Application of Product Lifecycle Management in the University Classroom and Laboratory

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Presentation Overview

Questions:

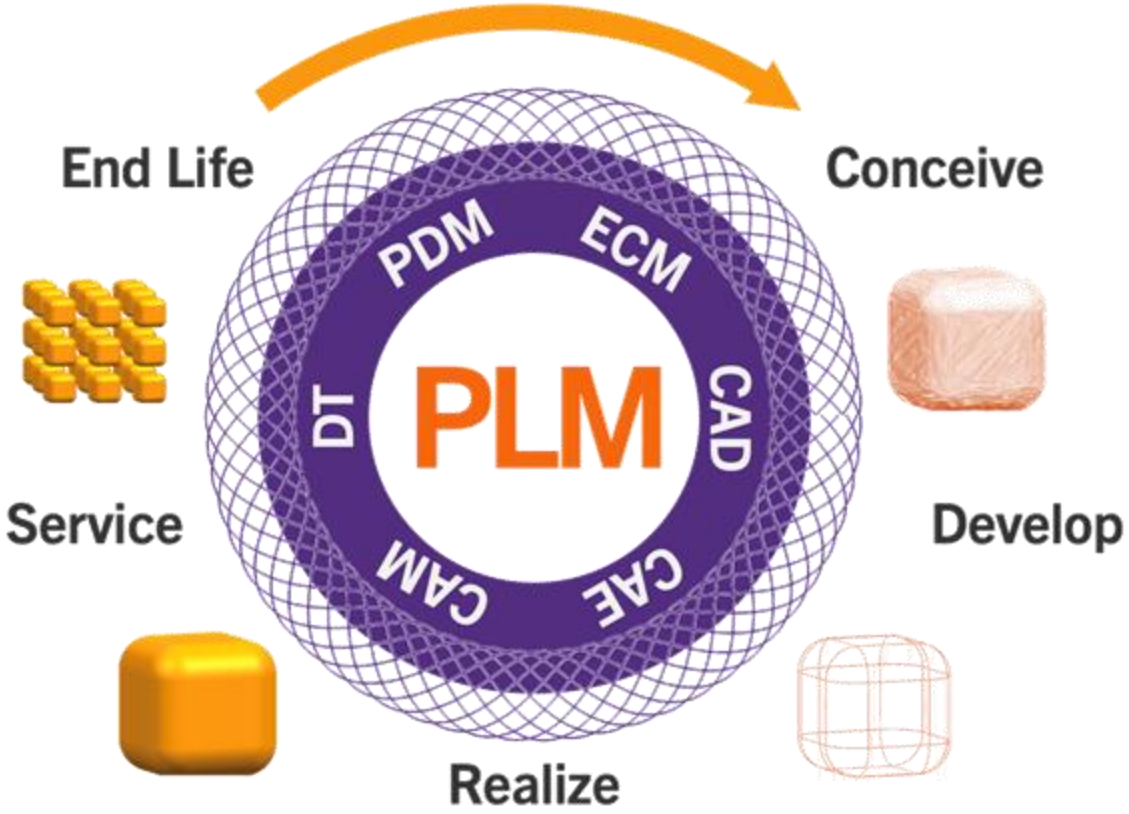
- What's the value of learning PLM as an undergraduate?
- How do we assist undergraduate engineers in understanding PLM at a university?

Summary:

- Motivation for PLM
- Introduce PLM Center at Clemson University
- Describe activities and observations

Product Lifecycle Management (PLM)

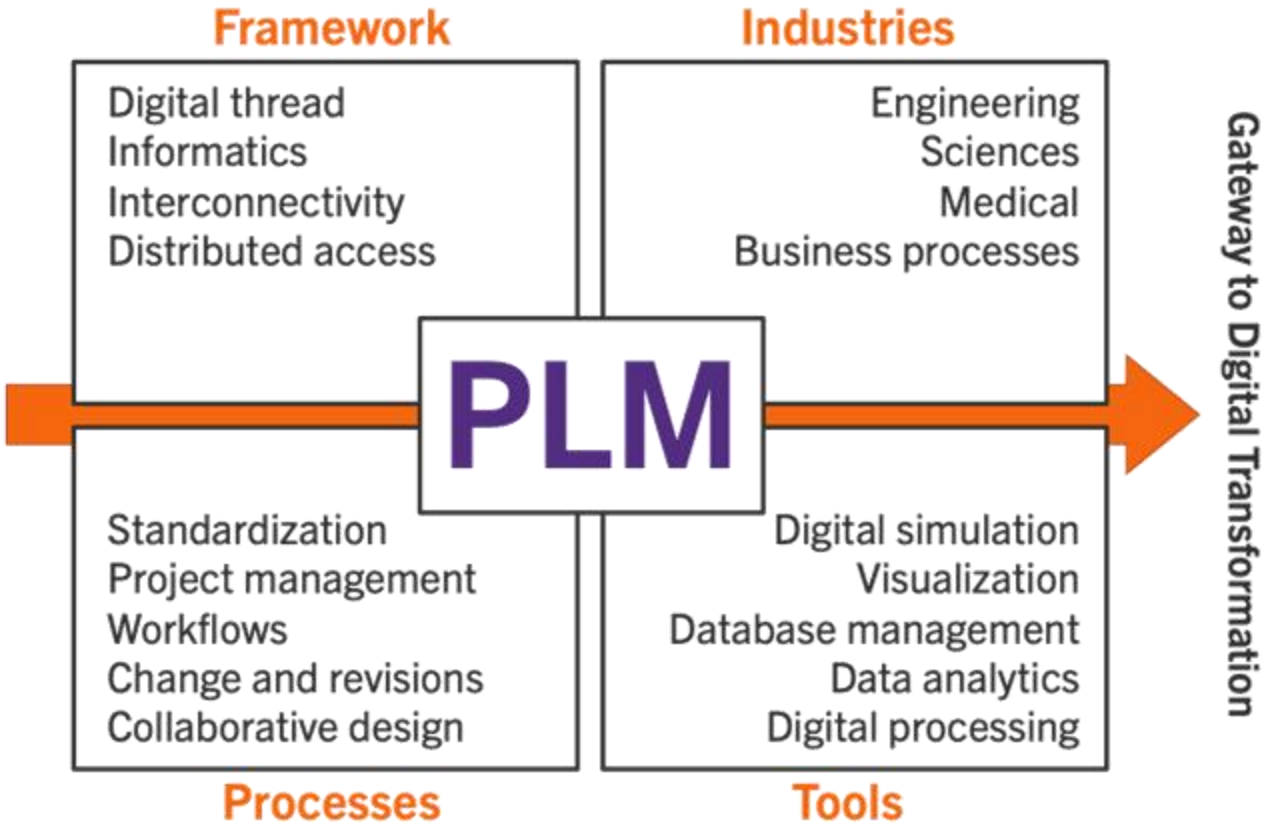
- Definition: The tools and processes used by an organization to manage the information defining and associated with a specific product throughout the product's lifecycle
- Digitally focused
- More than CRUD, integrates all information into a holistic ecosystem



Overview of PLM

Motivation

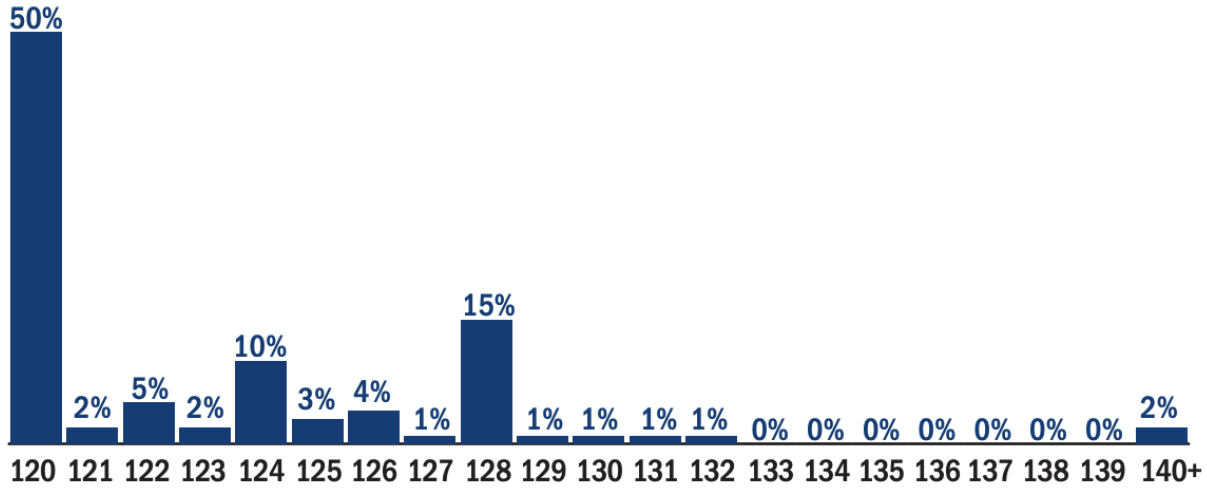
- Industry 4.0 is built upon drawing conclusions from integrated information
- Digital processes are fundamental to all enterprise operations
- PLM is a backbone to engineering:
  - Model-Based Systems Engineering (MBSE)
  - Part definition
  - Collaborative development
  - Digital twins



Components of PLM

Current State of University Programs

- 5 highest curriculums by credit hour are all engineering programs[1]
- High credit-hour programs make it difficult to make new classes
- 3 universities offering explicit PLM courses (including Purdue University)[2]
- Others offer PLM as subunits of other courses

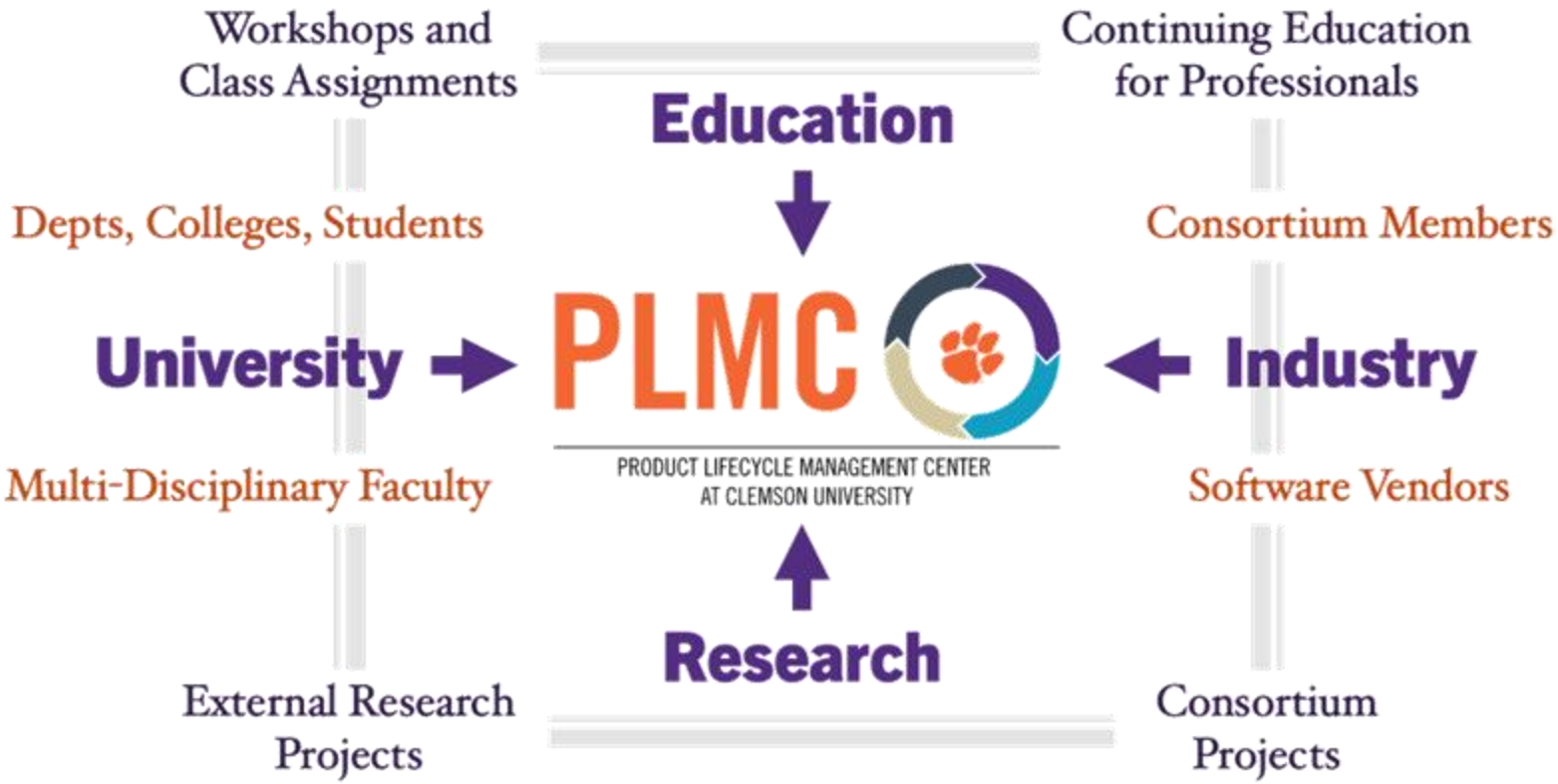


Bachelor's degree credit-hour program requirements for over 500 universities in the United States

Figure from [1]

1. N. Johnson, L. Reidy, M. Droll, and R. E. LeMon, "Program Requirements for Associate's and Bachelor's Degrees: A National Survey," Complete College America, Washington DC, Jun. 2012.
2. Based off course catalogs maintained by CollegeTransfer.Net, as of May 2023

PLM Center at Clemon University



Overview of PLM Center

PLM Center Technical Resources

- 24-seat computer lab, available 24/7 to university personnel
- Software from Siemens, Dassault Systemès, ANSYS
- Training modules (many provided by vendors)
- Classroom space for workshops, seminars, courses
- Assistance with class projects
- Provide software certifications

Summer camp teaching CAD methods to middle-school students operating out of PLMC Computer Lab

PLM Seminars

- 1 hr short courses on PLM topics
- Freely available to undergraduate and graduate level students
- Method overviews and technical training
- Provided weekly throughout each semester
- Available virtually, in-person, and on-demand

Presentation to ME undergraduates

Seminar Topics

Fundamental Concepts

1.1 Introduction to Product Lifecycle
1.2 Digital Components of PLM
1.3 PLM Functional Areas
1.4 PLM in Practice

Graphical Concepts

3.1 Computer Aided Design Methods (CAD)
3.2 Computer Aided Engineering (CAE)
3.3 2D Drawings and GD&T
3.4 System Simulation and Optimization

Digital Product Development

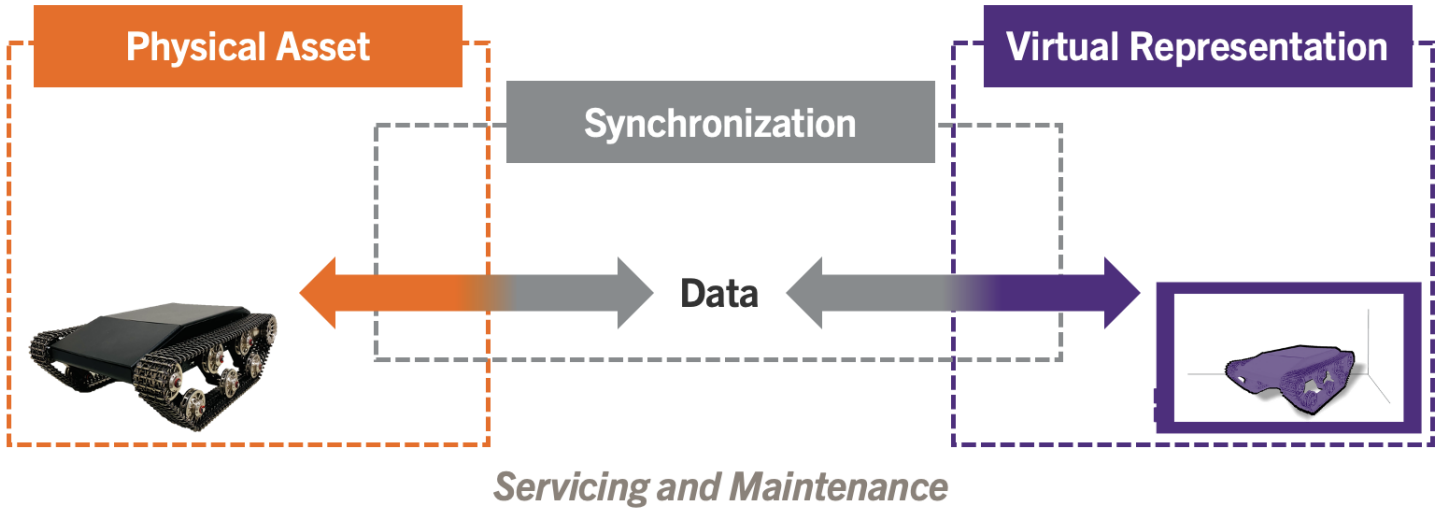
2.1 Product Design Tools and Approaches
2.2 Data Preservation and Security
2.3 Additive Manufacturing
2.4 Data Analytics and Mining

Non-graphical Concepts

4.1 Project Management
4.2 Product Data Management
4.3 Engineering Change Management
4.4 Systems Engineering and MBE

Extracurricular Course

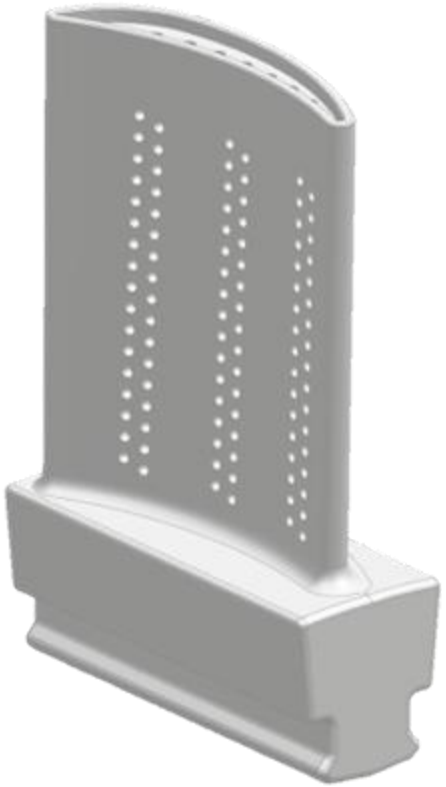
- 1 credit-hour course offered to undergraduates
- Centered on project to create a digital twin of tracked vehicle
- Flexible, can include individually-led research projects
- 4-10 participants, with ability to scale

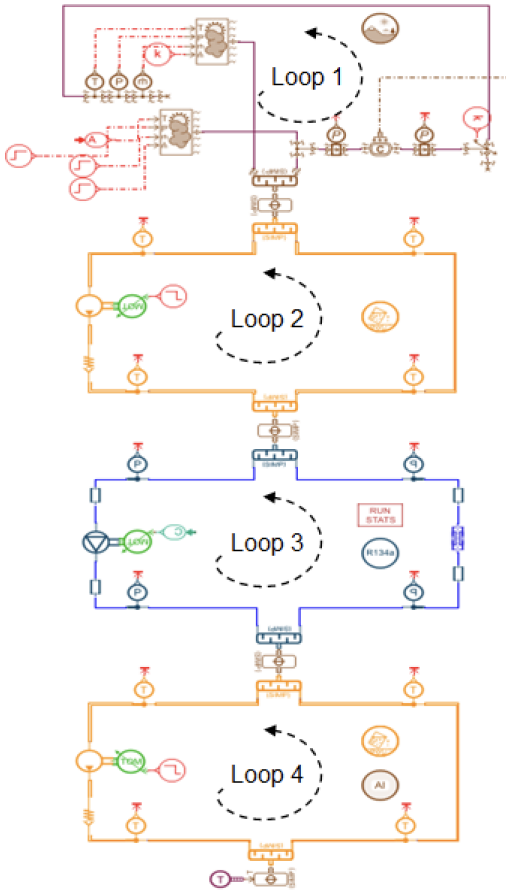


Overview of a digital twin showing the tracked robotic vehicle used in the course as an example

Research Activities

- PLM matures in conjunction with technology evolution
- Research aligns teaching and resources with state-of-the-art
- Relevant experiences and graduate school options for undergraduates
- Many PLM-focused schools operate industrial research centers

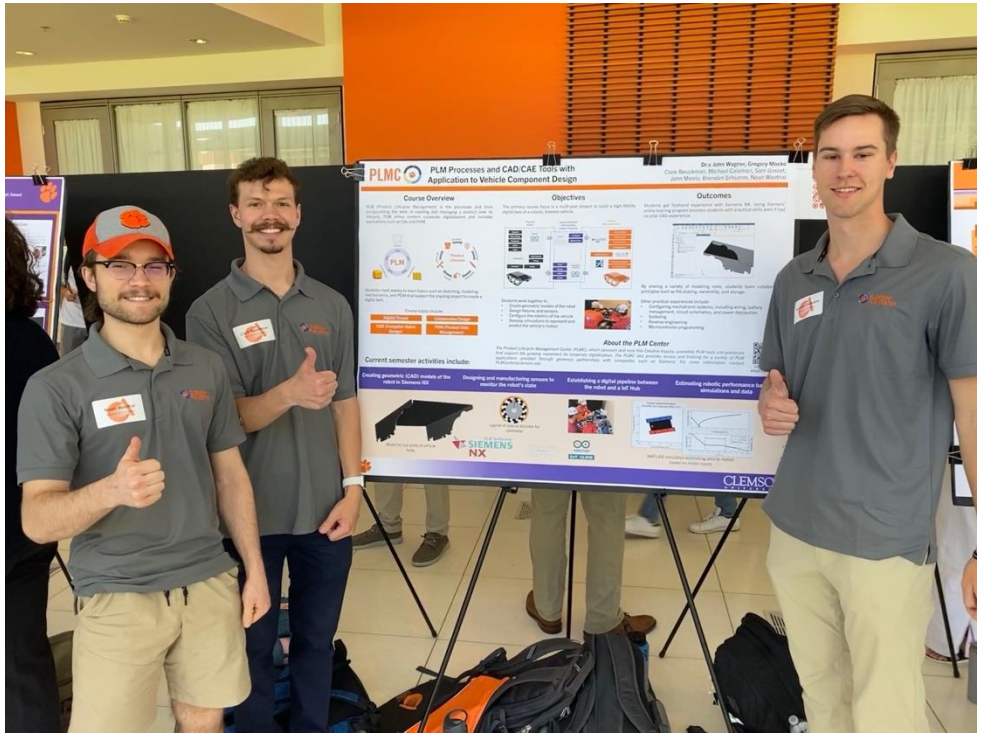




Left: Solid model of gas turbine blade with patterned turbulators
Right: Simulation model for digital twin of commercial HVAC system

Observations

- Value of PLM is not compelling enough to draw students without additional rewards
  - Course credit
  - In-class assignments
- Most self-motivated students are searching for jobs
- Needs:
  - Access to resources
  - Guidance on projects, training
  - Hands-on experiences working within a robust PLM ecosystem



Students present PLM research at undergraduate poster forum

Additional Methods

- Elective PLM courses (often draw students interested in design)
- Indirect integration with other courses
  - Collaborative projects using PDM software
  - Teaching MBSE principles in manufacturing/CAM classes
  - Expanding CAx/Design courses to cover reference additional tools and integrations (especially outside of normal domains)
  - In-class presentations

In-class presentation introducing PLM to undergraduate engineering students

Conclusions

- PLM is an important part of modern industry
- Students need access and motivation to learn PLM
- PLM doesn't need to burden existing curriculums
- Vectors:
  - Access to software, training
  - Course projects
  - Extracurricular project-based groups
  - Elective classes
  - Research efforts

Students engaging in PLM demonstrations

Questions

PLMC

PRODUCT LIFECYCLE MANAGEMENT CENTER
AT CLEMSON UNIVERSITY

This research was conducted through the Product Lifecycle Management Center at Clemson University.

More information on the center can be found at https://www.clemson.edu/centers-institutes/plm/