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COMPARATIVE SYNTHESIS BETWEEN STEP AND MOKA METHODOLOGIES AND NEW PROPOSAL FOR THE SCOPE OF MANUFACTURING AND INSPECTION PROCESSES.

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Abstract: *During the last decades computer assisted systems applied to manufacturing have evolved in a constant way. Among other reasons, evolution has come by the necessity of using more and more information when going from the data era, through the information era towards the knowledge era. Along this evolution, several standards and modeling methodologies have been generated with direct application to the manufacturing context. However, there is an excess of methods and languages to elicitate, capture and represent the information and knowledge that produces a sense of lack of integration and coordination among them. In this paper, a comparative synthesis of two well-known methodologies of wide industrial acceptance is done. These are the STEP methodology and the MOKA methodology.*
Key words: *MOKA, KBE, STEP*

1. INTRODUCTION

During the last years several methodologies have been developed to capture and formalize the knowledge associated to processes in diverse contexts of application. Some of these methodologies can be considered of general application and, therefore, they lack of concretion and are vague, while others are for application in a low-level and their concretion is clearer. For example, many researchers have looked for general methods to represent any type of knowledge. These initiatives are those that have given place to the growth of the KBS systems (Knowledge Based Systems). These general systems present a key characteristic: the marked gap between the knowledge and the manner in which it is processed. In other words, it is possible to maintain the objects knowledge (facts, data, product knowledge) independent from the knowledge related to the process of their transformation (activity flow, process models). However, other initiatives were developed with the objective of focusing in particular aspects. These methodologies are referred as KBE systems (Knowledge Based Engineering) and they are of special interest for this work.

On the other hand, during the last years efforts have also been increased to integrate all the information generated along the product life cycle, so that it can be shared and transferred quickly and efficiently (Nassehi et al., 2007; Xu & Newman, 2006; Zha & Du, 2002; Sharka, 2007).

Both research lines are justified for the change that is taking place nowadays from the information era towards the knowledge era (Milton, 2008; La Rocca & Van Tooren, 2007; Ammar et al., 2008; Preston et al., 2005). For many authors information and knowledge are two different items, but from a practical point of view they have much in common, because “knowledge is information in a context” and, therefore, both can be considered together.

Diverse methods and modeling tools have arisen from several initiatives related to both researching lines, which in many cases are superimposed. Although the underlying philosophy intended to follow is an integration of information and knowledge, however in the development roadmap and tools of some of these methodologies this philosophy based on common approaches is not applied.

To illustrate this fact, in this paper two well-known methodologies are analyzed, each one related to one of the two cited researching lines, that is, information management and knowledge management. The modeling tools used for both methodologies are analyzed and interrelation spaces are defined, which could serve as a good integration point to propose a sole integrative methodology. In particular, the methodologies analyzed are STEP standard (ISO10303) and MOKA methodology.

2. STEP DESCRIPTION

The most important characteristic of this standard is that it provides a method for the modeling and exchange of information throughout the entire life cycle of a product. There are two kinds of information models in STEP:

1. Resource information models: these represent the conceptual view. They are “integrated resources” which can be used by several applications and they are composed of object classes with attributes and constraints.
2. Application protocols (AP): they represent the external view and provide information in a specific application domain, such as draughting, surface geometry for mechanical design, etc.

There is another layer besides the conceptual and the external views. It is the internal view, which is related to implementation methods of the conceptual schema as a computer file system.

In this paper only the application protocol (AP) development is considered, since it is the final and applicative element of the development chain.

3. MOKA DESCRIPTION

MOKA stands for “Methodology and Tools Oriented to Knowledge based engineering Applications”. MOKA provides an architecture or infrastructure to represent and store knowledge. The infrastructure works at two levels: 1) the first one represents a simple informal level oriented to "experts with scarce formation in technologies of information"; 2) the second level is more formal to store and handling the knowledge.

The first level is referred as Informal Model and it classifies the knowledge in five classes: Illustrations, Constraints, Activities, Rules and Entities. These forms contain the description of the knowledge for the KBE application.

The second layer of MOKA is the Formal Model. It represents the translation of ICARE forms to a UML representation. The objective of the Formal Model is to provide precise meta-models using the MML language, which is an extension of UML. The stereotypes used are very similar to those provided by STEP in its integrated resources.

The Formal Model is constituted by two key elements: a) the Product Model (PM) and b) the Design Process Model (DPM). The PM meta-model provides an infrastructure for structural decomposition, representation, functionality, behavior, manufacturing and material. It is divided in five views: Structure, Function, Behavior, Representation and Technology. These views are built as UML and MML class diagrams. The DPM includes the global strategy, the flow of the process and links to the PM. It is mainly based on UML/MML Activity Diagrams.

4. COMMON ELEMENTS, PROPOSALS AND CONCLUSIONS

Once objectives, views and tools in both methodologies are analyzed, it can be concluded that there are several aspects where integration could be possible.

4.1 With regard to the levels of abstraction

STEP works at three levels: conceptual, external and internal views. The external view (APs) includes two particularization levels: the reference view and the interpreted view. The reference view includes the AAM and a first model in EXPRESS/EXPRESS-G using the terminology of the domain (ARM model). This reference view can be divided again in other more particular views using the concept of "Schema". The interpreted view includes the use of integrated resources in EXPRESS format. This model is understandable by computers to be processed for its implementation (AIM model). The internal view includes the implementation methods for the AIM model. STEP provides links to programming languages and interchange formats (C, C++, Java, XML).

With regard to MOKA, it also works at two levels: Informal Model and Formal Model. However, it does not offer elements to define the implementation view for the formal model, since it considers that models are neutral in format. However, it considers XML plus DTD as basis for knowledge transference between KBE platforms. Figure 1 shows a comparative among the views and meta-models proposed by both methodologies.

This figure shows that MOKA Informal Model is equivalent conceptually to the AAM and ARM of STEP. The Informal Model and the ARM model must be comprehensible for the domain expert, but the ARM model is more formal that the ICARE forms proposed by MOKA. Also, STEP manage the information in Units of Functionality (UoF) and makes use of the "Schema" concept for grouping entities, whereas MOKA organizes the knowledge in Units of Knowledge (UoK), two different ways of considering the same concept. (knowledge is information in a context).

The figure also shows that the Formal Model of MOKA is equivalent to the AIM model of STEP. The objective of both is to define a formalized model to be interpretable for computers, although it loses understanding for the domain expert. Both models use meta-models close to programming languages. However, in the case of the AIM the domain semantic is lost since it uses neutral terms. Stereotypes included in the five views of the PM of MOKA have correspondence with the AIM through the Integrated Resources that it uses. A direct equivalence could be done.

<table>
<tr><th colspan="3">STEP</th><th colspan="3">MOKA</th></tr>
<tr><td>Conceptual (IR)</td><td colspan="2">Integrated resources</td><td colspan="3">No tiene equivalencia</td></tr>
<tr><td rowspan="2">External (APs)</td><td rowspan="2">Reference view</td><td>AAM</td><td colspan="3" rowspan="2">Informal Model (ICARE forms) - UoK</td></tr>
<tr><td>ARM- UoF</td></tr>
<tr><td rowspan="2"></td><td rowspan="2">Interpreted view</td><td rowspan="2">AIM (meta-modelos EXPRESS)</td><td rowspan="2">Formal Model (meta-modelos UML/MML)</td><td>Product Model (PM)</td><td>- Structure
- Function
- Behaviour
- Representation
- Technology</td></tr>
<tr><td>Process Model (DPM)</td><td></td></tr>
<tr><td>Internal</td><td colspan="2">Interface to C++, Java, XML,..</td><td colspan="3">Not defined but XML as basis</td></tr>
</table>

Fig. 1. Comparative of views in STEP vs MOKA

4.2 With regard to the modeling tools

Hierarchical diagrams, process diagrams and user graphics are used in the MOKA Informal Model, without indication of specific graphic modeling languages. STEP outlines the use of IDEF0 modeling language for the AAM and the use of EXPRESS-G. It could be possible to use IDEF0 to model processes, to use user graphics as output from ICARE forms and later on EXPRESS-G for the most formal modeling. This would lead to a better integration with the STEP framework.

UML Class Diagrams are used in the MOKA Informal Model for the PM and UML/MML Diagrams of activities for the DPM. STEP does not consider diagrams for process modeling; it only make use of EXPRESS EXPRESS-G languages. It would be interesting to establish a direct relationship between UML and EXPRESS diagrams, since the last one is more formal and complete.

Mapping tables are used in STEP to flow from the ARM to the AIM. However, in MOKA the Informal Model is vague and direct rules do not exist to pass to the Formal Model; there are only some advices to transfering the ICARE forms to classes and attributes in UML. The concept of mapping tables can be of utility in MOKA.

MOKA was developed thinking in engineering design and STEP covers the full product life cycle (design, production, inspection, recycling, etc). Some authors have tried to enlarge the application field of MOKA, but their results are not widely accepted. It seems appropriate to extend the MOKA ontology to give support to other activities of the product life cycle in a similar way to STEP.

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