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LIFE CYCLE FRAMEWORK FOR MODULAR CONFIGURABLE AUTOMATION SYSTEMS

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Abstract: Despite the technological advancements within the last few decades in computer aided design and manufacturing systems, the existing solutions are still fragmented and typically target only small fragments of the production lifecycle. The engineering support required for the design and lifecycle management of manufacturing systems is not sufficiently developed. In particular there is no established integrated approach to support the lifecycle of manufacturing automation systems.
Automotive industry is one of the world's largest manufacturing sector, more effective service based approaches to lifecycle support are now needed as an integral part of manufacturing systems in order to effectively support rapid product or process change in a global business context. This research paper presents a lifecycle support framework for the development of new modular automation systems in order to bring greater agility to the manufacturing system using a collaborative work centre concept and also to investigate the new supplier relationships resulting from using a modular approach.

Keywords: Lifecycle support, Collaborative product development, modular approach, configurable automation system, automotive industry.

1. INTRODUCTION

Today global business environment is changing very quickly. The product lifecycle shrinks while product variety and complexity increase and profit margins decrease, and therefore the operation of manufacturing firms become more difficult (Molina, et al., 2005). Traditional centralised manufacturing systems are not able to meet such requirements (Harrison and Colombo, 2005). Significant changes have been made in recent years to enterprise strategies and manufacturing paradigms, particularly for companies wishing to remain globally competitive in volatile markets. A number of concepts emerged such as the agile manufacturing enterprise, virtual enterprise, extended enterprise and the so called next generation manufacturing enterprise (Tian, et al., 2002). Such new concepts refers to the application of new models, methodologies and information technologies with the goal of preparing manufacturing companies to become more competitive in a global and networked environment (Molina, et al., 2005).

In response to ever increasing business needs, highly flexible and agile manufacturing systems are needed to accommodate unforeseen business changes (Nof, et al., 2005). This innovation is needed in all manufacturing sectors and especially in the automotive sector. The operational domain in the

automotive industry is moving progressively from a mass production to a mass customisation philosophy. To become more responsive in the global markets, automotive industries need reconfigurable manufacturing systems with faster ramp-up, remote assistance and better lifecycle support.

Within the automotive industry the Ford Motor Company is one of the world's largest manufacturers involved with globally distributed suppliers for their production/assembly systems development. Rapidly changing global business plans are now the norm across the automotive industry including Ford. Thus end-users require more agile manufacturing strategies to remain competitive in terms of cost, quality and time to bring new products to the market. A new methodology is urgently required for automotive production/assembly lines to introduce new products (e.g. new engine varieties) onto existing production/assembly setups. This requires better collaboration between shop floor, business level and supply partner systems during the many lifecycle phases of production/assembly lines.

In this context next generation collaborative automation systems require a lifecycle collaboration framework, to efficiently support the lifecycle phases of automotive production systems and to enable more competitiveness in terms of time, quality and cost.

2. COLLABORATION FOR LIFECYCLE SUPPORT

Business success is the ability to identify the needs of the customer and quickly develop products to fulfil the customer desires at low cost with the shortest delivery time (Tseng and Piller, 2003). This success of manufacturing companies is not merely a marketing and sales problem, nor solely a design problem or manufacturing problem. It is rather a collaborative product development problem involving all lifecycle issues of product fulfilment (Jiao and Helander, 2006).

Today companies do not possess all the knowledge and resources for product development therefore relying on other organisations. In response to this the research community developed a solution know as "Collaborative Product Development". The collaborative product development system is "an Internet based computational architecture that supports the sharing, transferring knowledge and information of the product lifecycle amongst geographically distributed companies to aid the right engineering decisions in a collaborative environment" (Rodriguez and Ashaab, 2005).

Highly flexible and responsive operations to meet the customer expectations can be achieved through collaborative and cooperative manufacturing strategies. Such strategies need support of suitable technologies to share information according to agreed mechanisms and rules that should cover the entire product lifecycle (Bilbao, et al., 2004).

Today only innovative products differentiate themselves from others while being affordable, reliable and early to market. Such holistic products with supporting services are limited by information gap during the different phases of product lifecycle (Kiritsis, et al., 2003). The collaborative product development can cause innovation during different lifecycle phases with a primary goal to integrate knowledge, technologies and resources amongst all the stakeholders.

However higher level collaborations need new business models i.e. Product Lifecycle Management (PLM) to connect people, processes and data (Sharma, 2005). PLM is a new integrated business model (Kopacsi, et al., 2007), with the aim to streamline product development and boost innovation in manufacturing. It will also manage all the information about an enterprise throughout the product lifecycle (Sudarsan, et al., 2005). PLM enables collaboration between enterprises. It has been recognised that current PLM implementations are document oriented, with no customisable data models and facing many inter-enterprise integration difficulties (Aziz, et al., 2005).

The highest level of collaboration based on web based services with standard industry process followed by industry players allowing virtual collaboration, real time information processing and real time process integration (Sharma, 2005).

Figure1 illustrates PLM as a business approach and collaborative framework requirement during generic view of product lifecycle phases. In a novel business area, networked companies can be more competitive by improving their after sale service, product maintenance and recycling (Kiritsis, et al., 2003). For customer satisfaction service and maintenance are important practices to maintain product and process quality. Fault recovery, self maintenance and remote diagnostic features allow manufacturing and process industries to develop proactive maintenance strategies to guarantee the product, process performance and ultimately eliminate system breakdowns (Lee 2002). Lifecycle support opens

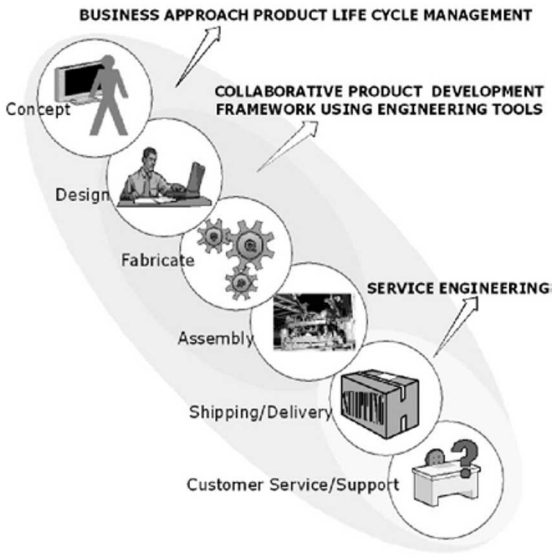

Fig.1. Generic Lifecycle View of Product Development