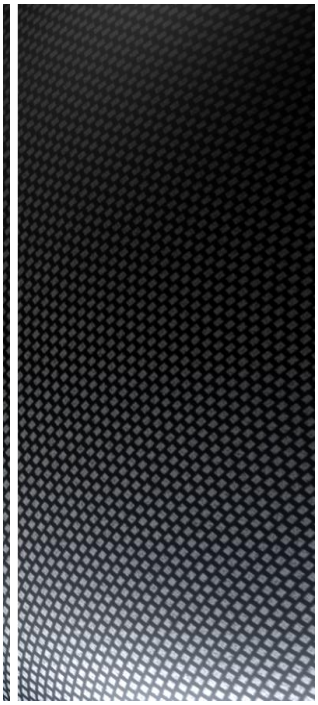


Product Planning & Development (21-423)

Advanced Manufacturing Laboratory
Department of Industrial Engineering
Sharif University of Technology

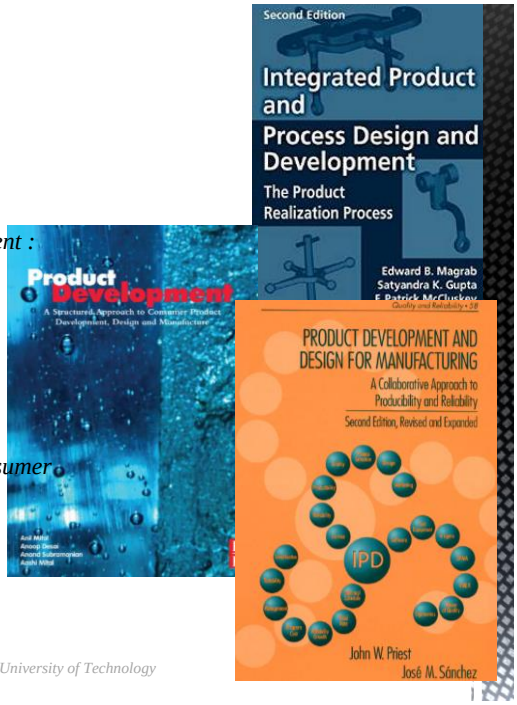
Session #14

Course Description

- *Instructor*
  - *Omid Fatahi Valilai, Ph.D. Industrial Engineering Department, Sharif University of Technology*
  - *Email: FValilai@sharif.edu , Tel: 6616-5706*
  - *Website: Sharif.edu/~fvalilai*
- *Recommended prerequisite*
  - *Manufacturing process I (21-418)*
- *Class time*
  - *Sunday-Tuesday 18:00-19:30*
- *Course evaluation*
  - *Mid-term (25%)*
  - *Final exam (40%)*
  - *Quiz (5%)*
  - *Exercise (Manufacturing Lab.) (30%)*

Session reference

- *Reference:*
  - *Edward B., "Integrated product and process design and development : the product realization process", CRC Press, 2010*
  - *John Priest, Jose Sanchez; "Product Development and Design for Manufacturing: A Collaborative Approach to Producibility and Reliability, Second Edition", CRC Press, 2001*
  - *Mital et al. , "Product Development A Structured Approach to Consumer Product Development, Design, and Manufacture", Butterworth-Heinemann, 2008*

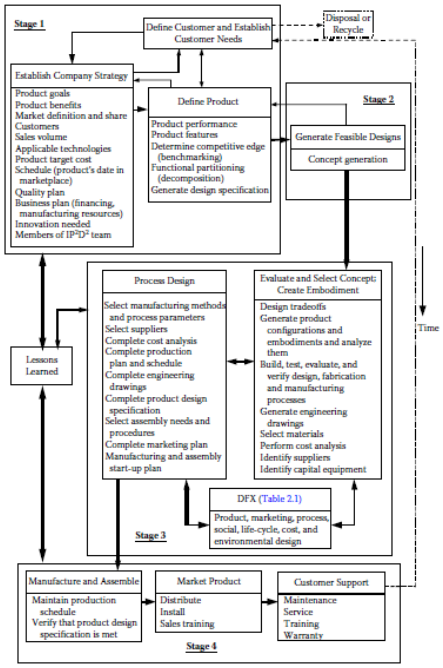


Course Description (Continued..)

- ***Contents:***
- *Product development in the changing Global world*
- *Stages of Product Development*
- *The Structure of the Product Design Process*
- *Early design: Requirement definition and conceptual Design*
- *Trade-off analyses: Optimization using cost and utility Metrics*
- *Detailed design: Analysis and Modeling*
- *Design Review: Designing to Ensure Quality*
- *Production System; Strategies, planning, and methodologies*
- *Production System Development*
- *Planning and Preparation for Efficient Development*
- *Supply chain: Logistics, packaging, supply chain, and the environment*

Detailed design: Analysis and Modeling

- *Detailed Design:*



Detailed design: Analysis and Modeling

- *Detailed Design:*
  - *Prototypes in detailed design*
    - *Prototypes play a large role in all phases of development especially in detailed design.*
    - *Physical models and software models (virtual reality) are used to gather information to reduce uncertainty optimize parameters and test the design.*
    - *Prototyping provides information that is especially important for:*
      - *Information that is not available*
      - *Software and software interfaces*
      - *Global and cultural design aspects*
      - *Innovative or creative products that are very different from the norm*
      - *Data for unknown uses or environments*

Detailed design: Analysis and Modeling

- *Detailed Design:*
  - *Modeling and simulation*
    - *Modeling and simulation are analysis tools for evaluating and optimizing designs and products.*
    - *The purpose is to assist the design team by constituting a process in which models simulate one or more elements of either the product or the environment.*
    - *Simulation and modeling can be low cost and effective methods to gather and verify information when compared to full-scale prototypes.*
    - *Modeling allows a designer to experiment with requirements, optimize design decisions, and verify product performance.*

Detailed design: Analysis and Modeling

- *Detailed Design:*
  - *Modeling and simulation*
    - *Reason for simulation*
      - *Increase the level of knowledge of how the product interacts with its environment*
      - *Assess the benefits, costs, and attributes of each requirement*
      - *Perform design trade-off studies to optimize various design elements,*
      - *Verify that the design can meet all requirements*

Detailed design: Analysis and Modeling

- *Detailed Design:*
  - *Modeling and simulation*
    - *Effective simulation*
      - *Realistic and correct*
      - *Useful and usable*
      - *Well-planned, well-managed, and well-coordinated*
      - *User acceptance*
      - *Favorable benefits-cost ratio*
      - *Modular, flexible, and expandable*
      - *Transportable*

Detailed design: Analysis and Modeling

- *Detailed Design:*
  - *Modeling and simulation*
    - *Effective simulation*
      - *Realistic and correct*
      - *Useful and usable*

Who are the users?
- Simulation staff
- Designers
- Management
- Customer
- Support engineers

What will the simulation be used for?
- Experimentation
- Development of requirements
- Design trade-offs
- Simulating environments
- Test
- Design verification
- Documentation

What outputs are required from the simulation?
- Statistics and plots
- Design optimization
- Hardware signals
- Software signals
- Human interactions

How does the user want to use the simulation?
- Interactive or batch
- Operator in loop
- Hardware in loop

Detailed design: Analysis and Modeling

- *Detailed Design:*
  - *Modeling and simulation*
    - *Effective simulation*
      - *Realistic and correct*
      - *Useful and usable*
      - *Well-planned, well-managed, and well-coordinated*
      - *User acceptance*
      - *Favorable benefits-cost ratio*

Degree of realism
A few complex simulations versus many simpler simulations
Digital computer versus analog computer versus hybrid computer
Choice of computer manufacturer and software packages
Discrete time versus continuous time
Periodic steps versus event-driven steps
Integration method and sample interval
Deterministic versus random inputs
Use of Monte Carlo techniques
Data availability and collection methods
Training requirements

Detailed design: Analysis and Modeling

- *Detailed Design:*
  - *Analyzing*
    - *Worst-case, Parameter Variation, And Statistical Analyses*
      - *Three methods are often used in design analyses to compensate for variability.*
      - *These methods are*
        - *worst-case analysis,*
        - *parameter variation analysis, and*
        - *statistical analysis methods, which includes root sum square, moment, and Monte Carlo techniques.*
      - *A major decision in the product development process is to select which models will be used for different design parameters to ensure an optimal design without "over designing".*

Detailed design: Analysis and Modeling

- *Detailed Design:*
  - *Analyzing*
    - *Worst-case,*
    - *A worst-case analysis is a rigorous evaluation of the ability of a design to meet requirements under the worst possible combination of circumstances.*
    - *This is accomplished by determining the worst-case values of critical design parameters, high and low, slow and fast, small and large, and long term degradations that could affect performance, reliability, producibility, and so on.*
    - *If the overall performance of each part or software module under these conditions remains within specified limits, then the design is reliable over the worst possible conditions.*

Detailed design: Analysis and Modeling

- *Detailed Design:*
  - *Analyzing*
    - *Parameter Variation*
      - *The parameter variation analysis method is a less rigorous methodology that determines allowable parameter variation before a design fails to function.*
      - *Parameters, either one at a time or two at a time, are varied in steps from their maximum to their minimum limits, while other input parameters are held at their nominal value.*

Project

- *Product Functional Requirements*