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# ENTERPRISE: PERFORMANCE AND BUSINESS PROCESSES

**PROCESS OF INNOVATION IN  
PRODUCT LIFECYCLE MANAGEMENT  
BUSINESS STRATEGY**

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**Abstract:** This article proposes a scenario of Product Lifecycle Management (PLM), as a innovative business strategy based on the analysis of business drivers, industry requirements, limit of current solution, and recent state-of-the-art review in the domain related to PLM. Potential industrial impact of the developed PLM technology solutions is analyzed. It is hoped that the proposed PLM technology solutions will form the frontier basis for further research, development, and application of PLM systems to quickly adapt to the dynamic changing market for industry companies to pursue the most advanced competitiveness. This article presents a process oriented framework to support effective PLM implementation with a set of lifecycle oriented business process reference models which links the necessary fundamental concepts, enterprise knowledge and software solutions to effectively deploy PLM.

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## Introduction

In today's highly competitive environment, business requirements always drive technology solutions. In response to increasing customer demand and dynamic competition, companies are under high pressure to shorten time-to-market by providing tailored products to the customer for the economy of scope, to reduce time-to-volume via mass production for the economy of scale, and to decrease time-to-profit by increasing the efficiency of the entire lifecycle for the economy of service. These business requirements drive technology needs: (1) to speed up product development, (2) to enhance manufacturing and supply capability and capacity and (3) to improve revenue from lifecycle efficiency.

To tackle such challenges, in past decades, with the support of advanced manufacturing technologies, manufacturing industry has shifted from mass production, which takes the advantage of scale of production, to concurrent engineering, which optimizes internal enterprise processes, and virtual enterprise, which leverages intellectual capital via collaborative innovation (Pol, Merlo, and Legardeur, 2008). In such a virtual enterprise environment, companies need to closely collaborate with customers, manufacturers, and suppliers in a

real time manner so as to quickly respond to dynamic market changes.

Accordingly, the business model in the manufacturing industry has shifted from make-to-order, to build-to-order, to engineering-to-order, to configure-to-order, to design-to-order, and in near future to innovate-to-order.

Key technologies to support these business models have changed as well from mass production, to a flexible manufacturing system, to manufacturing knowledge management, to product customization, to product knowledge management, and to product lifecycle management (PLM) (Saaksvuori and Immonen, 2008; Bernard and Tichkiewitch, 2008). As such, PLM is recognized by world's leading universities, institutes, and solution vendors as the next big wave in enterprise application software. PLM is recognized as one of the most effective approaches for better, fast and cheaper product development and management. In the modern global economy, companies are facing ever-increasing challenges for short time-to-market to enter into the market early, for reduced time-to-volume to occupy the market quickly, and for decreased time-to-profit to get return from market shortly. PLM is recognized as one of the key leading technologies to facilitate companies to overcome these challenges, which will offer companies a new

way to rapidly plan, innovate, organize, manage, measure, and deliver new products or services to their customers much faster, better, and cheaper in an integrated way.

### **Product lifecycle management as a new business strategy**

Product lifecycle management (PLM) innovates as it defines both the product as a central element to aggregate enterprise information and the lifecycle as a new time dimension for information integration and analysis. Because of its potential benefits to shorten innovation lead-times and to reduce costs, PLM has attracted a lot of attention at industry and at research. However, the current PLM implementation stage at most organizations still does not apply the lifecycle management concepts thoroughly.

PLM provides customers, developers, manufacturers, and suppliers with the most effective means of collaboratively managing business activities throughout product development. PLM supports the capability of innovation, creation, management, share, and use of product data, information and knowledge in virtual enterprise networks by integrating people, processes, and technology.

PLM systems manage a portfolio of products, processes, and services from its initial conception, through design, manufacture and supply, to service and disposal. Throughout the entire product lifecycle (Ming and Yan, 2005), there exist three major objectives, which are: 1 - customer benefit such as product quality and serviceability, 2 - company benefit such as product cost and profit, and 3 - society benefit such as clean and green environment.

These benefits become the *WHY* aspect of product lifecycle. Bearing these benefits in mind, the *WHAT* aspect of product lifecycle can be created, which is to model product specification, function, behaviour, structure, geometry, topology, machining process, schedule, supply chain, operation service, recycling, and disposal. The next step is *HOW* to model the product lifecycle, which are lifecycle processes including specification management, conceptual design, detailed design, process design, production, supply, service, and recycle.

To reach customer benefits, mass customization, time-to-innovation, product quality, and reliability are recognized as the key approaches enabled with technologies e.g., product family design, platform based design, modular product design, design process modelling and management, design knowledge management, collaborative design engineering, function/ behaviour/ structure design, etc. To achieve company benefits, time-to-market, time-to-volume, and time-to-profit are known as the key approaches enabled with technologies,

e.g., collaborative product service, product lifecycle process management, product lifecycle information and knowledge management, etc. To obtain society benefits, design for service, design for reuse, design for recycle are justified as the key approaches enabled with technologies, e.g. product/ service co-design, collaborative early design for lifecycle efficiency, environmentally conscious design, etc.

This article will focus on the discussion of technology solutions to achieve company benefits in product lifecycle, namely, product lifecycle management (PLM), which is also the dominant direction in the current market of enterprise software application. PLM provides customers, developers, manufacturers, and suppliers with the most effective means by collaboratively managing business activities throughout entire product lifecycle (Gecevska, Lombardi et al., 2010). PLM supports the capability of collaborative creation, management, dissemination and use of product assets (including data, information and knowledge) in virtual enterprise integrating people, processes, and technology (Stark, 2004). PLM systems manage a portfolio of products, processes, and services from initial concept, through design, engineering, to final disposal. As such, PLM offers companies a new way to rapidly plan, organize, manage, measure, and deliver new products or services much faster, better, and cheaper in an integrated way.

Following this trend, in this article, ever-increasing business drivers and industrial requirements are analyzed. PLM is proposed as a new weapon to satisfy modern needs for new business model of innovation-to-order. A recent state-of-the-art review for PLM, including both academe and industry is done. To effectively manage these product lifecycle processes for competitive advantages via efficient collaboration, technology solutions for PLM are proposed as the future trend. Accordingly, the impacts of PLM technology solutions to industry are analyzed.

### **Challenges in product lifecycle**

#### ***Business driver***

The current business environment faces new business challenges for effective management of whole product lifecycle (Grieves, 2009), e.g., shorter product lifecycles, increased outsourcing, mass customization demands, more complex products, geographically dispersed design teams and rapid fulfilment needs. In general, these challenges include increased speed, increased demand, increased outsourcing, and the use of Internet.

#### ***Industrial requirement***

To effectively tackle the above challenges in a modern collaborative enterprise environment

(Stark, 2004), new industrial capabilities are required in order to obtain business success in today's Internet economy:

1. Geographically scattered design teams and supply chain partners need to collaboratively design products on a virtual basis.
2. Static designs need to be replaced by mass customization often using predefined modules or building blocks to rapidly configure new product platforms that can be flexibly managed through lifecycle.
3. A new approach needs to be created to leverage net centric technology to liberate the inherent value in today's extended business model.
4. Such a new approach should enable business to use and leverage information needed by each partner to accelerate and enhance product development predictability.
5. That approach should provide a system to exchange and control product information and to perform real-time program/project management.
6. A system needs to emerge as the dominant technology for managing inter-enterprise data, information and knowledge.

To meet these requirements, a new system is imperatively required:

- to provide an information continuum in order to deliver pervasive, real-time analytics and reporting throughout the entire product lifecycle,
- to provide a collaborative environment bringing together multiple roles, constituents, and stakeholders in threaded discussions beyond four walls of enterprise,
- to enable interactive viewing upon product development through multiple devices and systems involved with the product lifecycle,
- to be integrated solution supporting key enterprise value disciplines of product leadership, customer intimacy and operational excellence.

Such a new system will provide customers, developers, manufacturers, suppliers and partners with the following capabilities: product lifecycle collaboration across virtual enterprises, common product lifecycle processes management, effective management of product lifecycle activities and convenient integration with other enterprise systems.

### Review of PLM approach

As companies move towards providing better customer-centric products and services quickly to maximally satisfy customer requirements, to improve market share and market size with continuously growing revenue, the efficiency and effectiveness of product lifecycle management becomes much more important in modern enterprise application systems (Stark, 2004). To address these needs, PLM has recently been

recognized as a new strategic business approach in support of collaborative creation, management, dissemination, and use of product assets, including data, information, knowledge, etc., across extended enterprise from concept to end of life ó integrating people, processes, and technology. PLM systems support the management of a portfolio of products, processes, and services from the initial concept, through the design, engineering, launch, production, and use to final disposal.

They coordinate and collaborate products, project and process information throughout the product value chain among various players, internal and external to enterprise. They also support a product-centric business solution that unifies product lifecycle by enabling online sharing of product knowledge and business applications (Saaksvuori and Immonen, 2008; Bernard and Tichkiewitch, 2008).

As such, PLM enables manufacturing organizations to obtain the greatest competitive advantages by creating better products in less time, at a lower cost, and with fewer defects than ever before. In summary, PLM not only provides service throughout the entire product lifecycle, but also enables effective collaboration among networked participants in product value chain, which differentiates it from traditional enterprise application systems.

### Collaborative PLM strategy

As a business strategy, PLM lets distributed organizations innovate, produce, develop, support, and retire products. It captures best practices creating a storehouse of valuable intellectual capital for systematic and repeatable re-use.

As an information technology strategy, PLM establishes a coherent data structure that enables real-time collaboration and data sharing among geographically distributed teams. PLM lets companies consolidate multiple application systems while leveraging existing legacy investments during their useful lives. Through adherence to industry standards, PLM minimizes data translation issues while providing users with information access and process visibility at every stage of the product's life.

PLM systems support the management of a portfolio of products, processes and services from initial concept, through design, launch, production and use to final disposal. They coordinate products, project and process information throughout new product introduction, production, service and retirement among the various players, internal and external, who must collaborate to bring the concept to fruition.

The PLM concept gives the strategies to organize and to manage product information the entire life cycle, from concept to re-cycling of the product through:

- Share the updated product information's within the organization to design, manufacturing,

- marketing and procurement divisions,
- Collaborate internal team with external users, suppliers and customers for iterating new designs,
  - Maintain a repository of product information for design reuse and to reduce part redundancy,
  - Systematically gather and analyze customer or market product requirements,
  - Streamline sourcing team to identify a list of preferred suppliers for purchasing custom and standard parts,
  - Streamline resource management and analyze the cost-benefits of allocating resources for specific projects.

Management and distribution of enterprise information by PLM system is realized on different data levels, as:

- ICT (Compliance with existing legacy system; Integration of PLM and ERP/CAD systems)
- Processes (Fragmented and unalterable; Modeling, controlling, improving)
- Data & Objects (Different data formats; Standard data representation; Preserving data integrity along the time; Supporting data evolution)
- Methods & Tools (Specific tools; New development methodologies)
- People & Organization (Functional organization promotes incommunicability; Supply chain approach).

### Establishing PLM

There are companies that supply software to support the PLM process (Siemens PLM, 2009). That software itself is just a tool and cannot make many contributions if the PLM process is not defined first and understood by its users whom it should contribute to at the end. Setting up PLM within the company is a process and project itself.

Select operations that should be managed as a part of the PLM across the company business would be:

- Customer relationship management (CRM) system for managing customer record,
- Enterprise resource planning (ERP) system for managing financial records,
- Supply chain management (SCM) system for managing supplier support,
- Human resource management (HRM) system to manage the employee record,
- Requirement management (RM) system for managing of requirements,
- Project management (PM) system for managing capabilities provide project scheduling, tracking, and resource management while the change management is driving the execution of these projects via the process workflows and part/document management capabilities.
- Product data Management (PDM) system for

managing product data and workflows.

First step in establishing PLM would be understanding and analyzing the company way of work, organizational structure, roles and responsibilities within the organization. Each of the PLM operational systems should be defined to specify who is contributing to the system, how the information is shared and responsible person appointed for each of the systems. It is not necessary that all those operation systems are integrated within one software tool, and usually for small and medium companies they won't be, while on the other side big companies might need to adopt available software and tools to their specific needs.

### Conclusion

Although a quite new method with short history PLM has proven itself to be useful for all management levels within the company in both vertical and horizontal organization. By making relevant historical information structured and available PLM is used both for those who are doing execution and decision makers within the organization answering to the rapid changes in the business environment. A business approach for coordinating design process through the implementation of PLM systems is proposed for improving design coordination in SMEs. Firstly, this business approach is based on a method for analysing informal collaborative practices and modelling detailed design processes. Secondly, these processes are implemented by using PLM technologies. Multi-level workflows are implemented to control progress of design schedule from project management level to document lifecycle management level.

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