Modeling Execution Techniques of Inscriptions[1]

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Abstract. The paper discusses a small ontology to better describe the features of the execution techniques of inscriptions, based on a recent contribution discussing the classification methodologies. The ontology described is also used in the EAGLE Vocabularies for Execution Technique, with possibly immediate impact on the many projects using the concepts contained there.

Keywords: Execution Technique, CIDOC-CRM, EAGLE, IDEA

1. Introduction

An ancient written artefact which may be defined as inscription[2] carries a text which has been produced in a way or another. The execution technique used to produce such artefact has been the object of a recent contribution by Silvia Evangelisti [2], where the author discusses the inadequacy of current classifications in use in epigraphical projects, in respect to the complexity of the information to be described. In this contribution the existing proposals of models for this type of information and the use of the EAGLE Vocabularies in this context are revised [3,4],[3] to propose a small ontology to better model this specific type of information, following the idea put forward in [18] according to which this is the task of domain specialists, namely in this case epigraphists. The need for a general Epigraphic Ontology has been expressed repeatedly and hopefully this contribution will contribute towards the existing efforts,[4] or provide a further trigger for a discussion on how to model this information in aggregation projects or for the construction of configurations and mappings.[5] The use of the ontology in the EAGLE Vocabularies already brings a further benefit of classifications of the

[1] This work is part of the efforts of the International Association of Digital Epigraphy, IDEA (https://www.eagle-network.eu/).
[*] Corresponding author. E-mail: pietro.liuzzo@uni-hamburg.de.
[2] See for a discussion of the many definitions [1].
[3] https://www.eagle-network.eu/resources/vocabularies/
[4] A dedicated conference has been held in Oxford in November 2018, and a further meeting is planned in the context of the IV Epigraphy.info meeting in Hamburg in February 2019.
[5] For example this could inform mappings in a XTriples configuration file, see [5] and [6]; or to produce mappings in Ontop.

concepts listed there, for the many projects using the Vocabularies, and especially the EAGLE portal, although this are at the moment yet unexploited.

The paper will start discussing the existing models for the representation of inscriptions,[6] the one produced by the EAGLE project[7] and CRM-Tex.[8] In other ontologies used for epigraphy, like the one used by Economic and Political Network (EPNet) project [9][9] and the one used by the Epigraphische Datenbank Heidelberg (EDH) [10],[10] this information is not yet modelled. The paper will then expand on this, to describe how a small ontology and the use of some of its classes in the vocabulary for execution techniques, concisely and deceivingly named 'writing' only,[11] and for the description of the written artefacts allows for a much better structured classification of this information, other ways inconsistently mixing tools, methods, aspects of the results of the execution technique, all in one point of the model.

2. Existing models

In the EAGLE model [11], the information related to the execution technique of an inscription would be modelled by relating to the object (`E22 Man-Made Object`) via `P31 has modified (was modified by)` or the more specific `P108 has produced (was produced by)` by a `E11 Modification` entity or one of its subclasses (`E12 Production`, `E79 Part Addition`, `E80 Part Removal`), which being a subclass of `E7 Activity` can be related via `P32 used general technique (was technique of)` to a value in the EAGLE Execution Techniques vocabulary which will be in the `E55 Type` class. This already allows, theoretically for several modifications which are distinct from the production and might be obtained with different techniques. An inscription INS1 which was engraved and then painted could be modelled as

```
@prefix crm: <http://www.cidoc-crm.org/cidoc-crm/> .
@prefix eagle: <https://www.eagle-network.eu/voc/writing/lod/> .
:INS 1 a crm:E22 ;
        crm:P108 :Activity1;
crm:P31 :Activity2 .
:Activity1 a crm:E12 ;
        crm:P32 eagle:3 .
:Activity2 a crm:E11 ;
        crm:P32 eagle:10 .
```

Because `E7 Activity` is indirectly a subclass of `E4 Period`, each of the actions can be qualified with a time span. Nothing prevents P32 from being used several times, although, in the current practice only one information is given in this context. *Caelo* will be used omitting the following phase, or deferring this clarification to a note elsewhere or another field of the description. The EAGLE model fits the current practice but maintains all the limitations which come with it.

In the CRM-Tex [12–14][12] extension the same model applies, but uses more specific classes, because `TX1 Written Text` is a subclass of `E25 Man-Made Feature`, a subclass of `E24 Physical Man-Made Thing`, which contains also `E22 Man-Made Object`, preferred by EAGLE, and `TX2 Writing`, is a subclass of `E12 Production` thus leaving out modifications in this case which can be qualified as above. Our example would then look like the following:

```
@prefix crmtex: <http://www.cidoc-crm.org/crmtex/> .
@prefix crm: <http://www.cidoc-crm.org/cidoc-crm/> .
@prefix eagle: <https://www.eagle-network.eu/voc/writing/lod/> .
:INS 1 a crmtex:TX1 ;
        crm:P108 :Activity1;
crm:P31 :Activity2 .
:Activity1 a crmtex:TX2 ;
        crm:P32 eagle:3 .
:Activity2 a crm:E11 ;
        crm:P32 eagle:10 .
```

The use of either or a mix of these models would already provide better descriptions for the execution technique, but can be further improved with an ontology which classifies the values in the SKOS vocabulary for Execution Techniques maintained by EAGLE and better defines the relations between them. In this Vocabulary, based on the authority lists used by the databases which were part of the EAGLE project, there are values which refer to several different aspects of execution technique: some refer to the tool used, some to the final aspect of the inscription, etc. The proposed ontology defines these different classes and is used in the vocabulary to classify them. In this way, project using the vocabulary can directly benefit of the classification, and its improved precision.

[6] See [7] for an overview of the existing attempts in this direction. A limited and too scarcely documented to be evaluated epigraphic ontology (EpiOnt), was already proposed in [8]. The little or no success of this proposal, which dismissed both CIDOC-CRM and EpiDoc with little cause is not relevant for this paper in as far as it appears that the ontology did not even have an interest in this aspect of execution.

[7] https://www.eagle-network.eu/
[8] http://www.cidoc-crm.org/crmtex/
[9] http://www.romanopendata.eu/
[10] https://edh-www.adw.uni-heidelberg.de/edh/ontology
[11] https://www.eagle-network.eu/voc/writing.html
[12] http://www.cidoc-crm.org/crmtex/

3. The execution technique ontology

Following the classification and argument proposed in [2], it was thought that this information definitely needs to be described in relation to the object and not to the text of the inscription, but this is so, although better specified, in the definition of the subclass in CRM-Tex as a feature of the object. However, the different "execution phases" need to be further modelled in order to use the three main classifications which are proposed in the article and which are:

- The execution techniques
- The tool used
- The actual characteristics of the letters

An inscription, among the many possible modifications it may have incurred into in the time, could have several Phases of execution, (`extech:Phase`, a subclass of `E11 Modification`) linked by a more specific property `extech:hasExecutionPhase` (subclass of `crm:P31_was_modified_by`). These more specific classes and properties would only grant the possibility to directly reach the desired type of modification. Our example of triples describing INS1 to this point, far from being different from the previous two, would look like the following:

```
@prefix crm: <http://www.cidoc-crm.org/> .
@prefix crmtex: <http://www.cidoc-crm.org/crmtex> .
@prefix extech: <https://w3id.org/executionTechnique/ontology
#> .
@prefix eagle: <https://www.eagle-
network.eu/voc/writing/lod/> .
:INS 1 a crmtex:TX1 ;
        crm:P108 :Activity1;
        extech:hasExecutionPhase :Activity2;
extech:hasExecutionPhase :Activity3 .
:Activity1 a crm:E12 .
:Activity2 a extech:Phase ;
       crm:P32 eagle:3 .
:Activity3 a extech:Phase ;
       crm:P32 eagle:10 .
```

This imposes a distinction of the execution techniques from the production act of the carrier, unless the production activity is associated to a parallel man-made object.

Also the CRM property `P32 used general technique` could be further specified with subclasses to extend on the CIDOC-CRM. The specific definition of a property `extech:uses_technique` would be that the Execution Technique (`extech:Technique`) in its domain will be defined, according to the definition given in the article, as

The effect that an instrument has on the support, which reacts to this tool on the basis of its specific nature, quality and morphology.

This requires a further classification of the values in the EAGLE vocabulary for execution technique, which contains a flat list of values, following the tradition of the databases from which it originated and which it continues to serve. Four classes have been defined for each of the execution techniques:

- `extech:ArsSubtractiva`
- `extech:ArsAddictiva`
- `extech:ArsPlastica`
- `extech:ArsMixta`

Additionally tools have been listed (and made part of the class `extech:Tool`), as well as the colors (`extech:Color`) and the result types (`extech:ResultType`). This resulted in a list of values to be added to the vocabulary to distinguish a tool from a technique using this tool and the assignation in the vocabulary via `rdf:type` of each concept to one of the execution technique classes or another class of information relative to this, as defined in the ontology. Our example would now look like the following

```
@prefix crm: <http://www.cidoc-crm.org/> .
@prefix crmtex: <http://www.cidoc-crm.org/crmtex> .
@prefix extech: <https://w3id.org/executionTechnique/ontology
#> .
@prefix eagle: <https://www.eagle-
network.eu/voc/writing/lod/> .
:INS 1 a crm:TX1 ;
        crm:P108 :Activity1;
        extech:hasExecutionPhase :Activity2;
extech:hasExecutionPhase :Activity3 .
:Activity1 a crm:E12 .
:Activity2 a extech:Phase ;
       extech:uses_technique eagle:3 .
eagle:3 a ExTech:ArsSubtractiva .
:Activity3 a extech:Phase ;
       extech:uses_technique eagle:10 .
eagle:10 a ExTech:ArsAddictiva.
```

The classes are actually specified in the Vocabularies directly, because their classification is defined in the article, thus removing the need to explicit them in a dataset describing an inscription, but the domain of `extech:uses_technique` had to be limited to a superclass of the four defined above, `extech:Technique`, to prevent the modeling in this position for examples of concepts

which define tools, which will be included in the class `extech:Tool`, to which the concepts in the Eagle Vocabulary can be associated. It would be then

```
@prefix crm: <http://www.cidoc-crm.org/> .
@prefix crmtex: <http://www.cidoc-crm.org/crmtex> .
@prefix extech: <https://w3id.org/executionTechnique/ontology#>.
@prefix eagle: <https://www.eagle-network.eu/voc/writing/lod/> .
:INS 1 a crm:TX1 ;
        crm:P108 :Activity1;
        extech:hasExecutionPhase :Activity2;
extech:hasExecutionPhase :Activity3 .
:Activity1 a crm:E12 .
:Activity2 a extech:Phase ;
        extech:resultsIn eagle:204 ;
        extech:uses_technique eagle:3 .
eagle:3 a ExTech:ArsSubtractiva ;
extech:usesTool eagle:215 .
:Activity3 a extech:Phase ;
        extech:uses_technique eagle:10 .
eagle:10 a ExTech:ArsAddictiva ;
        extech:hasColor "red" ;
crm:P126 eagle:2 .
```

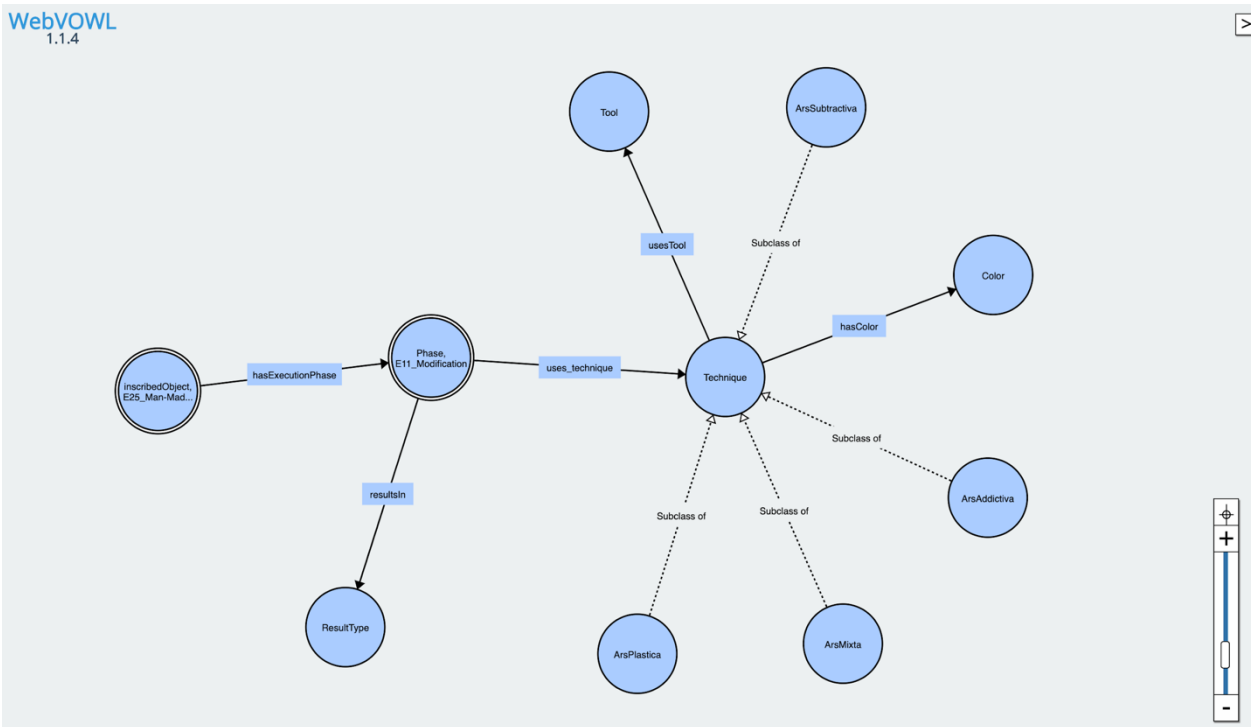

Figure 1

the `extech:Technique` class, which can be linked by a set of properties to other descriptive features, in the same way as for tools as follows:

- `extech:usesTool` will have as domain `extech:Tool`
- `extech:hasColor` will have as domain a `extech:Color`

The `extech:Phase` will be instead characterized by a result using `extech:resultsIn` which will have as domain a `extech:ResultType`, e.g. *litteris ageminatis*, U cut or V cut, which have been defined in the EAGLE Vocabulary for Execution Tecnique.

Because of the definition of `extech:Phase` as a subclass of `E11 Modification`, the property `P126 employed (was employed in)` could be used to link to a `E57 Material`, allowing to distinguish for example the material added while painting. One would then have the following.

This Execution Technique ontology would then be simply representable as in Fig. 1.

4. Examples

For all the examples, which are the same and in the same sequence as in [2], the following prefixes are always used

```
@prefix crm: <http://www.cidoc-crm.org/> .
@prefix edr: <http://www.edr-edr.it/edr_programmi/res_complex_comune.php?id_nr=> .
@prefix extech: <https://w3id.org/executionTechnique/ontology#> .
@prefix eagle: <https://www.eagle-network.eu/voc/writing/lod/> .
```

C.I.L. IX 1123 pars (EDR132130): *ars subractiva, scalpro, litt. sulcis angulatis.*

```
edr:EDR132130 a crm:TX1 ;
        extech:hasExecutionPhase :Activity2;
:Activity2 a extech:Phase ;
        extech:uses_technique eagle:1 ;
        extech:resultsIn eagle:203 .
```

`eagle:203` is a `skos:Concept` for *litt. sulcis angulatis,* which in the EAGLE Vocabulary for Execution Technique is assigned to the *Ars Subtractiva* class (so that this needs not to be added with the edition of the inscription) and the tool used is also given a URI and is linked to this `extech:Tecnique`, so that also this additional information can be already reused also by all those projects which use this concept in their classifications. In the Vocabulary these triples can be found as follows:

```
eagle:1 a extech:ArsSubtractiva ;
extech:usesTool eagle:232 .
```

C.I.L. I2 359 (EDR071974): *ars subractiva, caelo, punctim.*

```
edr:EDR071974 a crm:TX1 ;
        extech:hasExecutionPhase :Activity2;
:Activity2 a extech:Phase ;
        extech:uses_technique eagle:3 ;
        extech:resultsIn eagle:11 .
```

PACI 2007, pp. 220-222 n. 1 (EDR108760): *ars addictiva, carbone.*

```
edr:EDR108760 a crm:TX1 ;
        extech:hasExecutionPhase :Activity2;
:Activity2 a extech:Phase ;
        extech:uses_technique eagle:18 .
```

Ann. épigr. 1997, 535 (EDR134212): *ars plastica, forma, litt. eminentibus.*

```
edr:EDR134212 a crm:TX1 ;
        extech:hasExecutionPhase :Activity2;
:Activity2 a extech:Phase ;
        extech:uses_technique eagle:8 ;
        extech:resultsIn eagle:7 .
```

C.I.L. I2 2443 (EDR109855): *ars mixta, litt. adplicitis, aere.*

```
edr:EDR109855 a crm:TX1 ;
        extech:hasExecutionPhase :Activity2;
:Activity2 a extech:Phase ;
        crm:P126 <https://www.eagle-network.eu/voc/material/lod/109> ;
        extech:uses_technique eagle:6 .
eagle:6 a extech:ArsMixta .
```

In this last example, the material used in the execution phase has been also specified using `crm:P126` to link to a concept *Aes* in the EAGLE Vocabulary for materials. Also the Eagle vocabulary value for the `extech:Technique` is specified locally with a different Ars, from the one registered in the vocabulary.

The model allows also for the distinction between inscriptions produced by preparing a slot within which the letters are fit *(litteris applicitis in alveolis insertis)* from one where the letters are simply fixed to the support only with holes (*litteris applicitis ipsae lapidi*). In the first case there would be two `extech:Phase` the first describing the production of the *alveoli* with one or the other of the `extech:ResultTypes` `eagle:201` (*in alveolis insertis*) and `eagle:202` (*ipsae lapidi*) the second related to `eagle:6` (*litteris applicitis*), in the second case only the latter could also be sufficient.

From these triples, stored in a triples store or otherwise aggregated, queries can be made on the various values attached to each `extech:Phase`, distinguishing for example also those inscriptions which have more than 1 `extech:Phase` or fetching all the ones whose `extech:Technique` is an *Ars Subtractiva.*

5. Conclusions

By extending in this way the existing proposed models with this small ontology, one can make use of the description of the execution technique of an inscription much better, by making the separate pieces of information relate to each other instead of mixing concepts and providing in E55 Type sometimes a concept which refers to the tool used, sometimes a concept which is the description of the visible result of this process. This needs also an effort in the improvement of the vocabulary, which needs to be able to contain and classify the concepts needed. This is yet a proposal only, with no current applications beside its

use in the EAGLE Vocabulary for Execution Technique, as indeed are also the models from which it starts, but looking forward to the resources which will be built around the Epigraphy.info group [15–17], it is hoped that it will be of use. Eventually, nothing prevents this ontology to be used for other written artefacts, like coins, manuscripts, papyri, etc. also in conjunction with other ontologies based on cutting edge field studies, like the proposal based on the book *La Syntax du Codex* [19].

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