Knowledge Modeling, Ontologies, and Meta-modeling

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Abstract

Understanding the relationships between knowledge modeling, ontologies, and meta-models is crucial for building effective knowledge solutions in engineering. From a top-down perspective, a knowledge model in a given domain can be broken into its components that each come from some ontology. On the other hand, ontologies are realized in the form of meta-models at the implementation level. From a bottom-up perspective, a meta-model is an explicit implementation of a set of constructs and rules that define an ontology. In turn, ontologies provide the building blocks for knowledge modeling.

In another word, meta-modeling provides a framework for generalizing the concepts in a domain. Generalization provides consistency in modeling and a mechanism for extending modeling capabilities to areas that cannot be predicted while designing a knowledge system. Meta-modeling is one of the first steps in knowledge modeling, because generalizing information normally leads to creating knowledge. Most information systems implement an implicit meta-model in their object models. Knowledge systems, however, differ from other information systems in that they represent and implement an explicit representation of their meta-model.

A knowledge solution capable of modeling the growing complexity of today's aerospace systems should constitute a unified methodology and a set of supporting tools. The methodology should provide guidelines and recommendations for conducting different knowledge management activities such as knowledge mining, capture, structuring, formalizing, execution, storing, validation, versioning, and maintenance.

A knowledge management methodology for engineering should provide meta-models for representing the knowledge model for the product from different points-of-view such as function, behavior, structure, and manufacturing, as well as a set of meta-models for various processes that occur during a product lifecycle such as the engineering design process. A language for formal representation of the knowledge models should also be provided.

Having access to the right supporting tools is very important in successful implementation of a knowledge management methodology. For instance, an inference engine can take a knowledge model for a product and a set of input requirements to automatically generating design candidates, and hence reducing the design cycle. Such a tool helps justifying the value of knowledge management activities that have led to reducing time-to-market and development costs for that product.

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