

Middleware Platform for Customizable Vehicle Reconfiguration

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Abstract - Although the automotive industry is relatively efficient in managing the production line, mass customization remains a major challenge. The difficulty lies in the establishment of channels to support customer feedback and interaction in directing the planning and design new products. There is thus a big gap between user requirements and product features. We explore the development of a platform for bridging this “semantic gap” between user needs and the decision-making process new product planners and designers. This paper presents the framework for this platform, which will then serve as a support for a mass customization system.

Keywords – Image processing, knowledge acquisition, knowledge representation.

I. INTRODUCTION

There is a perceived need in automotive industry to obtain product information feedback from customers and the business chain that can be used in the development process, for benchmarking and for positioning a vehicle in the market during the conceptual design phase. Most manufacturers have a Product Development Management (PDM) system, linked to limited Computer-Aided Design (CAD) databases. In addition, consulting companies provide automotive information to manufacturers and suppliers, where some manufacturers actually decomposed competitor’s vehicles to obtain data that are important for their own manufacturing. In order to avoid “reinventing the wheel”, we rationalize on the need for a middleware to companies’ knowledge base systems to support reuse and optimization of available solutions.

II. VEHICLE RECONFIGURATION

Today, few automotive companies have mass customization systems. Bayerische Motoren Werke AG (BMW) [1] currently builds about six out of ten vehicles to order. Although the order-to-delivery time is very long, taking up to two months, much longer than for regular vehicles, customers are prepared to wait [2]. Smart GmbH, a subsidiary of Daimler Chrysler AG has a car configuration system [3]. Such systems provide limited choices for customers based on an array of configurations made available by a single manufacturer. Extending this system to provide additional functions and expanding to multiple manufacturers and suppliers requires a paradigm

shift. Furthermore, the digital customizer provides only two-dimensional presentations of product design. Design options, as e-catalogues in three-dimensional (3D) and enabling customer interaction via a virtual environment do not exist yet in the automotive industry.

This paper describes the architecture of a middleware platform to address the expansion of car configuration system originally provided by a single manufacturer to support multiple manufacturers and suppliers instead. We refer to this system as Middleware for Aggregated Knowledge Representation, Access and Retrieval (MARK) as a basis for capturing and representing product knowledge of manufacturers. Generic relationships and constraints involved in various phases of production are stored, reused and refined to build upon valuable organizational knowledge along the way.

III. MIDDLEWARE ARCHITECTURE FOR AGGREGATED PRODUCT KNOWLEDGE

Rather than the development of a system to decompose and learn from a competitor, a supportive environment that helps a manufacturer to build upon their design knowledge base is proposed. As such, it will become an approach to drive change, to learn and rationalize. It also enables companies to identify relevant processes by looking at how vehicle components are put together. To a certain extent, benchmarking via iterative decomposition and value-adds allows SWOT analysis [4] and to find opportunities for continuous improvement. Capturing information about unique components design parameters, usage conditions and the knowledge about technical compositional characteristics, allows the transfer and exchange of information across various phases in manufacturing process. Also, decomposition supports supply chain management in the design process.

A. Generic Data Model

In order to capture the simplified abstract view of the complex process, semantic modeling is required to capture the set of classes, relationships and functions in a universe of discourse or “ontology”. Example of ontology to describe concept of a car is shown in Fig. 1. Integrated Computer-Aided Manufacturing Definition (IDEF) language [5-7] originated from manufacturing industry consist of a suite of modeling methods used for modeling activities necessary to support system analysis, design and