**Product Planning & Development**
(21-423)

Advanced Manufacturing Laboratory
Department of Industrial Engineering
Sharif University of Technology

Session #14

**Course Description**

- **Instructor**
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- **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:

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:
  - 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.

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**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

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.

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**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