International Journal of Industrial Engineering and Management (IJIEM), Vol.3 No 1, Month 2012, pp. 15-23
Available online at www.iim.ftn.uns.ac.rs/ijiem_journal.php
ISSN 2217-2661

UDK: 005.7:658.6 **Research paper**

Lean PLM - Information Technology Strategy for Innovative and Sustainable Business Environment

Valentina Gecevska
Associate Professor, Faculty of Mechanical Engineering, University "Ss.Cyril and Methodius" in Skopje, Karpos 2 bb, P.O.Box 464, Skopje, Macedonia, valentina.gecevska@mf.edu.mk

Ivica Veza
Professor, Faculty of Mechanical, Electrical Engineering and Naval Architecture, University of Split, Split, Croatia, ivica.veza@fseb.hr

Franc Cus
Professor, Faculty of Mechanical Engineering, University of Maribor, Maribor, Slovenia, franc.cus@uni-mb.si

Zoran Anisic
Professor, Faculty of Technical Sciences, University of Novi Sad, Novi Sad, Serbia, anisic@uns.ac.rs

Nedeljko Stefanic
Professor, Faculty of Mechanical Engineering and Naval Architecture, University of Zagreb, Zagreb, Croatia, nedeljko.stefanic@fsb.hr

Received (18 December 2011); Revised (17 January 2012); Accepted (27 January 2012)

Abstract

In today's process manufacturing environment, innovation is viewed as critical to sustainable growth and business profitability. While innovation is regarded as the answer, the companies can effectively measure the return on R&D investment, have acceptable product success rates, achieve acceptable promotional effectiveness, or have visibility into their compliance risks or operational readiness for new product launches. Companies must have repeatable, compliant and responsive business processes, global ICT information infrastructure that provides a single source of the truth, alignment across departments and solutions that evolve without coding. With holistic strategy and supporting infrastructure, companies can consistently minimize the time to scale, improve product success rates and promotional effectiveness, and enjoy sustainable and profitable growth. The companies must first focus on the needs of their customer, continually minimize time to scale, eliminate waste, drive out costs and improve. These are core concepts of a Lean strategy. This paper will describe how Lean concept with PLM business strategy can leverage Lean with integrated compliance, continual improvement and other PLM best practices to increase the return on R&D investments and provide sustainable and profitable growth for business processes mainly manufacturing processes. The purpose of this paper is to review PLM approach linked to Lean concepts in order to achieve sustainable and innovative business environment with profitable growth.

Key words: *PLM, Lean concept, Innovation, Sustainability, Business environment*

1. INTRODUCTION

In today's challenging global market, enterprises must innovate to survive. Business innovation must occur in all dimensions—product, process, and organization—to improve competitiveness and business performance. To differentiate themselves, enterprises must capture, manage, and leverage their intellectual assets. This can best be accomplished through proper application of a Product Lifecycle Management (PLM) approach that addresses the needs of the extended enterprise [2,5,6]. PLM is a strategic business approach that helps enterprises achieve its business goals of reducing costs, improving quality, and shortening time to market, while innovating its products, services, and business operations and also, with including the idea of open innovation [2,4,8].

Once implemented, PLM solutions provide benefits that have demonstrated a positive impact on an enterprise's top and bottom lines. PLM solutions can improve business efficiency by providing:

- Reductions in time and cost of product changes;
- Significantly shorter product cycle and lead times;
- Decreased scrap and rework during production;
- Improved productivity in design engineering.

2. BUSINESS CHALLENGES

Businesses today face three on-going challenges: improving customer intimacy, achieving operational excellence, and providing product leadership. Improving

customer intimacy requires understanding and responding quickly to current and potential customers, their needs and providing consist, long-term customer value. Achieving operational excellence requires enterprises to focus on operating efficiently, effectively, and flexibly, working with their partners to reduce the cost and time necessary to deliver high-quality products meet their customer's requirements in a timely manner. Providing product leadership means delivering leading edge products and solutions tailored to customer needs.

To meet these challenges, businesses must become more innovative. However, being an innovative business doesn't simply mean creating innovative products.

It also means improving the processes a company uses to produce its products and how it supports its products using innovative approaches to the complete product lifecycle. Today, innovation is recognized as critical for a business to maintain its competitiveness in the marketplace. However, innovation must be achieved while reducing overall product-related costs across development, production, and service.

To be successful in global markets, organizations must develop and apply a diverse set of skills and business processes. Global enterprises must:

- Make effective use of a widely-distributed worldwide organization, creating a virtual value chain with no time, distance, or organizational boundaries.
- Ensure that corporate acquisitions and mergers work together.
- Create and enable virtual product teams composed of people that are spread around the world
- Leverage the intellectual assets in these dispersed teams and organizations
- Enable 24 x 7 development and product support using global teams

These drivers are putting increasing pressure on organizations to invest in solutions that include technologies, methodologies, best practices that can help them improve their ability to focus on product innovation, leverage business partners, and compete more effectively in the global market place.

There has been a continuous evolution of what PLM represents, as illustrated in the figure below, Fig.1. Fifteen years ago, custom implementations focused on precise applications wrapped around primarily engineering design data. In the late 1980's, the major emphasis was on how to manage engineering drawings, with limited solutions primarily sold to managers in engineering departments. Today, the focus is on complete business solutions that address top and bottom line issues. These solutions incorporate best practices to allow organizations to migrate their business processes toward industry standards.

2.1 **Business approach**

PLM is a definition of a business approach to solving the problem of managing the complete set of product definition information — creating that information, managing it through its life and disseminating and using it throughout the lifecycle of the product. PLM is not just a technology, but is an approach in which processes are as important as or more important than data. It is critical to note that PLM is as concerned with "how a business works" as with "what is being created."

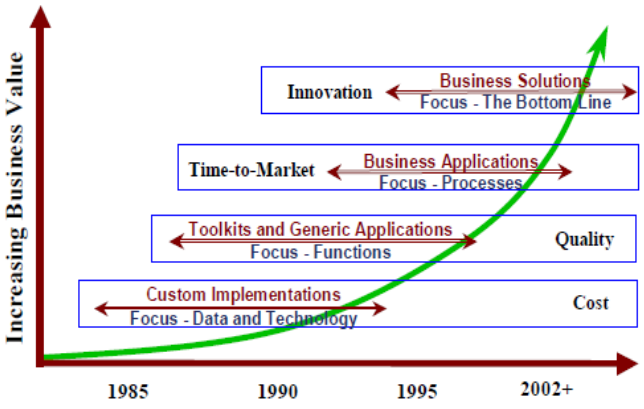

Figure 1. Evolution of PLM idea [1]

Three core or fundamental concepts of PLM are:
1. Universal, secure, managed access and use of product definition information
2. Maintaining the integrity of that product definition and related information throughout the life of the product or plant
3. Managing and maintaining business processes used to create, manage, disseminate, share and use the information.

PLM model describes the technology, management and process components of an enterprise PLM solution. Across the bottom of the model are technology foundation components that are an integral part of any PLM solution. Solution providers use these foundation elements to construct core functions, such as design automation, product structures and Bills of Materials, workflow and process management, and information and content management and vaulting. These core functions are inherent capabilities contained within PLM solutions.

ERP is integrated or interfaced with PLM. ERP has traditionally dealt with the product production lifecycle. Over the last several years, the focus shifted from ERP to other enterprise solutions such as SCM, CRM, and now, PLM. As part of the continuing evolution, new solution providers are beginning to deliver products that combine some ERP and some PLM capabilities into one offering. Other business functions, such as the logistics of supply chain management, logistics itself, marketing and sales, distribution, HR, and finance are not part of the basic PLM capabilities, but they all interact at multiple points along the product lifecycle or with components of a comprehensive PLM solution.

The figure below (Fig.2) shows the relationships between these enterprise solutions. Product businesses have at their core the intellectual assets describing their products. Typically, PDM solutions were used to manage product development and design work-in-process. Once a product could be released to

manufacturing, ERP took over. Supply chain management was often used by procurement to support the production function. Once the product was in the field, CRM systems helped manage the customer relationship. Today's businesses require enterprise solutions that can integrate all of this disparate information to optimize product development, production, and deployment. CRM data must be used to embody today's customer requirements into the next product generation. To save money, SCM systems must be active from the beginning of the product definition lifecycle, saving procurement time and money while supporting the product development process. Business partners, suppliers, and customers must all have visibility into this information to optimize their decision processes to benefit the enterprise. PLM is becoming the overall view port or portal into such product definition information and processes, providing collaboration and integration functions to synthesize information residing in CRM, SCM, ERP, and other business systems to enable new, complex business solutions.

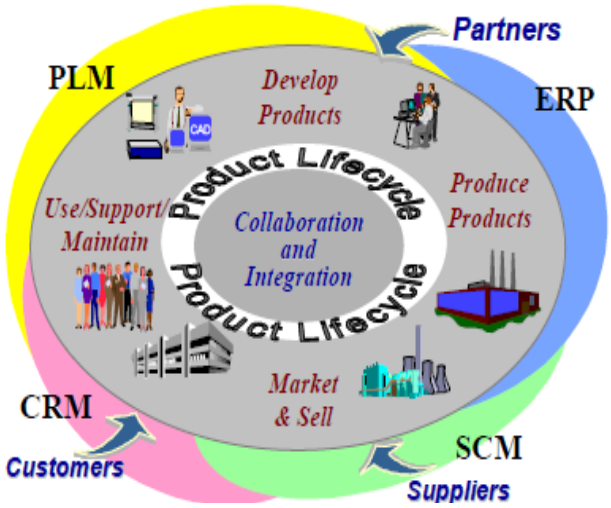

Figure 2. Relationships among Enterprise Solutions

Additionally, PLM solutions improve an individual's performance by managing not only product definition information, but by guiding and facilitating their tasks through well-defined business processes and workflows.

PLM solutions have a very positive effect on process efficiency and effectiveness by supporting and encouraging work in a more structured manner and providing the right information, at the right time, to the right people.

PLM solutions touch every aspect of an enterprise. The ability to effectively integrate and use product definition information is important to sales and service, marketing, production planning, plant operations, customers and suppliers. All disciplines need detailed, timely knowledge of what products are being designed and produced.

3. LEAN CONCEPTS COMPLIMENT PLM BEST PRACTICES

3.1 **Defining Lean**

According to LEI (Lean Enterprise Institute) [9], the core idea of Lean Management (LM) is to maximize customer value while minimizing waste. Simply, lean means creating more value for customers with fewer resources.

A lean organization understands customer value and focuses its key processes to continuously increase it. The ultimate goal is to provide perfect value to the customer through a perfect value creation process that has zero waste.

To accomplish this, lean thinking changes the focus of management from optimizing separate technologies, assets, and vertical departments to optimizing the flow of products and services through entire value streams that flow horizontally across technologies, assets, and departments to customers.

Eliminating waste along entire value streams, instead of at isolated points, creates processes that need less human effort, less space, less capital, and less time to make products and services at far less costs and with much fewer defects, compared with traditional business systems. Companies are able to respond to changing customer desires with high variety, high quality, low cost, and with very fast throughput times.

3.2 **Lean PLM**

The focus of lean PLM is to address the need of the right amount of product data in different stages of product life cycle to serve the requirement of business intelligence, based on which sound business decisions can be made in a timely fashion [10].

PLM is often global, across multiple business entities, therefore, lean PLM would also address the needs for intelligent, secure and efficient communication across board. For small and medium local businesses, lean PLM would address PLM needs in the form of on-demand requirements for on-demand services.

3.3 **Lean PLM Implementation**

Lean PLM implementation is to apply the lean principles to a PLM implementation to ensure that all ingredients in the implementation is well justified and of value and there is no waste and there is minimum change needs.

According to LEI [9], there are 5 steps in the lean practice:

1. **Identify value** - Specify value from the standpoint of the end customer by product family.
2. **Map the value stream** - Identify all the steps in the value stream for each product family, eliminating whenever possible those steps that do not create value.
3. **Create flow** - Make the value-creating steps occur in tight sequence so the product will flow smoothly toward the customer.
4. **Establish pull** - As flow is introduced, let customers pull value from the next upstream activity.
5. **Seek perfection** - As value is specified, value streams are identified, wasted steps are removed, and flow and

pull are introduced, begin the process again and continue it until a state of perfection is reached in which perfect value is created with no waste.

3.4 **Lean PLM collaborating aspects**

A core component of Lean is focusing on the customer. For many production and manufacturing processes, they must need to focus on the consumer or customer, retailer and distribution. To achieve this, collaborating with aspects of the value chain, validating constraints and compliance early and often, continually optimizing portfolio management opportunities, managing knowledge and intellectual property, integrating to the extended enterprise systems, engraining governance into processes and continually improving without coding are standard PLM best practices [12]. These PLM best practices will allow the company to continually minimize time to scale, eliminate waste, and drive out costs.

Focusing on the customers: To drive growth and profitability, companies need to focus on the customer and must identify their unique value propositions for customers and align these with their channel. Defining your critical-to-customer, critical-to-retailer and critical-to-quality characteristics is an important first step. With these critical characteristics, R&D costs can be lowered by not designing in non-value added capabilities, time can be reduced by eliminating non-value added iterations, excess material costs and carrying costs can be eliminated, product quality and consistency improved, and regulatory risks reduced. Integrating these into R&D concept, development and commercial applications and providing continual validation will ensure products meet customer expectations and improve product success rates. Additionally, lead times are reduced, waste is eliminated and costs are reduced.

Collaborating with aspects of the value chain: To improve quality, increase innovation, reduce costs and time, many researches concluded that increased collaboration is essential. Extending collaboration from R&D (research & development) and SCM (supply chain management) to suppliers and retailers will provide increased agility, extend internal capabilities, reduce time, improve quality, lower costs and improve innovation. To identify the best way to optimize profit potential, retailer collaboration can result in better shelf placement, increased revenue, improved turns and lower retailer costs. As part of developing retailer-specific products, the supply chain must be integrated into the process and operational readiness improved. As new capabilities or capacity are required, supplier collaboration and enablement programs can reduce time and costs, improve quality and increase innovation.

Further, many companies are increased levels of collaboration, both internally and across the enterprise, in an effort to increase agility and velocity. This results in reduced lead times, lower costs, improved quality and compliance and increased innovation, not to mention sustainable growth and profitability.

Validating constraints and compliance: As lead times are compressed, participation of additional resources and product complexity increased; early identification of potential issues and timely mitigation is critical. The earlier a project can be stopped or realigned, the less capacity is wasted, the further costs are reduced. At any stage of development, target specifications, product and project costs and projected dates can be validated, and regulatory restrictions by market and product type best-practices guidelines can be checked. In addition to these R&D-oriented validations, supply chain constraints and vendor compliance capabilities that are validated late in the development process can be proactively validated. A supplier's capability matrix rating, social responsibility, sustainability index, enablement status, quality rating, preference status, compliance risk and readiness values can be used to identify the best sustainable source of materials or products.

Managing knowledge: This is crucial phase of product's realization. Effective reuse of knowledge and intellectual property is keys to reducing time, eliminating waste, reducing costs and improving quality while meeting customer requirements. Ready access to relevant and accurate information can eliminate the need to search for information in multiple systems or offline sources. It will eliminate non-value added, trial-and-error iterations and halt the initiation of dead end projects. To achieve these benefits, information must be effectively captured, categorized, validated, secured, put into global content, referenced to adjacent information, and the relevance status maintained through the lifecycle. Semantic search engines can mine the data and visual-comparison engines can help turn data into relevant and actionable information. When information needs to be provided to the extended value chain, specifications are used to communicate the appropriate information and secure intellectual property.

Integration to the extended enterprise system: To make, source, distribute and sell products, PLM information must be integrated into extended enterprise systems. For most companies, the PLM system information will not be different from the operational planning systems. Some R&D-oriented or proprietary information will not be integrated to the extended enterprise systems. Items, components, formulas/recipes, routings, products, new vendors, quality specifications and new customers must be sent to the ERP system. To ensure R&D is working with the most current information, costs, quality, sourcing, product or pilot assays and production volumes and status changes must be communicated back into PLM. Collaboration with vendors, customers and retailers via collaborative workspaces or integration can shorten time, reduce costs and improve quality.

4. 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 [3,5,7]. 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.

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 3, conceptually presents the metrics development process.

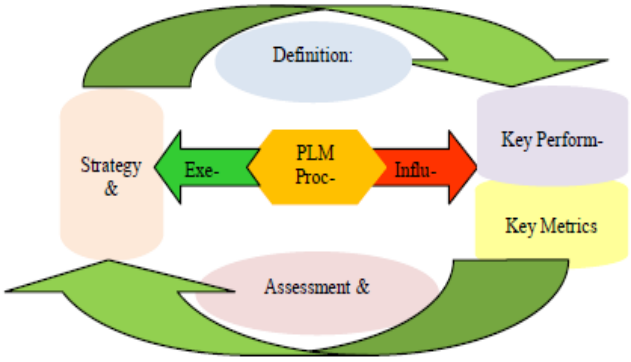

Figure 3. PLM Assessment Model [7]

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, explained in follow according to [2,6].

- 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.
- 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.

5. 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.

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 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.

5.1 **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.

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.

PLM with IT tool 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.

5.2 **PLM IT tool – Siemens PLM Teamcenter**

Teamcenter suite by Siemens PLM is built on the latest IT technology with a unified SOA and all modules share a common data model and database [13,14]. Teamcenter includes three foundational areas: Enterprise Knowledge Foundation, Platform Extensibility Services and Lifecycle Visualization.

Teamcenter also contains fourteen functional areas: Supplier Relationship Management; Systems Engineering and Requirements Management; Manufacturing Process Management; Simulation Process Management; Maintenance, Repair and Overhaul; Reporting and Analytics; Community Collaboration; Mechatronics Process Management; Engineering Process Management; BOM Management; Compliance Management; Content and Document Management; Formula, Package, and Brand Management; Portfolio Program Management.

The following paragraphs briefly describe the seventeen components of today's Teamcenter unified platform. Enterprise Knowledge Foundation provides the ability to capture and manage an extended enterprise's product definition information (i.e., the extended enterprise's intellectual assets)—integrating the organization's people, processes, systems, and data in a manner that enables all to collaboratively work together to define products and the processes necessary to define, build and/or assembly, maintain, and decommission and/or recycle.

Platform Extensibility Services deliver the ability to quickly and easily configure Teamcenter to support specific business and system integration requirements—not just when the solution is first implemented, but also in support of upgrades and general continuous improvement projects. The embedded Business Modeler Integrated Development Environment (BMIDE) is used to configure Teamcenter without having to write and support customized code. It can also be used to develop customer-specific integrations with other business systems that can be automatically upgraded as new Teamcenter releases are deployed.

Lifecycle Visualization enables people to view and work with both 2D and 3D product information. This capability is provided to users throughout the enterprise, suppliers, partners, and customers without the need for these people to own or know how to use the information authoring tools such as CAD.

Supplier Relationship Management (SRM) enables an enterprise to effectively manage and engage its supply chain to manage product costs and quality including supplier performance. It includes a disciplined and systematic process for reducing the total costs of externallypurchased materials, goods, and services while maintaining and improving levels of quality, service, and technology and to evaluate, prioritize, and manage preferences for supplier utilization.

Mechatronics Process Management provides mechanisms that support coordinated management of centralized data, workflow, authoring tools, and process management for the integrated development of mechanical, electrical, electronic, and software components and systems as part of a single product, and to communicate this information appropriately throughout the organization.

Systems Engineering and Requirements Management (SERM) provides a mechanism to facilitate the capture and analysis of customer needs and then associate those needs with formal requirements (e.g., performance, maintainability, reliability, manufacturability, usability, and ergonomics characteristics) that the product and/or productrelated processes must deliver. These requirements may be associated with the product across potentially all stages of the product lifecycle. SERM also provides mechanisms to outline and organize systems designs, in association with multiple product decompositions, and associate product requirements into the designs as appropriate for both initial product development and further enhancements and change process support.

Manufacturing Process Management (MPM) provides a mechanism to describe, simulate, optimize, and release manufacturing process plans and related definitions in collaboration with product design activities, and to communicate this information appropriately throughout the organization.

Simulation Process Management (SPM) provides mechanisms to integrate the creation, utilization, and management of simulation data and processes into the context of the full product definition and PLM environment. This also includes the ability to capture and utilize best-practice analysis processes to provide consistency and effective simulation support to product development.

Maintenance, Repair, and Overhaul (MRO) enables companies to manage the maintenance, repair, and overhaul of complex products such as aircraft, ships, and plants throughout their lifecycle—from concept through to end-oflife (e.g., decommissioning). It provides knowledge of a product's configuration, its maintenance and repair history, how it can be serviced, and what spares, test, and service equipment must be used to maintain the product or system as well as

capabilities to define, schedule, and track maintenance activities. Additionally, MRO supports claims and warranty management by providing capabilities necessary to define and manage processes specifically focused at handling those activities.

Reporting and Analytics includes the tools to collate, analyze, and produce data through pre-defined and ad-hoc reports, digital dashboards, and email for real-time sharing of business intelligence. It provides a basis for companies to establish, measure, and analyze key product related performance metrics to drive decisions and processes throughout the product lifecycle.

Community Collaboration provides a platform for sharing information and working together across the product lifecycle. Real-time collaboration and application sharing can be used to create an environmentfor product and process information to be communicated among all key participants in the product lifecycle. It provides capabilities to securely integrate product lifecycle management data from many different sources into one interface.

Engineering Process Management enables the overall management of the product design process and the resulting product definition information including the collaborative manage of all design process tasks and the process interaction with internal as well as external design supply chain partners. It supports the consolidation of product design and related information from multiple distributed sources within a single product data management (PDM) system and automation of engineering change, validation and approval processes. It supports multi-CAD data and the ability to aggregate design changes continuously.

Bill of Material (BOM) Management provides the ability to create and manage product structures and their multiple logical constructs. These products structures include part-to-part, part-to-document, and document-to-document elationships so that a complete bill of information (BOI) can be defined and managed throughout a product's and its associated information's lifecycles.

Compliance Management enables the definition, tracking, and reporting of all product-related information and activities required to confirm that a product meets regulatory compliance metrics. It is generally implemented with industry-specific solutions, e.g., Food and Drug Administration (FDA) compliance for pharmaceuticals or medical devices. Compliance Management is also used to support tracking and managing export controlled product related information, e.g., International Traffic in Arms Regulations (ITAR).

Content and Document Management provides the ability to define, authorize, illustrate, manage, and deliver exact product information in the reader's preferred language and media. It supports and can be integrated with multiple authoring environments including Microsoft Office and CAD design applications. It can automatically update documents and other content when components of those items are changed. Content and document management provides full configuration management and change control of all elements, components and full documents.

Formula, Package, and Brand Management supports the ability to define and introduce to the market formula-based products, including their packaging, artwork, labels, claims, and other package and brand-related content. This includes the ability to manage formulas and configurations of formulas, specifications, mixing instructions, etc. that describe specific recipes and how they are to be produced. it includes the ability to define and manage a set of intelligent specifications that are interrelated and that describe the various components of a formula-based product including management of the physical package definition, its artwork, labels, claims, etc. For brand management it supports the management of logos, product and package photos, marketing material, etc.

Portfolio, Program and Project Management encompasses three areas—idea and concept, product portfolio, and project management. Idea and Concept Managementenables organizations to capture ideas for new products or services, study their market potential and technical constraints, evaluate if, when, and how to efficiently produce them and then develop a short list of promising product concepts that match a company's strategy. Product Portfolio Management focuses on identifying, evaluating, and managing the "family" or portfolio of products that a company offers and maintains. It includes capabilities to compare product investment alternatives according to market demand, competitive pressures, macro-level cost rollups, project sales and profitability estimates, overall resource needs, status reporting (including visual dashboards), and other information and processes needed to enable a company to determine the best ideas and products in which to invest, build, and sustain. It combines and gives visibility into the financial, strategic, and operative aspects across the entire project portfolio to enforce governance, make fact-based decisions and maximize return on existing assets. Project Management enables project managers to control project structures, schedules, costs, and resources. This includes network planning techniques and aggregative tools that support cross-project cost, revenue, margin, schedule, and resource management.

At the Figure 4 is shown the interface of the software using the transformer as a real product.

6. 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. In this paper, it is made analysis of using of PLM approach, by those who are doing execution and by decision makers within the organization answering to the rapid changes in the business environment. 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. PLM workflows are implemented to

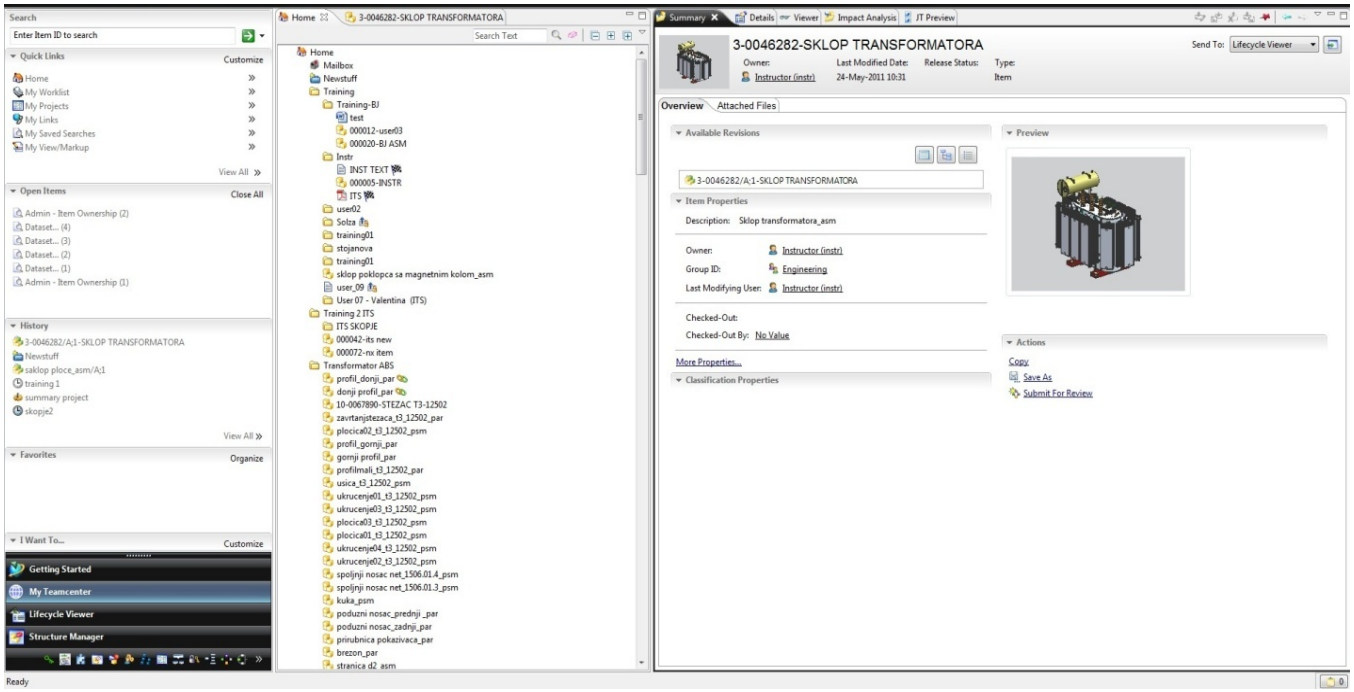

Figure 4 Teamcenter Interface

control progress of design from project management level to document lifecycle management level and connection with lean management is analysed.

PLM has proven itself to be useful for all management levels in the companies. 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. 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. Teamcenter enables customers to maximize the power of their product knowledge and leverage it to increase the profitability and productivity of every stage in their product lifecycle. The companies which are using this software notice personal and team productivity, shorter time to market, increased product quality and minimized product and lifecycle costs.

7. REFERENCES

[1] Product Lifecycle Management - Empowering the Future of Business, *CIM Data Inc.,* 2004.

[2] Pol, G., Merlo, C., Legardeur, J.: Implementation of collaborative design processes into PLM systems, *International Journal of PLM*, Inder-science, Vol.3, No.4 (2008), pp. 279-294.

[3] Saaksvuori A., *Product Lifecycle Management*, Springer, 2008.

[4] Grieves, M.: *PLM: Driving the Next Generation of Lean Thinking*, McGraw-Hill, 2009.

[5] Bernard A., Tichkiewitch S.: *Design of Sustainable Product Life Cycles*, Springer-Verlag, 2008.

[6] Stark, J.: *PLM: 21st century Paradigm for Product Realisation*, Springer-Verlag, 2004.

[7] X. G. Ming, J. Q. Yan: Technology Solutions for Collaborative PLM - Status Review and Future Trend, *Journal Concurrent Engineering,* Vol.13, No.4, 2005, pp.311-321.

[8] Gecevska V., Chiabert P., Anisic Z., Lombardi F., Cus F.: *Product lifecycle management through innovative and competitive business environment,* Journal of Industrial Engineering and Management, JIEM, 2010, Vol.3-2, pp.323-336.

[9] Rother M., Shook J.: *A Lean Tool Kit Method and Workbook*, Lean Enterprise Institute, USA, 2004.

[10] Smith R., Hawkins B.: *Lean Maintenance – Reduce Costs, Improve Quality and Increase Market Share*, Elsevier, 2005.

[11] Gareti M., Terzi S., Bertachi N., Branza M.: Organisational change and knowledge management in PLM implementation, *International Journal of Product Lifecycle Management,* Pub. Inder-science, Vol.5-1, 2006.

[12] Sustained growth and profitability through Lean PLM, Pub. Infor, USA, 2009.

[13] CIM Data: *Teamcenter "unified": "Siemens PLM Software's Next Generation PLM Platform*

[14] www.siemens.com/plm , Siemens PLM, 2009

Lean strategija upravljanja životnim ciklusom proizvoda – informacionionim tehnologijama za inovativno i održivo poslovno okruženje

Valentina Gecevska, Ivica Veza, Franc Cus, Zoran Anišić i Nedeljko Stefanić

Primljeno (18 decembar 2011.); Recenzirano (17 januar 2012.); prihvaćeno (27 januar 2012.)

Rezime

U današnjem okruženju procesne proizvodnje, inovacija se posmatra kao kritična za održivi rast i poslovnu profitabilnost. Dok se inovacija posmatra kao odgovor, kompanije mogu efikasno da mere povraćaj ulaganja u razvoj i istraživanje, da imaju prihvatljive stope uspeha proizvoda, da ostvare prihvatljivu promotivnu efikasnost, ili da imaju uvid u svoje rizike o saglasnosti ili operacionoj spremnosti za lansiranje novih proizvoda. Kompanije moraju da imaju ponovljive, saglasne i odgovarajuće poslovne procese, globalnu informacionu infrastrukturu o informacionim i komunikacionim tehnologijama koja omogućava jedini izvor istine, ravan u svim odeljenjima i rešenja koja evoluiraju bez kodiranja. Sa holističkom strategijom i adekvatnom infrastrukturom, kompanije mogu da konstantno minimiziraju podelu vremena, da poboljšaju stope uspešnosti proizvoda i promotivnu efikasnost, i da uživaju u održivom i profitabilnom rastu. Kompanije prvo moraju da se fokusiraju na potrebe svojih potrošača, da konstantno minimiziraju podelu vremena, da eliminišu otpad, uklone troškove i poboljšaju se. Ovo predstavlja osnovni koncept „lean“ strategije. Ovaj rad će opisati kako „lean“ koncept sa poslovnom strategijom upravljanja životnim ciklusom proizvoda može da utiče na „lean“ sa integrisanom saglasnošću, kontinualnim poboljšanjem i drugim najboljim praksama upravljanja životnim ciklusom proizvoda kako bi se povećao povraćaj investiranja u razvoj i istraživanja i kako bi se obezbedio održiv i profitabilan rast za poslovne procese, uglavnom proizvodne procese. Svrha ovog rada jeste da se istraži pristup upravljanja životnim ciklusom proizvoda povezan sa „lean“ konceptima kako bi se postiglo održivo i inovativno poslovno okruženje sa profitabilnim rastom.

Ključne reči: *upravljanje životnim ciklusom proizvoda, „Lean“ koncept, inovacija, održivost, poslovno okruženje*