83_had_at_least_duration</b>	E52_Time-Span	E54_Dimension
<b>P83i_was_minimum_duration_of</b>	E54_Dimension	E52_Time-Span
<b>P84_had_at_most_duration</b>	E52_Time-Span	E54_Dimension
<b>P84i_was_maximum_duration_of</b>	E54_Dimension	E52_Time-Span
<b>P86_falls_within</b>	E52_Time-Span	E52_Time-Span
<b>P86i_contains</b>	E52_Time-Span	E52_Time-Span
<b>P87_is_identified_by</b>	E53_Place	E44_Place_Appellation
<b>P87i_identifies</b>	E44_Place_Appellation	E53_Place
<b>P89_falls_within</b>	E53_Place	E53_Place
<b>P89i_contains</b>	E53_Place	E53_Place
<b>P8_took_place_on_or_within</b>	E4_Period	E18_Physical_Thing
<b>P8i_witnessed</b>	E18_Physical_Thing	E4_Period
<b>P91_has_unit</b>	E54_Dimension	E58_Measurement_Unit
<b>P91i_is_unit_of</b>	E58_Measurement_Unit	E54_Dimension
<b>P92_brought_into_existence</b>	E63_Beginning_of_Existence	E77_Persistent_Item
<b>P92i_was_brought_into_existence_b</b>	E77_Persistent_Item	E63_Beginning_of_Existence
<b>P93_took_out_of_existence</b>	E64_End_of_Existence	E77_Persistent_Item
<b>P93i_was_taken_out_of_existence_b</b>	E77_Persistent_Item	E64_End_of_Existence
<b>P94_has_created</b>	E65_Creation	E28_Conceptual_Object
<b>P94i_was_created_by</b>	E28_Conceptual_Object	E65_Creation
<b>P96_by_mother</b>	E67_Birth	E21_Person
<b>P96i_gave_birth</b>	E21_Person	E67_Birth
<b>P97_from_father</b>	E67_Birth	E21_Person
<b>P97i_was_father_for</b>	E21_Person	E67_Birth
<b>P98_brought_into_life</b>	E67_Birth	E21_Person
<b>P98i_was_born</b>	E21_Person	E67_Birth
<b>P99_dissolved</b>	E68_Dissolution	E74_Group
<b>P99i_was_dissolved_by</b>	E74_Group	E68_Dissolution
<b>P9_consists_of</b>	E4_Period	E4_Period
<b>P9i_forms_part_of</b>	E4_Period	E4_Period
<b>is_reflected_by</b>	owl:Thing	Reflective_Topic
<b>reflects</b>	Reflective_Topic	owl:Thing
<b>broadMatch</b>	(inherits domain and range restrictions from semanticRelation)	
<b>broader</b>	(inherits domain and range restrictions from semanticRelation)	
<b>broaderTransitive</b>	(inherits domain and range restrictions from semanticRelation)	
<b>closeMatch</b>	(inherits domain and range restrictions from semanticRelation)	
<b>exactMatch</b>	(inherits domain and range restrictions from semanticRelation)	
<b>hasTopConcept</b>	ConceptScheme	Concept
<b>inScheme</b>	Concept	ConceptScheme
<b>mappingRelation</b>	(inherits domain and range restrictions from semanticRelation)	
<b>member</b>	Concept	Concept
<b>memberList</b>	Concept	Concept
<b>narrowMatch</b>	(inherits domain and range restrictions from semanticRelation)	
<b>narrower</b>	(inherits domain and range restrictions from semanticRelation)	
<b>narrowerTransitive</b>	(inherits domain and range restrictions from semanticRelation)	
<b>related</b>	(inherits domain and range restrictions from semanticRelation)	
<b>relatedMatch</b>	(inherits domain and range restrictions from semanticRelation)	
<b>semanticRelation</b>	Concept	Concept
<b>topConceptOf</b>	Concept	ConceptScheme
<b>topic_interest</b>	Person	owl:Thing





**Figure 6: A visualisation of the CrossCult ontology showing classes with node degree greater than 7, foaf:Person and cc:Reflective\_Topic and their associated properties, produced with VOWL<sup>2</sup>**

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<sup>2</sup> [vowl.visualdataweb.org](http://vowl.visualdataweb.org)