

Product Lifecycle Management

Lesson 2: Fundamental (I)

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Outline

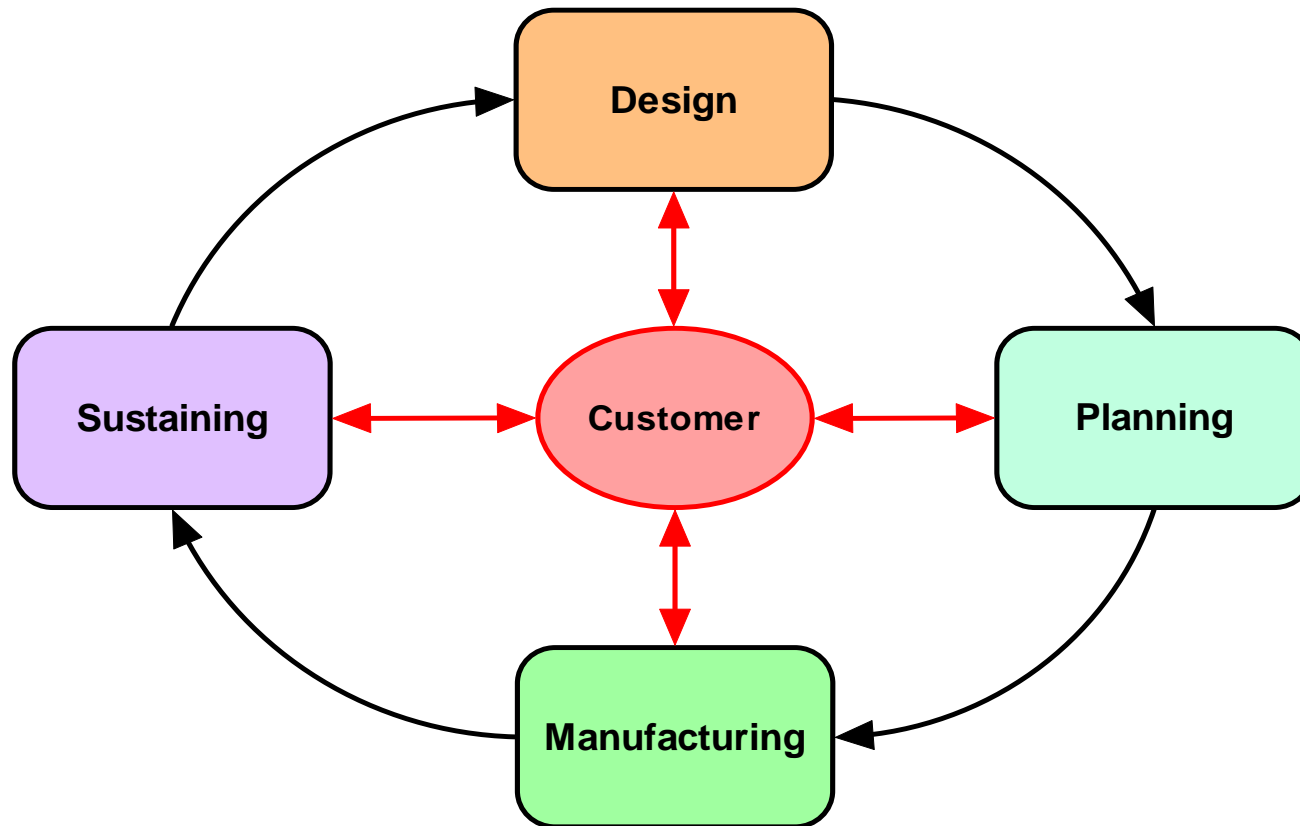
- Market research
- Conceptual design
- Detailed design
- Engineering analysis
- Prototyping and field test

Objectives

Students will be able to

- Conduct a market research for the given product
- Propose a conceptual design based on market research outcome
- Identify necessary design and analysis activities

Conventional product lifecycle

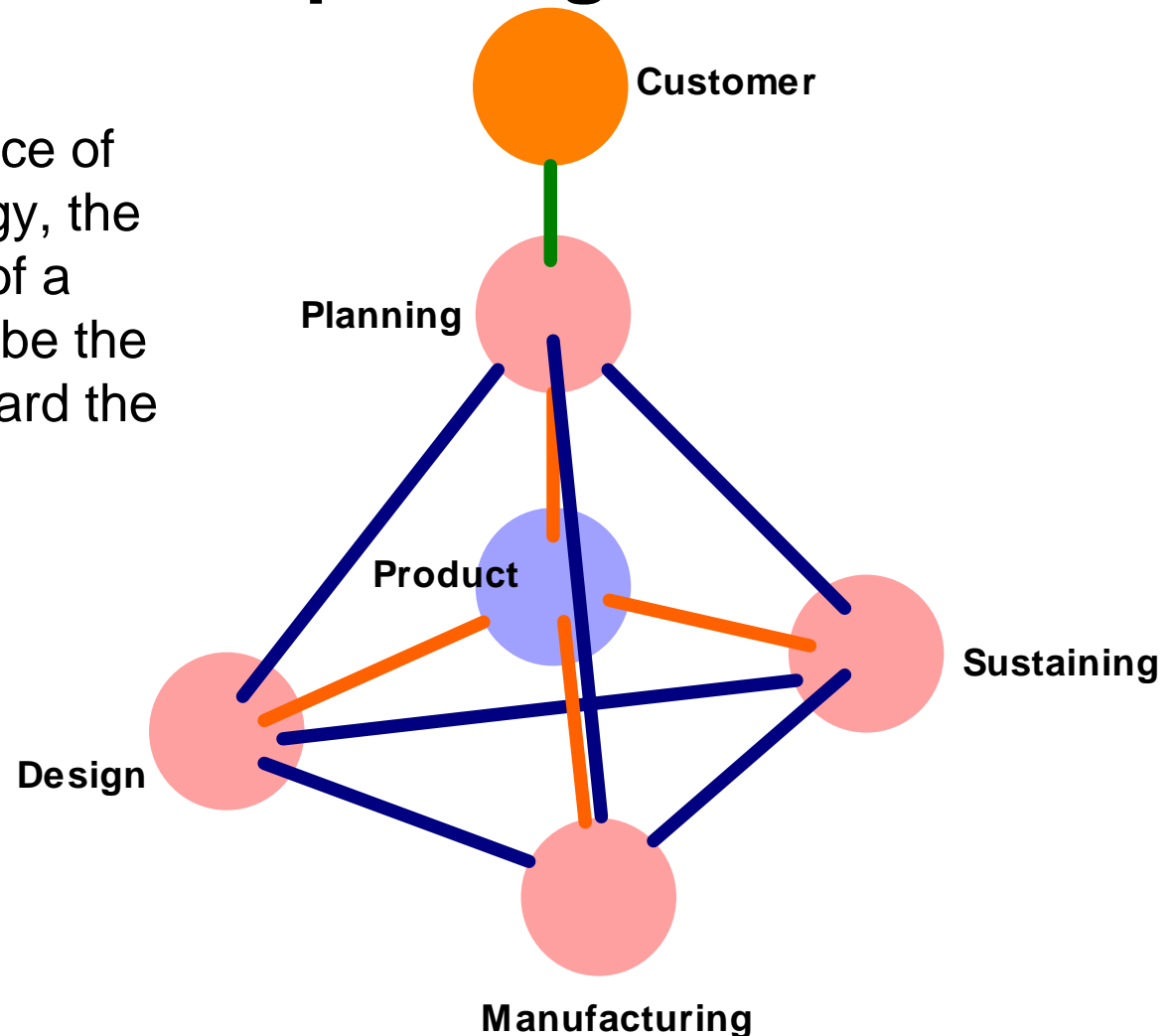


Major activities

- A cycle throughout the major activities
 - Design
 - Planning
 - Manufacturing
 - Sustaining
- Could such an approach be a problem?
 - Maybe concurrent, but still sequential
 - Does IT change the picture of a product lifecycle?

A new PLM paradigm

- With the latest advance of information technology, the planning operations of a product lifecycle can be the front end of PLM toward the customer
- Will this work?



Market research

- A generation of a new product (marketresearchworld.net)
 - Market Research is a systematic, objective collection and analysis of data about a particular target market, competition, and/or environment. It always incorporates some form of data collection whether it be secondary research (often referred to as desk research) or primary research which is collected direct from a respondent.
- Why do we want a new product?
 - Competition
 - Survival game
 - Industry trend
 - Tech break through
 - ...

Market analysis

- Target customer
 - Grouping: Age, gender, ethnic, income, etc.
 - Regional difference: Operation environment of the product
- Market segmentation
 - Overall market
 - Factors determining market size
 - Market size estimate/projection

Competition

- Who will you compete with?
 - Existing
 - Potential
 - IP (Intellectual Property)
 - Are you selling a product or [licensing](#) your innovation?
- [Analysis of competition](#)
 - Objectives
 - Strategies
 - Assumptions
 - Resources and capabilities

Conceptual design

- Based on the wish list
 - It should be the result of market research
 - An outlined solution for an engineering problem (French 1998)
- Configuration of a product or a family
 - Existing product – design modification
 - New design from scratch – What are the objectives?
- Product layout
 - Assembly level – product structure with functionality description
 - Component level – share or reuse of a certain part or parts

Industrial design

- Realization of a dream
 - A starting point of a new product or the end of a concept
 - What to consider
 - Time to market
 - Cost: R&D, production, logistics, etc.
 - Customer: User interface
- Visualization for proof of concept
 - Procedure: To check if a specified procedure works
 - Application: To check if a specific function can be performed

Detailed design

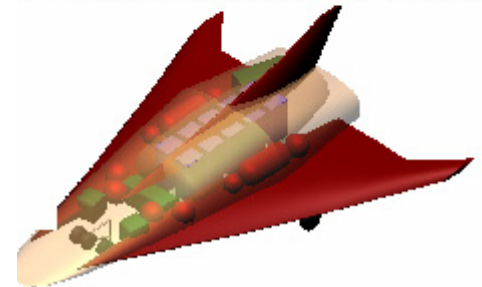
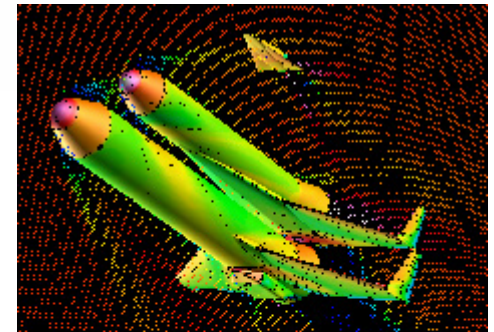
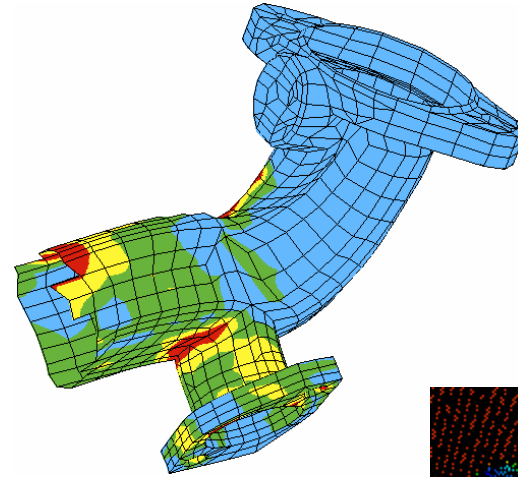
- Activity purpose: To achieve the desired
 - Geometry
 - Functionality
 - ...
- PLM usually covers three areas
 - Mechanical design
 - Electrical/electronic design
 - Software design
- Mechanical design
 - Housing/structure: Tolerance, durability, etc.
 - Mechanism: Kinematics, dynamics, etc.
 - Power: Intake/output/convergence of energy, etc.
 - Ergonomics: Safety, usability, etc.

Detailed design

- Electrical/electronic design
 - Power: Intake/output/convergence of energy, etc.
 - Heat: Generation, dissipation, etc.
 - Electromagnetic standards: Interference, safety, etc.
- Software design
 - Embedded: Integrated system, multi-functional, etc.
 - Modularized: Compatibility, data exchange/sharing, etc.
 - User interface: Usability, learning curves, etc.

Engineering analysis

- Purpose
 - To see whether the proposed design able to meet the product specification, e.g. desired
 - Geometry
 - Function
 - Life span
 - Manufacturing concerns
 - etc.
- Design evaluation
 - Part level
 - Product/system level



Part level evaluation

- Focus
 - To evaluate how the part performs desired functions or interacts with the rest of the system (product)
- Two main categories
 - Functionality
 - Structure: Strength, rigidity, spatial constraints,, etc.
 - Performance: Weight, durability, efficiency, etc.
 - Manufacturability
 - Cost: Cost of production, handling, support, etc.
 - Technology: Possibility to fabricate the proposed design

Product level evaluation

- Focus
 - To evaluate how the newly designed system perform in the designated environment
- Two main categories
 - System integration
 - Component interaction: Kinematics, dynamics, etc.
 - Fault detection: Clash detection, reliability, etc.
 - Environment interaction
 - Energy: Consumption, exhaustion, etc.
 - Standards and regulations: Safety, environment impact, etc.

Tools for engineering analysis

- Computer-based
 - Digital mockup
 - To evaluate kinematics, dynamics, clash detection or fly through
 - Level of detail: From original solid models, surface models, to simplified wired frame representation
 - Finite element analysis
 - Discrete/digitized simulation to identify the distribution of concerns, such as stress, temperature, magnitude, etc.
 - Level of detail: Depending on grid size and boundary conditions
- Physical
 - Physical mockup
 - 1-to-1 or scaled model with simulated operating environments
 - Field test with prototype
 - Evaluate real world performance before putting into production

Prototyping

- An essential part of bring any new product from a conceptual stage to a mass-produced product
- Why prototype?
 - Debugging the design so there will be no future surprise
 - Demonstrating the product to potential investors and customers
 - Collecting feedbacks from the target market before putting to mass production

The need of rapid prototyping

- Conventional prototyping material
 - Clay or wood
 - Exact or similar materials used for the real product
- Conventional prototype tooling
 - Hand craft: clay model used in automobile industry
 - Made by the job shop
- Problem
 - Long time to produce
 - Model accuracy

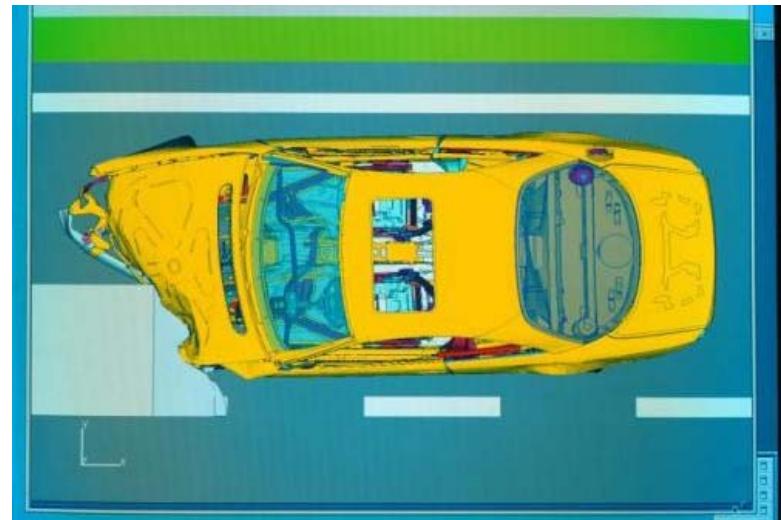


Rapid prototyping

- “RP is the automated fabrication technologies of seamlessly and rapidly creating accurate representative physical models of mechanical parts directly from 3-dimensional Computer Aided Design (CAD) data without the use of tooling and with minimal human intervention. “
- Available technologies
 - Plastic-based: SLA, SLS, FDM
 - Paper/wood-based: [LOM](#)
 - Metal: 3-D printers, DSPC
- Things to know
 - Implications of test results due to the materials used
 - Limitations of different RP processes

Field test

- Why field test
 - Close examination of individual parts
 - Performance evaluation of the whole system
 - Comparison of real and virtual models
 - Identification of unknown problems
- Models used for field test
 - Actual operation: Crash test
 - Simulated environment: Wind tunnel



Validity of field test

- **Field test is expansive but necessary**
- Things to consider
 - Actual field test
 - How to collect useful and meaningful data
 - How to interpret those results
 - How to apply it to improve the product
 - Controlled environment
 - How to control variables
 - How to interpret those results
 - What are the limits due to test assumption
- Physical model (automobile impact test)
 - How to address the issues of human-machine interaction
 - How to address the issues caused by different user groups

Review questions

- Find a product and conduct the following activities
 - List out possible lifecycle activities of this product, from market research to field test
 - Identify the data that can be generated by a specific lifecycle activity and how it can be used in the rest of the product's lifecycle

Reference

- Grieves, M. (2005). *Product lifecycle management: Driving the next generation of lean thinking*. McGraw-Hill. Chapters 1-2.
- Stark, J. (2004). *Product lifecycle management: 21st century paradigm for product realisation*. Springer. Chapters 1, 2, & 6.
- French, M. J. (1998). *Conceptual design for engineers* (3rd ed.). London, UK: Springer-Verlag

Additional Reading

- ITE (2006). *[Practical approach to engineering analysis](http://www.ite.com/~itek/whitepaper/white_paper.htm)*. Retrieved August 10, 2006, from http://www.ite.com/~itek/whitepaper/white_paper.htm

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