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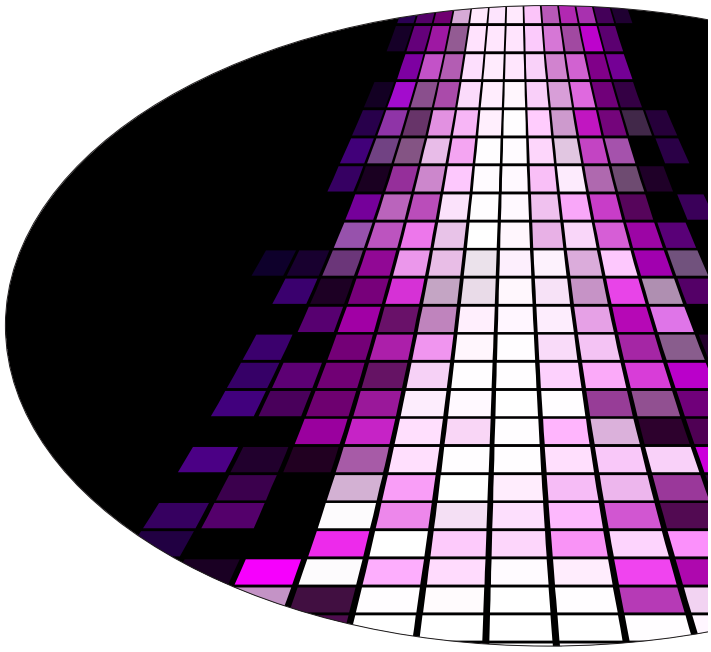

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An Analysis of Product Life Cycle Orientation in PLM Software Tool Vendors

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Abstract

A challenge in implementation of Product Lifecycle Management (PLM) tools is the selection of the right vendor and the solution. Implementing PLM entails huge financial investment on the part of the user and hence precise knowledge as to where each tool can be applied is a must. In this paper, seven PLM tool vendors are compared on their definitions of PLM and also their product offerings in different Product Life Cycle (PLC) phases, including the extreme ends of PLC viz. R&D and end-of-life phase, which are usually ignored. An integrated PLC model is developed and the tools are then mapped onto different phases of PLC. Vendors are compared based on number of tools offered in different PLC phases. The results reveal an uneven distribution in the applicability of various tools, with majority of them focusing on the product development phase and an astonishingly low number on the R&D and end-of-life phases.

Keywords *: R&D, Software Vendors, Product Life Cycle.*

INTRODUCTION

The ability to continuously innovate requires an environment that supports collaboration and allows a company to leverage the maximum potential of its intellectual assets. Product lifecycle Management (PLM) is an approach that supports such environments for innovation. Thus, PLM as a research area has attracted many researchers. Management of product lifecycle is not a new concept. Earlier, Product Data Management (PDM) was a leading concept for management of engineering information. In fact, PDM remains a foundation component of PLM. Today, PLM has emerged as the term used to describe a business approach for the creation, management and use of product associated information throughout the product lifecycle prior and post the market entry, and across the extended enterprise. PLM focuses on managing stages namely, “idea” to “product development” through to “retirement”.

The journey of PLM started in 1985 when American Motor Corporation (AMC) was looking at speeding up product development process in order to gain competitive advantage. The benefits of using computer-aided design (CAD) software and product data management system were so attractive

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that Chrysler purchased AMC and expanded the system throughout the enterprise. This made Chrysler the lowest-cost producer in the auto industry with its product development cost falling below half of the industry average in mid-1990s. Over time, Original Equipment Manufacturers (OEMs) developed their own software solutions (legacy systems) to harness the benefits of PLM.

These "legacy systems" were developed to suit the needs of individual OEMs and lacked the ability to provide collaboration across the geographies, which is becoming more and more important with increase in outsourcing activities. As OEMs started relying on suppliers for most of the components, the PLM concept along with its benefits spread to other manufacturing companies. This resulted in market opportunity for software firms to provide various engineering and fabrication applications. These firms today are known as PLM tool vendors. Tool vendors develop generic software tools which are then customized according to the requirements of the user. This paper looks at tool vendors and tools to classify the tools they sell into the product life cycle stages.

With the evolution of PLM, the view or definition of "product lifecycle" has also changed. In the late 1980's product lifecycle focused on the design engineering activity, as the software tools were concerned with CAD data management. Then the perspective began to expand to include information sharing capability between different design activities. The concept of PLM came into picture when firms realized the need to control and manage the whole lifecycle of a product, right from 'cradle' to the 'grave' and not just design activities. Due to its expanding scope and impact on the extended enterprise, today's PLM solutions are viewed as enterprise solutions.

There are many tool vendors who supply software (tools) to help companies manage products throughout their life cycle. Some of the companies are: Dassault Systemes, PTC, Siemens PLM (formally Unigraphics), SAP, Autodesk, Oracle, and Cadence. PLM market, in general, is divided into two categories, ERP vendors (SAP, Oracle, Infor) and CAD vendors (Dassault, PTC, Siemens, PLM) with players in each category trying to expand their markets by adding other features to their tool portfolio and at the same time capitalizing on their core competency. Then there are companies which provide limited solutions, like MSC software which focuses on Finite Element Analysis (FEA), Cadence which specializes in providing Electronic Design Automation (EDA) solution and Selerant which provides PLM solutions for the process industry.

Revenues from PLM applications on average have grown at 9% rate in the last 5 years and is expected to grow at same rate to reach $20b by 2012

(AMR research). According to a CIMdata report around $17.3 billion was spent in 2008 by companies worldwide on PLM tools. Traditionally, the focus of PLM tool vendors had been on CAD based products and in 2007 CAD contributed 53% in the total PLM revenue (AMR research). But today tool vendors are looking at a broader picture by providing tools for manufacturing, SCM, maintenance, intellectual property management, product data management, product portfolio management and collaborative functionality as users are looking at PLM as a mainstream enterprise application. (CIMdata, 2002)

Selection of the most apt tool for a given product development process is not a trivial task. Comparison of vendor offerings has become difficult due to differentiation caused by differing sizes, levels of complexity and strategies. A company that intends to implement PLM solution must take the evaluation and selection process very seriously since it involves committing a large volume of resources and can have a significant impact on the performance of the organization.

LITERATURE REVIEW

Product lifecycle as a concept lacks clarity, as it is understood in different ways depending on the frame of reference of the person who is defining it (Saaksvuori and Immonen, 2005). There are various product lifecycle models available in the literature, each describing the phases of product lifecycle differently. According to CIMdata, overall lifecycle of a product includes three intertwined lifecycles (CIMdata, 2002). The fist is product definition lifecycle and it involves the creation and management of intellectual assets. It starts with taking customer requirements and developing product concept according to those requirements and goes till the product reaches the end of its life. The second is production definition lifecycle**.** This lifecycle focuses on the production and distribution of the product. It helps a company decide how to produce, handle inventory and distribute the product more efficiently and effectively. The third is the operational support lifecycle. This lifecycle deals with all the support activities required throughout the product lifecycle. It involves managing core resources of the business like people, finances, technology and other resources required to support the business. PLM tools find their applicability in managing not just the three lifecycles, but also enable close coordination and communication among all three lifecycles. PLM tools provide seamless integration between the three lifecycles, which in turn help companies in building innovative products.

Management of product lifecycle is not a new concept. Earlier, Product

Data Management (PDM) was a leading concept for management of engineering information. In fact, PDM remains a foundation component of PLM. Today, PLM has emerged as the term used to describe a business approach for the creation, management, and use of product associated intellectual capital and information throughout the lifecycle and across the extended enterprise.

Srinivasan (2008) states that PLM needs to evolve itself on a constant basis to meet the requirements of the ever changing industry environment, where partners located in different parts of the world need flexible and robust tools to establish an efficient means of collaboration to realize a product successfully. Abramovici and Sieg (2002) have analyzed the penetration of PLM in different industries. They report that 25% of the mid-sized and 53% of the small companies have not yet introduced PLM and hence there is a good opportunity for software vendors to come out with PLM tools specifically for such companies.

Benassi et al. (2006), with the help of case studies on 2 industries, one belonging to the consumer products sector, and the other to the machine tool sector have provided some insights about the selection of pertinent PLM tools and the implementation in the industry. In future, PLM approaches would undergo changes and one of that would be the inclusion of service partners and prospective customers right from the initial stages of PLC. Future trends in PLM would include incorporation of PLM by non-industrial players like hospitals, insurances or service-companies as stated by Abramovici (2007).

Schuh et al. (2007) discuss the need for a process oriented framework for PLM implementation and propose one such framework that amalgamates the existing initiatives with the recently developed ones, thereby serving as a guideline for companies planning to implement PLM. They also collected data from 17 PLM software vendors through a questionnaire, to assess how the available software packages support PLM functions in the vendor neutrality catalogue developed by them. Subrahmanian et al.(2010) report the change in the manufacturing practices in the 21st century due to the advent of information technology (IT). The need for standards viz. information modeling standards, ontology standards and visualization standards has also been put forth. Guerra-Zubiaga et al. (2007) claim that classification of PLM tools into business, engineering and knowledge management is very important to integrate product data management (PDM), expert system (ES) and design for X (DFX).

The ability of PLM tools to cater to the needs of an industry has been

studied with the help of an analysis grid and interviews with industries by Djebbi et al. (2007).

Today there are thousands of PLM tools available in the market and it is tough for a company to select tools which will fulfill its strategic requirements. Many companies have found out the hard way that the successful implementation of a PLM solution greatly depends on the selection of the appropriate tools and tool vendors (CIMdata, 2002).

Though a lot of research has been done on building various PLC models, no study has been done to analyze the applicability of PLM tools in a specific phase. Wognum et al. (2008) say that a major challenge in implementing PLM is that the knowledge required to build a complete product is scattered around and this knowledge has to be brought into a single framework during product development. This so called 'scattered knowledge' can be better made into a coherent set of skills that can lead to a successful product if the apt PLM tool is utilized. Hence, the knowledge as to where a particular PLM solution can be applied is essential. This study aims at providing the user an idea as to which solution would be the best suited for maintaining one's product from 'cradle to grave'.

It must be noted that there is an important phase that is often ignored, the Research and Development (R&D) phase. R&D is not just the period before the introduction of the product into the market, it is also an integral part of PLM. R&D is the fountain head of products. Technical feasibility and economic studies are done regarding the product, once basic and applied R&D is over. The product is designed, tested, analyzed and redesigned. Innovation and green engineering are integral parts of the R&D period. The R&D period of the product dictates the entire life and functioning of the product.

METHODOLOGY

At the initial stage of selection of a PLM tool, it is important to see the vendor's view on PLM in terms of the definition provided by the vendor (Aseri, 2010). Selection of the PLM tool starts with business objectives in mind. It starts with a determination of whether a new system is warranted or not. This approach encourages a business case that carefully ties the software strategy to the strategy of the business as a whole. Although the selection process is very complex, the initial screening of relevant tools can be simplified by classifying tools based on their applicability in various phases of the product lifecycle.

Selection of Vendors and Tools

The sample in the present study consists of 7 vendors. While selecting the PLM tool vendors for this project, the vendor license revenue shares for 2007 as given by AMR research group (Table 1) are taken as the basis.

Table 1: PLM vendor license revenue share for 2007

Vendor	Revenue share in %
Cadence	20
Dassault Systemes	13
Mentor Graphics	10
Siemens PLM	8
Autodesk	7
PTC	6
SAP	3
MSC Software	2
Telelogic	2
Gerber	2
Oracle	1
Others	26

Source: AMR research, 2008

Cadence had the highest license revenue share. Dassault Systemes, PTC, Siemens PLM and Oracle are considered as the leaders in the PLM field as depicted in the vendor rankings given by CIMdata, Gartner, Aberdeen and AMR research. Despite having just 1% license revenue share, Oracle was selected for the purpose of this study as it acquired Agile PLM in 2007 and since then it has gained market share in the PLM space and has appeared in most of the vendor ranking reports. Autodesk and MCS Software have been selected as they are niche players in the field of CAD and CAE solution. Availability of data and ease of understanding the tool based on the information given by the vendor were also considered while selecting a vendor for this study. The tools of the following vendors (n = 7), Cadence, Dasault Systemes, Siemens PLM (earlier Unigraphics), Autodesk, Parametric Technology Corporation (PTC), MSC Software and Oracle feature in this study.

These vendors have large number of licensed tools in the PLM market. The number of tools per vendor varies from 10 for Oracle to 188 for Dassault Systemes. The list of number of tools per vendor is provided in Table 2. A total of 527 tools spread between 7 vendors have been analyzed.

Table 2: Number of tools per vendor

Sl.No.	Vendor	Number of tools
1	Dassault Systemes	188
2	Parametric Technology Corporation (PTC)	159
3	Cadence	78
4	Autodesk	56
5	Siemens	20
6	MSC Software	16
7	Oracle	10

MAPPING PROCEDURE

A phase-wise approach has been adopted to map the tools. By phase-wise approach, we mean that the product lifecycle has been divided into 5 phases viz. R&D, product development, manufacturing, maintenance and end-of-life as shown in Fig 1. A detailed comparison of PLC phases and literature on PLC is adopted from Aseri, 2010. Each tool is then mapped onto one or more phases depending on the phases of PLC they cater to. A comparison is made phase-wise, followed by within vendor and between vendor comparisons.

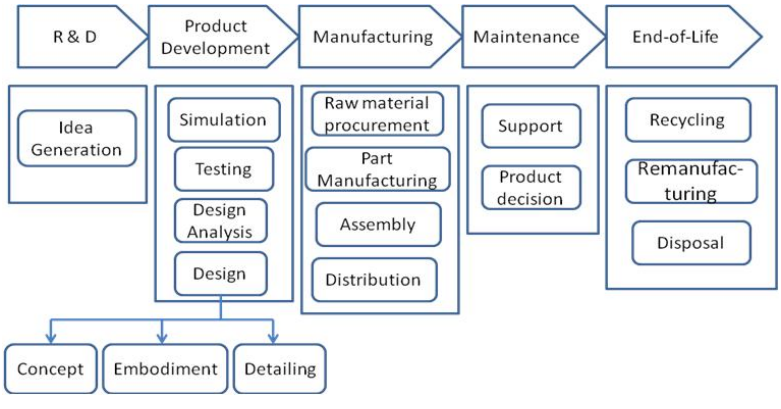

Figure 1: Integrated Model of Product Life Cycle

RESULTS

Mapping of PLM tools on PLC phases

From the literature review it is observed that classification of PLM tools based on applicability in various phases of product lifecycle has not been attempted. For the purpose of this project a total of 527 PLM tools spread across 7 tool vendors have been mapped on different phases of the integrated product lifecycle model. Information given in the tool factsheet in the form

of features, specifications and benefits is used to judge the applicability of a tool in a particular phase.

Figure 2 shows the result of mapping of all 527 tools on 5 broad PLC phases. It is evident that some tools are applicable in more than one phase and some are developed to cater to a specific phase only. From the figure it is evident that the product development phase is the most important phase when it comes to tools offered by the vendors. Not many options are available with the manufacturers for tools in R&D and end-of-life phase.

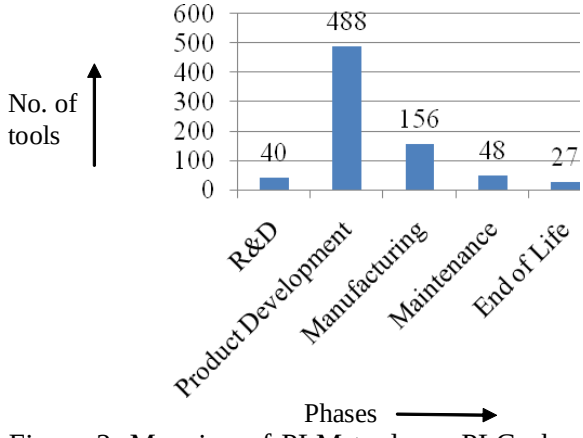

Figure 2: Mapping of PLM tools on PLC phases
(No. of Vendors = 7, No. of tools = 527)

Figures 3 to 7 show the result of mapping the PLM tools on individual phases. These figures help us in analyzing the strength of the tool vendors in each of the five phases. Cadence, Autodesk and MSC Software do not offer any tool to support the R&D phase. The representation of Dassault Systemes is the highest with 20 tools the R&D phase.

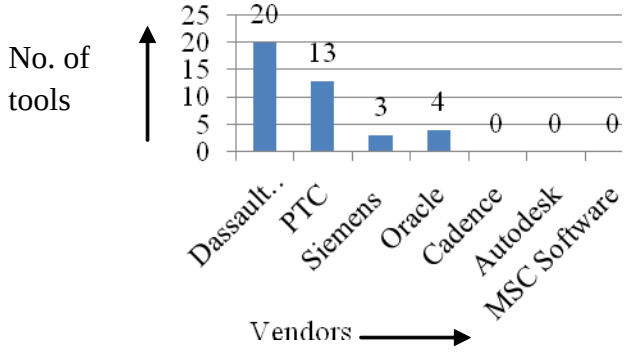

Figure 3: Mapping of PLM tools on the R&D phase (No. of tools = 40)

The product development phase, which has highest number of tools (488) is also dominated by Dasault Systemes and PTC. Cadence with its expertise in CAD tools also shows a fair representation in this phase.

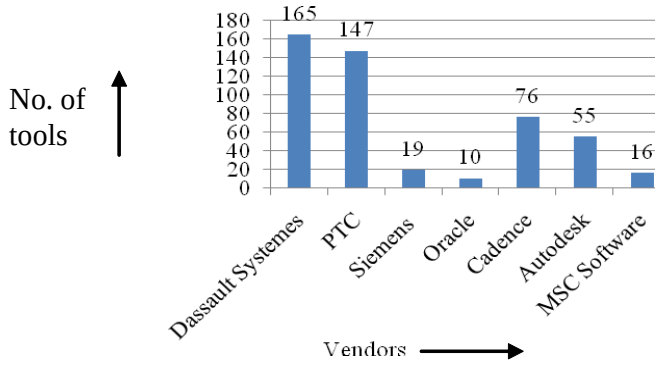

Figure 4: Mapping of PLM tools on the product development phase (No. of tools = 488)

In the manufacturing phase, Dassault Systemes leads by a greater margin as compared to other vendors. MSC Software offers only one tool in this phase.

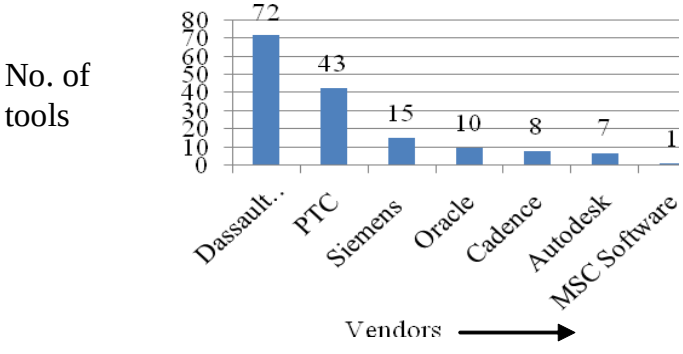

Figure 5: Mapping of PLM tools on manufacturing phase (No. of tools = 156)

In the maintenance phase, again we see the number of tools offered by all the vendors is very less. PTC is the leader in this phase in terms of number of tools provided. Cadence, Autodesk and MSC Software fail to provide any support to the manufacturer during the maintenance phase.

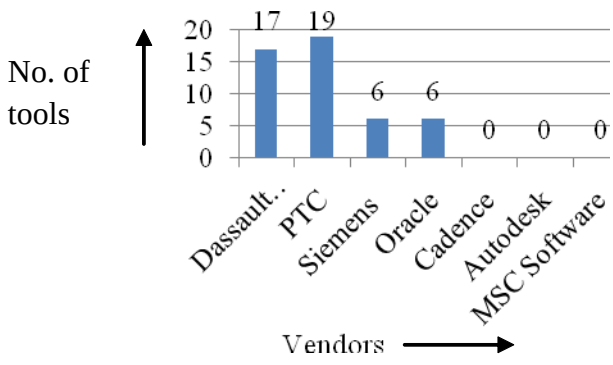

Figure 6: Mapping of PLM tools on the maintenance phase (No. of tools = 48)

In the end-of-life phase, Dassault Systemes is again the leader, although the number of tools provided to support this phase are quite less as compared to other phases. Cadence, Autodesk and MSC Software have zero representation in the end-of-life phase.

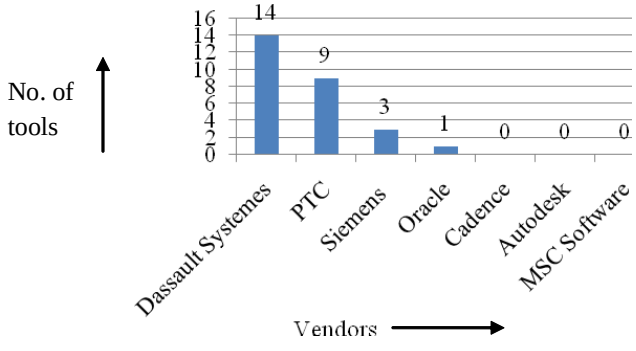

Figure 7: Mapping of PLM tools on end-of-life phase (No. of tools = 27)

To further compare the PLM tools vendors in terms of their product offerings, we perform a (a) within vendor and (b) between vendors analysis

Within vendor comparison:

This gives a comparison of the 7 tool vendors in terms of tools provided as percentage of total tools offered by a vendor in a particular phase. For example, out of the 188 tools offered by Dassault Systemes, 11% are applicable in R&D phase. It helps us analyse the strength of a vendor across all the phases of product lifecycle.

Between vendors comparison:

This gives a phase-wise comparison of a vendor in terms of tools offered by the vendor as percentage of total tools available in a particular phase. For example, Dassault Systemes offers 50% of tools out of the total 40 in the R&D phase.

Table 3: Within-vendor comparison for phases (in %)

Phases → / Vendors ↓	R&D	Product Development	Manufacturing	Maintenance	End of Life	Total no. of tools
Dassault Systemes	11	88	38	9	7	188
PTC	8	92	27	12	6	159
Siemens	15	95	75	3	15	20
Oracle	4	100	100	6	10	10
Cadence	0	97	10	0	0	78
Autodesk	0	98	13	0	0	56
MSC Software	0	100	6	0	0	16

From Table 3 it can be inferred that all the vendors have a strong focus on the product development phase. Tools offered by Cadence, Autodesk and MSC Software are concentrated in product development phase, but these vendors do not offer any tool for the R&D, maintenance and end-of-life phases. Oracle, with only 10 tools has 100% representation in the product development and manufacturing phases. It is evident from the above table that the R&D, maintenance and end-of-life phases are given relatively less importance by all tools vendors.

Table 4: Between-vendors comparison for phases (in %)

Phases → / Vendors ↓	R&D	Product Development	Manufacturing	Maintenance	End of Life
Dassault Systemes	50	34	46	35	52
PTC	33	30	28	40	33
Siemens	8	4	10	13	11
Oracle	10	2	6	13	4
Cadence	0	16	5	0	0
Autodesk	0	11	4	0	0
MSC Software	0	3	1	0	0
Total no. of tools	40	488	156	48	27

When we compare the tools vendors within a phase (Table 4), we find that MSC Software has the least representation in all the phases. Dassault systemes is the leader in 4 of the 5 phases. PTC competes closely with Dassault Systemes in all the phases.

CONCLUSION

A PLM solution can be called complete and comprehensive only if it has the tools that cater to all the phases of the product lifecycle. But in our study, we find that there is scope for vendors to think more broadly about the entire PLC of a product. Having PLM solutions that can single handedly take care of all the phases is a tough task or vendors can pool tools amongst themselves to make the complete PLC solution for a client. Although Cadence, Autodesk and MCS Software are included in most of the market research reports in the field of PLM, this study shows that these vendors qualify in specialized phases of the PLC phases. There is an urgent need to clarify the definition of PLM tools and the role these tools play to make innovative products.

Out of the 527 tools analyzed, more than 92% of the tools are applicable in the product development phase. This is one of the reasons that CAD based tool providers are leading the PLM market. Only 8% and 5% of the tools cater to the R&D and end-of-life phases respectively. R&D and end-of-life phases are the two extreme ends of a product. R&D is an important step in bringing out innovative products and thus it is an activity that must be integrated into PLM tool vendor focus. In today's globalized, collaborative, open innovation mode of working, collaborative R&D tools are an important agenda for innovation to happen. Today, to maintain their competitive position in the market, companies have to come out with innovative products more frequently. Further, end of life phases require urgent attention. Due to the increasing regulatory pressure, companies are getting more concerned about managing their products that were once discarded by the users. Manufacturers are looking towards closing the product cycle, wherein they take the responsibility of their product after it is discarded by the user. PLM tools can help companies in this process by managing the information of the product at the end of its life, in the very manner in which they are helping in managing the product information during product development process. The implications for tool developers and users buying PLM tools are significant, especially if users want innovative products as a goal.

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