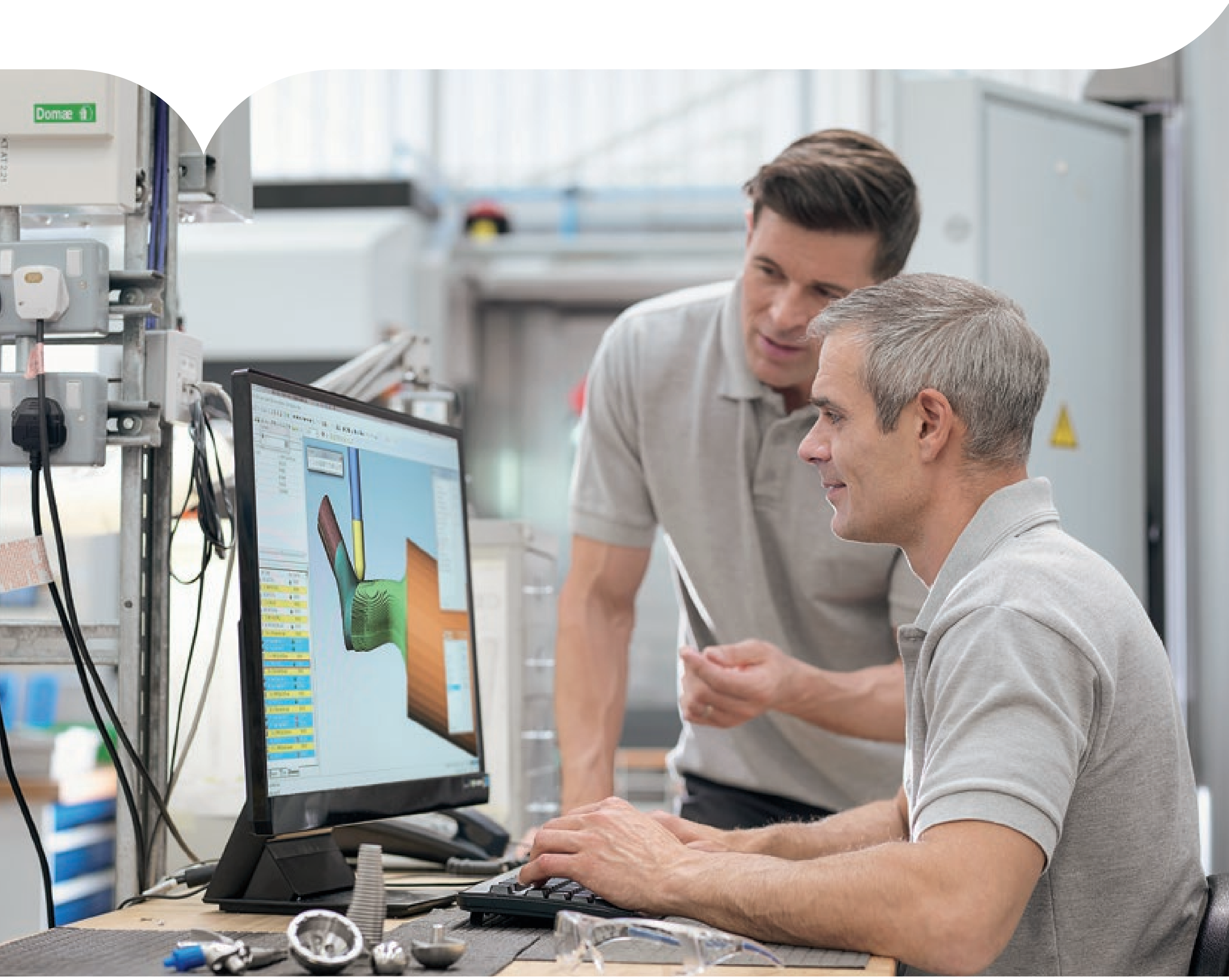
Unraveling the complexities and nuances of modern Product Lifecycle Management (PLM) solutions

Innovative approaches to collaborating, virtualizing, and accelerating your product design, development, and launch



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Abstract

Product lifecycle management (PLM) defines how to manage and automate product lifecycle processes, from product conceptualization to retirement. This paper outlines both the fundamental concepts and the key functional components of a PLM system. It describes key industry imperatives such as virtual product development, product-process-resources methodology, a collaborative PLM, and corresponding synthesis approach.

Manufacturing Challenges in the Digital Age

Today's manufacturers, no different from their predecessors, are intent on achieving faster time-to-market and lowering costs. It is not just large enterprises that are involved. Increasingly, small and medium enterprises are also taking on complex design, often in regulated environments, and demanding similar speed and control over new product development and launch processes.

Product Lifecycle Management (PLM) solutions today are a continuous source of innovation and improved industrial performance. The tools that enable this transformation result in products with strong value-add and establish collaborative business processes within both the company and the corporate ecosystem that optimize and control productivity.

In the digital era, the stakes are higher. Companies need to shorten the time it takes to get a product from concept to production by operating a seamless end-to-end process, regardless of the location of different teams. For example, they must be able to exchange data and design products independently of a team's location. Another key objective is to construct the entire product design cycle by building efficient information exchanges that enhance data traceability and minimize discontinuity across product development stages. Indeed, all the industrial processes leading to the manufacturing and maintenance phases must be transparent in order to ensure the accountability of any action taken. A key, rapid enabler of this is the complete virtualization of the PLM process to reduce the time and space requirements of the various PLM stages.

Product Lifecycle Management (PLM) is the underlying system that supports the management and automation of product lifecycle processes, from product conceptualization to retirement. PLM enables companies to automate, monitor, and track product development and revision processes with their customers, suppliers, and employees. It is an important tool to manage the increasing pressures of mass customization, connected products, globalization, regulatory compliance, increased outsourcing, and product accountability. PLM applications, typically integrated with ERP systems, extend critical product information visibility and processes beyond engineering and IT departments, influencing multiple parts of the value chain.

Fundamentals of PLM

How does PLM compare to Product Data Management and CAD?

PLM is much more than Product Data Management (PDM) and Computer Aided Design (CAD). While PDM and CAD permit quick data storage, evaluation and design modification, PLM actually guides the product through its entire lifecycle.

In addition to supply chain benefits, PLM promises to enhance the design environment by providing an integrated view of product engineering, manufacturing engineering, and plant resources. It applies a consistent set of business solutions in support of collaborative creation, management, and use of product definition information.

In the following sections, we highlight the three major components of PLM that work together to create an operational ecosystem for success:

Virtual Product Development Management (VPDM)

Manufacturing enterprises have always focused on increasing the efficiency of their operations to deliver higher levels of profitability and margins. They achieve this through a combined effort of improved product development and production processes, higher product quality, and improved customer satisfaction.

Virtual Product Development Management (VPDM)—suited for conceptual and early design—provides the answer through higher levels of product innovation, better product quality, lower costs, and accelerated time-to-market. Basic VPDM is the part of the PLM process that provides the necessary tools used to engineer product design phases. Here, the key success factor is to be able to manage powerful patterns such as design-in-context, relational design, features-based approach, and knowledge-ware-driven architecture.

Product-process-resources (PPR) methodology

The most successful PLM projects are the ones that tackle the issues between the interfaces of the different product phases. This is achieved by viewing PLM as a business process, not simply as an automated function. These projects use virtualization as a way to model their process and digitize all functions.

The design of products, along with processes and resources, must clearly map business information with the customer perspective. The ability to manage seamless information exchanges across the product lifecycle requires clear associations between the “design-centric” activities and the “process-centric” activities. It is directly linked to the capacity to implement basic modeling components that allow for collaboration between the products, the processes (using these products), and the resources or assets that model these products within the process. In real life, such associations must be managed in the configuration context by taking account of the various options and alternatives of the product for a given process.

Existing Architectures

In order to identify the value-add of the PPR model, it is necessary to put it in context with the architectures used in production today. Conceived in the nineties, these early systems manage configured data and associate them with process data to control the impact of modifications, and thus manage costs. The manufacturers that implemented such systems put in an array of complex components to meet their specific operational needs. Now these tools require interoperability to satisfy the current productivity challenges. Additionally, the leading manufacturers typically have several different software products that need to be integrated. Usually, this type of architecture includes the following systems:

- Configuration management system
- PDM system
- VPDM system

Today, these systems function at a significant cost: this is where the PPR model has the potential to add value. The more complex and heterogeneous the architectures become, the greater are the risks of disrupting conceptual models and customer business processes. Among the limitations of systems conceived a few years ago are:

- Systems working independently of each other, resulting in information silos
- Absence of model-driven approaches resulting in a lack of data associations required to federate data in a given context and to produce a clear objective
- Lack of association between these models, restricting any updates as per new design needs.

A slightly better alternative creates an associative copy, and allows users to create additional descriptions that adjust the feature to the new design context. However, these additions may contradict the original data, not just extend it. The source changes further require the updated copy to be re-interpreted and changed via these extensions.

The above challenges highlight that the cycle time for resynchronizing various models to ensure the integrity of the unit within each architecture component is far from optimal. This automatically limits the implementation of the scenarios based on the propagation and management of impacts though these scenarios represent a method to reduce costs. We can conclude that components of these architectures only allow data exchanges, rather than associated data management, along with a model-driven approach.

Modeling—a complex but necessary ingredient

A well-modeled PLM approach provides comprehensive knowledge of a company's product lifecycle. The associated process modeling effort can be complex and rigorous, but the effort will prove worthwhile. In parallel, it requires the management of a company's intellectual property (IP) rights in order to capitalize and protect them. In the PLM model, the availability of specific tools are very helpful due to their capacity to virtualize the processes without detracting from industrial reality. A robust simulation environment ensures that this industrial reality is maintained for all the design phases. The use of 3D modeling to simulate a product reference is one of the most relevant tools within a PLM framework for both engineering and IT. 3D modeling is also a key driver of digital manufacturing.

What are the components of a PLM solution?

The PLM solution comprises six distinct sub sectors including:

- Portfolio management (requirements and regulatory management)
- Program management
- Product data management
- Collaborative design
- Manufacturing process management
- Service and support management.

Combined, these solutions enable a company to manage its products over the entire lifecycle.

Digital Collaboration across Design Teams

Collaborative engineering is an integral element of successful PLM solution. It requires design teams to work on a virtual model of a product, and to connect using a digital communication network.

Collaborative engineering outlines the following key fundamentals for efficient PLM systems:

- Mechanism for sharing the configured digital mock up
- Ability to share all product data, including:
  - A configured product structure
  - The interfaces between Work Packages data
  - The 3D part definitions
  - Mechanisms, bounding box, simulation, etc.
  - Actions/modifications in progress
  - Conflicts/Studies

Some of the critical questions that collaborative engineering poses include:

- How to ensure the proximity and collaboration necessary to successfully achieve complex projects, even if teams are culturally diverse and work from different company locations?
- How to develop subsystems while taking into consideration the constraints of the broader system?
- How to maintain project cost reduction levels through cooperation among trade groups or equipment suppliers, while ensuring information security and IP protection?

In addition, concurrent engineering and design in context of an evolving product need to gain support from the ability to share “design intent” and product construction data such as specifications data, geometrical publications, or interfaces, with the pattern to manage interchangeability of the geometrical object, connectivity links, and applicable data (3D tolerance, knowledge rules).

This results in a shared baseline, that responds quickly to changes appearing late in the specifications definition. The transformation further strengthens the relationship between clients and subcontractors and reinforces their integration throughout the product lifecycle, allowing for division of the PLM reference frame into strong and clear semantic content and extending the benefit of the PLM across all stakeholders throughout the value chain. In addition, phases of teamwork for integration and collaboration can be balanced. Due to this approach, Virtual Co-location or Engineering Package Exchange can remedy any lack of collaborative alignment.

PLM Synthesis

In order to complete the overall life cycle of product management, we also need to consider the early product definition phase. Many companies start product development by listing product requirements in documents that act as the initial artifacts for product design and engineering teams to start product development.

Today few companies use dedicated Systems Engineering (SE) tools to capture the definition of product data. These SE tools, however, provide excellent support for the needs of systems engineers to capture data at the requirement and functional design level to build the logical system view.

This SE lifecycle integration would help to take advantage of key mechanisms across the different component aspects and result in traceability, impact management and inherent associations especially in a configuration context.

Key Benefits of PLM

The following are the major benefits of PLM when used as a foundation for product development:

Uninterrupted innovation

Taking a collaborative PLM approach enables better exploitation of digital capabilities for defining processes, creating mock-ups, and supporting rapid testing of more design options.

Product integrity

The use of numerical definition and the contextual part design can accelerate the synthesis and generalization of product simulation in order to cover the product cycle from requirements to maintenance and support.

Agility and Reactivity

Collaborative design will significantly reduce the effort required to realize design modifications.

Optimization of Costs

The use of precise numerical models reduces the number and complexity of tools, physical prototypes, and assembly schedules (predicting activities such as the pre-drilling of the parts).

Future of PLM

Competitive pressures, customer demand, and the need to cut operating expenses continue to drive the need for a shorter product life cycle. In this respect, PLM products and future applications with product-specific functionality give manufacturers the tools to collaborate with partners for faster time-to-market. There is a lot of room for PLM to grow as a suite of solutions with the potential to be as broad as existing CRM or SCM solutions. There are additional scenarios where PLM creates new roles or introduces new capabilities, such as:

- Exploiting PLM information beyond the engineering phases and bringing new tools to the industry in order to simulate and build new products
- Virtualization enables the production chain to assess the utility of new technologies for use in the manufacturing process
- Integrating these technologies in manufacturing plants will be possible by transforming them into solutions guided by improved industrial processes
- Many small and medium enterprises are creating products and competing with larger vendors in this PLM solution market
- Alignment of PLM services with technological standards and solutions will ensure compatibility and reuse.

Transformation of the entire PLM value-chain, while selecting the right tools and implementing digital capabilities, is a complex undertaking that requires the focus of top leadership, collaboration with partners, and comprehensive change management. Indeed, many organizations are choosing to work with integration partners to deploy their PLM solutions. This allows them access to three critical success factors: industrial business processes, use cases in operation, and inherent technologies. At the same time, next-gen PLM solutions aim to embrace technologies across Big Data, IoT and IIoT, analytics, connectivity, mobility, cloud, and security management while addressing dynamic customer expectations that continue to disrupt entire product lifecycle and corresponding business models.

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