Title:
Points of View Classification: A concept to Manage Knowledge Multi-representation in CAD Models and PDM/PLM Systems

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Introduction:
In order to address the market needs, and in a very strong competitive environment, manufactured products are more and more complex, involving expert knowledge from different domains and businesses. In order to design and manufacture products as quickly as possible, and engage the minimum costs, it is necessary to integrate all the expert knowledge earlier in the design process to make fast and robust decisions. In this vision, integrated design tools are available in order to reuse existing knowledge, elaborate solution concepts, and represent them. In this context, the Digital Mock-up (DMU) plays a central role which constitutes the central and principal element for the experts. However, each one of the experts should have a concept representation adapted to his business expertise. Thus, from a common element (digital mock-up) every expert should have a specific representation of the concept reflecting his knowledge and adapted to it. Often, multi-representation which is managed using a tree form, requires the definition of a hierarchy of different representations available using the concept of reference configuration. This paper proposes a different approach allowing the co-existence of different representations of the same technological concept, in an independent, flexible and extensible way. Points of view classification based on a "view management model" is used to manage knowledge multi-representation into the global data model in the digital mock-up.

CAD and PDM/PLM multi-representation:
Each expert needs a representation of the product and its related information and knowledge. In this way, geometric models evolved to integrate more and more domain knowledge, especially through knowledge management modules. PDM/PLM tools (Product Data Management) enable collaboration and co-construction of knowledge. Then, allow the establishment of shared, parameterized and scalable models, integrating more and more information about physical behaviour.
The data management tools (PDM/PLM), enables the management of the evolving models through the designing process, the management of the diversity of the product, and the multi-representation using the configuration concept. However, the systems are still very rigid and complex to handle, particularly the configuration concept. Indeed, it answers simultaneously the problems of design process dynamic management (effectiveness, phasing), product diversity management (options, alternatives), lifecycle management, context evolution (substitute products) and multi-representation management (different configurations of the same product corresponding to different business views). The tree description of configurations (shown in Figure 1) requires, for their management, the definition of a configuration

reference, and from that point, the identification of the derived configurations. This leads to the identification of the reference configuration data as the basis, common to all other configurations. This work is usually tedious and difficult. It can also be questioned and challenged at any time if a new configuration is to develop, which can change the definition of the reference configuration.

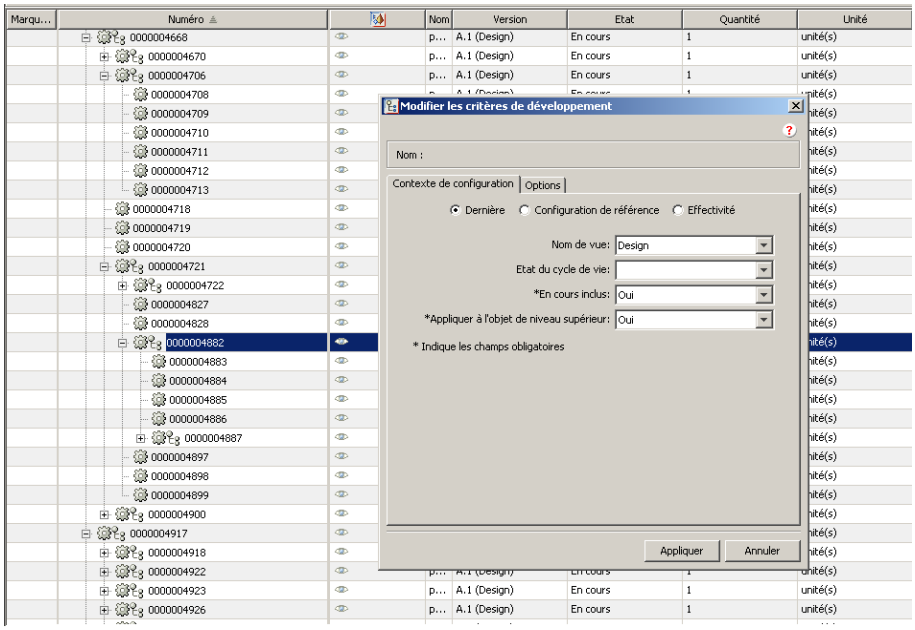

Fig. 1: Extraction parameters of a bill of material from a defined configuration in a PDM/PLM system.

Some research works proposed approaches based on the concept of inheritance to manage multiple knowledge representation. They specify a central model, with high levels of abstraction, allowing interoperability and consistency management into the digital model [2] with associated processes and organizations [7]. However, these models are still based on the description of data trees, limiting the extension to new areas of the representation using abstract classes.

Some other research works on CAD models, allows the translation from one CAD model to another one with different domain knowledge and perspective. They are based on heavy geometrical algorithms leading to long processing time, and the loss of models associativity necessary to changes management [3]. Other research works led to the development of interfaces that allows the annotation of geometrical models in order to generate other models, using data bases of specific geometrical functions and some processing in order to position these functions [6]. In all cases, a first geometrical model is used as a reference from which are derived other models specific to a domain knowledge and perspective, with associativity often based on changes propagation from the reference model, which constraints the generation of the derived models.
Thus, it is important to be able to manage CAD multi-representation in a more flexible and progressive way, and at the same time keep the independence of domain experts in constructing their own representation, and save the association and dependencies between models for changes management.
Managing points of view in the context of use of the digital mock-up is thus, still an important industrial and scientific challenge in order to get more flexibility and scalability.

Information points of view:

Points of view

The definition of points of view varies from one group to another. Some groups see them as a limitation on what the user can legally or contractually see and observe. Some others consider them as separating information into silos, which corresponds to particular expertise knowledge. In this article, the point of view is considered as an extraction from a global data model, or an enlargement using specific informational entities selected in order to obtain a sub-assembly of shared information which is specific, it is a set of entities with a chosen level of granularity and context specific. In other words, a model containing global information about the product, considered as a reference set of information, from which we could extract sub-sets of information and data which represents points of view.
It is possible to predefine points of view, such as the ones in enterprise business modelling (MoDAF and ToGAF [1]). Their goal is to support the descending construction of information (top down approach), in a way that each point of view is relatively independent from the others. The work consists on the isolation of the points of view, which define frontiers without describing information transformation rules between each point of view couple. However, since the business knowledge and expertise is rarely static, and the future need regarding reused information and knowledge is not known, points of view that have been predefined could rapidly become obsolete, since it is related to a well-defined context, and thus could not fit the design activity. Thus, providing a points of view construction process is, more interesting than only providing rigid points of view.
This way, points of view are not considered as the transformation of an existing information, nor the creation of new information, but rather as a way of presenting a complete coherent set of information, by selecting only the ones that are relevant to the context and goal of the design. Thus, the construction of a point of view is essentially an information selection process (Figure 2). Consistency is then carried out by the global set of information relative to the data and information model (in our case the product model), common to all the points of view.

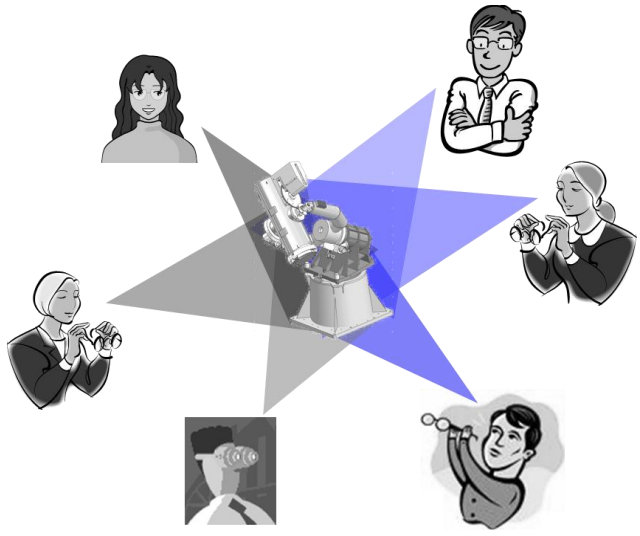

Fig. 2: Points of view defined as a view, and selection of information from a common set.

View manager in a product model context

The main idea behind this paper is that, using this definition of points of view, we develop a system that manages the points of view based on a reference information set which is the product model that gathers information about the product, not only geometrical or topological information, but also specifications, functional and behavioural informations.

In figure 3, we have a model [4] (used as a demonstrating product model), which represents a core basis gathering relevant information and aspects about the product, that can constitute the data structure of a PDM/PLM system. Adding to this model, extensions of information regarding each domain knowledge used in the product development process, the model will be completed and coherent, and at the same time, constitues a solid basis to information representation through different domain models which are connected.

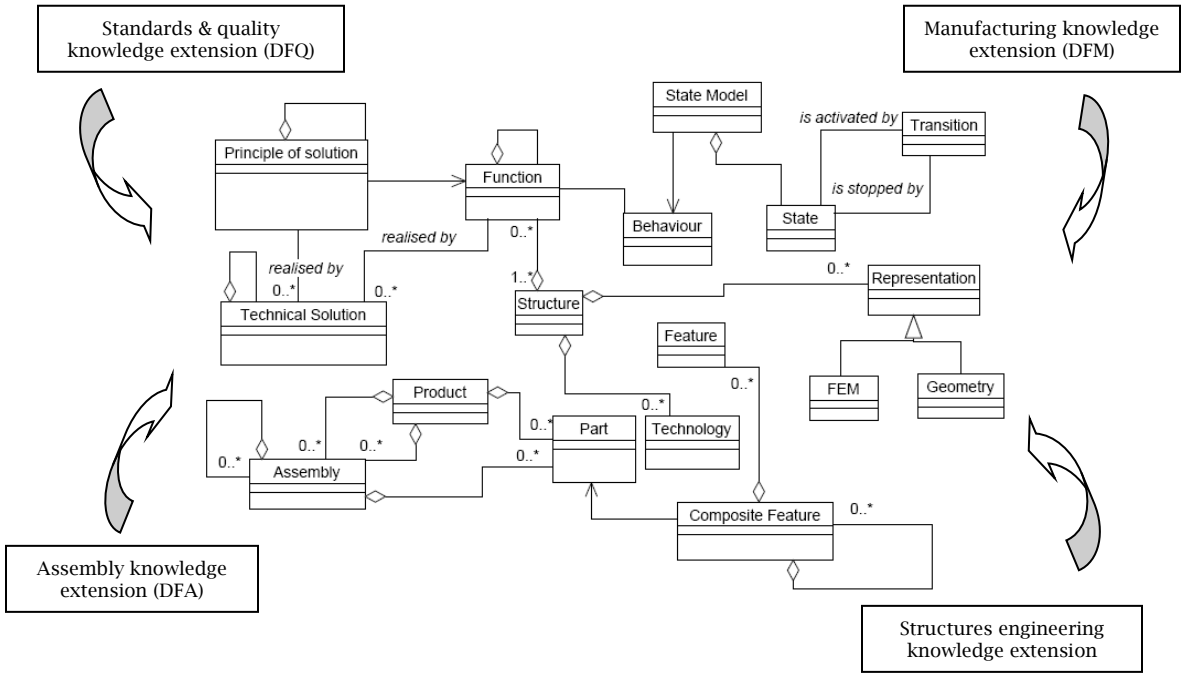

Fig. 3: MOKA product model [5] with possible expert knowledge extensions.

The domain knowledge extensions do not constitute points of view per se, since they do not include the whole set of information we find in the core information set. In addition it doesn't provide the basis for the association between models, since the core information set is not represented, and thus the relationship between points of view.
This model with its extension is then broken down into elementary information entities which constitutes the different points of view of different domain knowledge.
Starting from this, we propose a model of view manager which provides a points of view management framework that allows CAD software to be used by different domain experts. By only changing the point of view required by the user, the software switches from one representation using a specific domain knowledge, to another one using a different specific domain knowledge.

The view manager uses 4 different classes:

1. InformationEntity class, which is the class responsible for gathering the information entities that are found in the product model.
2. RepresentationMode class, which is the class that is responsible of the representation of the part/product information representation, it gathers information about the product in a representation mode.
3. StatePLM class which provides information about the impacted product life phase and also, the status of the current product development
4. SystemLevel class provides information about the position in the hierarchy of the system (whether it is a sub-system, a part, its interfaces, environment, etc.)

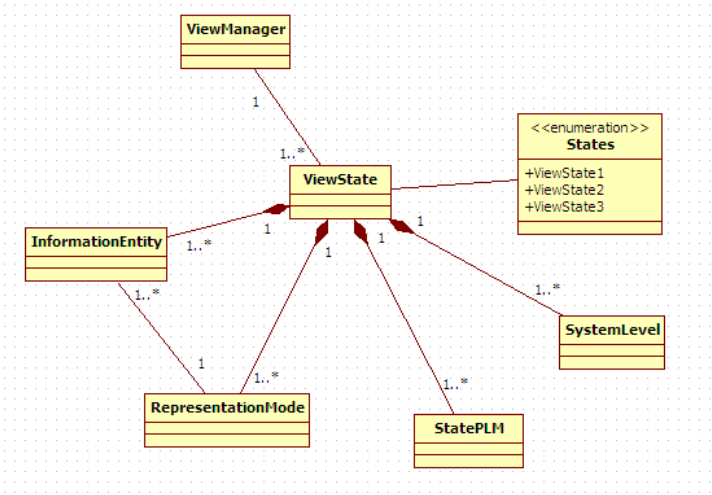

Fig. 4: View manager basic model – Extension connected to the product model to manage the different points of view.

The enumeration class "States" is here to gather the points of view that could be defined by the expert in the CAD software.
Using this view manager allows the flexibility that we are searching for when moving from one domain specific model to another, while maintaining association between them, and between different domain specific knowledge, by integrating them into one product model.

Conclusion:
In this paper is proposed a new approach to deal with information representation through the concept of points-of-view. The purpose of this concept is to allow the gathering of information relevant to a specific business context and represent it in a relevant way. Future work is on the integration of a product model in order to constitute a basis on which are constructed domain knowledge models that will be represented through the implementation of the view manager model.

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