Innovative Product Design using Metaontology with Semantic TRIZ

Koswatte R. C. Koswatte, School of Computer Science and Engineering, University of Aizu, Aizuwakamatsu, Japan

Incheon Paik, School of Computer Science and Engineering, University of Aizu, Aizuwakamatsu, Japan

Wonhee Park, Department of Management Science and Engineering, Akita Prefectural University, Yurihonjo, Japan

Banage T. G. S. Kumara, School of Computer Science and Engineering, University of Aizu, Aizuwakamatsu, Japan

ABSTRACT

In the manufacturing industry, supply chain management is playing an important role in providing profit to the enterprise. Information that is useful in improving existing products and development of new products can be obtained from databases and ontology. The theory of inventive problem solving (TRIZ) supports designers of innovative product design by searching a knowledge base. The existing TRIZ ontology supports innovative design of specific products (Flashlight) for a TRIZ ontology. The research reported in this paper aims at developing a metaontology for innovative product design that can be applied to multiple products in different domain areas. The authors applied the semantic TRIZ to a product (Smart Fan) as an interim stage toward a metaontology that can manage general products and other concepts. Modeling real-world (Smart Pen and Smart Machine) ontologies is undertaken as an evaluation of the metaontology. This may open up new possibilities to innovative product designs.

Keywords: Inventive Problem Solving, Metaconcepts, Metaontology, Semantic Web, Supply Chain Management, TRIZ

INTRODUCTION

Companies face tough competition with the globalization of markets and it is necessary to search for new alternatives that will enable their survival in the market (Giovannini, Aubry et al., 2012). In particular, supply chain management (SCM) has become the key for competition between companies. SCM is an integrated management technique for managing an order received, supplying materials and parts, stock, production, and delivering a product and
raising corporate profits (William, 2000). The supply chain process is very important because it influences the efficiency of the whole SCM and can save unnecessary costs and time of redesign and modification of the product. The cost of development increases very quickly as each stage from the preview stage to the mass production stage is passed. Therefore, the costs of design and planning in the initial fluid stages are not very high; however, they become very high during construction of a production line or at the mass production stage.

In a recent study, an integrated information infrastructure was suggested (Paik, Kim et al., 2011). The authors suggested applying the theory of inventive problem solving (TRIZ) ontology to the SCM process. Through the TRIZ ontology, we can automatically treat and share enormous amounts of information on a network. Thus, we can deduce and suggest versatile alternatives for innovative products in the SCM process. Therefore, this provides a chance for new possibilities to design innovative products. Despite these advantages, it must be predictable for innovative extension and change in the product design system with successful combination of many products to identify the changes of the product. For this, the TRIZ ontology must be designed in more depth. Therefore, we planned an interim stage toward metaontology. This helps us to find the required metaconcepts by analyzing the two TRIZ product ontologies, and this is a basis for our main objective. The main objective in this research is to develop a metaontology framework for innovative product design using TRIZ. The role of such a metaontology is manifold. First, it can serve as a central reference point. Second, such an ontology will serve as a structuring basis for product design. It will help to compare or relate ontologies of different domains to each other. Third, metaontology may serve as an educational tool. It will help to convey the state-of-the-art in innovative product design. The TRIZ ontology assists in successfully identifying changes in the product design system. The ontology model should accommodate possibly different perspectives of potential users and be easily modifiable to adapt to changing trends and products. A metaontology model is more extensible and flexible. The challenge of such metaontology construction is not to identify the lower level concepts that correspond to the individual approaches, but to work out and identify the upper level metaconcepts that would help to generate the metaontology.

Products can be in various domains and identifying the problems in the design stage of the SCM is very important. We proposed metaontology for product design. Our main original contribution is product design with innovative ideas that can be applied to multiple products in different domain areas. We have planned interim stage toward metaontology because we need to analyze TRIZ ontologies to design a metaontology. So, first meta-concepts were identified and then developed a meta-framework capable of domain independency.

The rest of this paper is organized as follows. In section II, we discuss related work. Section III discusses the interim stage toward the metaontology. Section IV describes the metaontology for products. Section V presents the application of the metaontology. Section VI presents an evaluation of the metaontology with real domain ontologies. Finally, section VII concludes the study.

RELATED WORK

Product Design Attributes in the Supply Chain

Information Infrastructure that integrates the four product attributes of cost, quality, function, and technology provides an effective environment to manage supply chains. Those attributes are necessary in the product design stage, which is the first step of SCM, and they are connected to each other. SCM started in manufacturing and aims to minimize waste and maximize efficiency (Paulson, 2001). The design stage is very important because some faults may cause several more problems in later stages. A supply chain refers to a complex
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