Wiki-I: A Semantic Wiki to Support the Ideas Development and Knowledge Sharing in Innovation Activities

Davy Monticolo, Laure Morel, Vincent Boly, Inaya lahoud

Abstract— **We will present in this paper how to ensure the creation and the validation of idea by using a Semantic Wiki approach. We describe the system called Wiki-I which is used by engineers to allow them to formalize their ideas during the research solutions activities. Wiki-I is based on an ontology about the innovation domain which allows to structure the wiki pages and to store the knowledge posted by the engineers. In this paper, we will explain how Wiki-I ensures the reliability of the innovative ideas base create from the Wiki thanks to a idea evaluation process. After explaining the interest of the use of semantic wikis in innovation management approach we describe the architecture of Wiki-I with its semantic functionalities. At the end of the paper, we prove the effectiveness of Wiki-I with a ideas evaluation example in the case of a students challenge for innovation.**

Index Terms— **Semantic Wiki for Innovation, Innovation Ontology, Ideas base for innovation.**

I. Introduction

THERE is abundance definitions of the innovation. "Inovations are qualitatively new products or processes, which distinguish themselves significantly from previous ones". Innovation concerns R&D, product and service development. Armbrustera in [1] distinguishes four different types of innovation: technical product innovations, non-technical service innovations, technical process innovations, and non-technical process innovations, understood to be organizational innovations.

Innovation is an approach to create value by solving problems. Creativity is a prerequisite for problem-solving and can be applied in several times during a product development process. But creativity in an innovation process is not enough to develop a new innovating product or service [14]. The results of the creativity need to be store into a framework which ensures that the development of the solution will be used them [33], [9]. In this paper we propose to organize, to annotate and store the ideas resulting from the creativities activities by using a semantic Wiki.

Moreover in an innovation process, knowledge about the definition of the new product (problem), about the market, about the new technologies or the industrial processes and about the evolution of our cultures have to be managed to make innovation a learning and prioritization process [20]. [19] explains that the knowledge management is a key factor of the innovation process. In this paper we will describe how the Semantic Wiki using a innovation ontology allow to develop the creativity of the engineers through idea cards and allows to build a innovative ideas base.

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II. Why using a Semantic Wiki to support the innovation process

A wiki is a web site allows collaborative distant creation of information and editing of hypertext content. Leuf & Cunningham [18] were 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 be-come 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 content in a quick and easy way, by editing some simple syntax known as wikitext [29]. Schaffert [27] 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 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 [25]. Indeed new research works [27],[32] propose wikis to exchange knowledge. Knowledge is information with a context and value that make it usable.

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Knowledge is what places someone in the position to perform a particular task by selecting, interpreting and evaluation information de-pending on the context [22] ,[31].

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 [6], [32] of traditional wikis as shown that they are not enough structured, and it's difficult to navigate and to find the relevant information. Be-sides, the wiki markup language (WikiML) used by most wiki engines makes internet users reluctant to contribute to the wiki. One solution to perform the ideas creation, evaluation and navigation inside wikis is to use technologies from the Semantic Web [2] 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 Innovation Wiki approach to propose a system to facilitate the creativity and to formalize ideas in the innovation activities by facilitating the knowledge sharing, updating and evaluation.

III. WIKI-I ARCHITECTURE

In this section we detail the architecture of Wiki-I with three layers (Fig. 1): 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.

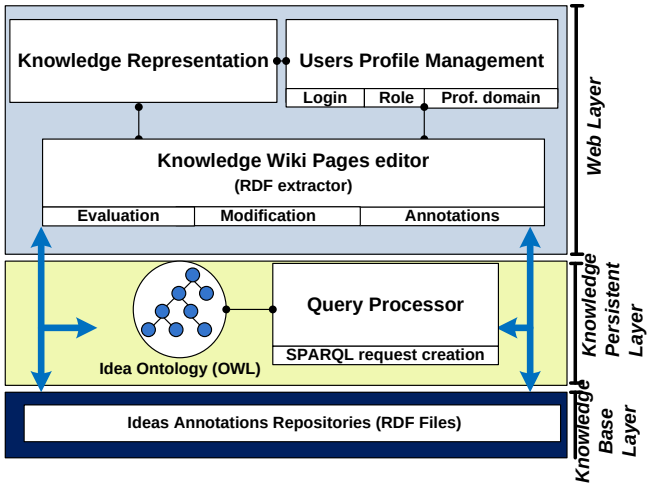

Figure. 1: Wiki-I architecture

The Knowledge Persistent Layer is based on the Idea ontology proposed by Riedl [26] about the innovation domain which defines a vocabulary and a semantic of the knowledge used in innovation ideas. The ontology 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, the Idea ontology provides an integrated conceptual model for sharing information related to an innovative idea.

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 [28] in order to exploit the RDF files which composed the knowledge base. We will describe the query process in section 3.

A. The Knowledge Persistent Layer

The Knowledge Persistent Layer is based on the domain ontology Idea which describes all the concepts used in a new innovative idea. The Idea ontology 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, the Idea Ontology 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 ideas sharing across the Semanic Wiki.

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 [28] in order to exploit the RDF files which composed the knowledge base. We will describe the query process in section 3.

B. The Web Layer

Wiki-I allows to relaying semantic tags and navigating functionalities in the wikipages. We have seen that the Knowledge Persistent Layer is composed by the Idea ontology which defined a vocabulary and a semantic of the Idea created in the research activities. Thanks to the relations in the ontology, Wiki-I 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 types of ideas

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origins associated to this term. The figure 2 shows three ideas origin links (Process, Technology, …) related to the term "hood".

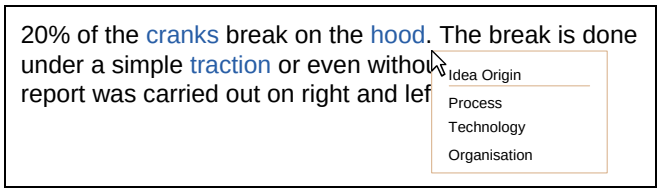

Figure. 2: Example of Knowledge links from a term in Wiki-I

In addition Wiki-I has an Idea Wiki Pages editor. The editor proposes a structure of the article according to the concepts and sub concepts of the ontology. For example an article describing a idea is organizing with the tags "Idea Origin", "What the Idea is usefull for", "Individuals or Sturcture involved in the development", "Advantages", "Limitation""impact", etc.

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-ki-I proposes to a user, when he is connected, a selection of wikipages created by other users and related to his profile.

C. Interface

Wiki-I uses a browser-based interface. A search page view is shown in Figure 3. From keywords the users request the Innovative ideas base. The list of articles (wikipages) is generated in the same page. Each result corresponds to a wikipage and has an evaluation according to its maturity (number of stars describing the number of evaluations) and its percent of positive evaluation.

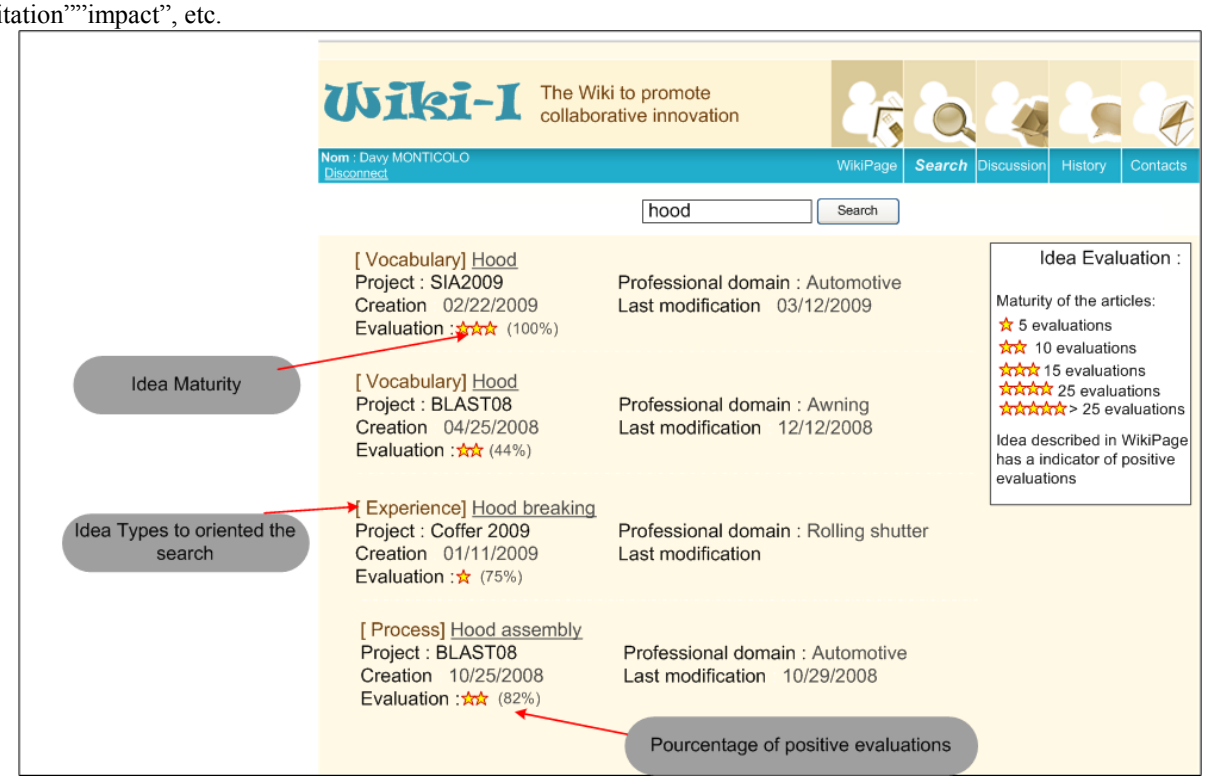

Figure. 3: Wiki-I interface

D. Collaborative Knowledge Evaluation

Inside Wiki-I, 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 assigns a positive evaluation for this article. Moreover when he refuses, the article obtains a negative evaluation. Wiki-I allows calculating the knowledge maturity by positioning 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 idea which has a score in lower than twenty five percent of positive evaluation, it is deleted in the innovative idea base. Indeed the system is able to automatically delete ideas which are become obsolete or are not a consensus inside the community of experts.

IV. Exploiting Semantics and Knowledge Representation

A. Browsing

There are two types of Wikis users; the readers and the creators. The first one use the elements stored in the knowledge base to search pertinent information and the second one creates new wikipages.

The readers have access to the ideas. A reader uses a keyword to apply a research. The navigation in Wiki-I is made by a click on a idea which takes along the reader to the wikipage related to this idea. The other way to navigate in Wiki-I is to use a right click on a term which presents the knowledge types related to the term. Each associated idea

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leads to one or several wikipages. For example in the figure3, we have a idea type 'technology', 'organization' and 'process' related to the term 'Hood' and this type leads to four wikipages describing four different ideas implying a hood.

B. 4.2 Querying

As shown in Figure 1, Wiki-I 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 ideas stored in the innovative ideas base. The Fig. 4 described a classical query to research ideas associated to the keyword "Hood".

```
PREFIX OntoDesign: <http://www.ensgsi.fr/DM/OntoIdea.owl>
SELECT  xml ?Technology, ?Process, ?Organization
WHERE
 { ?Idea  rdf :Type OntoIdea:Name "Hood"
   Union
   ?IdeaOrigin  rdf :Type OntoIdea:origin "Technology"  }
```

Figure 4: Example of request generated by the Knowledge Persistent Layer

The readers have the possibility to refine their requests according to the ideas and the origin of the idea.

V. Wiki-I Functionalities

All the knowledge inside the wikipages of Wiki-I is annotated in RDF according to the idea ontology. 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 Wiki-I.

A. 5.1 Typing/Annotating of links

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

B. 5.2 Context-Aware Presentation

Wiki-I 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 idea related to a new technology is automatically associated to others wikipages corresponding to others ideas related to technological innovation.

C. 5.3 Enhanced Navigation

Ideas types facilitate annotated links and provide more information for navigation. Whereas a traditional wiki only allows following a link, Wiki-I offers additional information about the relation the link describes.

For example Wiki-I 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 impact", etc.

Such information can be used to offer additional or more efficient navigation.

D. 5.4 Semantic Search

Wiki-I 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 process innovation concerning a hood".

VI. Performance Assessment

A. 6.1 Adhesion of the students

Since 2008, we organize in our university the innovation challenge "48 hours to create Ideas". In this challenge 500 students all over the world have to generate ideas to response to a industrial question like "what will be the glasses of the future" or "how to link generation with mobile phone". After generating ideas the students use Wiki-I to store and to share their ideas.

After the students have explained that this new system has two advantages:

- The capability to capitalize ideas and to annotate them in semi-automatic way and to make them reusable it in a easy way (thanks to a research based on the ideas types) inside WiIki-I;
- The possibility to make evolve Ideas in collaborative way, inside the wiki, by interacting with all the others students.

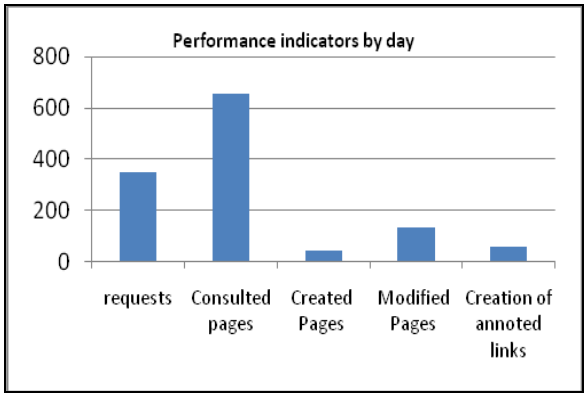

Figure 5: Performance indicators for Wiki-I

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In the case of the innovation challenge in 2011 (figure 5), we have noted that during the 48 hours, 876 ideas (articles) was created in Wiki-I by the software agents. Among these 876 pages, 430 were evaluated and\or modified to enrich the root idea by students or professional actors.

VII. Perspectives and conclusion

In this article, we have presented Wiki-I, a feature-rich semantic wiki allowing to create and evaluate new innovative ideas with pertinent links.

Wiki-I is currently used in several universities to support innovation challenge. The students, professors and proessional actors use Wiki-I to share innovative ideas. Wiki-I seems to provide a good framework to evaluate and to create new Innovative ideas in an easy way.

Now, future directions for the evolution of Wiki-I might be to provide more support to Idea 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. Thus the system will be able to understand the knowledge about a new innovative product, process or technology and not only an idea.

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 Wiki-I.

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