Ontologies combining design semantics and semantics used in operation and maintenance: Feedback from EDF power plants case studies

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Abstract
Usual langage pratices of industrial maintenance are rather different from those used during the power plants design. Maintenance is part of O&M (Operation & Maintenance) whose concepts are more "operational" than the ones of design phases. As co-researches in this work, we instigated these practices for a better understandability between semantic fields, as this inquiry offers food for thought, the theoretical as well as the practical. Also, the role of ontologies are questioned while the real case study are from the EDF (Electricity of France) power plants.

Keywords 1
Ontology, Tree of Porphyry, Classification, Conceptual Model, Operation & Maintenance, O&M, Job Community

1. Introduction

No doubt that semantic questions are important in all professional activities: it is the case in Power Plants as everywhere. Many different Job Communities (*communautés de métier* in French [2]) are working in Power Plants. How to be sure that a name has an unequivocal signification for each one? A good lexicon should be enough to assume that each stakeholder does understand all stakeholders in a Power Plant. But is it that sure?

We aim to propose here a collaborative research case: a collaboration between EDF engineers and academic researchers investigating and working together [1]. In this paper, the described use cases are "going on" industrial processes and they're not made for didactic purpose, presenting how they are processed from an unsatisfying starting point. In other words, the issue is not clearly defined at the beginning, they are different ways of thinking and speaking about things. The goal is to experience various ways to find a satisfying one (Pragmatism of Charles-Sanders Peirce, Dewey…) [4]. During the presentation of Figure 1 at a conference, a different audience feedback was received than expected, that has motivated this research group to look into a new perspective of the matter.

After introducing the context, this paper presents an experimentation of a conceptual model for valves and taps. The field is well known from decades by engineers but nevertheless causes classification difficulties due to lack of understanding between practitioners. In the last part, the open of the discussion is introduced followed by the conclusion.

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2. Context: Long-term Knowledge

The Lifecycle of a Power Plant starts with Design and ends with O&M before Deconstruction. Lots of documents are produced: design, technical documentation, operational qualification, knowledge of design changes, O&M documents, etc.

All of them includes very precise technical terminology while successful vocabularies have been used during years. The shifting to O&M Terminology was effective after handover: All-or-nothing Relays became Automatic Control Relays and Threshold Relays became Protective Relays due to the assumption that such Relays correlate with these functions.

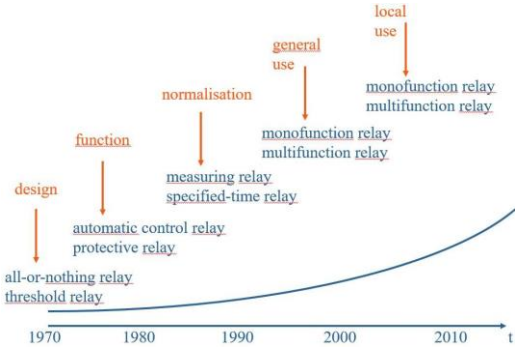

Figure 1: Terminology increases

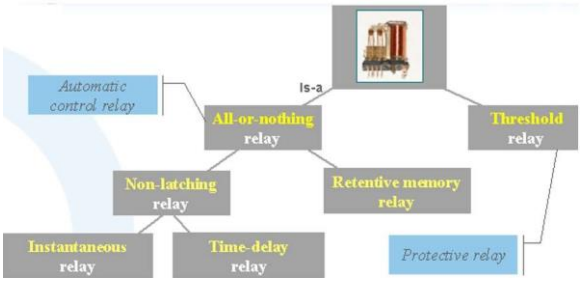

Figure 2: Tree of Porphyry of I&C' concepts

Our aim to share knowledge with stakeholders outside I&C Community (Instrumentation & Control) and thus this research group designed categories, each one more exclusive that the other one (partitions). The tree of Porphyry [5] introduced at the Figure 1 [3] uses Design Terminology where the tags are for usual terminology.

Recommendation must be made that dialog with an expert is needed in order to understand exactly the Design differences.

3. Conceptual Models of Taps

3.1. Power plants case study

The current study was obtained in collaborative work with Mansor Samba as he was in Master Degree at University of Versailles St Quentin with Zoubida Kedad (PhD). The objective was a model of taps and valves understandable by each community. The goal was to include this model in a semantic search engine.

The context of this study is flame thermal power plants. We had lots of documentation but an EDF Senior Expert François Delcer could help us even if he was very busy.

First, we prepared a preliminary Model before meeting him (a model done only with documents).

3.2. First Model of Taps

The training documentation of EDF was used to build the first model of the taps adapting it in order to understand the concepts. Specifically, Design principles are explained following these guidelines and building the tree with three main classes: Block Valve, Safety Valve, Fine-tuning Valve. This model has been done with Protégé[2], while the class Tap has 3 subclasses (see below).

[2] protege.stanford.edu

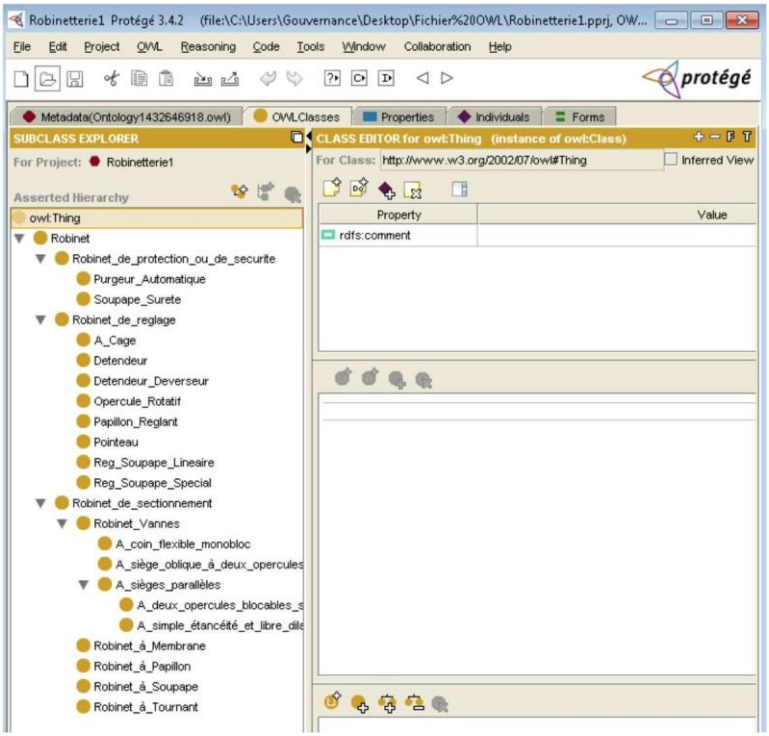

Figure 3: First classification of Taps

All the concepts within the technical documentation obtained from the power plant are included, especially technical characteristics for shut-off valves: hand-operated, electrical servomotor, pneumatic actuator, hydraulic actuator that became "attributes" in the Protégé tree as presented at Figure 3.

3.3. Second Model of Taps

The second model was established based on the O&M Documentation[3] that provided the guidelines on which tap to choose, how the installation should be done, what are the maintenance requirements, providing the precise description of taps as well as their function. Following this approach the previous model was modified. The second model has been refined with five new classes: Cut-off and Roll Valve[4], Protective and Security Valve, Control Valve, Fine-tuning Valve, Others Valves.

In this second model (see below), all five types of valves became subclasses of general class Valve. Operating Tap is now a class, at the same level with the Valve (in French: *Manœuvre Robinets*).

Figure 4: Second classification of Taps

First and second models are descriptive ones: classes are listed but not clearly defined and thus the experts help and assistance is necessary in order to clarify and support the classes with definitions.

[3] « Yellow Paper » Service de la production thermique [fascicule n° 57A]
[4] In French : *robinet de coupure et de laminage*

3.4. Third Model of Taps

The last model was done collaborating with the Senior Expert François Delcer refining the artefact (the second model) based on the discussions on:

- Language especially synonyms,
- Differences between concepts (among a Valve and a Tap, a Fine-tuning Valve and a Cut-off Valve, etc.).

The final model (see below) is now dichotomous where only two classes are at the top levels: Fine-tuning Valve and a Cut-off Valve which are exclusive.

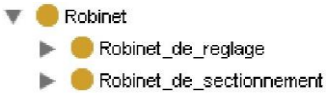

Figure 5: Third classification of Taps

Specifically, they eliminate everything which is not a tap, strongly distinguishing second Fine-tuning Valve and a Cut-off Valve providing a better built sets of thing related with the taps (e.g. Security Valve) than before. Security Valve is not exactly a Valve, it is only *related* to Valve.

4. Discussion and conclusion

First and second models are steps taken before building the last simple more reliable and affective model with explicit differences. The expert's assistance is needed that will provide explanations and definitions to ontology developers that will be able to differentiate concepts and make the model more and easy readable for stakeholders of different job communities (or later in the time). Experts are able to communicate across domain borders, they usually talk about differences between concepts whatever the names of the concepts are.

No matter the model, note must be made that none of them is ideal. All models are mediator artefacts, dialog around these artefacts providing the support for a better communication between job communities. Our ongoing studies highlight the importance of artefacts in particular for virtual assistant.

5. Acknowledgement

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