COLLABORATIVE KNOWLEDGE EVALUATION WITH A SEMANTIC WIKI: WIKIDESIGN

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Abstract: We will present in this paper how to ensure a knowledge evaluation and evolution in a knowledge management system by using a Semantic Wiki approach. We describe a Semantic Wiki called WikiDesign which is a component of a Knowledge Management system. Currently WikiDesign is use in engineering department of companies to emphasize technical knowledge. In this paper, we will explain how WikiDesign ensures the reliability of the knowledge base thanks to a knowledge evaluation process. After explaining the interest of the use of semantic wikis in knowledge management approach we describe the architecture of WikiDesign with its semantic functionalities. At the end of the paper, we prove the effectiveness of WikiDesign with a knowledge evaluation example for an industrial project.

1 INTRODUCTION

A wiki is a web site allows collaborative distant creation of information and editing of hypertext content. Leuf (Leuf, 2001) was the first to propose a web site where people could create, modify, transform and link pages all from within their browser and in a very simple way. Indeed Wikis become popular tools for collaboration on the web, and many active online communities employ wikis to exchange information.

Indeed for the most of wikis, public or private, primary goals are to organize the collected information and to share it. Wikis are usually viewed as tools to manage online con-tent in a quick and easy way, by editing some simple syntax known as wikitext (Singh, 2007). Schaffert in (Schaffert, 2006) enumerates the specifications of a wiki system:

- It allows the editing via a browser;
- It has a simplified wiki syntax i.e. simplified hypertext format usable by all the internet users;
- It manages a rollback mechanism i.e. it is able to versioned the changes in the content each time they are stored;
- Its access is unrestricted, everybody can write in the wiki;
- It manages the collaborative editing i.e. if someone create a article, everybody can extend this article;
- It proposes a strong linking, all the pages of the wiki are strongly linked with each other using hyperlinks;
- It has a search function over the content of all pages stored;

It allows the uploading of different content like documents, images or videos. Taking consideration to all these properties, Wikis seem to become a new approach to collaborative knowledge engineering based on social networks of the Web2.0 (Richards, 2009). Indeed new research works (Schaffert, 2006), (Vrandecic, 2006) propose wikis to exchange knowledge. Knowledge is information with a context and value that make it usable. Knowledge is what places someone in the position to perform a particular task by selecting, interpreting and evaluation information de-pending on the context (Malone, 2003), (Volkel, 2006).

However a serious obstacle for the development of Semantic Web applications is the lack of formal ontologies and knowledge. Indeed, one of the main reasons of this is the rather high technical barrier for

using Semantic Web technologies that deters many domain experts from formalizing their knowledge.

In another hand, wiki systems are becoming more and more popular as tools for content and information management. Much information is nowadays available in systems like Wikipedia. Unfortunately, this vast information is not accessible for machines. If a small amount of this information would be formalized to become knowledge, wiki systems could provide improved interfaces and advanced searching and navigation facilities.

Nevertheless, several analyses (Buffa, 2006), (Majchrzac, 2006) of traditional wikis as shown that they are not enough structured, and it's difficult to navigate and to find the relevant information. Besides, the wiki markup language (WikiML) used by most wiki engines makes internet users reluctant to contribute to the wiki.

One solution to perform the knowledge creation, evaluation and navigation inside wikis is to use technologies from the Semantic Web (Aumueller, 2005) to formalized information, content, structures and links in the wiki pages. These Wikis would take consideration of the semantic in their content management and become Semantic Wikis.

"Semantic Wiki" systems aim to combine "traditional" wiki systems with Semantic Technology. This combination bears much potential in many application areas.

Thus we propose to use a Semantic Knowledge Wiki approach to complete our knowledge management system by facilitating the knowledge sharing, updating and evaluation. This article is structured as follows: Section 1 introduces the Semantic Knowledge Wiki concept and describes features which represent advantages for the knowledge management; Section 2 briefly describes the architecture of our Wiki; Section 3 presents a simple application scenario to exploit knowledge and to represent it; Section 4 concludes with some perspectives.

2 WHY USING A SEMANTIC WIKI ON A KM APPROACH

We have developed a Knowledge Management System called StarDesign (Fischer, 2006) allowing capitalizing Knowledge from information shared and used by professional actors all along their engineering projects (Fig. 1). We use a social and cooperative approach in identifying knowledge needed to be capitalized and reused inside the collaboration between actors in project teams. Indeed the study of the professional actors' roles allows getting an organizational model (called OrgaDesign) 0 leading the knowledge capitalization inside professional activities and the knowledge reuse.

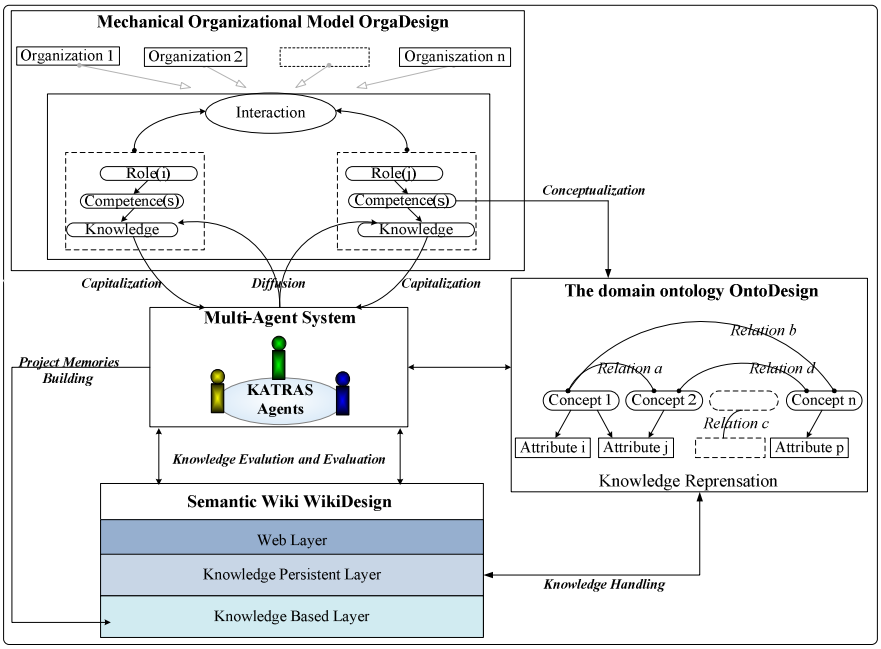

Figure 1: StarDesign: A Knowledge Management Approach

From this knowledge identification we have proposed a knowledge typology with six types (Project Context, Project Evolution, Project Vocabulary, Project Process, Project Rule and Project Experience). This knowledge typology is a result of a collaboration work with several companies (Djaiz, 2008) where project teams have determinate the information they want to capitalize and to reuse all along a project. Thus this typology defines the structure of a project memory.

This work is completed by the definition of a vocabulary and a semantic i.e. a domain ontology. This ontology (called OntoDesign) (Monticolo, 2007) allows to the knowledge management system to structure the knowledge according to the project memory model and to exploit knowledge in line with the actors' needs.

The Knowledge Management System is animated by a Multi Agent System (Monticolo, 2008) capables to lead the knowledge management through the 3 components presented below (OrgaDesign and OntoDesign). Agents are used to manage heterogeneous and distributed information. Moreover they perceive the social structure inside projects with the organizational model. Thus they are able to:

- Identify knowledge to capitalize during the profession-al activities thanks to OrgaDesign;
- Ensure a aided knowledge capitalization all along engineering projects;
- Anticipate knowledge requirements according to the professional roles inside activities.

Therefore the Knowledge Management System create Project Memories where are stored relevant information of a project. This memory is built according to the ontology and is consultable by the professional actors.

StarDesign is used since two years in companies but we have observed that the lack of this Knowledge Management System is that professional actors can read project memories (in html or pdf format) but are not able to modify it. Indeed the system is capable to capture new knowledge during project but not allow the creation of new knowledge from information already stored in project memories. So we have to think about a system which helps professional actors to evaluate, to make evolution or delete knowledge stored from past or current projects. This system will ensure the knowledge evolution in the KM approach.

Thus we propose to use a Semantic Wiki to complete our Knowledge Management Approach in allowing the know-ledge evolution. The next section describes the Semantic Wiki Architecture called WikiDesign.

3 WIKIDESIGN ARCHITECTURE

In this section we detail the architecture of WikiDesign with three layers (Fig. 2): Web Layer, Knowledge Persistent Layer and the Knowledge Base Layer. Each layer communicates with the others through a RDF flow making easy the knowledge diffusion.

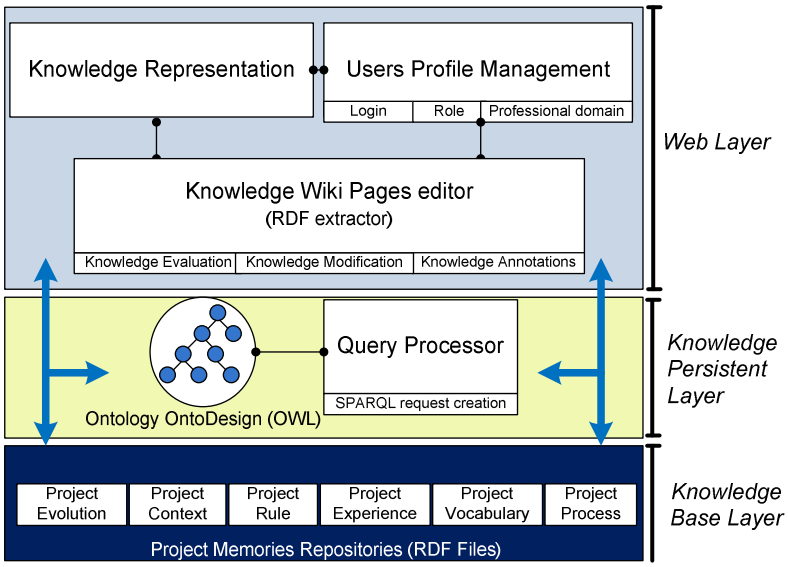

Figure 2: WikiDesign Architecture

3.1 A knowledge base to supply the Wiki

The Knowledge Management System, introduced in the above section, allows maintaining a knowledge base. This base is a part of the semantic Wiki. It is composed by knowledge captured by the Knowledge Management Sys-tem and also by the creation of wiki pages. The base is structured by six types of Knowledge according to the ontology OntoDesign (Table 1).

The Knowledge base is built with the RDF language i.e. it is formed by annotations describing the six types of know-ledge, the context where was captured the knowledge and their authors.

Table 1. Knowledge Types used in the Wiki

Knowledge Type	Knowledge
Project Context	-Knowledge presenting the origin and the organization of the project
Project Evolution	-Knowledge related to the history of the evolution of the project
Project Process	-Knowledge presenting the activities carried out during a project
Project Vocabulary	-Knowledge defining the vocabulary used during the project
Project Rule	-Knowledge related to the professional rules used to develop the product
Project Experience	-Knowledge describing the errors, failures and difficulties in the project

3.2 The Knowledge Persistent Layer

The Knowledge Persistent Layer is based on the domain ontology OntoDesign which define a vocabulary and a semantic of the knowledge used in engineering projects. Up to now this layer accept a unique ontology "OntoDesign". In a future work we will consider the addition of external ontologies. OntoDesign is developed in OWL-DL. This language is based on Description Logics (hence the suffix DL). Description Logics are a decidable fragment of First Order Logic and are therefore amenable to automated reasoning. It is therefore possible to automatically compute the classification hierarchy and check for inconsistencies in an ontology that conforms to OWL-DL.

Consequently, OntoDesign provides an integrated conceptual model for sharing information related to a mechanical design project. An OWL property is a binary relation to relate an OWL Class (Concept in OntoDesign) to another one, or to RDF literals and XML Schema datatypes. For example, the "infoInput" property relates the Document class to the Activity class. Described by these formal, explicit and rich semantics, the domain concept of Activity, its properties and relationships with other concepts can be queried, reasoned or mapped to support the Knowledge sharing across the mechanical design projects.

The Knowledge Persistent Layer is also composed by a Query Processor which allows formulating queries to exploit the knowledge based according to the structure of the ontology. The Query Processor builds queries with the SPARQL language (Seaborne, 2006) in order to exploit the RDF files which composed the knowledge base. We will describe the query process in section 3.

3.3 The Web Layer

WikiDesign allows to relaying semantic tags and navigating functionalities in the wikipages. We have seen that the Knowledge Persistent Layer is composed by a domain ontology OntoDesign which defined a vocabulary and a semantic of the knowledge used in engineering projects. Thanks to the relations in the ontology, WikiDesign is able to automatically tagging keywords in the wikipages. Thus these tags provide to the users, not only a link to wikipages defining the term associated to the tag but also a links to the six types of knowledge associated to this term. The figure 3 shows three knowledge links (Project process, Project Experience and Project Rule) related to the term "hood".

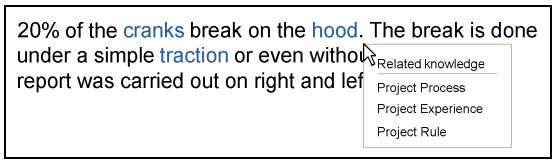

Figure. 3: Example of Knowledge links from a term in WikiDesign

In addition WikiDesign has a Knowledge Wiki Pages editor. A wikipage creator chooses a type of knowledge to classify this article. Each created page is automatically annotated according to its knowledge type. Thus a wikipage is annotated "Project Vocabulary" for the definition of a term,

"Project Process" for the description of a process, etc.

When the wikipage creator has chosen the knowledge type, the Knowledge Wiki Page editor proposes a structuring of the article according to the concepts and sub concepts of the ontology. For example an article describing a project experience is organizing with the tags "Failure, Success or Difficulty", "Description", "cause", "led actions", "consequences", "recommendation".

The structure and the content of the wikipages allow creating the knowledge base according to OntoDesign.

The Web Layer has also a Users Profile Management module where user can create and refine their profile. To be a creator user has to create a new profile. In this profile they can define the different roles they have in a project or their professional domains. According to this information, Wi-kiDesign propose to a user, when he is connected, a selec-tion of wikipages created by other users and related to his profile.

3.4 Interface

WikiDesign uses a browser-based interface. A search page view is shown in Figure 4. From keywords the users request the knowledge base. The users have the possibility in this interface to orient their search by knowledge types or projects. The list of articles (wikipages) is generated in the same page. Each result corresponds to a wikipage and has a evaluation according to its maturity (number of stars describing the number of evaluations) and its percent of positive evaluation.

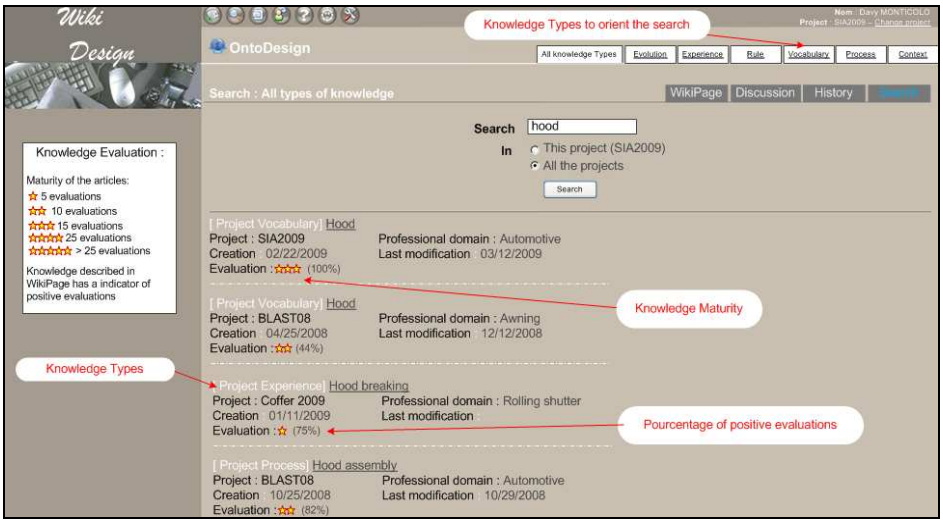

Figure. 4: WikiDesign interface

3.4 Collaborative Knowledge Evaluation

Inside WikiDesign, knowledge is subjected to an evaluation process by the professional actors. An actor can modify or accept an article i.e. knowledge related to the wikipage. Thus, when a user approves or modifies an article, he as-signs a positive evaluation for this article. Moreover when he refuses, the article obtains a negative evaluation. Wiki-Design allows calculating the knowledge maturity by posi-tioning a percentage of positive evaluation and a number of stars. Thus knowledge which has just been created has one hundred percent of positive evaluation. Progressively with the evaluations attributed by users, the percentage can decrease if the article obtains negative evaluations. In addition knowledge which has a score in lower than twenty five percent of positive evaluation, it is deleted in the knowledge base. Indeed the system is able to automatically delete knowledge which is become obsolete or is not a consensus inside the community of experts. Thus the knowledge evaluation ensures the reliability of the shared information in the company.

4 EXPLOITING SEMANTICS AND KNOWLEDGE REPRESENTATION

4.1 Browsing

There are two types of Wikis users; the readers and the creators. The first one use the elements stored in the know-ledge base to search pertinent information and the second one creates new wikipages.
The readers have access to the knowledge of a project or from several projects. The knowledge representation is structured according to the six different knowledge types described in the table1. A reader uses a keyword to apply a research. He has the possibility to choose answers from knowledge stored in the current project or for all the projects. The navigation in WikiDesign is made by a click on a term which takes along the reader to the wikipage related to this term (knowledge of the type Project Vocabulary). The other way to navigate in WikiDesign is to use a right click on a term which presents the knowledge types related to the term. Each associated knowledge type leads to one or several wikipages. For example in the figure 2, we have a knowledge type 'Project Experience' related to the term 'Hood' and this type leads to four wikipages describing four project experiences implying a hood.

4.2 Querying

As shown in Figure 1, WikiDesign has a semantic search engine for querying and reasoning on the knowledge base. This query processor used the Jena API. Jena allows loading ontological models in OWL or RDFS format and man-ages the SPARQL language. SPARQL may become a W3C recommendation to query RDF. It is based on a boolean combination of triples that can be constrained by evaluable expressions. It is also processes datatyped RDF literals, optional properties, alternatives and the named graph scheme of SPARQL using a source statement. It returns an RDF/XML graph or an XML binding format. The bindings are available through an API. SPARQL provides the select, distinct, sort and an equivalent of limit statements.
The Knowledge Persistent Layer module allows building queries according to the keywords posted by the wiki readers. The readers can oriented his requests on the knowledge stored in the current project or in all the projects. The Fig. 5 described a classical query to research knowledge associated to the keyword "Hood" in the current project "SIA".

```
PREFIX OntoDesign: <http://acsp.utbm.fr/OntoDesign.owl>
SELECT  xml ?Vocabulary, ?Experience, ?Rule, ?Process, ?Context, ?Evolution
WHERE
 { ?Terme  rdf :Type OntoDesign:Vocabulary "Hood"
           Union
   ?Projet  rdf :Type OntoDesign:Projet "SIA"
 }
```

Figure 5: Example of request generated by the Knowledge Persistent Layer

The readers have the possibility to refine their requests according to the names of the projects, the roles of the professional actors, the knowledge types, etc.

5 WIKIDESIGN FUNCTIONALITIES

All the knowledge inside the wikipages of WikiDesign is annoted in RDF according to the ontology OntoDesign. These annotations bring information about the type of knowledge, the authors, the project, etc. Thus the ontology makes the inherent structure of the wiki. Moreover the annotations facilitate the navigation between wikipages thanks to the links defined in the ontology. We describe in this section the advantages of WikiDesign.

5.1 Typing/Annoting of links

Like we have seen below, WikiDesign allows annotatating links by giving them certain types defined in the ontology OntoDesign. Thus a link created by a user almost always carries meaning beyond mere navigation. WikiDesign manages annotations in its Web Layer. Each WikiPage is annotated as soon as a user (creator) as defined the content related to a knowledge type.

5.2 Context-Aware Presentation

WikiDesign can change the way content is presented based on semantic annotations. This includes enriching pages by displaying of semantically related pages in a separate link box, displaying of information that can be derived from the underlying knowledge base. Thus a wikipage defining a professional term i.e. knowledge related to the type 'Project Vocabulary' is automatically

associated to others wikipages corresponding to others knowledge types (Project Experience, Project Process, etc.). For example the wikipage defining the term 'Hood' is automatically associated to wikipages describing the experiences associated to a hood. These relations are deduced from the ontology.

5.3 Enhanced Navigation

Knowledge types facilitate annotated links and provide more information for navigation. Whereas a traditional wiki only allows following a link, WikiDesign offers additional information about the relation the link describes.
For example WikiDesign propose to the creator of the wikipages to define the semantic links with the relation defined in the ontology. For example a wikipage about a assembly process of a hood can have some links categorised by "has synonymous", "has design rule", etc.
Such information can be used to offer additional or more efficient navigation.

5.4 Semantic Search

WikiDesign allows a "semantic search" on the underlying RDF knowledge base. As described above, queries are expressed in the language SPARQL, a query language recently proposed as W3C recommendation for RDF querying. Using "semantic search", users can ask queries like "retrieve all component composed a hood" or "retrieve all Processes and experiences associated to a hood".

5.5 Reasoning Support

Reasoning means deriving additional, implicit knowledge from the facts entered into the system using predefined or user-defined rules in the knowledge base. For example, from the fact that "a hood" is a part of a "rolling shutter", WikiDesign is capable of reasoning and could deduce that "hood" is a "Component" of the assembly processes of a rulling shutter. Although reasoning is an important feature which helps readers to understand the links between knowledge in the wikipages.

6 PERFORMANCE ASSESSMENT

6.1 Adhesion of the professional actors

Since 2002 the managers of the Zurfluh-Feller company have tried to set up a knowledge management program. The first tool to share and reuse information was a document management platform, giving access to project information and the ability to easily structure and share content in using repertories by professional fields. In each repertory, actors were able to add comments corresponding to a document. The comments explain the origin of the document (authors, aims, etc.) After several projects engineers don't take time to put and arrange documents of their projects and the majority of the comments were empty. After several debates with the professional actors, we have concluded that they don't use this system because they were sure that the documents and their comments were not read by others. Indeed the system doesn't give them a feedback or an interaction with the others. In conclusion the system didn't allow managing information in a collaborative way.

After using our knowledge management system (Star Design with WikiDesign) since almost two years and during several projects, the project teams explain that this new system has two advantages:

- The capability to capitalize knowledge in semi-automatic way (thanks to the multi-agent system of StarDesign) and to make reusable it in a easy way (thanks to a research based on the six knowledge types) inside WiIkiDesign;
- The possibility to make evolve knowledge in collaborative way, inside the wiki, by interacting with all the experts of the company.

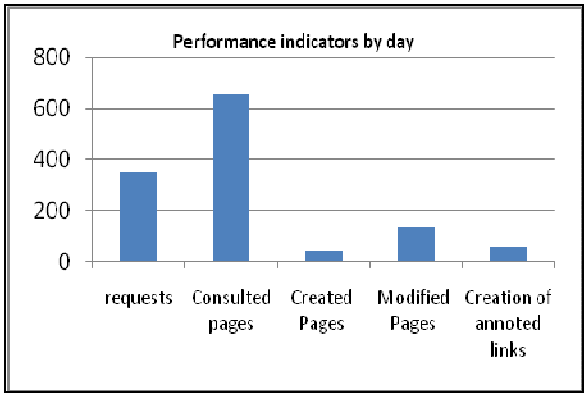

Figure 6: Performance indicators for WikiDesign

In exploiting the indicators of WikiDesign (number of connected people) and after a survey in the Research and Development department of the company (42 engineers and technicians) we have

observed that 96% of the professional actors take time to research information in WikiDesign and 82% use to create or modify articles.

In the case of the SIA2009 project (figure 6), we have noted that 56 articles was created automatically in WikiDesign by the software agents. Among these 56 pages, 28 were evaluated and\or modified to enrich the information by professional actors and 17 new articles were posted for this project.

7 RELATED SEMANTIC WIKIS

Since 2004 with the development of *Platypus Wiki (Campanini 2004)* , many semantic wikis have been created (*Rhizonne Wiki*, *SweetWiki*, *MaknaWiki* (Dello, 2006), *IkeWiki*(Schaffert, 2006), *OntoWiki* (Aumueller, 2005), *Shawn*, *Rise* (Decker, 2005), *Semantic MediaWiki* (Krotsch, 2007), *WikSar* 0) and provide the capability to edit RDF content like WikiDesign. All the semantic wikis quoted above are built according to the "wikitology" model 0 i.e. they consider wiki pages as concepts and typed links (in the page content). In these approaches the architecture of the wiki composed the ontology.

WikiDesign was designed differently. It use a ontology to the editing of page content and metadata as well as page tagging like only SweetWiki and IkeWiki make it. Nevertheless, differently of these two semantic wikis, WikiDesign was created to be complementary to a knowledge management system and to facilitate the evaluation and the creation of new knowledge from existing project memories. WikiDesign uses a domain ontology (OntoDesign) to edit its pages. Indeed each wiki page is editing according to the relation defined in the ontology. Moreover WikiDesign provides an navigation between its pages in proposing tags (figure 3) according to the knowledge typology described in OntoDesign.

WikiDesign also provide a framework based on the Jena Api to manage the OWL ontology language and a system uses a reasoning engine in its knowledge persistent layer (fig. 2). Even if WikiDesign does not employ a complete OWL reasoner, it provides partial reasoning support to structure wiki content and to browse data. Finally, semantic WikiDesign appears to be the only wiki which proposes a knowledge evaluation to users to ensure the reliability of the information content. Moreover WikiDesign are associated to a knowledge management system to enrich and initialize its knowledge base.

3 PERSPECTIVES AND CONCLUSION

In this article, we have presented WikiDesign, a feature-rich semantic wiki system which complete our knowledge management approach by evaluating and creating new knowledge with pertinent links.

The StarDesign knowledge management approach with WikiDesign is currently used in several engineering design departments in different companies. This approach gives good results because professional actors appreciate to use WikiDesign to share information. WikiDesign seems to provide a good framework to evaluate and to create knowledge in an easy way.

Now, future directions for the evolution of WikiDesign might be to provide more support to knowledge creation in using several ontologies. The system has to provide support for inferencing or ontology import i.e. it has to allow users to import data from external ontologies and exploits schema data to provide editing support.

We are currently working on how to merge several domain ontologies to propose more possibilities to create semantic links or to perform the semantic search engine of WikiDesign.

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