CONSTRUCTING MODEL OF KNOWLEDGE BASE ACCORDING TO MOKA METHODOLOGY

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Summary

The paper presents the structure of a model and the experience of model constructing according to MOKA methodology. The modeling process covers ontology creation of two parts of a model: formal and informal in Protégé-OWL system. Informal model is used for knowledge acquisition for the purpose of knowledge base creation for a Knowledge Based System. Interface of this part of a model are ICARE forms. Formal model includes target domain relations and ontology. Thus, the formal model orders ontology of informal model and defines fully the domain of a given knowledge base. The model has been tested in designing process of a group of machines and can be used in different phases of Knowledge Based System, first of all in designing but also in operation and maintenance. The model includes ontology for products and processes and complex relations between model elements require the usage of advanced tools such as Protégé-OWL for the purpose of model creation.

Keywords: Knowledge Based Engineering, Ontology, OWL, MOKA.

BUDOWANIE MODELU BAZY WIEDZY ZGODNEGO Z METODOLOGIĄ MOKA

Streszczenie

W artykule przedstawiono strukturę modelu oraz doświadczenia z budowy modelu zgodnego z metodologia MOKA. Proces modelowania obejmuje budowę ontologii w systemie Protégé-OWL dwóch części modelu: nieformalnego i formalnego. Model nieformalny służy do pozyskiwania wiedzy do celów budowy bazy wiedzy dla systemu opartego na wiedzy a zewnętrznym interfejsem tej części modelu są formularze ICARE. Natomiast model formalny zawiera docelowe relacje i słownik ontologii. Model formalny porządkuje więc ontologie modelu nieformalnego i definiuje w pełni dziedzinę zadanej bazy wiedzy. Model był testowany w procesie projektowo-konstrukcyjnym i może być stosowany w różnych fazach procesu tworzenia systemu opartego na wiedzy przede wszystkim w zakresie projektowania I konstruowania ale także w dziedzinie eksploatacji. Model zawiera ontologię dla produktów i procesów a złożone relacje między elementami modelu wymagają stosowania do budowy tego modelu zaawansowanych narzędzi budowy ontologii jakim jest Protégé-OWL.

Słowa kluczowe: Projektowanie oparte na wiedzy, ontologia, OWL, MOKA.

INTRODUCTION

MOKA methodology [8] (Methodology for Knowledge Base Engineering Applications) is a complex methodology which was published in 2001. It was made as a result of European Project aiming at elaboration of methodology for Knowledge Based Engineering - KBE. Among other methodologies [1], [5], [9] of creating Knowledge Based Systems it differs from others that it has specific domain of Knowledge Based System which is designing.

This methodology is the first widely spread solution facilitating in a complex way creation of KBE Applications. It covers first of all three most important phases of KBE system development:

- knowledge acquisition,
- knowledge formalization,
- creation of KBE applications.

One of the essential achievements of this methodology is ontology creation for designing domain, covering designed product as well as designing processes. In bibliographies [8] resulting from MOKA project the models are described as UML [10] (Unified Modeling Language) models and MML [8] (MOKA Modeling Language) which is a form of UML language, defined as UML language profile.

Despite the fact that UML language is commonly known and there is a great number of tools for modeling with the aid of this language, these tools are not aimed at solving problems connected with systems based on knowledge. Main usage of this language covers general modeling of environment requirements and issues connected with application modeling (CASE – Computer-Aided Software Engineering). It is favorable for broad usage of the methodology in practice to transfer ontology to

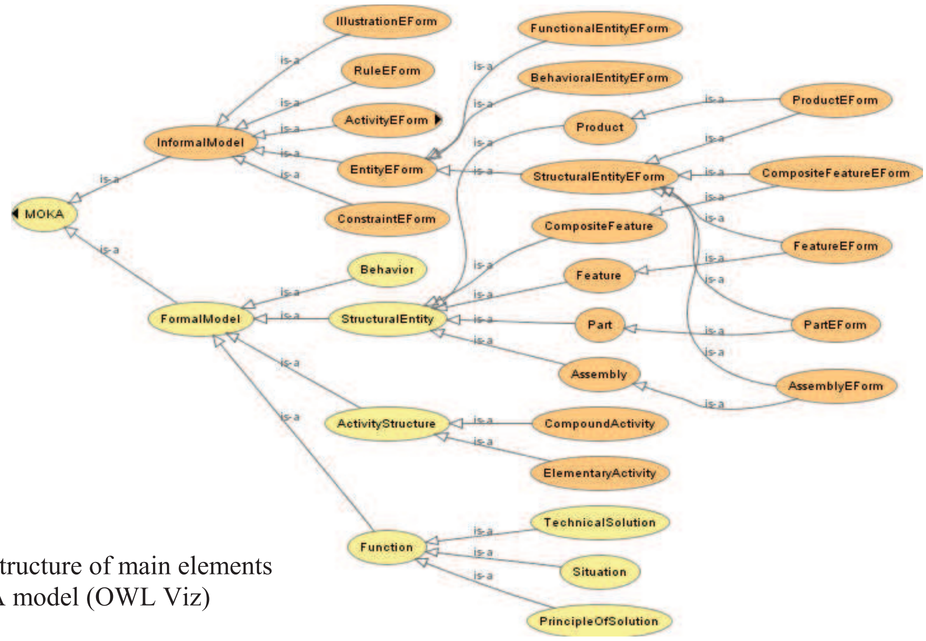

Fig.1. The structure of main elements of MOKA model (OWL Viz)

a commonly used format of ontology record and use popular tool which aids knowledge base creation and Knowledge Base Systems. Protégé [3], with formal language OWL [11] (Web Ontology Language), which is one of the newest formal languages of ontology record, fulfills these criteria

2. CONSTRUCTING MOKA MODEL USING PROTÉGÉ

Main elements of MOKA model designed in Protégé system has been presented in Fig.1. Original nomenclature of MOKA system has not been preserved as a whole due to specific model structure. In Protégé system the whole model constitutes one coherent namespace, which is not congruent with MOKa model where there are a few namespaces. It results in a names conflict because in each space a name must be unique. Although in Protégé system it is possible to create separate namespaces and to import them, it causes additional problems and therefore, it has been decided to change names of some ontology elements as opposed to MOKA pattern. It is not the only change since some other changes have been introduced to the designed model. Majority of them have been forced by the change of representation from UML (MML) to OWL, however, some extra changes resulting from the target usage of methodology have been added.

The main structure of MOKA model has been preserved and consists of two parts *InformalModel* and *FormalModel* represented in a system as classes, with *InformalModel* being defined class whereas *FormalModel* primitive class. *InformalModel* has five subclasses which form the most important tools of knowledge acquisition process. In MOKA model they are called *ICARE Forms* because they create forms for five categories of knowledge acquisition (**I**llustration, **C**onstraint, **A**ctivity, **R**ule, **E**ntity).

Due to the above mentioned conflict of names their notions have been changed by *EForm* sufix. In MOKA originally the forms have been given freedom in relation to formal model which played a role of a formal knowledge base for direct creation of KBE system. In the elaborated model the formal relations control the elements of ICARE forms and thus additional relations between formal and informal model are formed. In the further development of the model it should facilitate automatic creation of KBE system with the usage of CATIA system. For that purpose in the next phase it has been planned to develop the existing model with aspects connected with modeling in CATIA system and in particular Generative Model creation [6, 7].

For the created model it has turned out that the relations of *StructuralEntity* and *ActivityStructure* class and their subclasses are the most important. Relations from *StructuralEntity* subclasses control conceptually complex dependencies for product structure, reflecting them in forms, *ProductEForm*, *AssemblyEForm*, *PartEForm*, *FeatureEForm* and *CompositeFeatureEform*.

As refers to relations from *ActivityStructure* class they control relations of *ActivityEForm* subclass, whereas *Behavior* and *Function* classes of formal model there is no need for these relations between formal and informal model to exist.

Additionally, apart from the above mentioned classes of formal model there are *Technology* and *Representation* classes in MOKA. Since they have relatively little influence on target KBE system (Generative model), it has been chosen to leave them out in this model, concentrating on general problems of product structure and designing process. The product representation model (*Representation* class) in MOKA is very general and of signal character. For the purpose of representation in CATIA system it is necessary to elaborate

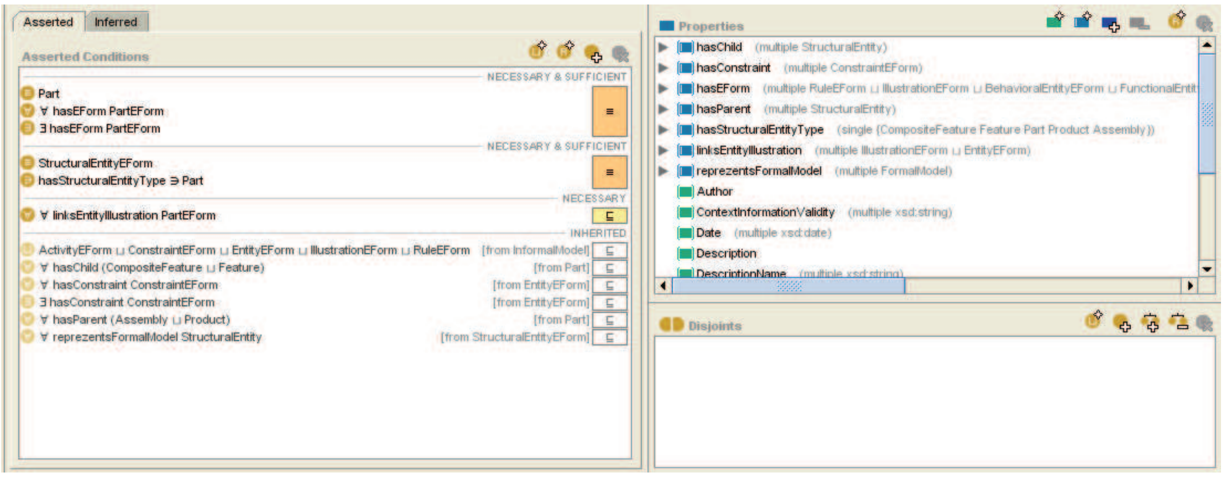

Fig. 2. Conditions and features defining *Part* class

separate detailed formal model of high degree of complexity.

Global structure of class is only a tip of dependencies defined in a model. For each class a number of properties are defined (Fig. 2). These are properties of two kinds: object properties and data type properties. The first ones can be put in a hierarchy. They are not the only ones of defining properties but these two types are of the greatest importance while defining classes. Moreover, conditions are added to classes and there are two kinds of conditions: asserted and inferred.

Conditions can be divided to groups:

- necessary and sufficient,
- necessary,
- inherited.

The first group is important for including a class to defined category. Conditions define a domain in a very detailed way and the range of class properties. Additionally, class resolution can be determined in a given class group. In a formal OWL record it is important since its fundamental assumption is open world assumption (OWA) [2]. Therefore, special attention must be paid to defining closure restrictions of sets of value ranges accepted by class properties. In some complex cases it can be helpful to declare class disjoints.

3. AN EXAMPLE OF KNOWLEDGE BASE ACCORDING TO DESCRIBED MOKA MODEL (PROTÉGÉ-OWL)

Purposely, MOKA model after the changes are introduced or the model reconstructed is aimed to be used for creation of KBE system with the use of Knowledgeware tools or VB programming [13] in CATIA system. However, up till now the model has been verified in creation of knowledge base for a group of devices using a system of a bolt-nut connection for creating lifting forces or pressure/thrust (screw lift and fly press) (Fig. 3)

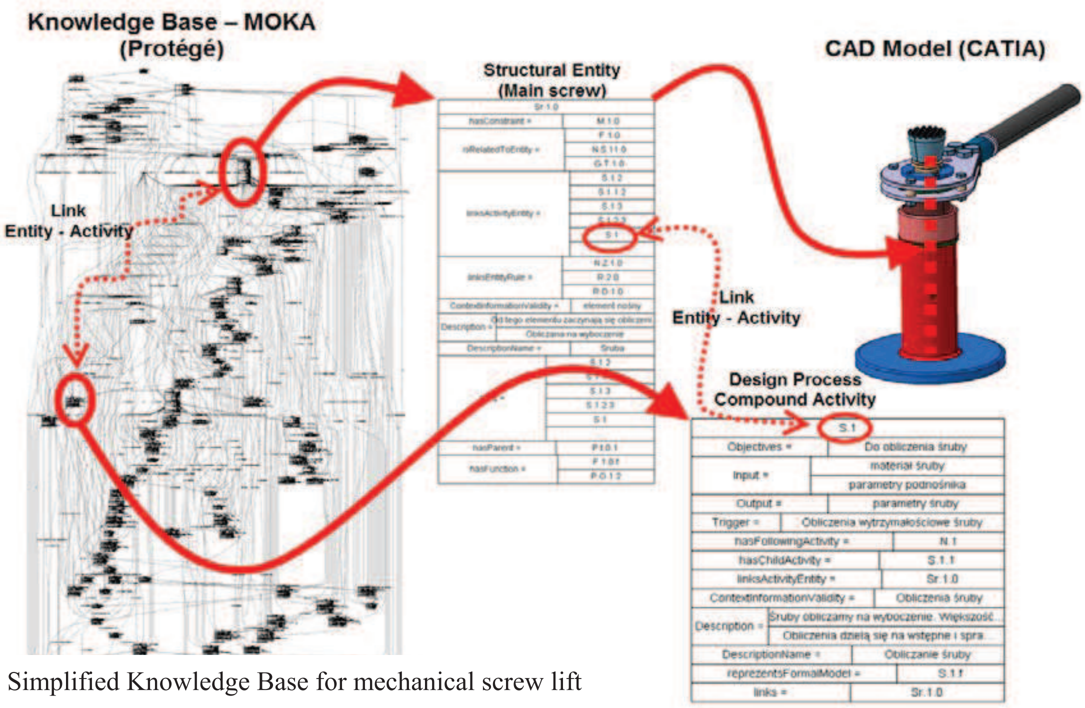

Fig. 3. Simplified Knowledge Base for mechanical screw lift

Due to knowledge base complexity it is not possible to present here the whole knowledge base even for so simple tools. Nevertheless Protégé system has tools which facilitate work with so complex knowledge bases as e.g. graphical representation of a net of relations, contextual functions facilitating recognition and getting to suitable elements of base and the most important – possibilities resulting from formal semantics of OWL and logical relations of ontology- reasoning which consists in generation of new relations between ontology elements derived from logical consequences of ontology in a form of inferred relations (taxonomy classification).

4. CONCLUSIONS

Creation of a model which is compatible with MOKA methodology in Protégé system and OWL language forms a very complex task. Similar task e.g. transferring CommonKADS methodology to Protégé system [4] also indicates high degree of complexity. Because of changes in model format it is not possible to reflect precisely the original MOKA model in Protégé system. UML model and graphical representation of this model has a more user friendly form. However, the lack of tools which would service UML for knowledge acquisition resulted in the choice of Protégé-OWL system. This system is very useful for ontology creation, complex interface requires an experienced designer in knowledge base or knowledge engineer. MOKA system built in Protégé system is very suitable for creation of knowledge bases connected with designing process. The construction of a system based on knowledge with the use of MOKA methodology as well as CATIA system necessitates considerable changes in MOKA model, especially in the aspect of using Generative Model [6], [7] and automation [12], [13] of its creation.

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