Semantic Web and Ontology Design for Cultural Heritage (SWODCH 2021) 21st September 2021

Joseph Padfield (NG) – @JoePadfield

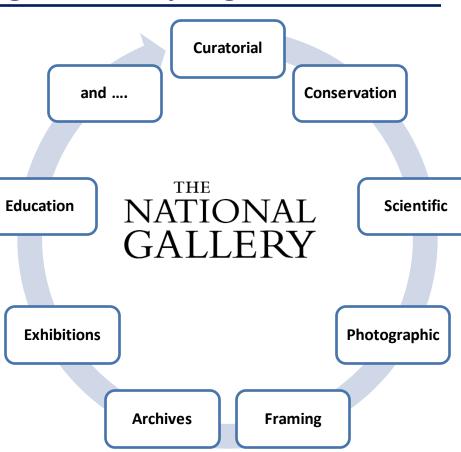# Digital Knowledge Presentation within the National Gallery, London

Lake Keitele, by Akseli Gallen-Kallela, 1905. NG6574.
Photo: Copyright © 2016–2021 The National Gallery

Digital Knowledge Presentations for Works of Art

- Capturing the knowledge created during the study of old master paintings can be very complex.

- The work involves modelling a range of different specialisms, processes and techniques.

- Potentially generating lots of data in many different forms.

- **This talk will present a few examples of how this work has developed over the last 20 years and show where we hope to go next.**

The National Gallery is looking to develop Digital Dossiers

- Could be **one place to go** for National Gallery research data – everything from bibliographies to images and spectra.

- Not a single system, but a hub **connecting systems, resources, people and knowledge**.

- Including **data provenance** and who has produced it.

- Providing the **digital tools**, that meet user needs.

- Creating **shared** National Gallery Data **Resources.**

- A platform for **collaborative research projects and groups.**

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- Curatorial
- Conservation
- Scientific
- Photographic
- Framing
- Archives
- Exhibitions
- Education
- and ....

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Digital Documentation: A complex collection of functions

Security, Project management

Search, Relationships, Collaboration, Re-use

Trust, Attribution, People

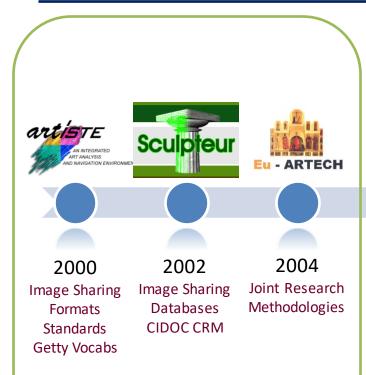Standards, Methods, Procedures, Workflow

Text, Images, Annotations, Reports, Data, Documents

Tools, Publication, Presentation

Multiple connected issues, addressed by a series of interoperable solutions or systems

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social sciences & humanities open cloud

Digital Documentation: A complex collection of functions

Security, Project management

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Standards, Methods, Procedures, Workflow

Text, Images, Annotations, Reports, Data, Documents

Tools, Publication, Presentation

Developing the expertise and institutional understanding to reach this stage can take a while ...

Multiple connected issues, addressed by a series of interoperable solutions or systems

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Collaborative Knowledge Generation and Sharing

2000
Image Sharing
Formats
Standards
Getty Vocabs

2002
Image Sharing
Databases
CIDOC CRM

2004
Joint Research
Methodologies

2007
Research Resource
Building
Documentation

2009
Joint Research
ARCHLAB

2015
Joint Research
ARCHLAB
Linked Data
Documentation
CIDOC CRM

2020 -21
Joint Research
ARCHLAB
Data Management
Interoperability
CIDOC CRM
PIDs, IIIF
National Initiatives

Raphael Research Resource 2007

- Digital documentation project.

- One information specialist and one art historian.

- Development of a prototype database and web-based presentation and dissemination system.

- Centred on Raphael paintings and data related to the National Gallery collection.

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Raphael Research Resource: Data Gathering

- Conservation Department.
- Curatorial Department.
- Framing Department.
- Library and Archives.
- Photographic Department.
- Scientific Department.

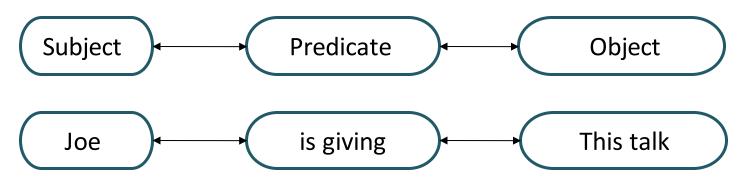# Raphael Research Resource: Database development

Initial database development aimed to move beyond standard relational databases. To produce a much more generic database schema that was flexible enough to cope with a much wider range of objects and information. This initial structure was based on:

- **Objects:** Paintings, buildings, sculptures, etc …

- **Events:** Acquisitions, Births, Loans, Treatments, etc …

- **Actors:** People, groups or organisations involved in the various events.

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Semantically describing paintings using RDF:

- The RDF data model is based upon the idea of making statements about resources in the form of subject-predicate-object expressions, called triples in RDF terminology.

- The subject denotes the resource, and the predicate denotes traits or aspects of the resource and expresses a relationship between the subject and the object.

- The project ontology was event driven – but simplified relative to the CIDOC CRM due to time and resource limitations in the project.

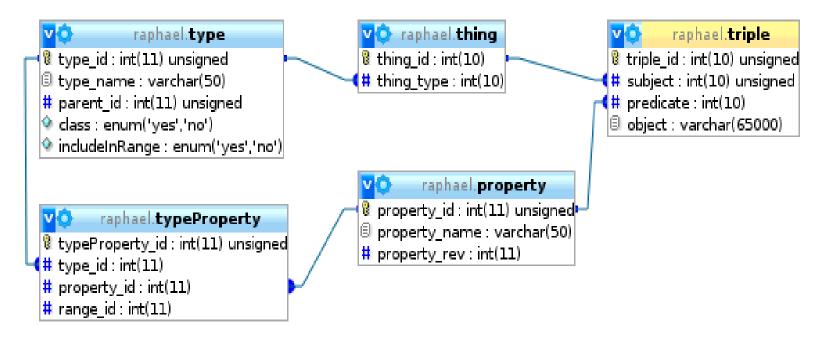| Subject	↔	Predicate	↔	Object
Joe	↔	is giving	↔	This talk

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Raphael Research Resource: Triple Store on MySQL

Semantic triple stores with full editing functionality were less common in 2007 so a bespoke MySQL based solution was created.

Raphael Research Resource

Raphael Research Resource

Galleries of Zoomable Images

Raphael Research Resource:
https://cima.ng-london.org.uk/documentation

Still running 14 years later …

Data presented as text plus related images

Customised Admin Tools

The Reynolds Research Project (2011)

- Systematic technical analysis of 12 paintings by Sir Joshua Reynolds.

- A 4-year collaboration between the Wallace Collection and the National Gallery, with funding from the Paul Mellon Centre for British Art.

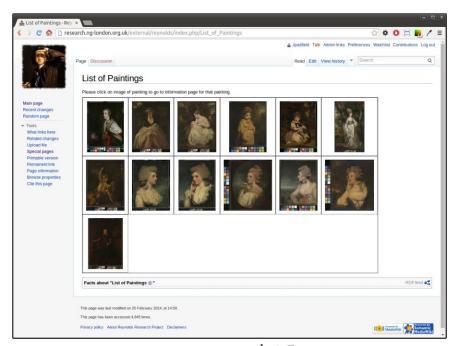- All project documentation captured in structured semantic forms using Semantic Mediawiki.

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Cultural Heritage

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The Reynolds Research Project (2011)

- Documentation of the technical examination and conservation treatment of these complex 18th Century paintings

- The technical research moved on from the lesson learned in the Raphael project to explore the potential of this open source solution
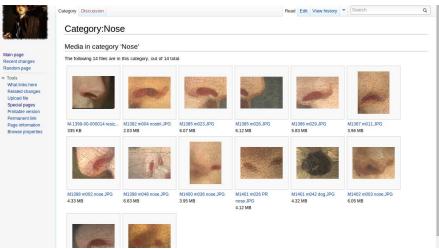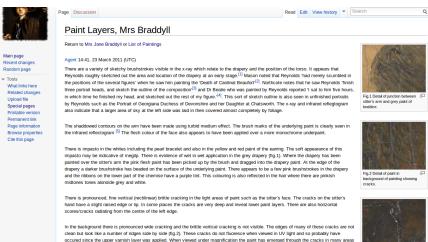
Category:Nose

Media in category 'Nose'

The following 14 files are in this category, out of 14 total.

M-1399-00-000014 resiz... 335 KB
M1382 m004 nostril.JPG 2.03 MB
M1385 m023.JPG 6.07 MB
M1385 m026.JPG 6.12 MB
M1386 m029.JPG 5.83 MB
M1387 m011.JPG 3.96 MB

M1398 m002 nose.JPG 4.33 MB
M1398 m048 nose.JPG 6.63 MB
M1400 m036 nose.JPG 3.95 MB
M1401 m026 PR nose.JPG 4.12 MB
M1401 m042 dog.JPG 4.32 MB
M1402 m003 nose.JPG 6.05 MB

Mrs Jane Braddyll

Wallace Collection Inventory Number: P47
National Gallery Reference Number: M-1382
Dimensions: 755 x 634 x 12 mm (Bust)
Panel
Return to List of Paintings
NG Images:M1382

Standard Pages [edit]

- Entry Text, Mrs Braddyll
- Works in Context, Mrs Braddyll
- Provenance, Mrs Braddyll
- Exhibition History, Mrs Braddyll
- Bibliography and Sources, Mrs Braddyll
- Technical Text, Mrs Braddyll
- History of Condition and Treatment, Mrs Braddyll
- Support, Mrs Braddyll
- Preparatory Layers, Mrs Braddyll
- Paint Layers, Mrs Braddyll
- Surface Coatings, Mrs Braddyll
- X-ray, Mrs Braddyll

Paint Layers, Mrs Braddyll

Return to Mrs Jane Braddyll or List of Paintings

Agent 14:41, 23 March 2011 (UTC)

There are a variety of sketchy brushstrokes visible in the x-ray which relate to the drapery and the position of the torso. It appears that Reynolds roughly sketched out the area and location of the drapery at an early stage.[1] Mason noted that Reynolds 'had merely scumbled in the positions of the several figures' when he saw him painting the 'Death of Cardinal Beaufort'.[2] Northcote notes that he saw Reynolds 'finish three portrait heads, and sketch the outline of the composition'[3] and Dr Beatie who was against by Reynolds reported 'I sat to him five hours, in which time he finished my head, and sketched out the rest of my figure.'[4] This sort of sketch outline is also seen in unfinished portraits by Reynolds such as the Portrait of Georgiana Duchess of Devonshire and her Daughter at Chatsworth. The x-ray and infrared reflectogram also indicate that a larger area of sky at the left side was laid in then covered almost completely by foliage.

The shaddowed contours on the arm have been made using turbid medium effect. The brush marks of the underlying paint is clearly seen in the infrared reflectogram.[5] The flesh colour of the face also appears to have been applied over a more monochrome underpaint.

There is impasto in the whites including the pearl bracelet and also in the yellow and red paint of the earring. The soft appearance of this impasto may be indicative of megilp. There is evidence of wet in wet application in the grey drapery (fig.1). Where the drapery has been painted over the sitter's arm the pink flesh paint has been picked up by the brush and dragged into the drapery paint. At the edge of the drapery a darker brushstroke has beaded on the surface of the underlying paint. There appears to be a few pink brushstrokes in the drapery and the ribbons on the lower part of the chemise have a purple tint. This colouring is also reflected in the hair where there are pinkish midtones tones alongside grey and white.

There is pronounced, fine vertical (rectilinear) brittle cracking in the light areas of paint such as the sitter's face. The cracks on the sitter's hand have a slight raised edge or lip. In some places the cracks are very deep and reveal lower paint layers. There are also horizontal scores/cracks radiating from the centre of the left edge.

In the background there is pronounced wide cracking and the brittle vertical cracking is not visible. The edges of many of these cracks are not clean but look like a number of ridges side by side (fig.2). These cracks do not fluoresce when viewed in UV light and so probably have occured since the upper varnish layer was applied. When viewed under magnification the paint has emerged through the cracks in many areas and onto the surface of the varnish (fig.3). This paint has since dried and appears like glossy globules. A 19th century description of a ...

Fig.1 Detail of junction between sitter's arm and grey paint of boddice.

Fig.2 Detail of paint in background of painting showing cracks.

Surface Coatings, Mrs Braddyll

Return to Mrs Jane Braddyll or List of Paintings

Agent 14:42, 23 March 2011 (UTC)

The painting has a very yellowed appearance. In UV illumination the varnish fluoresces green/yellow but the cracks in the sky do not fluoresce. This does not appear to be due to restoration but indicates that the paint has cracked and moved since the most recent coat of varnish was applied.

Over the surface of the drapery and some of the flesh small red fibres can be seen under the microscope. These appear to be in the varnish layer. The varnish has been abraded at the edges and at the top of some of the lines of impasto.

FTIR and GC-MS analysis of samples of the varnish indicated that it consists primarily of pine resin with the addition of some heat bodied linseed oil. An initial scraping of the upper varnish layers was rather a small sample but this contained some heat-bodied linseed oil with a little pine resin.[1] A further scraping of varnish from the same sample site identified substantial quatities of pine resin with only a small amount of oil. In this sample traces of mastic resin were just detectable but at much lower levels than the pine resin and this is thought to be connected to the underlying paint.[2] Cross sections samples taken from the painting do not appear to indicate a single, uniform varnish over the whole painting. In some areas there appear to be several layers of varnish on top of a clearly delineated paint layer, whereas in other areas the definition between paint and varnish layers is not so clear.[3]

1. ↑ M1382: Sample O-4
2. ↑ M1382: Sample O-7
3. ↑ See Cross-sections, Mrs Braddyll

Categories: Related to M-1382/P47 | Surface coatings | Report

Facts about "Surface Coatings, Mrs Braddyll" 　 RDF feed

Fig.1 A detail showing a clump of red fibres in the varnish over the drapery.

MediaWiki Extensions

- The MediaWiki system can be enhanced with additional functionality and tools using MediaWiki Extensions.

- A large range of Extensions has already been developed to:

- alter the look and feel, add in Google Analytics, do citations, work with calendars, etc.
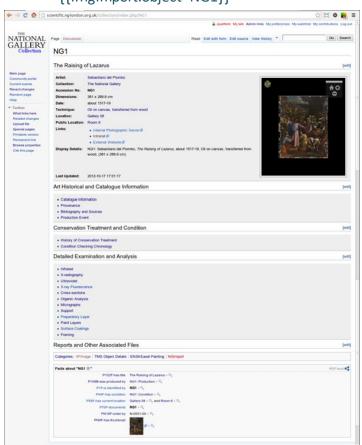
- Detailed documentation also exists to explain how new bespoke extensions can be developed.

- Three new extensions where developed during this work.

National Gallery Import Extension

{{#ngimport:object=NG1}}

{{NGImport|what=subpage|which=NG1093: X-radiography}}

- Combines Live CMS data, IIPImage, MediaWiki Templates and the CIDOC CRM.

- Automated version of the structured pages developed in the Reynolds Project.

```xml
1  <?xml version="1.0" encoding="UTF-8"?>
2  <!DOCTYPE rdf:RDF[
3      <!ENTITY rdf 'http://www.w3.org/1999/02/22-rdf-syntax-ns#'>
4      <!ENTITY rdfs 'http://www.w3.org/2000/01/rdf-schema#'>
5      <!ENTITY owl 'http://www.w3.org/2002/07/owl#'>
6      <!ENTITY swivt 'http://semantic-mediawiki.org/swivt/1.0#'>
7      <!ENTITY wiki 'http://scientific.ng-london.org.uk/collection/index.php/Special:URIResolver/'>
8      <!ENTITY property 'http://scientific.ng-london.org.uk/collection/index.php/Special:URIResolver/Property-3A'>
9      <!ENTITY wikiurl 'http://scientific.ng-london.org.uk/collection/index.php/'>
10 ]>
11
12 <rdf:RDF
13     xmlns:rdf="&rdf;"
14     xmlns:rdfs="&rdfs;"
15     xmlns:owl ="&owl;"
16     xmlns:swivt="&swivt;"
17     xmlns:wiki ="&wiki;"
18     xmlns:property="&property;"
19     xmlns:cidoc="http://www.cidoc-crm.org/rdfs/cidoc_crm_v5.0.4_english_label.rdfs#"
20     xmlns:ngex="http://rdf.ng-london.org.uk/2012/4/NG_CIDOC_v5.0.4_extra_0.3.xml#">
21
22     <owl:Ontology rdf:about="http://scientific.ng-london.org.uk/collection/index.php/Special:ExportRDF/NG1">
23         <swivt:creationDate rdf:datatype="http://www.w3.org/2001/XMLSchema#dateTime">2012-11-13T17:21:23+00:00</swivt:creationDate>
24         <owl:imports rdf:resource="http://semantic-mediawiki.org/swivt/1.0"/>
25     </owl:Ontology>
26     <swivt:Subject rdf:about="http://scientific.ng-london.org.uk/collection/index.php/Special:URIResolver/NG1">
27         <rdf:type rdf:resource="&wiki;Category-3AIIPImage"/>
28         <rdf:type rdf:resource="&wiki;Category-3ATMS_Object_Details"/>
29         <rdf:type rdf:resource="http://rdf.ng-london.org.uk/2012/4/NG_CIDOC_v5.0.4_extra_0.3.xml#EN39.Easel_Painting"/>
30         <rdf:type rdf:resource="&wiki;Category-3ANGImport"/>
31         <rdfs:label>NG1</rdfs:label>
32         <swivt:page rdf:resource="http://scientific.ng-london.org.uk/collection/index.php/NG1"/>
33         <rdfs:isDefinedBy rdf:resource="http://scientific.ng-london.org.uk/collection/index.php/Special:ExportRDF/NG1"/>
34         <swivt:wikiNamespace rdf:datatype="http://www.w3.org/2001/XMLSchema#integer">0</swivt:wikiNamespace>
35         <cidoc:P102F.has_title rdf:resource="&wiki;The_Raising_of_Lazarus"/>
36         <cidoc:P108B.was_produced_by rdf:resource="&wiki;NG1-3A_Production"/>
37         <cidoc:P1F.is_identified_by rdf:resource="&wiki;NG1"/>
38         <cidoc:P44F.has_condition rdf:resource="&wiki;NG1-3A_Condition"/>
39         <cidoc:P55F.has_current_location rdf:resource="&wiki;Gallery_08"/>
40         <cidoc:P55F.has_current_location rdf:resource="&wiki;Room_8"/>
41         <cidoc:P70F.documents rdf:resource="&wiki;NG1"/>
42         <ngex:PN16F.order_by rdf:datatype="http://www.w3.org/2001/XMLSchema#string">N-0001-00</ngex:PN16F.order_by>
43         <ngex:PN5F.has_thumbnail rdf:resource="http://roundtable.ng-london.org.uk/iip-thumb/NG1.jpg"/>
44         <swivt:wikiPageModificationDate rdf:datatype="http://www.w3.org/2001/XMLSchema#dateTime">2012-07-
   30T13:06:04Z</swivt:wikiPageModificationDate>
45         <property:Modification_date-23aux rdf:datatype="http://www.w3.org/2001/XMLSchema#double">2456139.0458796</property:Modification_date-
   23aux>
46         <swivt:wikiPageSortKey rdf:datatype="http://www.w3.org/2001/XMLSchema#string">NG1</swivt:wikiPageSortKey>
47     </swivt:Subject>
48     <swivt:Subject rdf:about="http://scientific.ng-london.org.uk/collection/index.php/Special:URIResolver/NG1-231-23">
49         <swivt:masterPage rdf:resource="&wiki;NG1-231"/>
```

Open access publications: making the research accessible

- In relation to FAIR - The publications are Findable and the content is (open access) relatively Reusable by humans, but the Accessibility and Interoperability could be improved.

- The original resource data is currently closed and not FAIR.
  - But it was created as working conservation documentation resource, for the project, not as a reusable dataset, so no re-use licence was considered.

- Highlighting the importance of planning for the possibility of re-use.

Padfield, J. and A. Gent. 2014. Making complex documentation simpler: Combining existing resources with MediaWiki to provide a flexible documentation platform. In ICOM-CC 17th Triennial Conference Preprints, Melbourne, 15–19 September 2014, ed. J. Bridgland, art. 0202, 7 pp. Paris: International Council of Museums. (ISBN 978-92-9012-410-8) https://www.icom-cc-publications-online.org/PublicationDetail.aspx?cid=21c65062-54a-4da5-93a7-e9bc3f2ada0b

National Gallery Technical Bulletin Volume 35
This special edition is dedicated to the paintings of Joshua Reynolds in the National Gallery and the Wallace Collection. https://www.nationalgallery.org.uk/research/research-resources/technical-bulletin/technical-bulletin-volume-35

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Raphael Research Resource (2011)

- As part of the European Association for Digital Humanities (EADH) - InterFace: Symposium for humanities and technology (2011)

- Work was carried out to open up a SPARQL end-point to the Raphael content to improve access.

- In 2011 the system was based on 4Store (developed at Garlik).

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InterFace 2011 Workshop

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4store

The Raphael Research Resource began to examine how complex conservation, scientific and art historical research could be combined in a flexible digital form. Exploring the presentation of interrelated high resolution images and text, along with how the data could be stored in relation to an event driven ontology in the form of RDF triples. In addition to the main user interface the data stored within the system is now also accessible in the the form of open linkable data combined with a SPARQL end-point at http://rdf.ng-london.org.uk/raphael.

This workshop will introduce and discuss the information which is and is not currently available within this resource and some of the web-base tools that have been developed to disseminate it. Some examples will also be provided in relation to the National Gallery Collection as a whole and a few other related projects. The workshop will then move on to examine how this type of linkable data can be re-used to create new presentations.

This process will be based on but not necessarily limited too:

- How to perform basic SPARQL queries.
- Using PHP to collect and format the results of basic SPARQL queries.
- Using existing IIPImage JavaScript libraries to present high resolution images.
- Using PHP and HTML to dynamically present the results of a set of queries.

This work-shop is intended as a basic introduction to these particular resources and some of the techniques currently being used to explore them. The resources will remain public ... ... those who wish to continue to work with them. An archive of ...

Simple Example Queries

- Find National Gallery paintings
- Find a painting's thumbnail
- Find related things by ...
- Find x-ray images
- Find artist details for a given painting

Complex Example Queries

- Find main details for a given painting
- Find main details for a given ...
- Find ... ...

Display Exa...

- Find mai...
- Find mai... ...
- Find details for a given digital text

More recently (2019) this example was refreshed as part of the work carried out in relation to the AHRC funded Linked Conservation Data project.
https://rdf.ng-london.org.uk/workshops/lcd/

blazegraph

This site was developed by: Joseph Padfield, The National Gallery Scientific Department.

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Raphael Research Resource – SPARQL End-point

More recently (2019) this example was refreshed as part of the work carried out in relation to the AHRC funded Linked Conservation Data project.

Simple query example: Find National Gallery paintings

SPARQL Query

```
PREFIX rdfs:<http://www.w3.org/2000/01/rdf-schema#>
PREFIX owl:<http://www.w3.org/2002/07/owl#>
PREFIX rdf:<http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX crm:<http://www.cidoc-crm.org/rdfs/cidoc_crm_v5.0.2_english_label.rdfs#>
PREFIX rro:<https://rdf.ng-london.org.uk/raphael/ontology/>
PREFIX rri:<https://rdf.ng-london.org.uk/raphael/resource/>

SELECT * WHERE {
        ?ngp rro:RP24.has_owner rri:The_National_Gallery;
        rdf:type rro:RC12.Painting .
} LIMIT 5
```

Soft limit [   ] [Execute] [Reset]

Query Results

```
Array
(
    [0] => Array
        (
            [ngp] => Array
                (
                    [type] => uri
                    [value] => https://rdf.ng-london.org.uk/raphael/resource/NG1171
                )

        )

    [1] => Array
        (
            [ngp] => Array
                (
                    [type] => uri
                    [value] => https://rdf.ng-london.org.uk/raphael/resource/NG168
```

Simplified PHP Code

```php
<?php

require_once ("header.php");
setGlobals();

$q = "PREFIX rdfs:<http://www.w3.org/2000/01/rdf-schema#>
PREFIX owl:<http://www.w3.org/2002/07/owl#>
PREFIX rdf:<http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX crm:<http://www.cidoc-crm.org/rdfs/cidoc_crm_v5.0.2_english_label.rdfs#>
PREFIX rro:<https://rdf.ng-london.org.uk/raphael/ontology/>
PREFIX rri:<https://rdf.ng-london.org.uk/raphael/resource/>

SELECT * WHERE {
        ?ngp rro:RP24.has_owner rri:The_National_Gallery;
        rdf:type rro:RC12.Painting .
} LIMIT 5";

$r = selectQuery($q, true);

echo "<pre>";
print_r ($r);
echo "</pre>";

?>
```

This site was developed by: Joseph Padfield, The National Gallery Scientific Department.

Raphael Research Resource – SPARQL End-point

- **Artist:** Raphael
- **Artist dates:** 1483 - 1520
- **Full title:**Portrait of Pope Julius II
- **Date made:** 1511
- **Medium and support:** Drying Oil on Poplar Panel
- **Dimensions:** 108.70 x 81.00 cm
- **Inventory number:** NG27
- **Location in Gallery:** Room 8
- **URI:** NG27
- **NG Website:** NG27

Simplified PHP Code
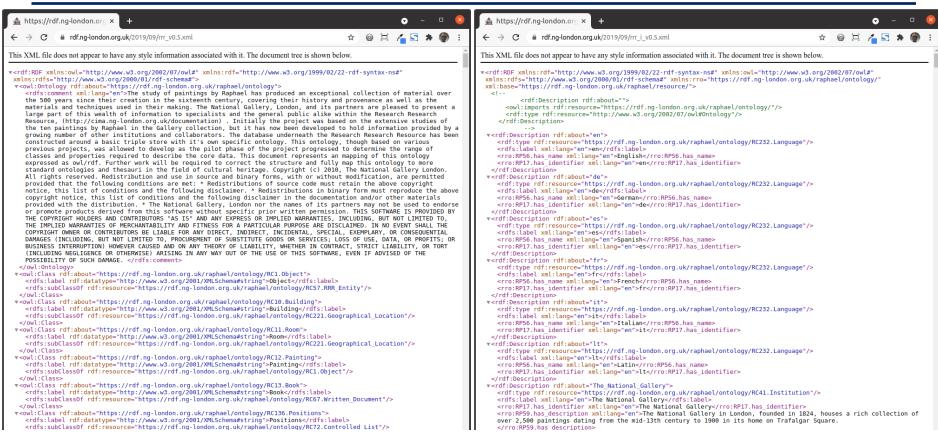
```php
<?php

require_once ("header.php");
setGlobals();

$q = "PREFIX rdfs:<http://www.w3.org/2000/01/rdf-schema#>
PREFIX owl:<http://www.w3.org/2002/07/owl#>
PREFIX rdf:<http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX crm:<http://www.cidoc-crm.org/rdfs/cidoc_crm_v5.0.2_english_label.rdfs#>
PREFIX rro:<https://rdf.ng-london.org.uk/raphael/ontology/>
PREFIX rri:<https://rdf.ng-london.org.uk/raphael/resource/>

SELECT
  ?Painting ?Label ?Location ?Medium ?Support
  ?Height ?Width ?Collection ?Title ?sTitle
  ?Artist ?Date ?Thumbnail ?Curator

WHERE {
  ?Painting rdf:type rro:RC12.Painting;
    rro:RP10.has_current_location ?Location;
    rro:RP72.was_produced ?Production;
    rdfs:label ?Label;
    rro:RP99.is_part_of ?Collection;
    rro:RP231I.has_the_display_image ?dim .
  Optional { ?Painting rro:RP9.has_curator  ?Curator . }.
  Optional { ?Painting rro:RP20.has_medium ?Medium . }.
  Optional { ?Painting rro:RP32.has_support ?Support . }.
  Optional { ?Painting rro:RP36.has_width_in_cm ?Width . }.
  Optional { ?Painting rro:RP16.has_height_in_cm ?Height . }.
  Optional { ?Painting rro:RP34.has_title ?Title . }.
  Optional { ?Painting rro:RP31.has_short_title ?sTitle . }.
  ?dim rro:RP259.has_thumbnail ?Thumbnail .
  ?Production rro:RP43.was_carried_out_by ?Artist;
  Optional { ?Production rro:RP209.has_time-span ?Date . }.
  FILTER ( ?Painting = rri:NG27 ) . }";
$r = selectQuery ($q, true);
$r = $r[0];
$tb = imgUrl ($r["Thumbnail"]);
$arr = selectQuery ($q, true);
$r = $arr[0];
$p = $r["Painting"];
$tb = imgUrl ($r["Thumbnail"]["value"]);
$r["Label"] = $r["Label"]["value"];
echo htmlHeader ();
echo <<<END
```

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Full updated XML versions of the Data can be explored

https://rdf.ng-london.org.uk/2019/09/rrr_v0.5.xml

https://rdf.ng-london.org.uk/2019/09/rrr_i_v0.5.xml
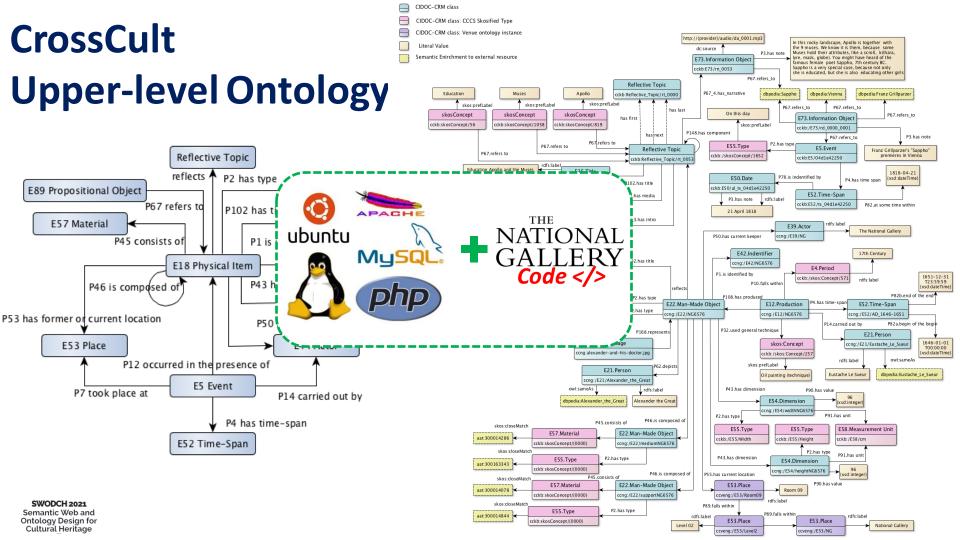
CrossCult – H2020 EU Project (2016)

- Data Re-use in practice: Empowering reuse of digital cultural heritage in context-aware crosscuts of European history

- https://cordis.europa.eu/project/id/693150

- The National Gallery was involved with creating a mobile "guide" based on semantic data published from a new end-point.

- https://data.ng-london.org.uk/resource/examples/

Where HISTORY meets IT

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CrossCult
Upper-level Ontology

Mapping JSON NG data to the CIDOC CRM

```
object {13}
    type : location
    pid  : 006-001M-0000
    name : Room 30
    title : Spain
    description : <p>Spanish painting flourished during the 17th
                  century principally in the service of God and
                  King. The evolution of a Catholic Counter-
                  Reformation religiosity is revealed in a variety
                  of powerful, individual styles. Not long after El
                  Greco had portrayed the divine with ethereal
                  idealisations of figures, space and light, Diego
                  Velázquez and Francisco de Zurbarán turned to
                  realism to represent the mystical.</p>\n<p>To make
                  religion more personally relevant, they used
                  naturalistic light to convey divine presence and
                  they depicted the saints as ordinary people, with
                  a vivid physicality and facial expressions. Taste
                  changed after 1650, and Bartolomé Esteban Murillo
                  appealed to popular piety with an ideal style of
                  soft forms and colours, and a sweet and gentle
                  mood.</p>\n<p>At the court of Philip IV, Velázquez
                  transformed his style of earthy realism in order
                  to express the dignity and splendour of the
                  monarchy. He developed an elegant technique of
                  artful brushwork that calls attention to itself
                  and yet conveys compelling actuality when viewed
                  from a distance.</p>
  ▶ objects {21}
    example_object : 000-01D6-0000
  ▶ artists {3}
  ▶ date_range {2}
  ▶ contains [0]
  ▶ keywords {63}
    license : https://creativecommons.org/licenses/by-nc-nd/4.0/
    attribution : This data is licensed under a Creative Commons
                  Attribution-NonCommercial-NoDerivatives 4.0
                  International License (CC BY-NC-ND 4.0)
                  https://creativecommons.org/licenses/by-nc-nd/4.0/
```

RAW JSON DATA

```php
function CIDOC_LocationXML ($a)
{
  global $otherPIDs, $ngPID;

  if (!isset($a["triples"]))
    {$a["triples"] = getRemoteJsonDetails (array($a["pid"]),
      "localtriples", false);}

  $xmlStr = "";

  $lts = array(
    array("p" => "crm:P102.has title", "o" => "_:title_".$a["pid"]));
  $lls = array();

  $xmlStr .= simpleRDFDesc ("_:title_".$a["pid"], "crm:E35.Title",
    $a["name"], "", $otherPIDs["ftitle"], array(), array());

  if ($a["title"])
    {$lts[] = array("p" => "crm:P102.has title", "o" => "_:subtitle_".
      $a["pid"]);
      $xmlStr .= simpleRDFDesc ("_:subtitle_".$a["pid"], "crm:E35.Title",
        $a["title"], "", $otherPIDs["sub title"], array(), array()); }

  foreach ($a["triples"]["subject"] as $sk => $v)
    {$lts[] = array("p" => $v["predicate"], "o" => $v["object_pid"]);}
  foreach ($a["triples"]["object"] as $sk => $v)
    {$xmlStr .= simpleRDFDesc ($v["subject_pid"], "",
      "", "", array(), array(
      array("p" => $v["predicate"], "o" => $a["pid"])));}
  foreach ($a["objects"] as $opid => $n)
    {$xmlStr .= simpleRDFDesc (
      $opid, "", "", "", "", array(), array(
      array("p" => "crm:P55.has current location", "o" => $a["pid"])));}

  foreach ($a["keywords"] as $p => $v)
    {$xmlStr .= simpleRDFDesc (
      "$p", "", "", "", "", array(
      array("p" => "crm:P67.refers to", "o" => $a["pid"])));}

  $xmlStr .= simpleRDFDesc ("$a[pid]", "crm:E53.Place",
    $a["name"], strip_tags($a["description"]), "", $lls, $lts);

  return ($xmlStr);
}
```

PHP Function

```xml
<?xml version="1.0" encoding="UTF-8"?>
<rdf:RDF
  xmlns:ng="https://data.ng-london.org.uk/resource/"
  xmlns:xsd="http://www.w3.org/2001/XMLSchema#"
  xmlns:crm="http://www.cidoc-
crm.org/sites/default/files/cidoc_crm_v6.2.1-2018April.rdfs#"
  xmlns:owl="http://www.w3.org/2002/07/owl#"
  xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:dc="http://purl.org/dc/elements/1.1/"
  xmlns:cc="https://creativecommons.org/licenses/"
  xml:base="https://data.ng-london.org.uk/resource/" >
  <owl:Ontology/>
  <rdf:Description rdf:nodeID="title_006-001M-0000">
    <rdf:type rdf:resource="crm:E35.Title"/>
    <rdfs:label xml:lang="en">Room 30</rdfs:label>
    <crm:P2.has_type rdf:resource="00A-00DP-0000"/>
  </rdf:Description>
  <rdf:Description rdf:nodeID="subtitle_006-001M-0000">
    <rdf:type rdf:resource="crm:E35.Title"/>
    <rdfs:label xml:lang="en">Spain</rdfs:label>
    <crm:P2.has_type rdf:resource="00A-00DU-0000"/>
  </rdf:Description>
  <rdf:Description rdf:about="000-00A8-0000">
    <crm:P55.has_current_location rdf:resource="006-001M-0000"/>
  </rdf:Description>
  <rdf:Description rdf:about="000-0196-0000">
    <crm:P55.has_current_location rdf:resource="006-001M-0000"/>
  </rdf:Description>
  <rdf:Description rdf:about="000-01AQ-0000">
    <crm:P55.has_current_location rdf:resource="006-001M-0000"/>
  </rdf:Description>
  <rdf:Description rdf:about="000-01AW-0000">
    <crm:P55.has_current_location rdf:resource="006-001M-0000"/>
  </rdf:Description>
  <rdf:Description rdf:about="000-01D6-0000">
    <crm:P55.has_current_location rdf:resource="006-001M-0000"/>
  </rdf:Description>
  <rdf:Description rdf:about="000-0208-0000">
    <crm:P55.has_current_location rdf:resource="006-001M-0000"/>
  </rdf:Description>
  <rdf:Description rdf:about="000-020Z-0000">
    <crm:P55.has_current_location rdf:resource="006-001M-0000"/>
  </rdf:Description>
  <rdf:Description rdf:about="000-02PV-0000">
    <crm:P55.has_current_location rdf:resource="006-001M-0000"/>
```

CIDOC CRM - RDF XML

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Mapping NG data to the CIDOC CRM

https://data.ng-london.org.uk/resource/000-01D6-0000&rdf=1
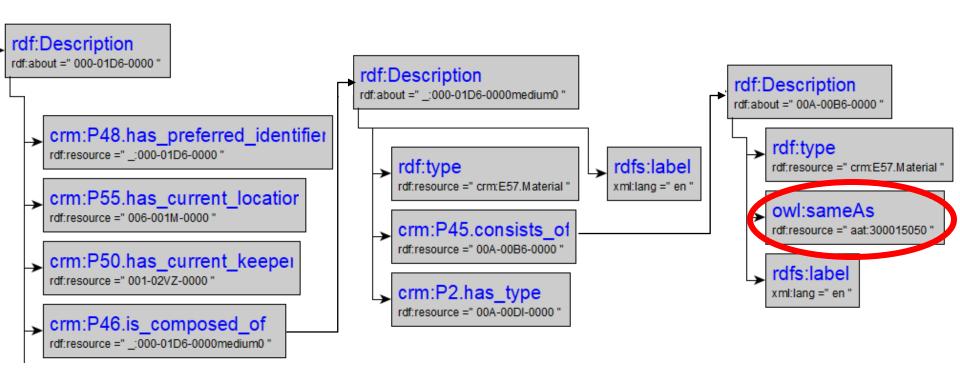
NG2057: Diego Velázquez, The Toilet of Venus ('The Rokeby Venus'), 1647-51

Linking NG Data to AAT

http://vocab.getty.edu/page/aat/300015050

Art & Architecture Thesaurus® Online
Full Record Display

? Help

Click the 🔧 icon to view the hierarchy.

[Semantic View](#) ([JSON](#), [RDF](#), [N3/Turtle](#), [N-Triples](#))

ID: 300015050   **Record Type:** concept
Page Link: http://vocab.getty.edu/page/aat/300015050

🔧 **oil paint (paint)** (<paint by composition or origin>, paint (coating), ... Materials (hierarchy name))

Note: A paint made by grinding pigments with a drying oil such as linseed oil. After 1940 alkyd binders were often added to oil paint to provide faster drying times.

Terms:

oil paint (paint) (**preferred**,C,U,English-P,D,U,N)
oil paints (paints) (C,U,English,AD,U,N)
paint, oil (paint) (C,U,American English,UF,U,N)
oil (paint) (C,U,English,UF,U,N)
oils (paints) (C,U,English,UF,U,N)
oil color (C,U,American English,UF,U,N)
oil colour (C,U,British English,UF,U,N)
oil colours (C,U,British English,UF,U,N)
油性漆 (顔料塗層) (C,U,Chinese (traditional)-P,D,U,U)

IPERION-CH (2015-19)

- Integrated Platform for the European Research Infrastructure ON Cultural Heritage

- 4 year project - H2020-INFRAIA-2014-2015, under Grant No. 654028

- 24 partners and more than 35 research groups from 12 EU Member States and the USA

- Wide range of Heritage Science based research

- One research Work-package dedicated to Digital Documentation

IPERION CH

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IPERION-CH (2015-19)

- 3 Joint Research Work-packages, one (WP-8) was focused on – "Developing of digital documentation and data"

- One of the key deliverables of this Work-package focussed on the model heritage objects and related analytical work

- D.8.5 Completed example of prototype designs for integration of various types of documentation and analytical data generated for a single object

- https://doi.org/10.5281/zenodo.5519016

IPERION CH

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CIDOC-CRM: Object Model - Painting

crm:E22.Man-Made Object
ng:0FJS-0001-0000-0000

crm:P46.forms part of
- E78. Curated Holding
  - ngo:001-02VZ-0000
  - rdfs:label → "The National Gallery Collection (London)"@en

crm:P12.was present at
- crm:E5.Event
  - Further Events

crm:P48.has preferred identifier
- crm:E42.Identifier
  - _Blank Node
  - crm:P2.has type
    - crm:E55.Type
    - aat:300312355
    - "accession numbers"@en
  - rdfs:label → "NG1171"@en

crm:P102.has title

crm:P108.was produced by
- crm:E35.Title
  - ngo:00C-02FT-0000
  - crm:P2.has type
    - crm:E55.Type
    - aat:300417208
    - "brief titles"@en
  - rdfs:label → "The Ansidei Madonna"@en
- crm:E12.Production
  - ngo:002-0432-0000

rdfs:comment
"Raphael painted this altarpiece for the Ansidei family chapel dedicated to Saint Nicholas in the Servite Church of S. Fiorenzo in Perugia. The date MDV (1505) is inscribed in gold on the ..."@en

rdfs:seeAlso

Different types of objects will have different additional properties and links to external resources.

crm:P43.has dimension
- crm:E54.Dimension
  - _Blank Node
  - crm:P2.has type — aat:300055647
    - rdfs:label "width"@en
  - crm:P90.has value 147.600 # xsd:decimal
  - crm:P91.has unit aat:300379098
    - rdfs:label "centimeters"@en
- crm:E54.Dimension
  - _Blank Node
  - crm:P2.has type — aat:300055644
    - rdfs:label "height"@en
  - crm:P90.has value 216.800 # xsd:decimal
  - crm:P91.has unit aat:300379098
    - rdfs:label "centimeters"@en

crm:P46.is composed of
- crm:E57.Material
  - _Blank Node
  - crm:P2.has type — aat:300163343
    - rdfs:label "media (artists' materials)"@en
  - crm:P45.consists of — aat:300015050
    - rdfs:label "medium: oil paint (paint)"@en
- crm:E57.Material
  - _Blank Node
  - crm:P2.has type — aat:300014844
    - rdfs:label "supports (artists' materials)"@en
  - crm:P45.consists of — aat:300012363
    - rdfs:label "support: poplar (wood)"@en

crm:P70.is documented in
- crm:E31.Document
  - This allows a link to standalone and/or legacy reports, publications, databases, etc.
- crm:E31.Document
  - _Blank Node
  - owl:sameAs https://cima.ng-london.org.uk/documentation/files/2009/10/01/Raphael%20Catalogue%20Complete.pdf
  - rdfs:seeAlso https://www.book-info.com/isbn/1-85709-999-0.htm
  - rdfs:label "Raphael: From Urbino to Rome"@en

crm:P2.has type — aat:300033799
- rdfs:label "oil paintings (visual works)"@en

crm:P2.has type — aat:300234093
- rdfs:label "religious visual works"en

crm:P2.has type — aat:300033656
- rdfs:label "panel paintings (paintings by form)"@en

CIDOC-CRM: Sampling Model

rdfs:label "Example NG Staff Member"@en
crm:P2.has type aat:300025820
rdfs:label "conservation scientists"@en

crm:E21.Person
ngi:00D-002-0000

crm:P14.carried out by

crm:P113.removed

crm:E22.Man-Made Object
ngi:NG1171-IS31

Samples can then be fully defined like all generic objects

crm:P138.has representation

crm:E22.Man-Made Object
ng:0FJS-0001-0000-0000

crm:P112.diminished

crm:E80.Part Removal
_Blank Node

crm:P4.has time span

crm:P2.has type wd:Q205892
rdfs:label calendar date@en
crm:P82a.begin of the begin "2001-02-13 00:00 # xsd:dateTim"
crm:P82b.end of the end "2001-02-13 24:00 # xsd:dateTime"
rdfs:label 2001-02-13@en

crm:E36 Visual Item
ngi:N-1171-00-000052

crm:E52.Time-span
_Blank Node

crm:P59.has section

crm:P7.took place

crm:P148 has component

crm:E36 Visual Item
_Blank Node

crm:P1.is identified by

crm:E53.Place
ngi:N-1171-00-000052-S01

crm:P70.is documented in

crm:E31.Document
_Blank Node

crm:P2.has type wd:Q1710397
rdfs:label "reason"@en
rdf:comment "Actual textual content"@en

crm:P2.has type

crm:P1.is identified by

crm:E55.Type
ngo:00A-00E0-0000

"Area of interest"@en

crm:P70.is documented in

crm:E31.Document
_Blank Node

crm:P2.has type wd:Q1200750
rdfs:label Description@en
rdf:comment Actual textual content

crm:E41.Appellation
_Blank Node

crm:P70.is documented in _Blank Node
crm:P2.has type aat:300026100
rdfs:label annotations@en
rdf:comment Actual textual content

crm:P138.has representation

crm:E36 Visual Item
Optional, additional images specifically representing the sample site.

crm:P43.has dimension

crm:P2.has type ngo:00A-00DX-0000
rdfs:label "Y Dimension"@en
crm:P90.has value 6239 # xsd:decimal
crm:P91.has unit aat:300266190
rdfs:label "pixels"@en

crm:E54.Dimension
_Blank Node

crm:E54.Dimension
_Blank Node

crm:P2.has type ngo:00A-00DW-0000
rdfs:label "X Dimension"@en
crm:P90.has value 170 # xsd:decimal
crm:P91.has unit aat:300266190
rdfs:label "pixels"@en

CIDOC CRM

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CIDOC-CRM: Working with Analytical Data Model – GC-MS

Developing Modeling Options

- The IPERION-CH and CrossCult work contained a number of complex semantic models

- These models were all created manually in different system—the models were good but their creation was not very efficient

- An alternative approach which allowed rapid model creation, that were easy to replicate, re-use and edit was required.

- Early experiments with https://mermaid-js.github.io led to the creation of an open simple dynamic modeler.

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Sharing Modelling Examples and Development on GitHub

https://jpadfield.github.io/cidoc-crm.examples

Sharing Modelling Examples and Development on GitHub

Automatically formatting semantic models - Process converts simple text triples or JSON-LD into formatted flow diagrams

```
////////////////////////////////////////////////////////////
// Model: artist // Primary relationships describing an Artist
// D8.5 Figure 4
////////////////////////////////////////////////////////////
ng:0F6J-0001-0000-0000crm:P2.has type          crm:E21.Person          aPID@@crm
ng:0F6J-0001-0000-0000crm:P2.has type          aat:300411314
aat:300411314          rdfs:label          artist painters@en
ng:0F6J-0001-0000-0000crm:P2.has type          aat:300024987
aat:300024987          rdfs:label          architechts@en
ng:0F6J-0001-0000-0000owl:sameAs          ulan:500023578
ulan:500023578          rdfs:label          Raphael@en
ng:0F6J-0001-0000-0000owl:sameAs          wd:Q5597
wd:Q5597          rdfs:label          Raphael@en
ng:0F6J-0001-0000-0000rdfs:seeAlso          https://cima.ng-london.org.uk/documentation
https://cima.ng-london.org.uk/documentation          rdfs:label          Raphael Research
Resource@en
ng:0F6J-0001-0000-0000rdfs:comment          Free Text@en
ng:0F6J-0001-0000-0000crm:P14.performed          ngo:002-0432-0000          aPID@@ePID

_Blank Node          crm:P2.has type          crm:E41.Appellation
ng:0F6J-0001-0000-0000crm:P131.is identified by _Blank Node
_Blank Node          rdfs:label          Raphael@en

_Blank Node          crm:P2.has type          crm:E74.Group          aPID@@crm
ng:0F6J-0001-0000-0000crm:P15.was influenced by          _Blank Node
_Blank Node          owl:sameAs          aat:300107304
aat:300107304          rdfs:label          Ancient Italian@en
```

https://jpadfield.github.io/cidoc-crm.examples

https://jpadfield.github.io/cidoc-crm.examples/Objects,%20Creators%20and%20Events.html
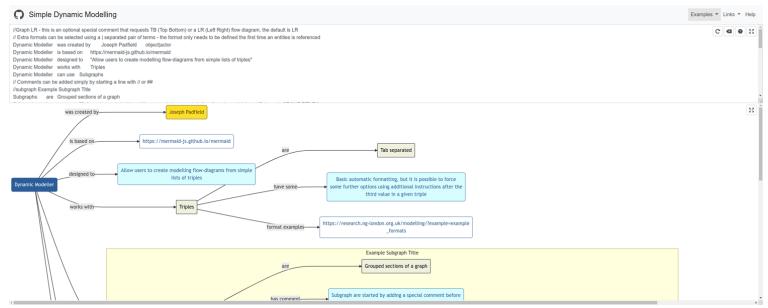
The Dynamic Modeler: https://research.ng-london.org.uk/modelling
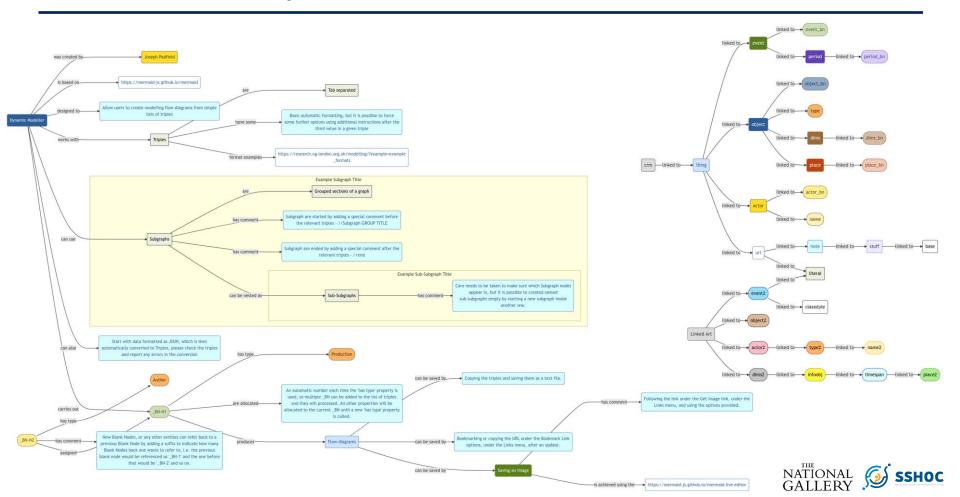
- In order to facilitate live, virtual, collaborative development of semantic maps a dynamic version of the modeler was developed. Automatically converts tab separated triples or JSON-LD into formatted flow diagrams

- Diagrams can be shared as images or live (long) URLs

The Dynamic Modeler: Instructions in models

SSHOC – H2020 (2019)

- EU-funded as part of Horizon 2020

- Social Sciences and Humanities Open Cloud – focused on open data examples and regulation

- Our work package – Innovations in Data Access

- Our specific task – "develop examples of making Heritage Science and archaeological data more interoperable and accessible in the SSH"

- Senior Researcher: Orla Delaney

  – https://orcid.org/0000-0002-7114-7929

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SSHOC – the NG contribution

- Remodeling existing NG scientific datasets to bring them in line with the FAIR principles

- Presenting examples of the remodeled data and making the datasets publicly available

- Remodeled data will be in linked data/semantic web format

- GOAL: to standardise research data; to provide a complex worked example of FAIR linked art historical data

Findable Accessible Interoperable Reusable

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NG Scientific Datasets to be standardised

The Raphael Research Resource

- Originally built in 2007
- Linked data repository of information on the Raphael paintings owned by the Gallery
- Contains scientific imaging, provenance documentation, exhibition history, curatorial comments
- Not FAIR – vocabularies used are bespoke and non-standardised
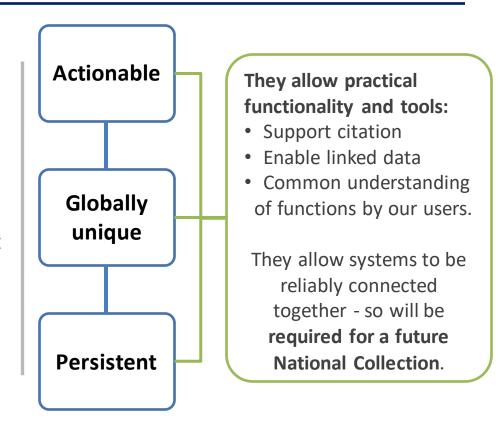
The GROUNDS Database

- Built 2018-19
- Standard relational database of painting samples and analyses (specific focus on grounds layer)
- Contains Gallery paintings and contributions from others
- Not FAIR – completely self-contained, no PIDs, hard to connect to outside resources

What are Persistent Identifiers (PIDs) ?

- A PID is a **stable long-lasting generic reference** to an object (or the digital information about it).

- **The purpose of a PID system is to provide unique generic identifiers that can be used and re-used across multiple systems**, particularly in relation to publishing information that can be accessed over the Internet.

- Similar to ISBN for a book or a DOI for a publication.

- **NG Beta PID system: https://data.ng-london.org.uk**

Actionable

Globally unique

Persistent

They allow practical functionality and tools:
- Support citation
- Enable linked data
- Common understanding of functions by our users.

They allow systems to be reliably connected together - so will be **required for a future National Collection**.
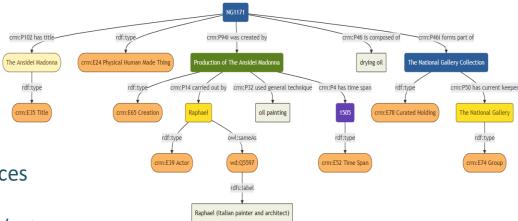
Linked Data and CIDOC-CRM

- Linked data: a database structure resembling a map or graph rather than a series of tables
- Focused on **relationships** between entities in the database
- Relationships described using set vocabularies – making it FAIR
- Incorporates PIDs
- Can extend the web of relations indefinitely and link to outside sources (Wikidata, Getty vocabularies)
- CIDOC-CRM: a linked data **ontology** (set of rules) developed by and for cultural heritage organisations

Mapping Gallery data to CIDOC-CRM

What does that actually look like?

Old Raphael dataset – bespoke data structure
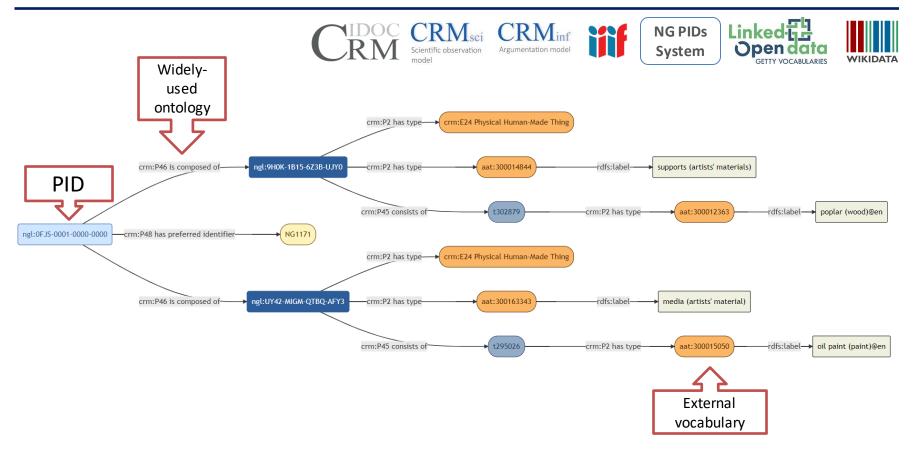
Old GROUNDS dataset – Data gather via complex multi paged excel spread sheets

object_id	object_inventory_number	medium_name	medium_comment	support_name	support_comment
144	NG1171	oil	NULL	wood (poplar)	NULL

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New dataset(s) – Mapped to Relevant Standards and Systems

New processed semantic data stored in Blazegraph

Custom SPARQL Queries sent to Blazegraph

Results formatted as tab separated triples

Graphical Presentation of SPARQL Query Results

Further developments needed to automatically apply agreed colour and formatting.

Bookmarking and sharing models

https://research.ng-london.org.uk/modelling/?data=eJy1lVFzojAUhZ%2FtTP9DHrcPt4IIik9rlUWtigpS9YVJMWpmgTCB1vXfb6TdXezG2c7oviRkMuR8nJt7SLZRS7GeBqAoinoclGKo7PI8bVWr%2B%2F3%2BPqRrFkLI43vGt9Xfq%2BqkFuxwFuSHlFQwzluaeE%2FTDLV5e3OyrPD1JmtF%2BJlElRTTJKfJNkNfXmn2giO0Z%2Fx7dnd7kwiQabM7gfHE1mFuKSOwHVX7FIhmBjHB2Qsn60oi%2F6DzAiW6DmdZhlwS5pQlyMVxGglWxDZobBv15vsh17VLN07s0o1TuxISoZJpfx6fD2jDeHz3lST%2FAathmmUssSxjMXoCdVLJi3lU5Z2I5hEpytlb6HXwZo4DruaY8DgxJm8Sko0ypntERAO2S1C%2Bl%2BgBpznNcjThBlc7gX4Zp64VmMciEB4wHoQvnJMkDyIW4uMFKtibhmPAyljasBwaI1CVzuxNVrJRZp8xFqPmZYR1o6DLghTzPGCbAmhluw747W4NzJWig2J03lUkG2UgTzg4Lr5LlNrGUUT4AXWYmItuuZC0WXiZcrIhwsR1QNfCSbqhhFdys6YY4ja%2BzWWkclNqXd8DrWO4UNPdOdQG1vK60SETKLH0kw3H4hA02bGcbTlOd4ePwfHNHYrM6ft1MO3OEKY9fXFdRpnAST%2FIA63vGT0YribiqMFKg6eZ5lyXSyYg825GNsfrdMa%2BUX%2Bogf809sAdrkbQqD%2B0r4spEyhhFpWNacjP8PmN9gB0b%2BSA2dSmYHVd%2B7p8MoESn08z%2BhwRNKTbXY76Md6Sj4hLdVCDsT0SeeP1e6D51icrrRb9GbP1sSf%2FgSkTKf9kWZIR%2FlpEyUe%2BQa3Xh549dGGkayqo5sL83D%2BjFrCwyF8RHUkg0v6YJRlJQvIr987iyjTLVefslSRYnPRXOy8bPjwqIjB73fYSfHd%2B5baRCZTIFjDDB2T9wDFNpG463bEPljf3wHKtKfidx%2Bl1AWUCJcDRsVeykKU0lGP%2BBHi6Nh4%3D
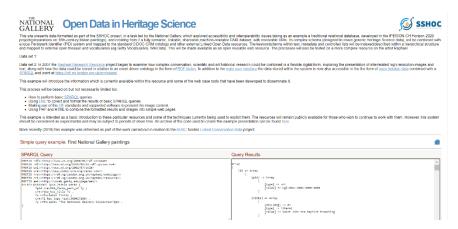
Outcomes and Possibilities

- Working example of different databases in the NG can now work together

- Development of best practices for the documentation work

- Increased **opportunity to collaborate** with other GLAM institutions

- Integrate work with future NG Digital Dossier Programme

- Development of new IIIF based presentation options.

- Webpages that can be used by general public but have **bespoke search options** for researchers and art historians

- **Persistent** Gallery data with introduction of PIDs – better citation

THE
NATIONAL
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Semantic Web and Ontology Design for Cultural Heritage (SWODCH 2021) 21st September 2021

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Thank you