Chapter 14

Design and Implementation of Product Structure Ontology

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ABSTRACT

Knowledge Management consists of processes to capture, share, and effectively use knowledge. Knowledge capture means the process of development and creation of the knowledge, and formalization is an example of direct knowledge capture. Knowledge formalization refers to knowledge representation that is concerned with how to formally think and represent the domain of discourse, and ontologies are now in widespread use as a means of formalizing domain knowledge. Currently, several works using ontologies have been done to formalize knowledge in the manufacturing domain. However, these ontologies have not been shared, and the detail of the implementation of the ontology has not been explained clearly, and as such, the ontology cannot be reused and extended, making several tasks in developing ontologies, i.e., design, performance, annotating works, and applying the ontology, challenging. Therefore, the goal of this study is to formalize knowledge in the manufacturing requirements domain to standardize the engineering terms and analyze the usage of shared terms between products, enabling the ontology to be reused and extended. An ontology named as Product Structure Ontology (PSO) has been developed in order to standardize the engineering terms. PSO is represented by terms in manufacturing engineering, which relate to the product structure. These terms are structured as a hierarchical Directed Acyclic Graph (DAG) and have three main categories of knowledge, namely “product-specific knowledge,” “industry-specific knowledge,” and “generic term.” PSO annotation has been developed in order to analyze the usage of shared terms between products. The PSO terms and engineering product are related to each other to solve the problems of heterogeneity. The PSO development framework and artifact has been

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shared to enable the ontology to be reused and extended. The framework was designed based on Noy and McGuiness’s methodology and has been modified based on application requirements. Four artifacts have been developed and shared, which are website, browser, database, and documentation. The PSO website is a central platform to provide information about PSO. The PSO browser provides interface to represent the PSO and annotation and allows users to use the PSO tree to query the database. The PSO database contains PSO data in MySQL form and PSO documentation gives general information about ontology category, annotation, evidence code, and database guide.

INTRODUCTION

Product structure provides important information that has become a part of product manufacturing requirements in a real manufacturing field. Product structure is a hierarchical classification of items that form a product, and also show the product complexity. It illustrates the material, components, parts, sub-assemblies and other items in a hierarchical structure that represents the grouping of items on an assembly drawing, or the grouping of items that come together at a stage in the manufacturing process. With product structure, the understanding of the components that compose a product as well as their attributes can be represented. Product structure is normally presented on a Bill-of-Material (BOM), or a parts list, or a variant specification. A BOM is a formally structured list for an object (semi-finished or finished product) which lists all the component parts of the object with the name, reference number, quantity, and unit of measure of each component in any product instance that may be manufactured. The engineering BOM normally lists items according to their relationships with parent product as represented on assembly drawings. This study attempts to formalize knowledge related to product structure in the engineering manufacturing area.

BACKGROUND

Knowledge management comprises a range of strategies and practices used in an organization to identify, create, represent, distribute, and enable adoption of insights and experiences. There are many different definitions and approaches on knowledge management, such as those by Galagan (1997), Demerest (1997), Quintas et al. (1997), Bukowitz and Williams (2003), Wong and Aspinwall (2004), Lee et al. (2005), and Daginfous and Kah (2006). For this chapter, our knowledge management begins by formalizing knowledge in a manufacturing domain using ontology. There has been much discussion in recent years about formalizing knowledge using ontologies, whether for general usage or specific domains. Previous work about ontologies has been found in studies on principles and methodologies to create them (Corcho, 2003; Lammar, 2003; Kayed, 2002; Sugumaran, 2002), their use (Morbach, 2007; Williams, 2006; Naphade, 2006), and their evaluation (Burton-Jones, 2005; Gomez-Perez, 2001; Guarino, 2000). Noy and McGuiness’s (2001) definition affirms that an ontology is a common vocabulary for a researcher who needs to share information in a domain of use. For a more appropriate meaning, ontology is a category of things that exist or may exist in some domain. It is an explicit formal specification of the objects, concepts, and other entities that are assumed to exist in some area of interest and the relationships that hold them. In the context of Artificial Intelligence, we can describe ontology by defining a set of representational terms. As there are many concepts in product manufacturing requirements and it remains divergent among company, ontology becomes important to support the sharing and reuse of formally represented knowledge by explicitly stating concept, relations, and axioms.