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REQUIREMENTS ANALYSIS IN THE IMPLEMENTATION OF INTEGRATED PLM, ERP AND CAD SYSTEMS

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ABSTRACT

Product Lifecycle Management (PLM) system implementation is a major investment when the technology is used in manufacturing companies. This paper provides an analysis of the requirements for the integration of PLM systems with Enterprise Resource Planning (ERP) systems incorporating the design aspects of Computer Aided Design and Manufacturing (CAD/CAM) within the product development process. PLM implementation deals with various existing product data and information generated over years both from CAD and ERP systems. Data integration is very challenging and has important impact on future decisions while creating new processes. The information management plays very important role not only in PLM implementation but also in the way this will be used in future production. Therefore it is very important to analyse how product information is transferred to PLM system. It also need to be investigated that what, when and how the data will flow from and to PLM systems.

Keywords: Product Life Cycle Management (PLM), Computer Aided Design and Manufacturing (CAD/CAM), Enterprise Resource Planning (ERP).

1 INTRODUCTION

Product development is a complex process involving many poorly understood variables, relationships and abstractions. It addresses a wide range of issues, and is carried out by people of a wide range of roles using a wide range of practices, methods and systems working with different environments. Cooper's (2001) survey revealed that "80% of products are defined during the development phase. 80% of product's life is beyond factory gate. 46% of resources devoted to the development and launch of new product's are spent on products that either fail or never make to market". There are many factors in product development for these failures. One area which this paper will discuss is product information traceability and how this information flows between different functions. One of the main issues is the reuse of the existing proven product knowledge to reduce the overall product development cost and time.

Companies normally have been manufacturing products for years, and the data produced from product development, to product release, supporting, and obsolete are stored in different systems. Most information is one way or other related to product(s), and is generated and stored in different systems for different functions. However, there is a lack of connectivity between these systems / functions. In practice there is a major gap for finding information of a particular existing product.

The particular area that this investigation is concerned with is how PLM systems are connected to CAD/CAM systems where the digital or virtual products are created, and to downstream ERP systems which supports the production systems. Vijay Srinivasan (2011) defined that PLM deals with creation, modification, and exchange of the product information throughout a product's life cycle. PLM has a main function which is to manage product configuration. Figure 1 illustrates that PLM is connected to two main systems in the product development process, i.e., CAD/CAM and ERP.

Figure 1: Simple Product Information (Data) Flow

2 IMPORTANCE OF PLM IN PRODCUT DEVELOPMENT

The term Engineering Data Management (EDM) and then Product Data Management (PDM) emerged in late 1980s as engineers recognized that there is a need for tracking the growing volumes of design files and documents generated in engineering design and related processes. PDM allowed to standardize the storing and controls of documents, including Bill of Materials (BoMs), Revision controls so that the history of information is captured, and most importantly the relationships between parts, assemblies and sub-assemblies can be maintained. Then came the term Product Lifecycle Management (PLM). While PDM focuses on managing design and product associated data and information, PLM centers on reengineering product development and manufacturing processes related to the whole product lifecycles. PDM is a design-focused technology that increases efficiency within existing product development processes by improving the management of product design data. PLM, on the other hand, is a strategic, process-centered approach that leverages PDM and other technologies, along with consulting services, in order to manage product lifecycles, remake processes, and increase throughput. As a result, PLM improves productivity across the connected enterprise rather than in a single department or a specific process. PDM can be regarded as a subset of PLM which includes the management of intellectual asset information and their relationships. PDM is an important basic requirement that supports PLM, and you cannot do PLM without PDM. PLM includes asset creation through CAD, engineering analysis, digital manufacturing, documentation, images, and software issues. There is generally no creation of intellectual assets in PDM. There are usually few collaboration capabilities within PDM. However, a strong foundation for PLM starts with a comprehensive and strong PDM solution.

PLM is an integrated, information-driven approach comprised of people, processes, practices, and technologies to all aspects of a product's life cycle, from its design through manufacture, development and maintenance culminating in the product's removal from service and final disposal. By trading product information for wasted time, energy, and material across the entire organization and into the supply chain, PLM drives the next generation of lean thinking. The goal of PLM is to digitally transform the life cycle that companies use to conceive, design, manufacture, service and improve your product offerings. This enables companies to capture all their product information and knowledge, and leverage it in an integrated lifecycle process that improves the efficiency of the whole product lifecycle activities from start to finish. Companies traditionally implemented ERP, Supply Chain Management (SCM) and Customer Relationship Management (CRM), are more related to the operations side of their business. All these systems do not have functionality in managing the whole life cycle of products.

There are many functions / activities that will take place in the entire life cycle of product development. These depend upon the type of product, industry practice and procedures, size of the enterprise and many more factors. Some of the most common functions or activities are shown in Figure 2 along with the type of system these activities are using. PLM systems sit in as very critical

systems because they are strongly linked to CAD/CAM and ERP systems. The information (data) flow between PDM/PLM and CAD/CAM is bi-directional in most cases where as the information between PLM and ERP is one way that is information flow from PLM to ERP in most cases. Some of the functions are shared between two or even three systems as shown. One such system is change management.

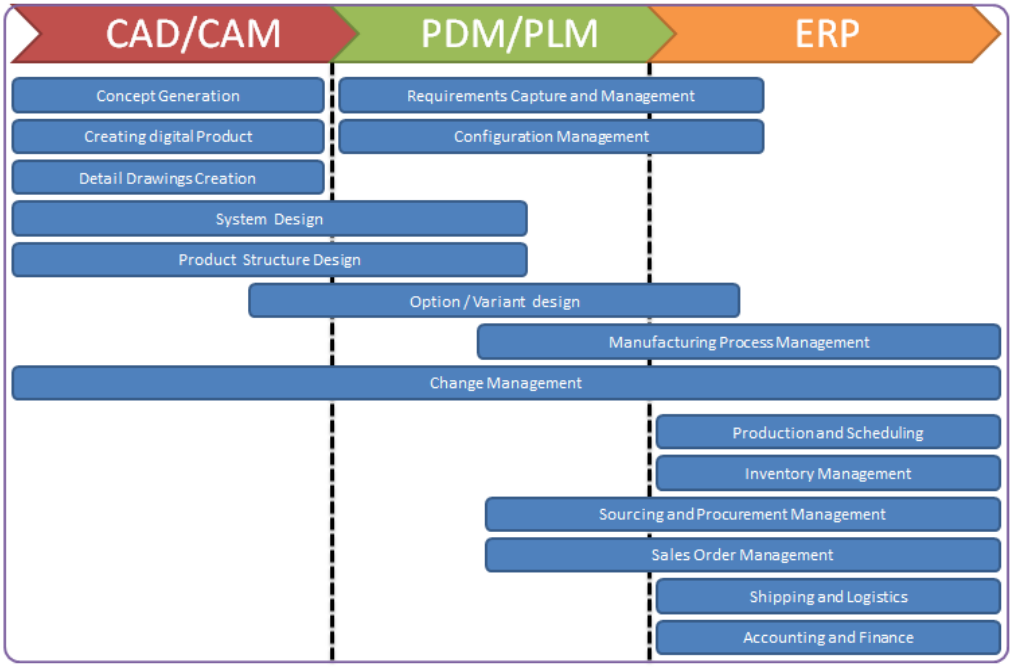

Figure 2: Product Development Activities vs Different Systems [Parametric Technology Corp.]

3 COMMON INDUSTRIAL ISSUES AND REQUIREMTS IN PRODUCT LIFE CYCLE

An industrial investigation has been carried out in this research, and the results related to common industrial issues are summarised below:

In Engineering main issues and concerns are:

- loss of time and money in reworks;
- slow process in engineering changes;
- differences between product specifications used by engineering production and sales;
- not enough reuse of existing parts; and
- inconsistencies between CAD models and BOM files.

In Global Supply, mail issues and concerns are:

- suppliers does not have the information about latest product changes;

In Manufacturing, main concerns are:

- redundant part numbers;
- old version of drawings are provided/used; and
- engineering changes are not timely communicated by designers

In Customer Support, main concerns are :

- technical issues with products in the field;
- inadequate customer service;
- high service costs; and
- product manuals does not have latest information.

In Cross Functions, main issues are information searching which:

- takes lot of time or cannot search the existing product information;
- communication silos – people in different functions not talking to each other;
- data silos –data in one department not being easily available to other departments;
- impossibility to migrate data from a legacy system to a new system;

- many parts, that are either no longer in use or duplicates, are still maintained in the database;
- poor product quality;
- Excel spreadsheets containing a lot of different information about a Product, often conflicting, each other about a product; and
- conflicting lists of the configuration of a product at a customer site.

Common requirements in product development are summarised below:

In the past product development was concentrated on local regions. Products are designed and manufactured locally and then distributed to other regions. Now products are developed and manufactured in many regions of the world which makes company's global operators. The true global companies are emerging to the concept of 'Design Anywhere, Manufacture Anywhere, Sell Anywhere and Service Anywhere (DAMASASA)'. To achieve the Product traceability plays a very important role. How the product is developed by whom and when and where, all these information is very important and gives good traceability about the product. If these information is linked to product life cycles that makes the information accountability as well. The accountability gives information about who and when. This also leads to effective product innovation. In the global companies different functions are performed in different locations for example design teams may be located in several locations in different countries, manufacturing in different locations and sales in different locations. This makes product development even more complex. Good communication system needs to be there for collaborative product development in this new operation context.

4 PRODUCT INFORMATION FLOW ACROSS DIFFERENT FUNCTIONS

Figure 3 illustrates the product data and information flow in industrial case study. This is the backbone for PLM strategies evolved from early product data management (PDM) offerings, usually just focused on managing computer-aided design (CAD) data created and used by workgroups. Companies see the benefits of managing and sharing this information more broadly, extending the use of enterprise PDM solutions to enable collaboration across more functions. Manufacturing companies see the benefits of using this data downstream in manufacturing to better plan and simulate production facilities and processes, using solutions now referred to as "digital manufacturing" to provide those capabilities. CIMdata (2012) estimates from PLM solution providers that the amount of data necessary to produce a car is in the gigabytes, with the engineering work-in-process data, including all of the evolving designs, perhaps an order of magnitude larger, in the one terabyte range.

PLM enables the innovative companies to quickly create right to market products and to leverage part re-use. It focuses on the digital, context-oriented intellectual property (information), functions and business processes. It manages the definition of lifecycle and the relationships between product related information and process.

Invention is the generation of newness or novelty, while innovation is the derivation of value from that novelty. Clearly, innovation is an extension of invention, yet they are distinguished by the fact that the quantity of inventions exceeds that of innovations by several orders of magnitude. Hamel G (2006) stated that ''Innovation in whatever form follows a power law: For every truly radical idea that delivers a big dollop of competitive advantage, there will be dozens of other ideas that prove to be less valuable''. This may be explained by Patterson M (1995): ''Translating a market opportunity into a new product requires perhaps 15% invention. The remaining 85% of the work involves previously learned processes that often are undocumented and undisciplined''. Therefore it is very important to manage the information (data) in logical manner so that the existing product information in new product development can be reused which will reduce in time, resources which in turn reduces the overall product cost. This will give confidence in releasing the product to market quickly with RFT (Right First Time).

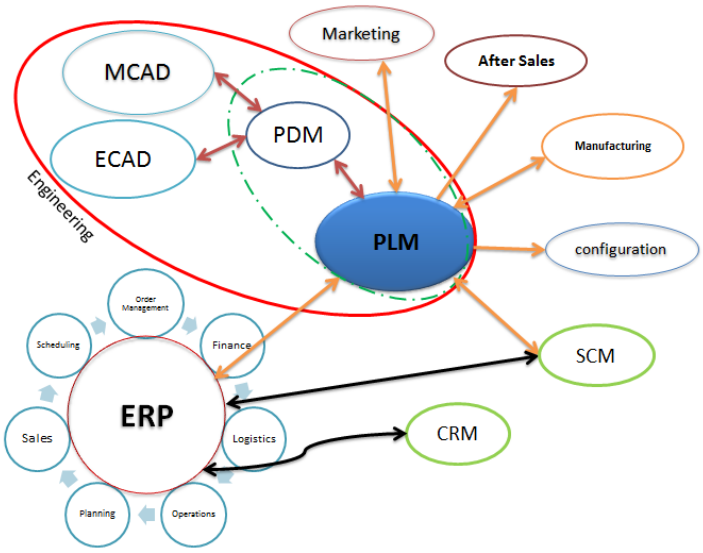

Figure 3: Product Information Flow in the Industrial Case Study

5 PLM IMPLEMENTATION ISSUES

When a company starts thinking to implement PLM it is thinking to change the structure of the Engineering team for sure, and also some other functions which are closely related to Engineering. PLM brings new technology to industry and it will not normally replace existing systems in use.

There are two sides of PLM implementation, the first is how to handle product information after implementation (future planning), and the second one (more important than the first) is how to migrate the existing product data (information) which had been created since company started to the new PLM system. A large number of different types of data is generated during product design, manufacturing, testing and support and service of the product across life cycle. Examples are customer requirements, design specifications, process models, part drawings, assemblies drawings, engineering drawings, analytical models, simulations results, manufacturing tool and fixture designs, test results, quality issue documentation, manufacturing process documents, process plans, engineering Bill of Material (as designed), manufacturing Bill of Material (as built), revision control data, option assembly management, standard product data (as delivered), configurable product data (as ordered), service manuals and user guides. The size of data depends on many factors like size of the company, type of products, number of products and variations, type of systems and many other factors. All these data is very important and is the intellectual property of the company. This data will be in many different formats and depends upon how many types of systems are used in product development. All the data mentioned above is only related to product development. The latest PLM systems can handle many different types of data. Some of the new PLM systems can handle configuration management along with manufacturing system management.

PLM implementation is normally a very big program. Planning is a very important aspect of implementation. PLM is one where product data is initially created and maintained in logical manner. It is very important that this data is populated correctly since it drives all other systems. System integration is very important in total PLM implementation. System integration and related problems are often most difficult and laborious parts of a project.

The improper integration between the systems may lead to the following problems:

- Project delays;
- More resource requirements for project completion;
- Increase in project implementation cost;
- More resource and time in customization; and
- More process to follow after implementation.

Data migration is also very important in PLM implementation. There are some tools which will help migrate data to PLM systems. However this needs to be done very systematically and logically. Very thorough investigation need to be carried out with these data. Data cleaning process need to be

carried out. It may take time to do all these activities, but this would be the roadmap for future product development as well. This will take care of some of the issues mentioned above. Another important issue that need to be taken care of is PLM system integration. As discussed PLM has two way connection to many systems like CAD/CAM, ERP, configuration, manufacturing, marketing, after sales, technical documentation, service engineering and many more systems. Data flows in and out of the systems. All these information need to be maintained in PLM. The three main things that can be achieved are traceability, accountability and securely maintenance of this information (data).

6 CONCLUSIONS

PLM implementation not only creates new processes and methods for future product development, but also deals with existing information (data). It has been identified through investigation carried out in this project that much of the information is generated in different stages of product development.

As highlighted, huge amount of data already exists within a company which plans to implement PLM, hence appropriate tools are required to migrate this data and any future data to be organised in a systematic way which enables to achieve easy traceability, accountability and secure maintenance of this information. Future study within the research will aim to integrate and implement the framework and develop tools to provide solution in allowing the migration of existing information to PLM from different functions; and for future identification of product information to be stored in systematic and logical manner. This will allow the company to resolve most of the common industrial issues and common requirements highlighted in this paper.

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