Taking a Step Forward in Lean Thinking: A Product Lifecycle Management Course

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Abstract

Product Lifecycle Management (PLM) is a discipline oriented to manage and control each phase of the product, since it is conceived as an idea until it is finally delivered to the customer. Product Lifecycle Management is considered the next step in lean thinking. Lean thinking is a strategy that has already been successfully implemented at several manufacturing settings in order to produce efficiently. Any activity performed at a factory that creates no value for the customer such as loss of time, extra cost, or overstock of inventory can be considered as "waste." Consequently, lean thinking is the answer to eliminate such waste and achieve efficiency, quality, and safety in production. Through the years, several different solutions have been proposed to achieve improvement, such as Enterprise Resource Planning (ERP), Supply Chain Management (SCM), and Customer Relationship Planning (CRP). Much of these systems adopt several interesting strategy management techniques. PLM is a relatively new concept that concentrates on the product; and it links the best practices of industrial engineering and operations management.

Students and employees should be educated in PLM. They have a tremendous responsibility, while they hold the future of the company in their hands. Therefore, a course that will teach the most important aspects of PLM is crucial. This paper will be a proposal for a course in this discipline. .

Product Lifecycle Management

There are several definitions of Product Lifecycle Management. CIM data, a research company, defines PLM as follows:

> 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 (Grieves, 2006, p.37).

The Product Lifecycle Model

The most important part of the PLM model is information. This is the engine that moves all areas (see Figure 1). Following the characteristics of a product's life, the PLM model includes the following divisions: plan, design, build, support, and dispose.

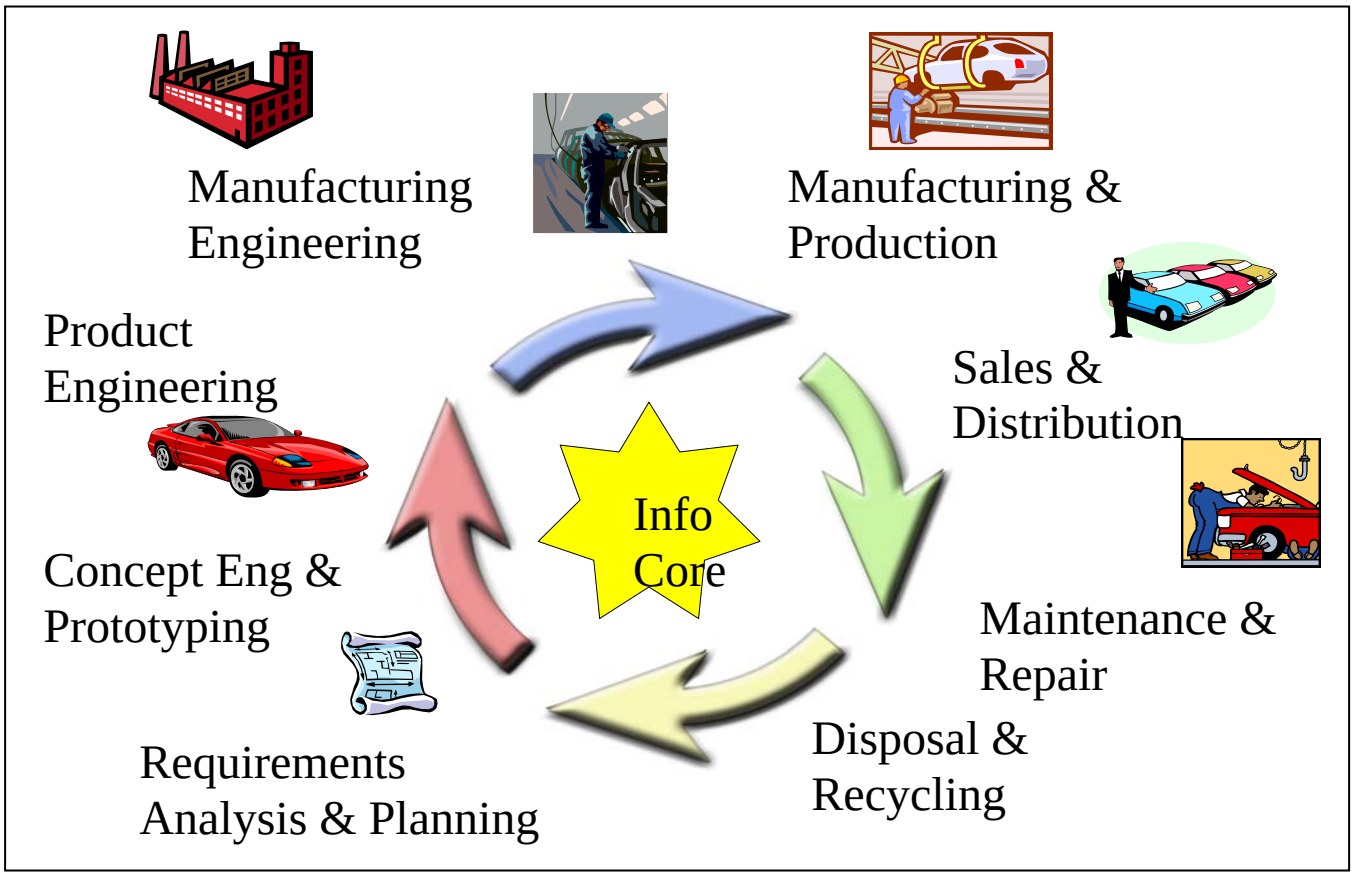

Figure 1. The PLM Model (Grieves, 2006, p.41)
(http://www.corestrategies.com/en/docs/casestudies/plm_cross_functional.pdf)

The plan division is the study and examination of the future product before it is introduced into the market. All the characteristics of the product itself are analyzed in this phase. Special emphasis is given to technical and engineering attributes. According to lean manufacturing strategies, the planning of a product should be based on customer needs and demands. In order to avoid any waste (extra inventory, extra cost, defects, etc) it is important to anticipate demand and plan the production, in quality and quantity, according to what the customer wants.

There are several ways in which the product can be manufactured. In the design phase the physical attributes such as color, form, size, and ornaments of the product have a great importance. Quality standards are also taken into account. Based on all attributes and

requirements, the production engineers actually build the units. Technicians make sure that the design is achievable.

The building process involves all manufacturing procedures. Factory selection, machinery, materials, and the most qualified workforce are chosen in this phase. It is not uncommon to discover that an apparently good design is actually not feasible. The assembly department will inform if indeed the machinery is appropriate to make a particular creation or if there are necessary tools, or human skills, to convert a sketch into a real product.

The support of a product can be divided into two goals: the marketing of the product and the maintenance of it. In this case, marketing is informing the customers about the product and how to obtain the best performance of it. Maintenance has to do with solving any technical problem that may arise.

Finally, the last stage of the PLM model, dispose, has to do with all possibilities of reuse, reprocessing or any potential salvage of the product.

Complements to PLM

Michael Grieves (2006) states that the concept of PLM incorporates many important aspects of several disciplines such as Computer Aided Design (CAD), Engineering Data Management (EDM), Product Data Management (PDM), and Computer Integrated Manufacturing (CIM).

> Computer Aided Design (CAD) is the use of computers to assist the design process. Specialized CAD programs exist for various types of design: architectural, engineering, electronics, roadways, and woven fabrics to name a few. CAD programs usually allow a structure to be built up from several re-usable 3-dimensional components, and the components (such as gears) may be able to move in relation to one another. It is normally possible to generate engineering drawings to allow the final design to be constructed (http://www.compinfo-center.com/cad/cad.htm).

One of the best advantages in the use of CAD is its reliability. Illustrations and measurements can be included and retrieved with accuracy. The fact that currently CAD is a three dimensional design tool makes it a powerful means for PLM. The perfection of CAD made it possible to have many other uses such as analysis of organizations, constructions, and accomplishments. The distribution of data is another crucial CAD feature.

The use of EDM is a good complement for CAD. The main features of the product, such as shape, volume, heaviness, mass, and resistance can be addressed with the use of EDM. The procedures for assembling the product can also be described with the use of this concept. EDM focuses on facts and characteristics that describe, summarize, and explain the product.

PDM is the origin and the center of PLM. PDM were created to put in order the many CAD files that were being used by engineers and designers. "PDM introduced the idea that the

product data could safely and effectively be organized, maintained, and accessed in native digital form (Grieves, 2006, p. 53).

CIM is a modern concept that focuses on the use of diverse software to combine the necessary tasks used to conceive, fabricate, and assemble a product. A definition of CIM follows:

> A computer-automated system in which individual engineering, production, marketing, and support functions of a manufacturing enterprise are organized; functional areas such as design, analysis, planning, purchasing, cost accounting, inventory control, and distribution are linked through the computer with factory floor functions such as material handling and management, providing direct control and monitoring of all process operations (http://en.wikipedia.org/wiki/Computer_Integrated_Manufacturing)

The use of CIM facilitated the communication between processes of conceive and construct. CIM runs the equipment and manufacturing operations to avoid the failures that results from a possible incompatibility between planning and executing.

PLM Elements

Several different authors have diverse opinions regarding the principal elements of PLM.

The essential elements of PLM are:

- Management of design and process documents
- Product structure (bill of material) management
- Central data vault (electronic file repository)
- Part and document classification and metadata ("attribute") management
- Materials content identification for environmental compliance
- Product-focused project task assignment
- Multi-user secured access, including "electronic signature"
- Data export for loading downstream ERP systems (http://www.product-lifecycle-management.com/plm-elements.htm)

Michael Grieves (2006) considers that the basic elements of PLM are three: people, technology and process-practice (see Figure 2).

People

People are indeed the most important part of PLM. It is the workforce which transforms raw material into finished goods. Workers are the ones to be trusted throughout the processes and the lifecycle of the product. Not only can they detect and reveal defects, but also, because they are the ones directly involved in manufacturing, they can suggest solutions. Ability, aptitude, and order are three skills that must be demonstrated by people.

Ability is achieved with knowledge, instruction, preparation, assistance and encouragement. Knowledge is based on expertise. The study and analysis of processes, cases

and techniques are crucial for knowledge. The appropriate instruction is a key element for success of the human resource. Instruction should be periodical and endless. In modern days, experts advise rotating employees throughout the many areas of the business. Not only employees gain a global idea of entire operations, but also they will be qualified to substitute for any co-worker. Assistance is strongly related to instruction. This characteristic is essential in order to avoid re-worked units and the misuse of time and resources. Finally, encouragement is the base for motivation, and motivation leads to effort and success.

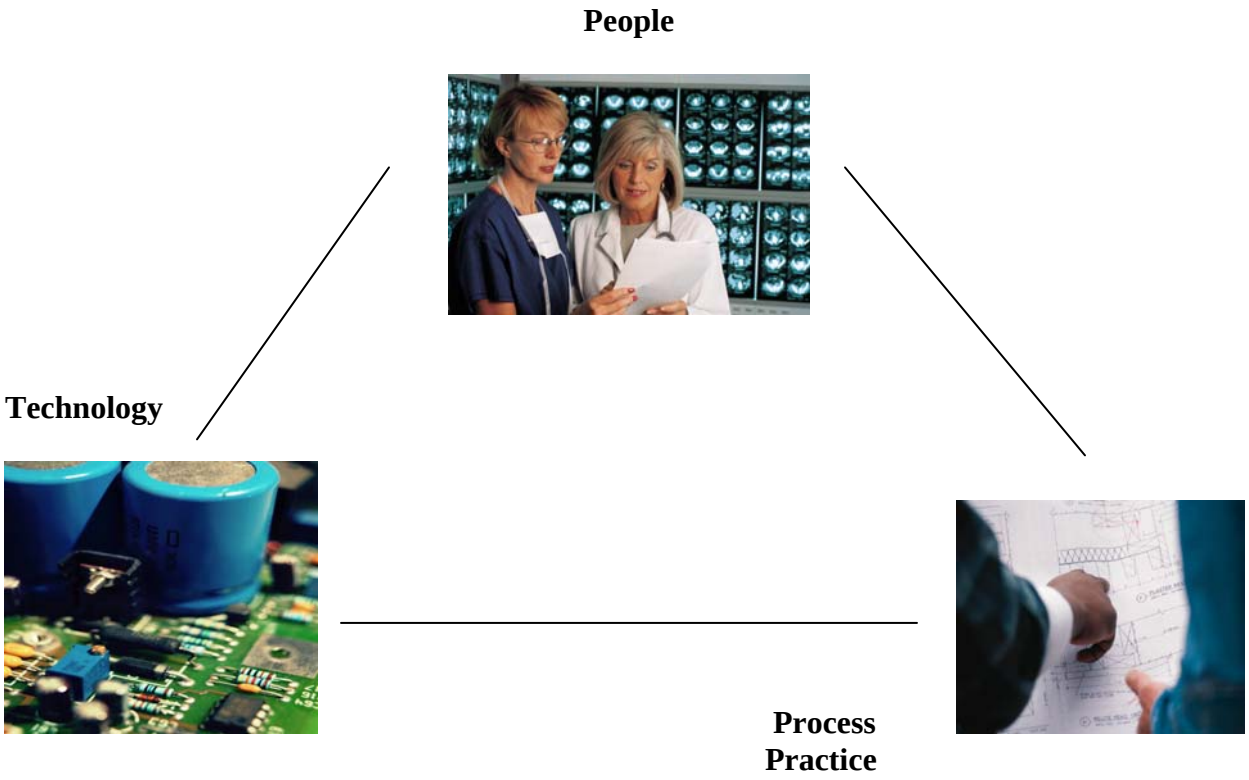

Figure 2. Elements of PLM (Grieves, 2006, p.134)

Aptitude is related to intelligence and mental talent. Nevertheless, in business settings, the establishment of compensation and penalty methods has offered good results. Accomplishments should be recognized and praised. This is not only a fair treatment, but also the rewarded good work will be an example to be followed by other workers. It is an invitation for effort. Unfortunately, if on the one hand, recognition is necessary, on the other hand so are penalties. Bad attitudes, actions, or mistakes should be corrected. The purpose of penalties is basically the avoidance of more problems.

To achieve order it is necessary to have a well designed organization. Clear rules and procedures avoid conflicts and aid for the reach of efficiency. Grieves (2006) emphasizes the use of cross-functional teams.

> Organizations that encourage cross-functional teams of various kinds will see the benefits of cooperation across these various functional areas, and they will tend to get designs that optimize the design itself and not the particular special area that is being worked on (Grieves, 2006, p. 142).

A second component for order is the existence of the principle of leadership. Leadership is decisive in any business and in almost any human activity. To follow a lead due to admiration for the leader works better than the sole application of power.

"Leadership is the process of influencing people and providing an environment for them to achieve team or organizational objectives" (Mc Shane & Von Glinow, 2000, p. 434).

Technology

The use of technology involves design software, robots, and complicated automated machinery. Lately, the use of CIM has developed into e-manufacturing, an Internet based tool for advanced industrial applications.

> E-manufacturing involves sharing real-time data with trading partners and customers and making collaborative decisions about production based on that data. In order to collaborate, information must be converted into electronic form, protocols for communication must be established, and infrastructure must be in place for connectivity with customers, suppliers, and partners. Rather than making huge volumes of standard products in anticipation of demand, e-manufacturing uses real-time information on customer orders and productive capacity across the supply chain to speed customized products directly to the customer (Russell & Taylor, 2006, p. 241).

Technology is quickly becoming the most important asset for organizations, second to the workforce. It can be the key for gaining competitive advantage. Nevertheless, the implementation of technology implicates considerable investment funds. According to Russell & Taylor, the investment in technology should consider capital budgeting techniques such as payback period, net present value, and internal rate of return. These authors include the following issues when performing the financial analysis of technology:

- Acquisition cost
- Operations cost
- Uses of the new technologies
- Annual savings
- Revenue augmentation
- Replacement possibilities
- Competitive environment
- Risk analysis
- Compatibility of new technologies with existing ones

Process/Practice

Processes are highly organized and well planned. Practices, on the other hand, require formless uncontrolled information. Processes and practices should both be present in an operational setting. Nevertheless, a common mistake that managers make is to use and to focus on practices instead of processes.

For PLM purposes, it is important that managers have a profound and meaningful perception of the processes and how they could be re-designed eventually. Additionally, those processes should not be implicit; in other words, processes should be clearly and unambiguously described. The more the workforce gets involved in the knowledge of the processes, the better results for the company. Furthermore, processes should be combined together and re-designed so they can be managed and controlled with the use of new technologies.

Practices, on the other hand, pursue the goal of information gathering. With practices, it is intended to develop norms, rules, and instructions to spread knowledge among all members of the organization, not only a few specialists.

Creating a PLM Strategy

In order to create a PLM strategy it is necessary to evaluate the current situation, set goals, and plan for the required actions that will lead the company from its current situation towards the achievement of goals. Developing a strategy is a matter of ability, expertise, and leadership.

A brilliant PLM strategy has certain characteristics that should be studied carefully:

- The leading executives and directors should be completely committed
- Organizers must have plenty of experience and employees should have the freedom to make decisions.
- Managers should do benchmarking and obtain benefits from outsourcing

The advantages of PLM

Saaksvuori & Immonen identify the following advantages of a PLM system:

- Saves time
- Improves quality
- Reduces tied-up capital
- Measures the business benefits in daily operations
- Reduces inventory tied capital
- Improves the productivity of labor

The principal benefit offered by PLM is the complete control that management can have of the product in all of its stages. This feature allows corrective actions to be taken in order to reduce defects and improve efficiency in production.

PLM has also been the link to several other disciplines and techniques such as CAD, PDM, and CIM. With PLM new products are reaching the market, more profits are gained due to larger lifecycles, and less waste is generated.

A PLM course

A PLM course can be taught in different modules as follows:

Module 1: Introduction

- Definition of PLM
- Advantages of PLM
- Challenges in the implementation of PLM
- PLM elements
- Strategies in implementing PLM

Module 2: PLM Systems

- Product development
- Sales and marketing
- Process structures

Module 3: Combination of PLM with other techniques

- Database integration
- Computer Aided Design (CAD)
- Computer Integrated Manufacturing (CIM)
- Product Data Management (PDM)
- Enterprise Resource Planning (ERP)
- Supply Chain Management (SCM)
- Customer Relationship Planning (CRP)

Module 4: PLM Readiness Assessment

- Assessment of current systems
- Workforce assessment
- Process assessment

Conclusion

PLM is indeed the next step in lean thinking. Today the challenge is to produce with efficiency and to eliminate any source of waste in order to achieve competitive advantage. The difference between success and failure is preparation. From that point of view, a course in PLM will offer great benefits for students, managers, and employees.

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