Identification of Critical Building Blocks in PLM System Implementation in the Automotive Supply Chain

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PLM System Implementation in an Automotive Tier 1 Supplier: The Critical Building Blocks

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Abstract. In today's industrialised world, manufacturers must adapt and evolve their Product Development (PD) processes through the adoption of bespoke ICT tools. Product Lifecycle Management (PLM) and its associated tools are one option manufacturers may choose to assist in this change. However, PLM tools are not always viable due to costs associated and system integration issues; therefore, careful selection and consideration of the most appropriate tool, which meets company requirements, needs to be taken before selection and implementation. This paper presents a case study of a Tier 1 supplier in the automotive industry, identifying the critical building blocks for successful implementation and integration of a PLM system in to their manufacturing operations. We further propose a framework to assist manufacturers in identifying and ranking the building blocks which should be considered when implementing such PLM tools.

Keywords. Product Lifecycle Management, Product Development, PLM Implementation Requirements, Automotive Supply Chain.

1. Introduction

As the world's manufacturing industry transitions through The Fourth Industrial Revolution (Industry 4.0) and adopts more interconnected and digitized working practices, information and Knowledge Management (KM) are being viewed as crucial components for PD [1]. A critical tool in helping define and develop a company's products and ensure mass customisation is product lifecycle management [2], which is a methodology and tool that aids engineers to capture and document the product definition, while also assisting information and knowledge sharing and collaboration among the whole enterprise [3].

While PLM tools are generally believed to be only viable for large manufacturing companies, a lot of attention from the PLM industry is now being placed on smaller companies working within the extended supply chain [4] due to the potential volume of customers. However, the implementation of such PLM tools is not considered an easy process and can be an expensive investment, both in terms of financial and resources. It is also indirectly disruptive on PD processes during its implementation and uptake. For

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this reason, smaller companies must tread carefully when deciding on any type of PLM implementation to guarantee success and realise benefits.

This paper proposes a framework that aids in the selection of PD processes to be implemented inside PLM tools, designed for smaller companies that are involved in the PD and manufacture of automotive products. The presented framework provides a ranking classification of processes that can be used as the building blocks of bespoke PLM tools. We first provide a background of the subject area; this is then followed by an explanation of the industrial investigation, from which the results, conclusions and recommendations are presented and analysed.

2. PLM and its implementation in Tier 1 and Tier 2 Automotive Supply Chains

PLM is an engineering management principle which when applied to any product from start to finish produces tangible-improved results in product design, production efficiency and quality [5]. The application of PLM tools and processes to different products in development helps improve the end product quality and overall quality of the development processes [6]. This vision is enabled with recent advances in information and communication technologies and is needed to support current industry requirements for faster innovation cycles combined with lower costs [7]. This makes it a critical tool for any size of organization to ensure that they are not left behind by competitors.

In today's age of ever-changing technologies, Original Equipment Manufacturers (OEMs) have become more 'assemblers of components', whereby components are being designed and manufactured by Tier 1 and Tier 2 Suppliers [4, 8]. This shift in capabilities has been a growing trend for many years now, but while OEMs work in a rich environment of product definition and control throughout the product lifecycle with the help of PLM tools, Tier 1 and Tier 2 suppliers have remained disconnected and therefore often miss out on all the benefits that PLM tools bring with them. Interestingly, OEMs are now requesting stricter control on the design, quality and cost of new products, with a lot of Tier 1 and Tier 2 suppliers recognizing the benefits of implementing such tools within the PD process.

In PD companies, managing product information through the whole lifecycle is now seen as an answer to the growing demands in product complexity requirements, the integration of multidiscipline engineering fields and the shortening of time to market [9]. Nevertheless, many manufacturers view PLM tools as complex, expensive, service-dependent software and the challenge is solving the costs related with IT technology and infrastructure investment [10]. This is due to the high risks and costs in adopting these tools [11]. Careful consideration must be paid to the scope and complexity of adopting such tools, as this often determine the success and acceptance by its users. PLM implementation projects constitute a complex, multi-level approach that must start with a detailed definition of the different business processes that take place during the product lifecycle, such as design, manufacturing, change management, service and support [12] and selecting the right processes.

By exploring the main PLM software vendors, such as PTC, Siemens, Dassault Systems, Aras and many others, they offer a vast array of functionality and modules. These tools have been developed and fine-tuned, adopting best practices developed during the last decade. Choosing the right process to be captured inside PLM is critical due to the cost and disruption such systems can bring with them. Figure 1 shows the PLM platform offered by Siemens in the their Teamcenter platform.

Figure 1. Siemens Teamcenter; PLM platform [13]

3. Industrial Investigation

The aim of this industrial investigation is to identify the PD processes that are considered ideal when first implementing a PLM tool in order to maximize the impact towards the business and their PD process, while also minimizing the possibility of failure. All PD processes of the collaborating industrial partner were identified and listed for this analysis. The analysis was carried out with the help of an extended stakeholders team, coming from different departments and different experience levels from the industrial collaborator, to provide an extended overview of the complete organisation. The benefit in having stakeholders with different levels of experience was seen as a requirement to mitigating stakeholders being 'set in their old ways', effecting the analysis outcome.

As stated, a complete list of PD processes with their potential advantages and saving opportunities were compiled. Stakeholders were then asked to rate the different processes against the following categories: Importance, Risk and Impact in relation to the organisation. The rating system consisted of 3 classes: Low, Medium and High, with each category having a weighting range of 1 to 3. A sixth column includes prerequisites, which considered the considerations if a process in question required another process to be implemented first for it to function correctly. Processes with no prerequisites were given a rating of 3 while processes with prerequisites had a rating of -1 for every prerequisite it had. The final column included the financial impact the process would have to the organisation. Table 1 provides a summary of this extended analysis and shows the top rated process. Financial information has not been included.

Table 1. PLM processes analysis selection matrix.

Item No	Process	Advantages	Savings opportunity	Importance Rating 1 - Low 2 - Medium 3 - High	Risk 1-High 2-Medium 3-Low	Impact 1 - Low 2 - Medium 3 - High	Prerequisites 3-N/A Any pre.req = 1	Rating
1	Enterprise BOM	Real time, unique BOM updates with instant visibility, fully integrated with ERP system minimizing errors .	Reduction in data entry staff, cost of mistakes	3	3	3	N/A	12
2	Project management	Project tasks and milestone management with real time budget and resources management.	Improve project visibility through personalized user dashboards highlighting status of tasks, improved project status tracking	3	3	3	N/A	12
3	Bid management	Structured new business bidding process providing a more accurate project costings	Better overview of bidding process and analytical tools to collerate bidding data with actual project spends highlighting future improvements within the bidding process	2	2	3	1	6
4	Engineering change management	Most obsolete stock is a result of poor BOM management, and visibility of the logisitcal chain effecting a change.	Improved visibility of changes affected components used across the product range, which would reduce costly errors during an engineering change	3	2	3	1	7
5	Supplier management	Improved analitical tools to better evaluate supplier capabilities across the product range and improved quality tracking of suppliers	Improved visibility of supplier problems enabeling users to address these quickers and reducing quality issues during product development or product manufacture	2	2	2	1	5
6	Purchasing management	Organized and searchable purchasing data decreasing repeated requests of enquiries for existing components freeing up resources for commercial negotiations	Resources utilisation improvement Improved visibility of purchasing problems enabeling users to address these quickers and reducing quality issues during product development	2	2	2	1, 2, 3	3
7	Product Data Management	Implemening the different product definition databases or document storages locations within PLM makes these systems redundant, freeing up IT resources, alos providing the user a single version of the truth and single location to look for this information.	Improve user searching for informaiton and reduces the risk of users using out of date information which would reduce the amount of errors considerabily.	3	3	2	1	7
8	Quality Management	Improving quality tools for NPD and manufacturing. Also providing all the complete database of quality concerns that can be linked directly to NPD project during for example FMEAs reducing the incidence of Cost of Poor Quality over the product lifecycle.	Reduce cost of failure during development resulting in an extensive saving in the long run.	3	2	3	1, 2, 3, 7	4
10	Documentation Control			2	1	1	All of the above	-4
12	Data bases consolidation	Implemening the different product definition databases or document storages locations within PLM makes these systems redundant, freeing up IT resources, also providing the user a single version of the truth and single location to look for this information.	Improve user searching for informaiton and reduces the risk of users using out of date information which would reduce the amount of errors considerabily.	2	2	1	All of the above	-3

4. Proposed Framework

The proposed framework shown in Figure 2 shows the highest rated PD processes that should be implemented as the first building blocks of the PLM tool. The items selected have been chosen due to their immediate impact to the organisation and being the right

building blocks to carry on building and evolving the PLM tool as the main product definition tool within the organisation. The critical information backbone of the system is the Bill of Materials (BOM) structure, which contains all product definition and manufacturing information. This is considered the main building block also due to the implementation methodology which follows the enterprise BOM methodology. The second building blocks that would provide significant impact towards the organisation are: Product data management, Bid management for new business, Project Management and Engineering Change Management.

The processes highlighted as the second building blocks can be implemented at one time or following a staggered implementation approach. In this use case, these processes in building block two either do not have any dependencies and, therefore, can be implemented independently or else are dependent on the critical information backbone, the BOM structure, and, therefore, can only be implemented after this critical block.

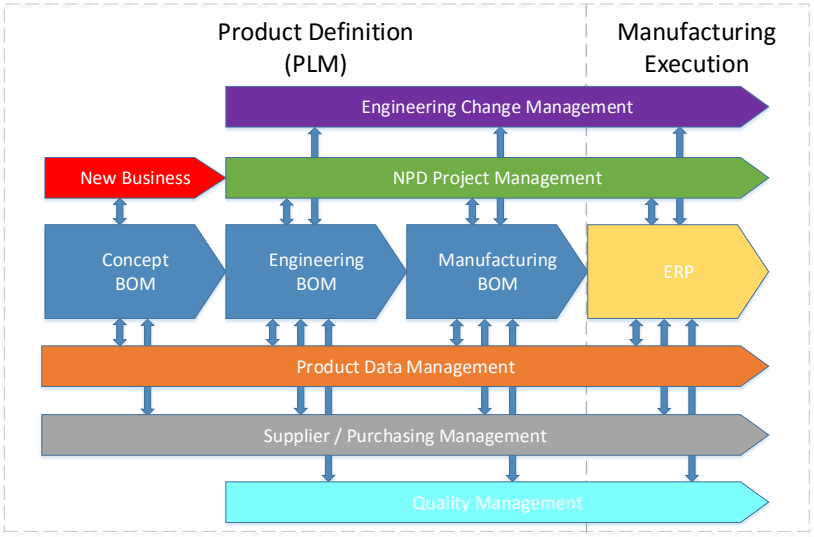

Figure 2. PLM system: Identified building blocks.

The third building block is Supplier / purchasing management and quality management. While these processes are highly rated in impact and importance, the main reason for these having lower ratings are because they are dependent on other processes being implemented first and, therefore, involve some risk in implementation.

The complete list of processes is not limited to the proposed framework, but can be further extended with additional PD processes which, at this early stage of implementing and adapting to PLM tools, provide too much risk to be implemented and, therefore, have been omitted from this framework. This does not mean that they are not required or should not be implemented. Any PLM methodology or tool should be viewed as a live system which is implemented ‘today’ and will change and evolve into an improved tool over time. A system that does not evolve and improve with time is a dead system which will affect the PD capabilities of an organisation.

5. Conclusion.

Implementing any PLM tool has significant cost implications to any size of organisation. However, the smaller the organisation, the bigger the impact will be. These implications will not only have a financial impact on purchasing of the system, but will also have a significant impact on the organisation's human resources expenditure, organisation disruption during implementation and reduction of PD capabilities during system take up. PLM implementation is not an IT solution or 'plug-n-play', but is a complete organisational cultural change of how employees work together during PD processes.

PLM tools offer vast functionality and complexity and, therefore, careful consideration and attention of which process should be implemented at the beginning of such a project is critical. The selected process for implementation should provide enough impact to the business that provides a relatively quick return on investment. It should also minimise impact on end users and provide some form of continuity to guarantee user up take. The cultural change PLM tools bring to an organisation should also never be underestimated and requires entire organisation support to drive its implementation and adoption from top management to the end user.

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