# AC 2008-595: THE UTILIZATION OF A PRODUCT LIFECYCLE MANAGEMENT SYSTEM WITHIN A TEAM DESIGN PROJECT

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# The Utilization of a Product Lifecycle Management System within a Team Design Project


## Abstract

This paper describes the utilization of a product Lifecycle management system within an engineering design course. This course is required for engineering, engineering technology and industrial technology management students at Central Michigan University. This course teaches the fundamentals of engineering design, design sketching, computer-aided design, and engineering graphics. A major component of the course is a team design project. This paper describes the course in general and the design project in detail. Emphasized within the description of the team project is the utilization of a collaborative product data management application to improve data sharing efforts between team members.


## Introduction

The management of design data is critical for manufacturing enterprises. The wealth of knowledge that goes into the design of a product can be overwhelming and difficult to manage, especially when attempting to leverage geographically dispersed resources. But competition in a global economy demands that a product is designed efficiently, effectively, and quickly. Due to this, design data needs to be current, rapidly available, flexible, and complete. Design information also needs to be of high quality while at the same time cost effective.

Product Lifecycle Management (PLM) is an approach to managing design data that is currently being utilized by most high profile original equipment manufacturers. The Boeings, Fords, GMs, and Toyotas of the world are fine tuning their approaches to product design with a particular emphasis on the utilization of PLM strategies. But what is PLM? According to CIMdata, a leading consulting firm, PLM is "a strategic business approach that applies a consistent set of business solutions that support the collaborative creation, management, dissemination, and use of product definition information."[1] While often looked at as software technologies, PLM is intended to be a philosophical or strategic approach to design.

Within CIMdata's definition the "collaborative creation" phrase is critical to the success of PLM implementations. Collaborative product development is an important design enabler for companies dealing with increased competition, globalization of commerce, outsourcing, and roles of first tier suppliers. It involves the seamless integration of tier suppliers into the design lifecycle of a product. This component of PLM will continue to grow in popularity as enterprises "recognize the need to improve their management of intellectual assets and more clearly recognize their need to become better integrated with customers and suppliers to address cost, quality, and delivery."[2]

Due to the growing importance of collaborative design strategies, the author of this paper developed an engineering design course with a PLM system as an important product information backbone. This course, *Engineering Design Graphics" (IET 154)*, is required for engineering, engineering technology and industrial technology management students. This course teaches the fundamentals of engineering design, design sketching, computer-aided design, and engineering graphics. A major component of the course is a team design project. This paper describes the course in general and the design project in detail. Emphasized within the description of the team project is the utilization of a collaborative product data management application to improve data sharing efforts between team members.

**Product Lifecycle Management Fundamentals**

Product Lifecycle Management (PLM) gradually evolved from collaborative design, just as concurrent engineering was a predecessor to collaborative engineering. Collaborative design remains an important component of PLM. According to Dohrman, "PLM is a strategy companies develop to generate, manage, distribute, and use product information through collaboration to improve delivery to market. PLM is also a way to take a product from concept to retirement."[3] It is the product information backbone for companies and their extended enterprises. Downstream technologies such as computer-aided design (CAD), computer-aided manufacturing, enterprise resource planning, product data management systems, and a variety of collaboration systems are the tools used within PLM to lower product design costs and to speed product time-to-market. PLM solutions help design engineers control the flow of design data within a product's lifecycle. "Product teams can easily, securely and cost-effectively collaborate on and manage product information within their extended enterprise and across the supply chain."[4]

On its surface PLM may only seem relevant to original equipment manufacturers (OEM). Companies with products that can significantly impact the environment are under the microscope to ensure that the entire span of a product lifecycle is managed, to include product disposal. But smaller OEMs also have a stake in PLM. On the positive side, PLM is important for companies interested in product innovation or improvement. On the other hand, smaller companies are being squeezed by larger OEMs to invest in PLM technologies. This can be a significant monetary problem for struggling tier suppliers.

There are other issues that OEM's must face when implementing PLM. According to Gould, if a company wants to develop design/engineering collaboration within their supply chain, there are three potential problems.[5] First, sharing CAD data of products between organizations is difficult because of the size of data files. Second, without high-end graphics workstations, displaying, manipulating, and revising digital representations of data can be very slow. Finally, engineers and even marketing people would like to have precise displays of visual data when they are developing new products. Resolving these problems should be the first and most important activity for companies which want to develop design collaboration across their supply chain.

An important and difficult principle of collaborative design is for geographically dispersed individuals to work within true team environments. These dispersed teams should be organized in a manner that allows for equal participation from all group members. This organization requires individual responsibility while promoting interdependence among group members. According to Johnson, Johnson, and Smith, five essential elements are necessary to allow for true team efforts: (a) positive interdependence, (b) individual accountability, (c) face-to-face interaction, (d) social skills, and (e) group processing.[6]

Positive interdependence stipulates that successful outcomes of one team member are dependent upon the successful outcomes of each team member. In addition, well functioning groups require every team member to be held individually accountable for handling their share of the load. Through design or through neglect, these two elements of cooperative learning are not incorporated into most team design projects. While neglecting these two elements can still lead to successful group outcomes, there is no assurance that social loafing will not occur or that all members of the team will benefit equally.

Based on Johnson and Johnson's collaborative learning principles, the risk of social loafing is increased when team members cannot meet face-to-face.[7] It is difficult to hold individuals responsible and accountable without one-on-one encouragement. Fortunately, technology is providing avenues to bring people virtually face-to-face.

**Team Design Project**

As previously mentioned, the team design project highlighted in this paper occurred within a freshman level engineering design graphics course in a department of engineering and technology. This course has two goals: 1) to teach students the fundamentals of engineering design, and 2) to teach students how to utilize graphics, to include CAD, within engineering design processes.

The PLM system utilized in this course was Smarteam and the CAD system was CATIA. Both applications are owned by Dassault Systemes and are available to academic institutions through IBM's HEAT program. Instead of saving their individual assignments to their network folders, students were required to manage all their projects through Smarteam. This included the checking in and out from the PLM system's vault all CAD and non-CAD assignments.

A team design project is a significant component of this course. The project assigned during the timeframe of this paper was a coffee mug. Students within their individual lab sections were organized into teams of three or four students. Each team followed a formal design process which included the following steps:

1. Customer Needs
2. Product Target Specifications
3. Design Concept Generation
4. Design Selection
5. Final Product Specifications
6. Detail Design

Team development and organization were important considerations within each design project. Teams were required to be self-administrated and managed. When problems arose within a team, such as social loafing, the team (not the instructor) was responsible for finding and implementing a solution. When teams were formed and the design problem presented, the instructor provided a list of required tasks along with approximate times necessary to complete each task. From this list, each team assigned tasks for specific members to perform. Additionally, each team developed a group mission statement and a set of team rules and polices. Examples of issues addressed within a set of rules include: (a) meeting attendance, (b) communication methodologies, (c) personal problem solving, and (d) member task requirements.

**Student Feedback and Evaluation**

At the end of the course a survey was administered to the course's students (N = 34) to measure their perceptions on how effective Smarteam was at managing their design data within the team design project. A Likert scale was utilized to measure responses (1 Strongly Agree, 2 Agree, 3 Disagree, and 4 Strongly Disagree) to the following statements:
Smarteam was effective in regards to my group project.

1. Smarteam was easy to use.
2. Smarteam helped to provide accessibility to my team members' work.
3. Smarteam helped to provide convenience that my data was stored in one place and that all team members had access to my data.
4. I will consider using Smarteam for other classes or projects as a way of storing data and sharing information.
5. Smarteam is a valuable tool.
6. I never seemed to fully grasp the usefulness of Smarteam
7. You should keep using Smarteam in your courses.

One-sample t-Tests were used to assess student perceived feelings about the effectiveness of the group project. Within the tests, the sample data were compared to a neutral response of 2.5.

There was only one response that showed any significance from neutral. Students felt that Smarteam helped to provide confidence that their data was stored in one place and that all team members had access to the data ($M = 2.08$, $p = .000$). Some of the remaining responses seemed to indicate that Smarteam could be a valuable tool, but the technological problems encountered were detrimental to its proper function. Some students felt that Smarteam was a valuable tool ($M = 2.22$, $p = .035$) and was effective in regards to their group project ($M = 2.33$, $p = .194$), especially in regards to their ability to access their team members work ($M = 2.25$, $p = .037$).

Some students had issues with Smarteam. Many never seemed to fully grasp the usefulness of Smarteam ($M = 2.69$, $p = .182$). This could be due to the difficulty in learning to use the system. Students were neutral in their opinion of the ease of use of Smarteam ($M = 2.58$, $p = .52$). Many students said they would not consider using Smarteam as a mechanism for managing project data ($M = 2.83$, $p = .019$). Finally, the students were neutral on whether Smarteam should be included in the course in the future ($M = 2.53$, $p = .831$).

**Conclusions**

From a professor's point of view, Smarteam is a valuable tool. It is a different method for storing data. Most individuals are use to simply saving their work to a file location. The concept of Checking in and checking out CAD models and documents from a vault may seem foreign.

Observations clearly showed that students were continually forgetting to check their work back into the vault. This probably led to frustration and dissatisfaction with Smarteam

There is a significant learning curve for new users of Smarteam. The class was freshman level. The content in the course was full without adding a new software application. It addition, there were many technical difficulties with Smarteam. These were primarily due to software being new to the department. With this being said, all students and instructors seemed to be progressing in their knowledge of Smarteam at the end of the course.

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