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I. PLM – BASIC CONCEPTS

PLM, or Product Lifecycle Management, is the business strategy and methodology used to control the phases that make up a product. The entire cycle takes a product from the concept stage, through design of that product, into release and full production, and ultimately to retirement and/or disposal. It incorporates business, policy, process, people, equipment, business systems, and data, as well as provides the product management structure to collaborate with external sources such as vendors, suppliers, customers and partners.

According to CIMdata, three core or fundamental concepts of PLM are:

- Universal, secure, managed access and use of product definition information
- Maintaining the integrity of that product definition and related information throughout the life of the product or plant
- Managing and maintaining business processes used to create, manage, disseminate, share, and use the information

Another way of looking at it would be the similar yet different approaches taken when comparing processes between the operational functions and the technical functions of a company. Each has its place in the manufacturing business strategy, and although each has its place in the business strategy they are not actually given the same priority.

For the most part, most businesses concentrate large amounts of effort on the supply chain and will spend thousands or even tens of millions of dollars in streamlining the operational process to reduce costs, increase output, reduce waste, improve product quality, etc. The technical
aspect is usually not the main concern for most manufacturers and frequently the design process suffers.

This is where PLM comes into play. When a PLM solution is researched, understood, defined, and implemented, the same benefits seen from a supply chain perspective can be equally realized on the design side. The actual benefits will differ for each case, however if correctly executed can potentially save a mid- to large-sized company millions of dollars.

**Case Study**

A case study provided by the PLM Technology Guide illustrates the expected Return on Investment (ROI) that could be anticipated in a PLM implementation. A multi-national electronics manufacturer with sites in several European countries faced several issues that the company felt would be solved through PLM. Due to increased competition and each site performing their own product design that may or may not have been specific to the design site, significant work was being performed for the same product at more than one site or the products were being manufactured according to incorrect specifications and drawings. This was the cause of excessive costs and management headaches due to production issues. Moreover, the lack of communication generated excessive issues in making sure suppliers and vendors were meeting the expected specifications set out by engineering. As a final rub, the products were slow to get out the door because of slow design times and lagging market reflex.

The company understood that the root of their problems was the lack of comprehensive product management framework and turned to a PLM analyst for advice. The PLM team designed and implemented a series of PLM development projects:

1. PLM vision and roadmap creation with product process GAP analyses and PLM maturity analyses as well as baseline definition for success criteria
2. PLM development planning
3. PLM concept creation with new PLM related product management model
4. PLM system selection and business requirements definition
5. PLM implementation and roll-out (delivered by a system vendor)
6. Process for continuous PLM redevelopment

After setting success criteria and prioritizing those criteria, the project team opted for a two-phased site-by-site implementation strategy. Once the project was completed, these were the success metrics:
The following sections will explore what PLM is and how its roots and development allowed it to become what it is today.

II. HISTORY OF PLM

PLM takes its roots from the advent of Computer Aided Drafting (CAD) as companies started creating electronic drawings and design. The increased throughput and flexibility not seen with paper drawings and blueprints were being realized in forms that simply stated astounded the engineering field. Because of this increase in efficiency, companies could provide shorter design deadlines and the birth of “lean manufacturing” began to take shape.

In 1985, the Automotive Industry began its exploration into PLM by way of the American Motors Corporation (AMC), which began reviewing methods they could utilize to reduce production design cycles. They created a system that allowed management, control, and communication to help decrease design conflicts and shrink engineering costs. Since this method works very nicely with CAD, the evolution of the modern PLM systems and methodologies was born.

The Aerospace and Defense Industry also benefitted from a separate but similar approach by Rockwell International in the early 1980’s. As a government contractor awarded the contract to build the B-1B
Bomber, this was a monumental task that required significant rethinking of the approach to R&D and design. Brian K. Seitz, one of the key players, reminisces on his blog about how they came up with the fundamentals of Product Data Management (PDM), PLM and CAD integration.2

Rockwell International was able to take the Engineering Data System (EDS) and augment it to interface with Computervision’s mainframe CAD system (CADDS3 & CADDS4) and Lockheed’s Computer-Augmented Design And Manufacturing (CADAM) systems to track part configurations and lifecycle of components and assemblies.

“A paper on this topic and strategy was presented during those years at a Computervision User’s Group meeting in San Diego. Shortly after Computervision released its system implementing only the PDM aspects as the lifecycle model was specific to Rockwell and Aerospace needs.”3

As these pioneers of PLM began exploring the PLM process and understood the implications, more and more companies became aware of the benefits and a new business strategy was born.

### III. PLM AS A CORNERSTONE OF A BUSINESS

PLM is considered one of the four data cornerstones of a business in conjunction with the following:

- Customer Relation Management (CRM)
- Enterprise Resource Planning (ERP)
- Product Lifecycle Management (PLM)
- Supply Chain Management (SCM)

Understanding this foundation allows a business to strive for integration and collaboration by truly bringing data to the fingertips of all stakeholders involved within the confines set by the organization.

The integration of PLM with other systems is critical. Typically PLM integrates with ERP however some ERP packages are designed for discrete manufacturing and may not necessarily be the best solution for something such as a process manufacturing facility. This concern needs to be kept in mind when identifying the underlying IT platform that will help a company reach the next level.

By considering the integration of PLM data with ERP, this allows the engineering Bill of Material (eBOM) to be analyzed and broken down to its individual components and permits production to review, disseminate, and reconstruct the engineering data into something more representative of a production BOM (pBOM) – replete with operations, specifications, and assembly instructions. Normally, the engineer is not concerned with the manufacturing process, however if the production engineer is allowed to review engineering data and provide feedback that may improve the overall design to facilitate the manufacture

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of the product, this can become quite advantageous for the company. There is even talk of letting production handle the transformation from eBOM to pBOM within PLM, something that was not even considered a few short years ago. There are some shortcomings to this approach if the business IT infrastructure does not allow full CAD/CAM integration as most CAM programs are not normally integrated with CAD or all-inclusive. Still, there is discussion amongst the software developing companies and it is worth noting and looking to the future for a more integrated approach.

IV.  PLM AND ITS DIFFERENT FLAVORS

Although PLM has evolved from a need to reduce product development cycles in the manufacturing environment, there are several permutations that have developed over the years. Each has its niche in the market and can be traced back to the original need for shorter, more efficient product development processes. Industries have become quite creative in the exploration of PLM and have tailored several of the PLM strategies to specific needs, based on business requirements as well as the ever-changing enterprise landscape. Technology has a critical role in how this has been accomplished, but is not limited strictly to a technological revolution. Moreover, many approaches have simply been ingenious in that they take the concept of PLM and apply it to other industries and trades.

For this discussion we will limit our review of the two major styles with an eye towards the future.

A.  Discrete Manufacturing

Discrete Manufacturing is generally considered the most common PLM strategy. This stems directly from AMC’s approach to automobile manufacturing – taking the final product, which is an aggregate of many parts and breaking them down to the individual pieces or components. In a later discussion we will explore top-down design, bottom-up design, and “both ends meet in the middle” design approaches. For now, we will discuss the basic concepts and characteristics.

1.  Design Approach

In a discrete environment, PLM is traditionally used to handle the individual part or component by controlling the development and design of said part. Considering it normally comes from some brainstorming or “think tank” session for a radically new design or from an existing design but with some new requirement or application, design components are created in a CAD system and controlled as to the ability for the designer/engineer to only make changes at specific intervals. Typically, the engineer is initially given full rein to make any changes that are required to develop the design of the part, however once the engineer feels the design of that piece has been fully developed, it is “checked in,” or the design is frozen from any further changes.

If there are more components which fall into some product structure, there may be several, to dozens, to thousands of new parts requiring development and design. Eventually the design is completed either as a full eBOM or through iterative
2. **Approval Process**

It is at this point that the part/component or assembly is connected or attached to a New Product Introduction (NPI) process that kicks off the approval process. It is here that PLM begins to take what was static documentation and data and allows users and management the opportunity to review the proposed changes for consistency, accuracy, and design soundness. This dynamic tactic is key to allowing input and collaboration that solves the disjointed and siloed mentality that unfortunately plagues many companies.

Traditionally, a fellow engineer checked the designer’s work (more as a peer review) or an engineering manager verified the design was within the bounds set by engineering. This policy usually would be somewhat short-sighted in that the business needs are not realized as only the engineering perspective is ascertained. That is not the case currently, or at least that is not the trend for PLM – businesses are slowly gravitating towards a more proactive and holistic approach. By allowing such departments as Finances, Planning, Production, and Procurement to have some knowledge and say in the process before the product is released allows a greater reaction time for production while shortening the process by which input can be given about certain aspects that Engineering simply cannot provide. This is as true for any NPI process as for any engineering changes to existing product, or Engineering Change Order (ECO) based off of an Engineering Change Notice (ECN) process.

3. **Current PLM Products**

Although there have been many PLM products in the past, for the sake of argument, only the most notable ones in the current PLM market are listed. In the context of this article, the history and development will not be expounded upon, but simply will identify market presence as viable solutions.

   a) **Teamcenter**

   Developed and distributed by the Siemens Industry Automation division, Teamcenter™ is arguably the most known PLM solution on the market to date. Siemens has been a powerhouse in the CAD industry for years, marketing NX™, SolidEdge™, and Parasolid™. The PLM suite that comprises Teamcenter has been mostly built through acquisition.

   b) **Windchill**

   Originally branded as Pro/INTRALINK™, PTC, makers of the Pro/ENGINEER™ CAD systems (WildFire™ and Creo™ brands), moved to Windchill™ to handle the PLM aspects of 3D design and move away from a traditional “green screen” approach, as Microsoft Windows™-based applications are more prevalent and user-friendly.

   c) **ARAS**

   Not well known in the PLM arena, Aras Innovator™ is considered the “new kid on the block,” but its presence is being known. One huge difference between Aras and other PLM packages is that the product is considered open source – a free download of a fully functional core product is possible from the [www.aras.com](http://www.aras.com) website. There is a catch – the development costs are absorbed into the integration packages and support fees. This may equate to giving the Mercedes for free and charging $10/mile to drive it.
Time will tell if this is the new trend in PLM software solutions.

d) **PLM Discrete**

Although not as prevalent as some of the other solutions, Infor’s PLM Discrete™ is a viable PLM option that is CAD-independent. Originally considered a bolt-on to Baan™, a venerable Infor ERP system that was the predecessor to Infor’s LN™ ERP, it has since become an integrated or a standalone product that has morphed into a system worth reckoning. It works well with Infor ERP systems and is able to interface with most CAD systems.

Infor recently announced a partnership with Aras in offering Infor PLM Innovator, a new cloud-ready PLM solution based on the Aras PLM engine. This is still a story in the making therefore no further comments can be made.

There are many other discrete manufacturing PLM software solutions that would be worth mentioning, however in the essence of brevity and since this is an introduction to PLM, suffice it to say no one PLM solution is considered a best fit and each business needs to evaluate their individual requirements before selecting the PLM software package.

B. **Process Manufacturing**

If discrete manufacturing handles most “widgets” and the assembly process that is most common in industry, process manufacturing might be considered second rate or not as important as the first thought when manufacturing is mentioned – the author wishes to make it known that that is **not** the case.

Many products are not solid but liquid or gaseous by nature (or were at some point) and the process of combining these parts or ingredients is not an assembly but a formula or recipe. This is process manufacturing, one that encompasses most food and beverage, paint and coating, adhesive, chemical, pharmaceutical, textile and cosmetic industries. The formula is the governing instruction that controls and dictates what, how and when things are combined. Certain additional processes may be needed such as quenching, baking, knitting, centrifuging, and many more processes that cannot be adequately reviewed in this article.

It is also important to note the quantity of a certain element is essential to the makeup of a product to the point that a certain batch or process can be ruined by not adding enough or conversely too much of one ingredient.

1. **Design Approach**

Although the concepts for change and control of the product are still a major part of the process, the method by which this is achieved is significantly different from discrete manufacturing. This creates a significantly different perspective as to how the process is carried out, although there is still a brainstorming or ideation process to come up with new and innovative product. It simply is done in a kettle in a laboratory instead of on a designer’s CAD machine. Irrespective of the approach, PLM concepts
are preserved and the design process is enhanced. The CAD design engineer is replaced with an equivalent such as a lab technician or chemical engineer that is the author of the new product or process. As components and ingredients are added and tested in a small-scale laboratory, the process is refined and the formula is finalized. Specific ingredients are selected and specified in the process formula.

2. Approval Process
Once design has been completed to the satisfaction of the formulator, the approval process begins. At this stage, as with the peer review in a discrete manufacturing business, the same holds for a process manufacturer. Engineering will review the formula and possibly start scale-up proceedings, but at some point the approval process is finalized and the formula is approved. This process may vary as much as the product itself and is unique to each company, as they base their process off the company quality assurance plan.

3. Current PLM Products
Because of the emphasis on discrete manufacturing and the often overlooked arena of process manufacturing, the number of truly robust products tailored specifically to the process industry is relatively small. Many companies attempt to use a PLM product geared towards the discrete market as a stopgap, but usually find frustration and more issues attempting to create product with process improvements in mind. There are some general concepts that can be translated into either, but from the approach noted above and how disparate the products are, it truly does require a software package that is made specifically for the process industry. Fortunately there are a few.

a) Optiva
Infor’s process PLM solution, Optiva is a robust product that is designed with the formula in mind, allowing a rollup calculation to provide total values for the entire product or certain sub-formulas.

Business-Software.com describes Optiva as such:

“Infor Optiva is a complete PLM solution that helps businesses achieve faster product development and lower costs, while ensuring compliance with regulations. By streamlining the development process and integrating with ERP processes, Infor Optiva can increase development speed by up to 50% or more. Materials, inventory and manufacturing analytics inform buying to optimize production and operational processes. No matter your industry, Infor Optiva will ensure that your product is always in compliance with industry regulations in your area so you can focus on your core product.”

b) Agile
Oracle’s Process PLM is made by a well-known company, but can be overwhelming for the small- to mid-sized business. Cloud-enabled, as well as on-premise deployments, allow superb flexibility for the bold customer who is willing to invest significant amount of time in understanding all the functionality offered. Oracle states the following:

“Agile Product Lifecycle Management for Process (Agile PLM for Process) enables process-oriented consumer packaged goods and food and beverage companies to simultaneously reduce costs, mitigate risk, accelerate time to market, and improve worker productivity—all while boosting the bottom line contribution that products make to your overall profitability.”

c) Arena PLM
A cloud-based PLM solution, Arena’s PLM is cost effective yet somewhat limited in personalization and customization. Arena caters to smaller start-ups that want to leverage the benefits of PLM without the overhead cost and management of one of the other name-brand PLM solutions.

C. Other PLM Strategies
There are other approaches to PLM such as fashion PLM, R&D PLM or ScPLM, and SDPLM to manage software development. The author would like to see a Packaging PLM “best of breed” solution since most companies, if they do manage packaging, simply “make do” with standard PLM to handle their needs.

There may be many other applications as well, therefore this market is not by any way fully developed, and the author will expect many other applications to develop over the next couple of decades.

V. FINAL WORDS
No matter what type of manufacturing business you run, PLM can assist in the day-to-day operations and process that will provide integration, cohesion, and stability to your product line. Rockwell Consults is there to help. Contact us to allow us to review your business needs, identify process issues, collaborate with you to create a PLM strategy, and bring your bottom line to the next level.