Concurrent Engineering of Mechatronic Products in Virtual Enterprises: Selection and Deployment of a PLM System for the Machine Tool Industry

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Abstract. The development of mechatronic products requires the integration of different technical disciplines by personnel who reside in separate locations, a fact that is particularly evident for the case of virtual enterprises. Concurrent engineering of these products can be enhanced significantly through the use of sophisticated data management and visualization tools such as Product Lifecycle Management (PLM). The key benefit of a PLM system is its ability to facilitate the coordination of the activities among geographically distributed team members. This paper describes models and procedures that were developed and implemented during the selection and configuration of a PLM environment for machine tool design and construction in a virtual enterprise. The experiences from this case, particularly the bottlenecks and how they were addressed are discussed in detail. Finally, recommendations for better deployment of PLM for similar conditions are presented.

1 Introduction

Mechatronic products for today's markets are complex components whose design and production require the integration of multiple disciplines. Examples of mechatronic products range from consumer goods such as coffee makers and cameras, to high performance / low volume systems such as machine tools. Development of these products is typically done by teams whose member's expertise span a variety of fields, from marketing through engineering, manufacture and support. The specialists responsible for the development of the different systems of the product work in an asynchronous manner and even in separate locations, while bounded by stringent budgets and schedules.

The above conditions are particularly evident for the case of virtual enterprises. A virtual enterprise (VE) is a temporary alliance of companies, who combine their resources to integrate a service or product that could not be provided otherwise. Upon completion of the alliance's goals, the members return to their original niches.

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Lately, the use of Product Life Management systems (PLM) has gained wide acceptance among producers of consumer goods. A PLM facilitates the process of concurrent engineering of these products, because it enhances the coordination of the activities among all the actors involved in the development and support of these products. Given the variety of PLM systems available in the market, the selection and configuration of such a system for a particular application or industry has become an important activity, whose result affects the capacity of the development team to deliver successful products. In general, PLM require high initial investments and costly maintenance. Consequently, their economic application is particularly suited for the case of companies that specialize in products for a significant sector, and whose volumes justify the investment. The use of PLM in virtual enterprises and for high performance product, on the other hand, presents unique challenges that have not been addressed yet. This paper describes the experiences obtained during the selection and configuration of a PLM environment for the machine tool industry in a virtual company.

2 Literature Review

Products for current markets require complex management. Hahn [1] describes a concept and architecture for product modeling and integration, which encompass all the necessary product inter-relations. Information is administrated by an integrated PLM system functionality combined with knowledge management technologies. The proposed platform reduces product administration efforts during the design, and manufacture, presenting a PLM architecture that can easily integrate all product lifecycle activities, as documentation, integration, installation and maintenance.

Information technology and communications had evolved at a very fast rate. In his work Sharma [2] attempts to integrate three topics: collaboration, product development, and innovation, using an information technology framework based on process alignment that can be adopted to realize the benefits of a collaborative environment. Challenges raised by factors such as location, human behavior, culture and the adoption of PLM are exposed. He points out that companies that produce automotive and pharmaceutical products seem to be ideal candidates to embrace collaboration to their full potential.

Atkinson et al. [4] present the strategies that Denso used after evolving from a provisional supplier to Toyota to one of the largest suppliers of the automotive industry. Denso proposes a Global New Product Innovation and Development framework in a way to reduce costs and improve quality of new products, a PLM in essence. As with Sharma, this work presents and example of the benefits of the use of a PLM in a company that produces goods for mass consumption– Roller et al. [5] describe methods to reduce iterations during product design and development, using techniques for parallel development processes. Their work identifies certain product attributes to solve common security and consistency problems that arise during distributed product development processes.

Sudarsan et al. [3] proposed a PLM system framework, which supports all different information needs. He bases his framework on the National Institute of Standards and Technology Core Product Model, with four main components: Open Assembly