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Reusing knowledge based on ontology and organizational model

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Abstract

The work presented in this paper is related to knowledge management during the design process of mechanical products. More exactly, we are concentrating on the knowledge reuse process. We propose a knowledge reuse system (KRS) based on two approaches. Namely, an organizational approach and a modeling user approach. Both are ontology-based models. Our system takes into account, the actors' *roles* (by the organizational approach), their *preferences* (by the model user approach), and their *collaboration* throughout the product design process in order to help designers to get knowledge that is considered the most relevant in all the phases of the product design process.

Peer-review under responsibility of KES International.

Keywords: Knowledge management; reuse process; ontology; organizational approach; user modeling Introduction

1. Introduction

In an economic environment more competitive and changing, some companies, on one side, cannot face this instability and they eventually disappear. Others, on the other side, are taking advantage of these difficult circumstances to improve their position through a good control of their future. Companies need to be reactive to ensure their sustainability. This sustainability is conditioned by an effective knowledge management. Therefore, knowledge management is required in all ambitious companies. Organizations are more and more driven to improve their profitability and to better adapt themselves to the frequent changes of the customers 'needs. One of the main difficulties that meets companies today is how : « to give the best information to the right person, at the right time to make the right decision»[10]. This can be solved through a good knowledge management. This discipline is

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generally defined as "The set of organized activities that company realizes to obtain a bigger value of the knowledge that it has"[3].

In this work, we are interested in the knowledge reuse process in order to help actors by providing the most relevant knowledge during the achievement of a design activity. An effective knowledge management avoids redoing the same errors, and reduces the time dedicated to the fulfilment of the activities[2]. The problem is not the availability of information, but its relevance to the specific user's needs derived from his preferences[1]. The user model provides better management of intellectual capital via the personalization of the knowledge management system' responses. The goal of this work is to propose a knowledge reuse system in mechanical product design projects, based on the integration of both user and organizational models. This paper is organized as follows: section 2 introduces the background used in this work. Section 3 describes our reusing knowledge approach. Preliminary experimental results are presented in section 4. In section 5, we give an overview of related work and we conclude by stating the main research ideas and future research directions.

2. Background

2.1. Meta-Model RIOCK (organizational model)

In engineering design projects, business actors work together for a common goal. That's why, they must use and share their knowledge to accomplish the tasks in order to achieve that goal. For this reason, our knowledge cartography is based on Monticolo's research work[9]. The organizational model proposed by Monticolo[9] takes into account the social and cooperative nature of the design process through the representation of actors' roles, their knowledge and their interactions during designing activities.

This model represents a guide for capitalization and reuse knowledge in design projects. It is based on the meta-model RIO[7] with its essential concepts: Role, Interaction and Organization. Thus, the organizational model, position for each knowledge shared and used by the actors, an organizational context, in which it was created.

The meta-model RIO does not allow the explicit representation of the competences and the knowledge used by the role when they interact with the other roles in the same organization.

The meta-model proposed by Monticolo[2,9] includes two other concepts: competence and knowledge defined as follows:

- Competence: ability to make implementation expertise.
- Knowledge: Interpretation of information in a specific context.

Figure 1 shows an example of RIOCK model. In the activity (i.e. Organization) 'Requirements analysis' we observe two roles. The role 'Technical assistant' uses one of its competences; we read it like *the capability to* 'Formalize the customer requirements'. This competence requires one element of Knowledge that is used to satisfy the organization. In the RIOCK diagram the type of knowledge is read like *Knowledge on*, for example the role 'Technical assistant' possesses the Knowledge on 'Customer requirements'.

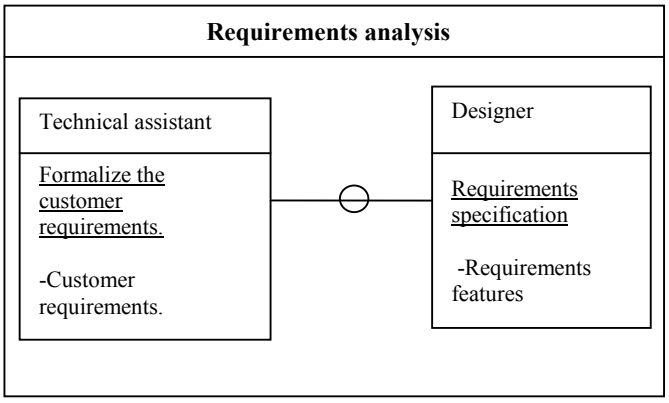

Fig. 1. RIOCK model for the activity "Requirements analysis".

2.2. Project memory model

The project memory is defined as follows: "An explicit and persistent representation and indexation of knowledge and information in an organization, in order to facilitate their access, sharing and reuse by the members of the organization for their collective or individual tasks"[4].

We used a project memory to store and represent the knowledge used by business actors. The proposed memory project supplies a frame for the indexation of knowledge to be archived during designing project process.

3. Proposed reuse approach

In the context of this work, we developed a KRS that proposes mechanisms to help the actor by reusing the knowledge shared within an organization. Indeed, the proposed system assists the actor during the project design by integrating the user's preferences into the knowledge reuse process. The system is developed with: java as programming language; NetBeans as IDE and the ontology is created by Protégé Editor.

3.1. Building the ontology

The Ontology is used to provide a shared conceptualization of knowledge between humans and software. Ontology allows better representing and indexing the knowledge that contributes to a better knowledge reuse. The use of ontology seems to be the key technology to encourage the knowledge reuse and the shared understanding among organization's members.

We built our domain ontology that is shown in figure 2.The first step of the knowledge reuse process aims to define the concepts, attributes and relationships between them. This leads to build the ontology which allows handling knowledge.

Our developed ontology takes into account the organizational aspect through the actors' roles modelling, also, the user model via the modelling of his preferences.

The figure 2 below shows an excerpt of our proposed ontology. This passage highlight the combination between the two models (organizational and preferences).

As shown in this ontology, the design process is composed of four phases: feasibility study, preliminary study, detailed study and industrialization. Each phase is composed of activities. Each activity is realized by business actors, requires tool and Raw material and delivers an element which has technical parameters and which is part of the product.

The proposed ontology includes concepts related to (1) user preference modelling: preferences-oriented project. For example: the user is interested in the projects produced in France and dated from the year 2005 to the year 2010. Also, preferences- oriented product. For example: the user is interested in the products which belong to the category four wheels, with more than 10 000 cost €.

It also includes organizational modelling (2) concepts. For example: process design, phases, activities, roles, etc. The table below shows some concepts of our ontology.

Knowledge described in the organizational model and in the user preferences are presented throw Concepts, attributes and relationships in the ontology. Based on the organizational model, the KRS extract knowledge from the ontology deduced from the user's role and activity and filters it thanks to the user preferences.

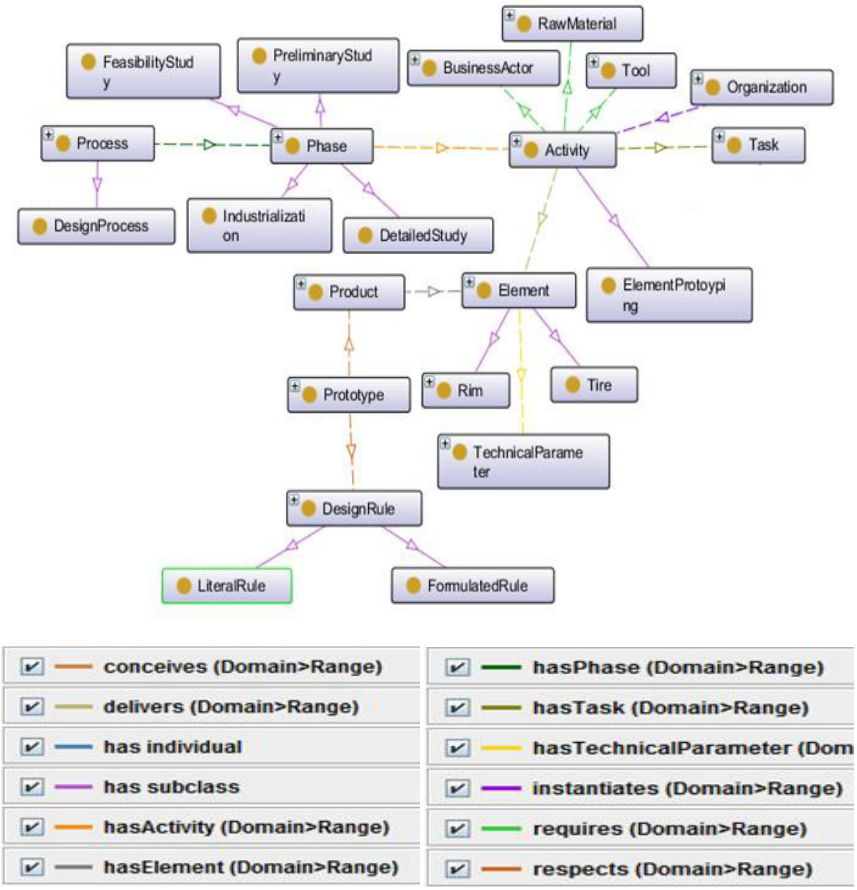

Fig. 2. Excerpt of the proposed ontology.

Table 1. Some concepts of the proposed ontology.

term	**Concepts**		
	Concept ID	***Parent ID***	***Definition in natural language***
process	process	----	The process in question
Phases	Phases	process	Phases of a process
Activities	Activities	phases	
Role	Role	Activities	Roles associated for each activity

3.2. User model approach

The user model integrated into a KRS, takes into account the characteristics of users and their needs in order to filter knowledge through various criteria that correspond at best to user's needs.

User modelling is a key element in the KM. Indeed, by focusing on individuals, it is possible to build and maintain a useful description of a user's preferences. These features can be used by the system to improve the assistance to this user[11].

It aims to model the user in order to personalize the system responses. This is designed, as ontological concepts, to facilitate the process of filtering, which is to extract the relevant knowledge from a large body of knowledge.

The modelling of user preferences is an essential element in the development of the knowledge reuse system whose efficiency strongly depends on the accuracy of these preferences.

The system interrogates the ontology to extract the knowledge from it corresponding to these preferences (Figure 3):

- Preferences oriented project (date; country).
- Preferences oriented product (category; cost).

We obtain results refined by eliminating a large part of the knowledge that do not answer the user's preferences.

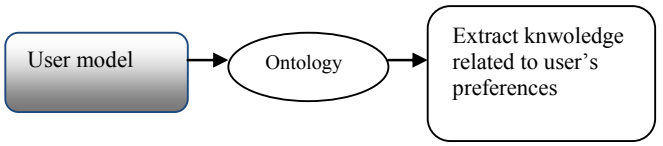

Fig. 3. User model.

3.3. Organizational approach

Once the system, based on its user model, presents the list of the projects and the products, according to the user's preferences, the organizational model detects the organizational knowledge relative to the actor and to the project in question. For that reason, the organizational model queries the ontology to extract this knowledge from it.

It determines for every knowledge (Figure 4)

- The business activity in which it was used.
- The role of the actor which uses this knowledge.
- The roles of the actors with whom this knowledge was shared.

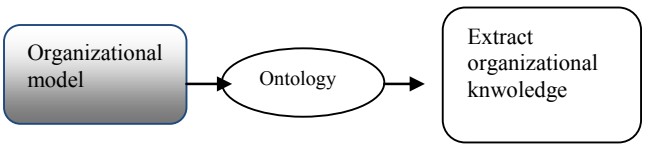

Fig. 4. Organizational model.

In the User Profile approch the the KRS interrogates concepts related to the user's profile in the ontology. However, In the organizational approch the KRS interrogates knowledge described in the organizational model. The user model takes into account the user's preferences and the organizational model contains knowledge required from the business actor to realise the activity.

3.4. PUSH: Proposes the relevant knowledge to the user

According to our approach, the reuse process (PUSH) is made based on the organizational model and the user model (Figure 5). The knowledge extracted from these two models will be exploited in order to extract the most relevant knowledge which answers at the same time the preferences of the user and his role within the organization.

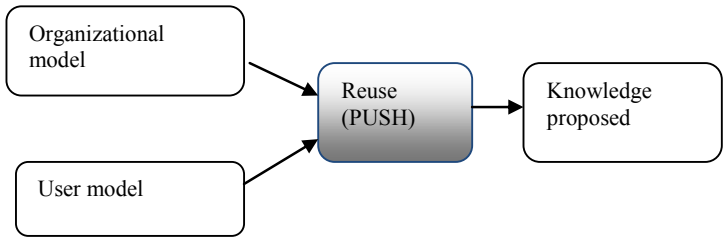

Fig 5. Reuse knowledge (PUSH).

An example of a Sparql query is presented below. It searches the attribute's list of the concept Requirements (presented in the Sparql query by "hasnamerequirement") and based on user's preferences (presented by "pref" in the Sparql query)

```
PREFIX pref: <http://www.owl-
ontologies.com/Ontology1333637453.owl#>

                SELECT ?y

                 WHERE {

                ?processus pref:hasnameactivite \"" +
activitesproposes.getSelectedItem().toString() + "\"."

                 ?processus pref:hasrole ?role

                { ?role pref:hasnamerole \"" + rool + "\"."   }

                { ?role pref:answers ?x  }

                 { ?role pref:answers ?x  }

                ?x pref:hasnamerequirement ?y }
```

As a result of the Sparql query the user receives a help window which provides him with knowledge in need. Figure 6 shows a portion of the push interface that presents an example of how the knowledge is proposed. By the way, the help concerns also the list of the projects that correspond to the user's preferences, the list of activities in which the user is participating, the list of the technical parameters for each element, the functions of each concept

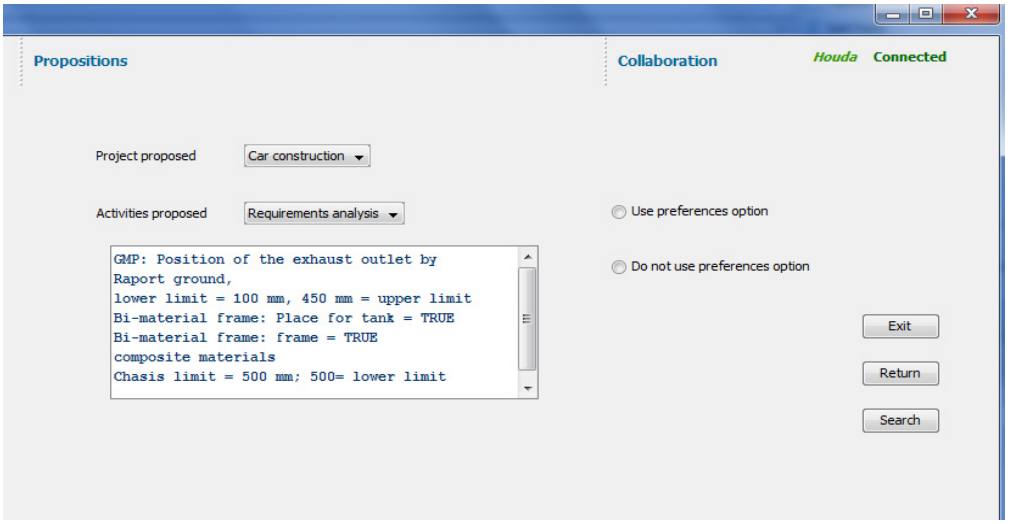

Fig. 6. The help window proposed to the user.

By the way, the help concerns also the list of the product's elements, the list of the technical parameters for each element, functions of each concept etc.

The user can take into account this help and realizes the current activity using the proposed knowledge and can also ignore it.

3.5. PULL: Personalized search for knowledge

We propose a personalized search that suggest to the user, the terms to look for. Once the actor seizes a letter in the field of research, he obtains automatically suggestions of terms that can be looked for. This suggestion is based on the organizational model and the user model. He obtains the knowledge connected to this term filtered according to his role and his activity in the organizational model also according to his preferences in the user model Suggested terms: This suggestion is based on the model user (Figure 7). The terms proposed are mainly related to the user's interests. For example, if the actor is interested in products belonging to category four wheels, the terms suggested for this kind of product are the elements like Body, GMP, chassis etc.

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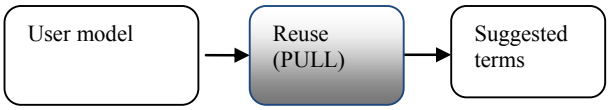

Fig 7. Reuse knowledge (PULL) : Suggested terms

Suggested knowledge: the suggestion of the knowledge is based on the organizational model. The returned knowledge is filtered according to the activity in which the actor participates, as well as his role within the organization, as the figure 8 below shows.

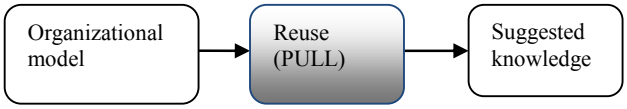

Fig. 8. Reuse knowledge (PULL)

3.6. Collaboration

Our system holds on account of the social and collaborative aspects of the actors. It is in this optic that is situated the objective of the collaboration's module. It is based on the organizational model to deduct the roles which are in interaction with the role in question. Afterward, the module of collaboration interrogates the ontology and extracts the list of the knowledge of the roles in interaction, as well as the list of the knowledge shared between these last ones, in other words, the knowledge resulted from the interaction between these roles, as the figure 9 below shows.

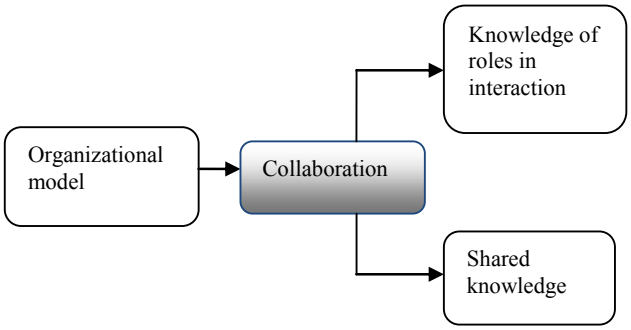

Fig 9. Collaboration.

4. Experiments

Experiments have been performed by 42 Students by filling questionnaires with some specific questions such as: Is the suggestion provided is relevant, what are suggestions really exploited in your project, in which phase this suggestion was used etc. The students attributed a note between 0 and 5 for each phase (No benefit, Small benefit, Moderate benefit, Large benefit, Very large benefit, Extraordinary benefit). The more the note is raised, the more the proposed suggestions are relevant and were used. The results extracted from the questionnaires are presented in Figure 10. This figure shows that the proposed suggestions are mostly used during the first two phases. This can be explained by the lack of information about product to be developed.

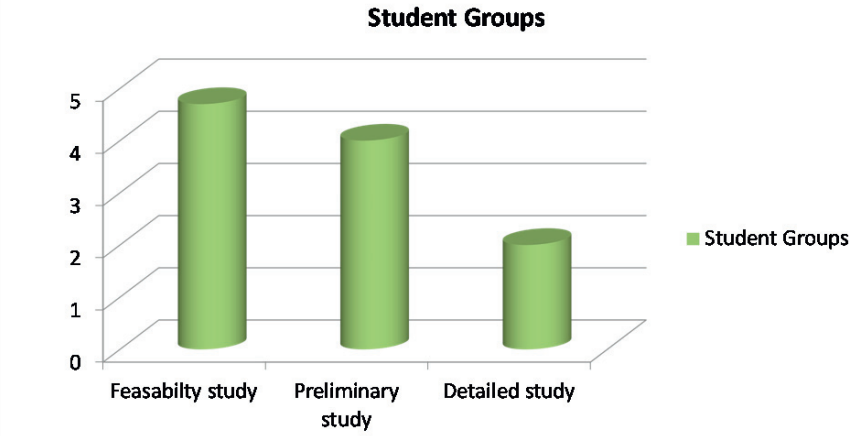

Fig. 10. Suggestions use per phase

Some limitations are reported by students during the experiments and will be taken into consideration to enhance the framework and its supported tool. For example, most of students highlighted that the tool does not allow managing knowledge for the activities which are not described in the Ontology. Indeed, certain students do not want to limit themselves to the usual activities of the product design process. This establishes one of the major limits of the tool. These limitations constitute our ongoing work.

5. Related work

Knowledge reuse is based on the interpretation of the user's needs in a given context. The reuse process is crucial for the organization because it determines the performance of the whole knowledge management process[6].

Existent knowledge management systems have adopted different models such as the organizational model[2-5-9] to identify organization's knowledge. Monticolo[9] presents an organizational approach to design KMS ontology-based. This approach contributes, essentially, to knowledge capitalization process. The organizational model proposed by Monticolo et al.[9] focuses on the social and cooperative aspects of the design process. The system proposed by[2] providing knowledge to the actors by exploiting their roles within the organization. We are based on Benmiled[2] to implement the reuse process. However, [2-9] are based only on the organizational modeling. The user model such as [8-11] in order to integrate the user's preferences in the reuse process, to filter and detect the appropriate knowledge to return. We had concentrated mainly on these two models.

Letizia[8] is a KMS that helps user to search on the internet which contributes to the knowledge reuse process. It is based on the user model. Onto-logging[11] is a web-oriented system based on the user model. Indeed, user's preferences are designed as ontological concepts.

Compared to all these works, our approach differs fundamentally by the combination of the two models (organizational and user model) which allows the user to receive knowledge that is the most relevant based not only on his role but also on his preferences.

To summarize, our goal is to propose a model to implement the knowledge reuse process, taking into account user's preferences on the one hand, and user's roles on the other hand.

6. Conclusion

In this paper, we presented an analysis of the proposed system by bringing to light its objectives and its main mechanisms of functioning. Our contribution focuses particularly on the reuse process.

The proposed system assists the actor during the design project of the mechanical products by joining the preferences of the user in the knowledge reuse process.

Our approach is mainly based on the creation of an ontology which brings to light the organizational aspect and the modeling user aspect.

The interest to join the user model, is to personalize the answers of the system to refine and filter the detected knowledge and then, propose them to the actor what brings to improve the reuse process.

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