HOW TO VALUE AND TRANSMIT NUCLEAR INDUSTRY LONG TERM KNOWLEDGE

Anne Dourgnon-Hanoune
EDF R&D, 6 quai Watier, 78401 Chatou cedex, France

Eunika Mercier-Laurent
EML Knowledge Management & Innovation, 620 Chemin des Grives, 34160 St Drezery, France

Christophe Roche
University of Savoie, team Condillac, Campus scientifique 73376 Le Bourget du Lac cedex, France

Keywords: Ontology, Knowledge Management, Common language

Abstract*:* The French nuclear industry deals with technologies which will soon be thirty years old. If such technologies are not renewed they must last for another ten years- or more if the decision is taken to keep them working. There is a risk of technological obsolescence- something which is allowed for in other national and international projects. There is also the question of constant commercial demand- something also considered elsewhere in establishing contracts. Another problem is now beginning to emerge; the continuity and transmission of knowledge and experience concerning these plants. Personnel in the energy sector are being renewed. Most current employees are due to retire in the course of this decade. How is knowledge (both of maintenance and planning) to be transmitted to the new generations ? This knowledge includes written information but also know-how and implicit working assumptions; expertise, experience, self-learning. In the United States the EPRI produced a technical dossier [EPRI 1]. The problem of knowledge of old technologies is therefore recent, but almost universal. As far as EDF knows, nobody is considering this subject in its entirety. Instead, each technology puts the emphasis on operation (and thus safety) according to a fixed timetable (ten-year visits, end of use). In this perspective the initial knowledge can be lost. It can happen, for example, that the need for renewal can oblige the agency to carry out a costly or difficult retro-engineering project so as to recover the original knowledge and technology. If we look ahead, the policy of long term development (notably extending the life of plants) requires us to consider the life-span of the different skills and knowledge required by each environment. So it is necessary to take into account the entire life cycle of a nuclear installation. We are working on organizing all this knowledge and building an innovating solution for easy acquisition, access and sharing knowledge and experiences. First we are creating an ontology-based common language for all involved and defining some applications on Intranet. Ontology, understood as an agreed vocabulary of common terms and meanings shared by a group of people, is a means for representing craft concepts upon which knowledge can be organised and classified. We shall present one of the first applications based on the Logic Diagrams Designer's ontology whose main goals are to keep in memory the craft knowledge about relay circuits schemas and to allow accessing and retrieval information. This choice of ontology as a basis provides an easy and relevant navigation, indexing and search of documents...

1 INTRODUCTION

The French electricity generation capacity includes 58 PWR nuclear plants in operation, in 3 power levels (900 MW, 13000 MW and 1450 MW) and 6 reactor types, that is of the same design.

In terms of life cycle management, the EDF general strategy is to operate nuclear power plants for 40 years at least. For a operating life of 30 years, the personnel who took part in the design and commissioning of units are still with EDF, which will not be the case for much longer. With time, modifications to units become increasingly

Dourgnon-Hanoune A., Mercier-Laurent E. and Roche C. (2005).
HOW TO VALUE AND TRANSMIT NUCLEAR INDUSTRY LONG TERM KNOWLEDGE.
In *Proceedings of the Seventh International Conference on Enterprise Information Systems*, pages 323-326
DOI: 10.5220/0002512303230326

significant and may lead to partial redesign, which requires total mastery of the design and justifications of the choices made. The ageing management programme includes therefore a long-term maintenance of knowledge approach to "pass the baton" to those generations who did not take part in the original design choices or construction.

This problem is shared with other utility companies. It is covered by the Euratom programme.
In the USA, where the loss of knowledge and of undocumented know-how has been identified in the Energy sector, a study [EPRI 1] noted the risk of the disappearance of knowledge, particularly knowledge of design and modifications, which concern us here. It also raises the question of the maintenance of knowledge of feedback, but this is subject to a specific organisation in France.

2 THE PROBLEM OF 900 MW NPP RELAY CIRCUITS

2.1 The I&C of 900 MW power plants

Relay technology is highly significant for instrumentation and control (I&C) in the oldest nuclear units of the French reactor stock, the 900 MW nuclear power plants (NPP), where there are tens of thousands of relay circuits, involved in all functions. The traceability of documentation (design, modifications, feedback) has always been very important.
In so far as design documentation is concerned, it mainly dates back to end of the 1970's, the period of construction and commissioning of the 900 MW power plants. The engineers (operation, instrumentation, automatic control) who were at the start of the design of these power plants, are coming to the end of their careers.

2.2 Knowledge of relay circuits

The first of the players, the operator, has no worries with relay systems: the relay circuits has not changed, they have aged a little, but its excellent reliability has protected it from modifications and replacements. The documents are as is, hardly ever amended but often reproduced. The installations themselves change little, therefore modifications are rare.

When knowledge is no longer put into practice, it tends to be forgotten. Therefore, in operation, knowledge appears to crystallise on components, boards and relays. The overview of the installation is less important, the "memory of installations" (design, modifications) often disappears as personnel leave.

Engineering offices are the guardians of "the memory of installations". This memory is in the extensive and highly diverse documentation (functional design diagrams, logic specification diagrams and wiring diagrams …), accessible in CAD systems. The design of these diagrams is given in writing, but know-how is transmitted orally, through training sessions or apprenticeships.

The memory of installations "goes down" to the memory of equipment. In this case, the combination is very important, given the large number of equipment configurations and their use. Once again, oral know-how of the options adopted during the design phase and the choice of modifications is important; it is often heuristics that limit or classify combination.

Essential knowledge is therefore of two kinds; semi-formal representation on the one hand (design, specification, production rules and forms of representation of diagrams) and, on the other, practical oral knowledge of the interpretation of previous knowledge. This is what interests us.

3 CONSTRUCTION OF A COMMON LANGUAGE

3.1 Our approach

The awareness of this very important combination and an initial analysis of knowledge has enabled us to avoid two pitfalls; that of non standardised modelling [we use standard ISO 704], without a consistency check, and preliminary, non modifiable modelling. As we shall see below, we have linearised the problem by describing it in the form of a tree-structure and not a graph. This modelling is incremental and involves all players.

The questions which will be raised over the next 10 years and beyond, are partially unknown. The first stage for us, ensuring that the knowledge of relay circuits could make sense later, was to ensure that they are shared, whatever the situation, profession and activities of all those concerned, whether in a context of preserving or renewing technology. The last pitfall, and not the least, would be not to make such knowledge independent of the context. We shall also see how the solution adopted meets this challenge.

As in any capitalisation, valorisation and of transfer of knowledge approach, the first stage consists in defining, in detail, the trade terminology. That is, the terms used and their meaning, which constitute a common language giving access to professional concepts and the corresponding documentation.

3.2 The Logic Diagrams Designer's Ontology

The objectives of consensus, consistency and sharing for the common language have led us to choose a solution based on ontology. Ontology as an agreed vocabulary of common terms and meanings shared by a group of people, is a means for representing business concepts according to which knowledge can be organised and classified.

The profession of the 900 MW Logic Diagrams Designers that we have adopted for this experiment, like professions in the nuclear industry in general, imposes severe restrictions as to the definition of its terminology: the definition of terms should be precise and consistent with the logical meaning of the term. It should also be based on a construction methodology and can be understood and accepted by those in the trade, be they experts or novices in training.

It is for this reason that we have adopted an ontological approach where professional concepts are defined by specific differentiation: a professional concept is defined on the basis of an existing concept by identifying what distinguishes it. Therefore, a "functional logic diagram" is a "functional diagram" which is "logical". "Functional diagrams" are therefore broken down into " functional logic diagrams" and "analogue functional diagrams", "logic" and "analogue" being two specific, opposing differences.

Such an approach has many advantages :

- a linguistic base as shown by the structure of the professional expressions themselves;
- an epistemological base: everybody can agree with the specific-difference definition where concept A is concept B with the specific difference d;
- no multiple hierarchy and therefore no problem of inheritance of different values;
- sound logical properties which are exploited during the building of ontology;

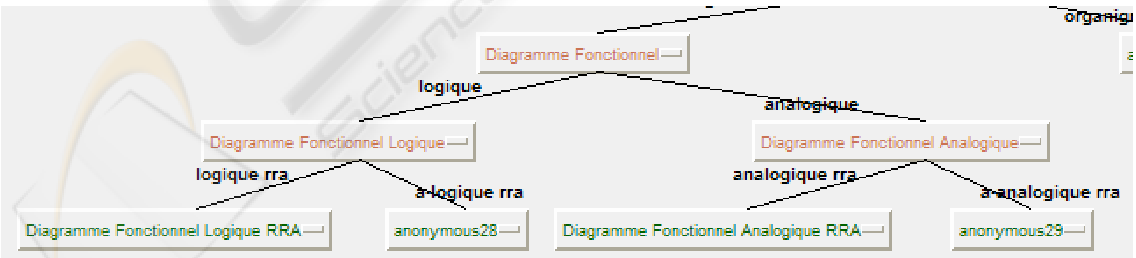
last but not least, the agreement problem is reduced to the sole problem of agreement on the terms that denote differences. It is all the simpler since the application field is technical.

3.3 Ontological indexing and retrieval

We have already seen that ontologies may be used to model and capitalise on professional concepts for which it is possible to define the terminology for the field in a precise, consistent and consensual manner.

Ontologies may also be used to index all documents on the field to such concepts for the purposes of training but also for finding information.

We have therefore created, after defining the ontology of the Logic Diagrams Designers of 900 MW Relay circuits, an experimental software environment devoted to terminology on the one hand and business concepts and, on the other to the search for and navigation through documents that refer to such concepts. The figures below illustrate some of the functions of the software environment accessible on the EDF intranet.



Functional diagram

Logic *analogue*

Logic Functional Diagram *Analogue Functional Diagram*

Rra logic *rra a-logic* *rra analogue* *rra a-analogue*

RRA Functional Logic Diagram *anonymous28* *RRA Analogue Functional Diagram* *anonymous29*

Figure 1: Example of an ontology

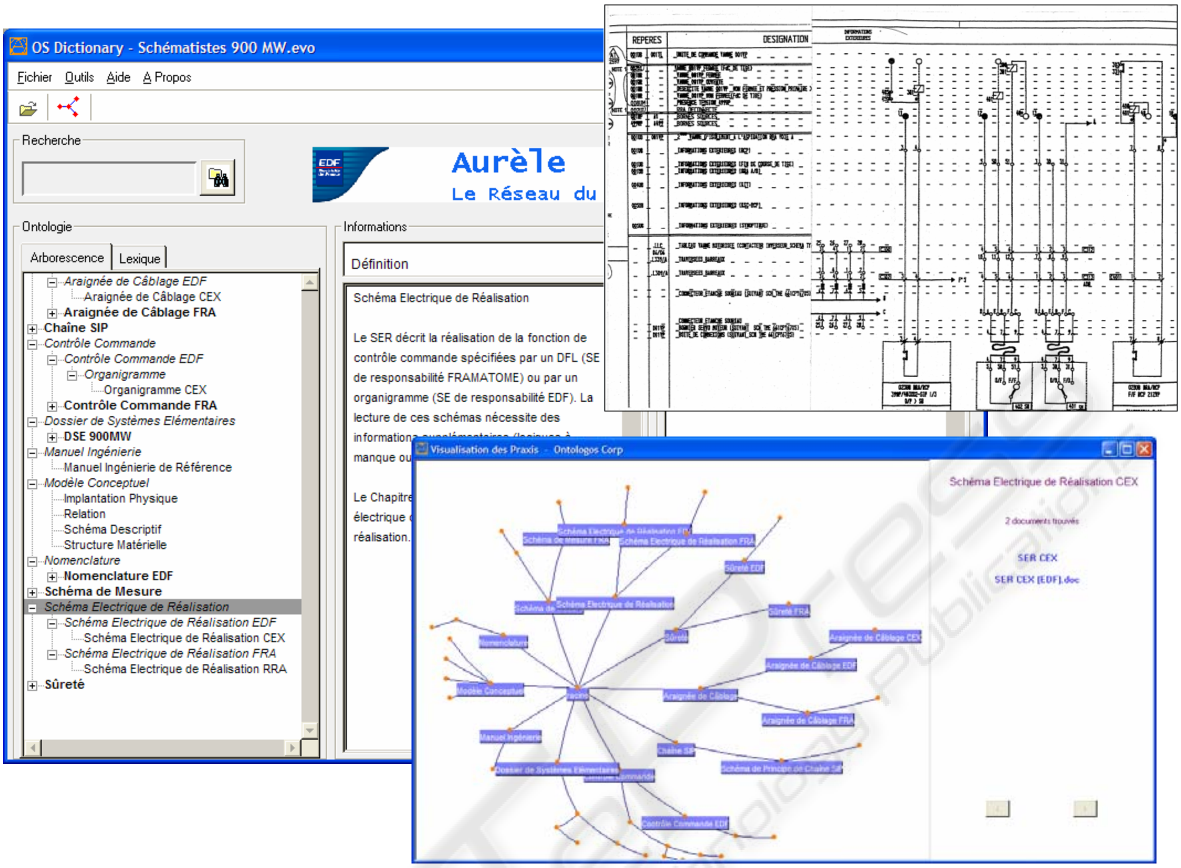


Figure 2: Some of the functions of the software environment

4 CONCLUSION: CAPITALIZING ON KNOWLEDGE FOR FUTURE GENERATIONS

Overall flow is created step by step by creating exchanges which progress from exchanges based on documents, photographs, glossary to achieve a true sharing of knowledge and knowledge of equipment, functional aspects and diagrams.

Our incremental construction approach for a common solution has the advantage of providing for virtually automatic acceptance of the system proposed by all participants and which we have to validate. This approach is modular and provides for the gradual construction of a common reference language.
Ontology is the basis of this language, which enables us to model knowledge of professions involved in relay circuits and to ensure appropriate access to aspects of knowledge, such as documents, diagrams, photographs, training documents… at the same time.

This language shall form the basis for effective communication in a global flow knowledge created by the participation of communities concerned with relay circuits and others who wish to learn.

REFERENCES

Amidon D.M., Formica P., and Mercier-Laurent E. : *Global Knowledge Innovation at work.* (soon)

Ballay J.F. , 1997 : *Capitaliser et transmettre le savoir-faire de l'entreprise*, Editions d'Organisation

Ballay J.F. , 2002 : *Tous managers du savoir !* , Editions d'Organisation

EPRI, December 2002 : Capturing high value undocumented knowledge in the Nuclear Industry. In *Guidelines and methods 1002896 Final report.*

Gruber T., 1995 : Towards principles for the design of ontologies used for knowledge sharing. In: *International Journal of Human Computer Studies*, 43: 907-928