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Product lifecycle management through innovative and competitive business environment

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Abstract: Product Lifecycle Management (PLM) is the process of managing the whole life cycle of a product starting from generating an idea, concept description, business analyzes, product design and solution architecture and technical implementation, to the successful entrance to the market, service, maintenance and product improvement. At present, a wide range of stakeholders including consumers, regulators, shareholders and public bodies are demanding that companies address product management through all life cycle in a more comprehensive and sustainable way. However, even if a company actually wishes innovate its processes for improving the way to account for project management, it will face relevant difficulties to deal with different guidelines, tools and methods currently addressing the matter from various points of view. The purpose of this paper is to review literature on PLM from an operational point of view with the objective to help companies to answer to the main market needs.

Keywords: product lifecycle management, business process, competitiveness

1 Introduction

In today's demanding global economy, product success depends on company's ability to beat the competitors to market with products that capture customers' imagination with stylish yet appropriately functional content that performs as

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required while being delivered at a price the market is willing to pay. In other words, the products must be able to satisfy customer requirements for:

- Timing, Function, Performance, Style, and Price.

Since these variables frequently change during the course of a product lifecycle, the innovation process must be able to account for change and easily accommodate its demands on a systematic and repeatable basis.

Delivering the right product to market is only half the battle that today's product makers' face. Best-in-class companies employ lean manufacturing and design for-manufacturing initiatives to optimize the product lifecycle's downstream processes (Pol et al., 2008; Saaksvuori & Immonen, 2008; Grieves, 2009). The goal here is to enable product development teams and manufacturing teams to work together as early in the product lifecycle as possible to: minimizing production cost, improving product quality, delivering more reliable products, providing easier to service products, driving "green" initiatives that facilitate a sustainable environment.

Product Lifecycle Management (PLM) enables the kind of convergence that Enterprise Resource Planning (ERP) and Customer Relationship Management (CRM) prompted in the past. In the early 90s, ERP unified finance, HR, manufacturing and warehouse systems. A decade later, CRM brought call centre and sales force automation together. Now, Computer-Aided Design (CAD), Computer-Aided Manufacturing (CAM), Product Data Management (PDM) and manufacturing process are converging through PLM. Yet PLM is unique from other enterprise software solutions because it focuses on driving top-line revenue from repeatable processes. Through PLM, the products are a path to innovation, industry leadership, and top-line growth (Saaksvuori & Immonen, 2008; Grieves, 2009; Bernard & Tichkiewitch, 2008; Stark, 2004).

2 Product lifecycle management approach

Product Lifecycle Management (PLM) is generally defined as a strategic business approach for the effective management and use of corporate intellectual capital. Today, challenges faced by product development teams include globalisation, outsourcing, mass customisation, fast innovation and product traceability. These

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challenges enhance the need for collaborating environments and knowledge management along the product lifecycle stages. PLM systems are gaining acceptance for managing all information about the corporation's products throughout their full lifecycle, from conceptualisation to operations and disposal. The PLM philosophy and systems aim at providing support to an even broader range of engineering and business activities (Pol et al., 2008; Stark, 2004).

PLM is a strategic business approach that applies a consistent set of business solutions in support of the collaborative creation, management, dissemination and use of product definition information across the extended enterprise from concept to end of life – integrating people, processes, business systems and information. PLM is an integrated, information-driven strategy that speeds the innovation and launch of successful products, built on a common platform that serves as a single repository of all product-related knowledge, data, and processes. PLM is the process of managing the whole life cycle of a product starting from generating an idea, concept description, business analyzes, product design and solution architecture, technical implementation and product testing, to the successful entrance to the market, service, maintenance and product improvement. PLM gathered and make accessible data and information of all stages of this process.

As a business strategy (Pol et al., 2008; Saaksvuori & Immonen, 2008; Grieves, 2009; Bernard & Tichkiewitch, 2008), PLM lets distributed organizations innovate, produce, develop, support, and retire products, as they were if they were a single entity. It captures best practices and lessons learned, 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 (Figure 1) (Siemens PLM, 2009). They coordinate products, project and

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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.

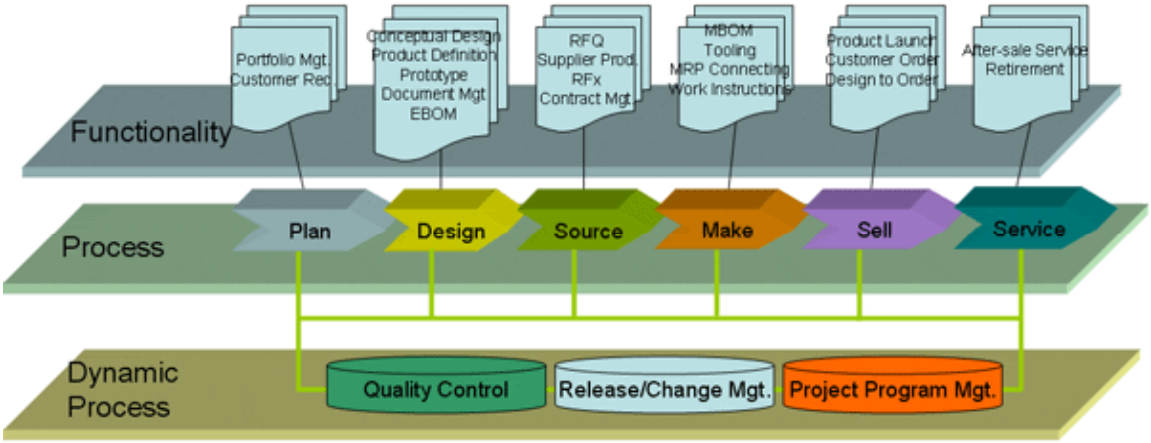

Figure 1. "Structure of PLM System". Source: Siemens PLM, 2009.

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:

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- 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 (IGES, STEP…)
    - Preserving data integrity along the time; Supporting data evolution
- Methods & Tools
    - Specific tools (CAD, CAE)
    - New development methodologies (Six Sigma, Axiomatic design…)
- People & Organization
    - Functional organization promotes incommunicability
    - Supply chain approach

3 Establishing of PLM

There are companies that supply software to support the PLM process. 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 (Kecojevic et al., 2010).

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

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- 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.

Fist 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.

As an example, for IT companies (Kecojevic et al., 2010), for collaborative software development projects can be used as SCM system where reusable implementation blocks can be stored. However, it is important that they are well organized and that information about its assessablity is available for all developers within the company, as well as that effective process is established for contributing creation and updating of those building blocks.

Similar applies, for example, for the ERP system where the solution can be some of the project management tools that are already used in the company.

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4 Application of PLM

4.1 Medium to large enterprises

In the current economic climate, addressing global business challenges is the top priority of most medium and large enterprises. Whether they want to expand their customer base in new markets, or to leverage more cost competitive resources, conducting their business globally is a necessity (Pol et al., 2008). To sustain an advantage, they have to overcome the challenges of a dispersed organization, while still empowering individual team members to excel.

PLM concept offers comprehensive solutions to help enterprises address their challenges and create competitive advantage. Five areas where medium and large enterprise should have achieved success include:

- Managing new product introduction, to create a winning product portfolio.
- Achieving concurrent engineering globally, to be faster to market.
- Creating platforms for reuse, to reduce cost and speed product customization.
- Managing product and manufacturing complexity.
- Supporting products currently in-service, to ensure they are available for use at minimum cost.

4.2 Small to medium enterprises

Small and medium enterprises have special needs and limited resources. PLM concept brings a complete solutions designed specifically for them; solutions that help them respond better to their customer's needs.

Small businesses need a product lifecycle management solution designed from the ground-up –one that is pre-configured with the industry's best practices, and offers fast and affordable deployment. Fully integrated PLM solutions are designed to provide what small and medium enterprises need to maximize their innovation strategy, and easily scale to meet their needs tomorrow.

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One producer of that type of PLM software solutions is Siemens PLM software (Siemens PLM, 2009). It helps mid-sized manufacturing companies to transform their process of innovation by applying preconfigured best practices to everyday engineering tasks and processes. Companies using PLM software benefit from:

- Securing their corporate design data while facilitating access by authorized personnel
- A more successful move from 2D to 3D
- Increasing their design reuse, facilitated by a powerful and flexible search capability
- Streamlining their engineering process with simple design review and release workflows and effective change management
- Error reduction through more effective collaboration between their departments and the elimination of mistake manual handoffs to manufacturing
- Rapid deployment of a full-featured product data management (PDM) solution
- Low total cost of ownership.

5 PLM Metrics Development Process

The questions often asked in business and commerce are how well do we know we're doing, and how do we know what we're doing is working? There is important to find out the metrics process for measuring what is important and meaningful (Grieves, 2009). The only way to find out answers to these questions is to measure the processes and outcomes of these processes. As PLM transforms the way companies do business, it is important that companies understand how well they are doing. To determine the effectiveness of PLM implementation within any context, PLM processes and outcomes need to be measured. Measurement of PLM requires the development of metrics that are important and meaningful to the process. It is essential that what is identified as a metric is relevant, appropriate and important, since typically what gets measured gets done.

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The objective of the metrics development process is to identify, develop, and articulate PLM metrics that would help companies implementing PLM determine the extent to which their PLM efforts are paying off. The PLM assessment process model shown at the Figure 2, conceptually presents the metrics development process.

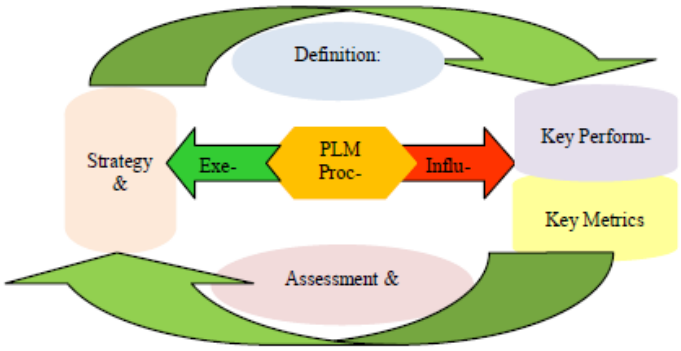

Figure 2. "PLM Assessment Process Model".

The PLM processes, including ideation, design, build, service, disposal, and recycling, on one hand influence the determination the key performance indicators of success on the other hand the execution of the strategies and initiatives depends on them. The key performance indicators are directly impacted by the organizational strategies and initiatives. In other words, the organizational goals and objectives define what the organizational considers success which should determine the key performance indicators. Key metrics are derived from the performance indicators. The key metrics measure what is relevant and important to the organization as outlined by the organizational strategic plan. Outcomes of the assessment and analysis using the key metrics impact the organizational strategic plan. These metrics are all tied to business objectives related to growth, revenue, and profitability.

PLM metrics can be applied at various levels of complexity:

- At the very basic Level 1 Input metrics are measured. At this level, the question is whether the organization is applying appropriate resources to the PLM process, i.e. investments.

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- At Level 2, metrics are used to determine if the appropriate PLM processes were implemented, e.g., Requirements Management, Sourcing and procurement, Distribution Quote/order generation.

- Level 3 focuses on customers being reached.

- Level 4 and 5 metrics examine the efficiency whether the outputs meet the needs of customers are being met (e.g., requirements traceability, visualization, concepts, design capture & accessibility, change control & change capacity, configuration management, commercial cost of risk, product quality) and effectiveness, if desirable results are being achieved (e.g., generation of new business, software integration, cost performance, market share, cost reduction, design reuse).

- At the highest Level 6 metrics are used to measure the impact of the implementation of PLM by measuring the extent to which procedures and controls have been integrated and the return on investment. Level 6 metrics are the most complex and difficult to measure. These include waste reduction, innovation/ new products, continuous improvement, and sustainable green manufacturing.

6 PLM Business Value

When the enterprise implements the PLM concept in work, than it can move forward strategically while achieving near-term results and can establish a platform for innovation. As the enterprise address specific business issues and builds a solid foundation for future success through PLM platform, it will be able to realize measurable innovation benefits both immediately and over the long term, shown on the Figure 3.

Traditionally, companies brought their products to market in time-consuming serial processes that delayed the participation of downstream contributors, such as suppliers, manufacturing experts and service/maintenance providers. By allowing to the enterprise to execute as many lifecycle tasks as possible in parallel processes, PLM enables to the enterprise to streamline and collapse critical stages in the product lifecycle. PLM delivers aligned, accurate, and highly synchronized product knowledge to multiple disciplines early in product lifecycle – thereby

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avoiding the cost and scheduling impact that comes when late suggestions and unexpected concerns arise from downstream players. PLM enables to the enterprise to beat the competition to market with innovative product content that carries first to-market advantages and drives early product sales.

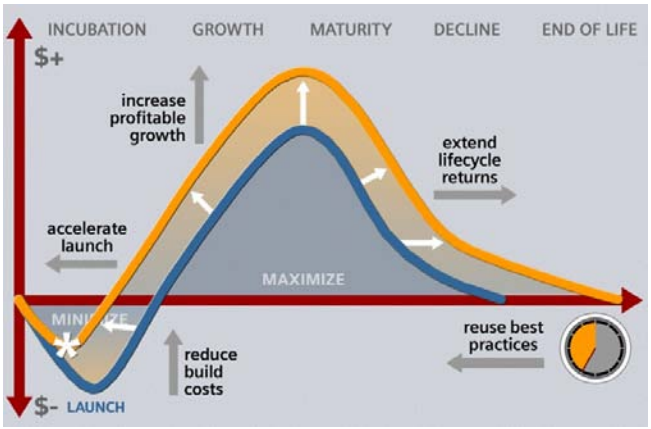

Figure 3. “PLM business value”.

6.1 Increase profitable growth

PLM allows the enterprise to create, capture and share the product-related requirements, expectations and preferences of targeted customers and markets and align these requirements with specific innovative content that customers want for a price they can afford at the time when it is needed. PLM concept gives new product ideas against quickly rising customer requirements and cost effective manufacturability. Global cross-functional teams collaborate in real time on the development process, each contributing their unique experience and perspective. Knowledge and “lessons learned” are captured for potential re-use in a process of continual innovation. PLM facilitates mass customization by enabling to rapidly and costs effectively deliver customized product offerings that satisfy the needs of individual customers and targeted market segments. PLM combines the advantages of configuration management with option and variant management. These state-of-the-market capabilities allow the enterprise to perform portfolio planning in as flexible and continuous a process as possible.

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6.2 Reduce build costs

PLM allows the enterprise to reduce cost across all of the stages in the product lifecycle – which in turn, enables to minimize the cost of the product offerings that plan, develop, manufacture, and support.

For example, by leveraging PLM to understand the time and resource impacts of proposed design changes and requirements changes, the enterprise's team can make decisions that minimize lifecycle and product costs. By using PLM to catch design flaws up front in the lifecycle, the team can avoid the cascading rework and cost associated with changing the products during the manufacturing stages of the product lifecycle. Also, the enterprise's team can use PLM to incorporate the concerns of the maintenance and service groups into the product designs and minimize warranty costs. By digitally creating and re-using the manufacturing plans, plant information and manufacturing processes, the enterprise can reduce the overall operational costs. The enterprise can also use PLM to implement virtual prototyping that enables to reduce the validation costs associated with physical prototyping.

Implementation of the PLM concept in the enterprise enables to cost effectively deliver product enhancements, derivatives, niche offerings and add-ons that extend the profitable duration of the product lifecycle. PLM facilitates this objective by enabling to create product platforms that accelerate start up processes, minimize take to market cost and maximize the revenue generated by a product's initial release.

PLM enables the enterprise to maximize the re-use of the best-practice processes, intellectual capital, human resources, product plans, production plans, production facilities and value chains across a continuing set of take-to-market programs and complete set of product and production management capabilities.

7 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

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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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