Product Planning & Development  
(21-423)  
Advanced Manufacturing Laboratory  
Department of Industrial Engineering  
Sharif University of Technology  

Session #9

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
Trade-off analyses: Optimization using cost and utility Metrics

- Early Design:

- Product Cost Analysis
Trade-off analyses: Optimization using cost and utility Metrics

- **Trade-off analyses**
  - **Trade-off analysis** is an important method for developing information to help the design team in making design decisions.
  - **Almost any design or service parameter can be converted to a currency-based measure.**
    - This allows the development team to perform analyses of different parameters based on a single performance metric.
  - **Two commonly used methodologies are design to cost (DTC), which minimizes unit production costs and life cycle cost (LCC), which minimizes the cost of the product over its entire life.**

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Trade-off analyses: Optimization using cost and utility Metrics

- **Trade-off analyses**
  - **Design to cost (DTC)** is a cost analysis technique aimed at reducing or minimizing a product's price or cost, which results in increased sales volume.
  - **Life cycle cost (LCC), is a cost analysis discipline that develops a model of the total cost for development, operation, maintenance and disposal of a product over its full life to be used in design trade-off studies.**
    - The model is used to optimize product costs and predicting future costs of maintenance, logistics, and warranties.
Trade-off analyses: Optimization using cost and utility Metrics

■ Trade-off analyses models
  ■ Models provide information to the design team.

■ The quality of the model and its parameters determines the quality of the information provided.

■ A cost model is used for estimating the manufacturing cost of a bearing by the bearing’s configuration, material, length, diameter, and tolerance on diameter (AD) as modeled by (Tandon and Seireg, 1989).

\[
C_m = \gamma(k_0 + k_1/\Delta_D^2)(k_2 + k_3 LD^2)
\]

Where

\[
\gamma = \text{Machining cost factor based on the material hardness}
\]

\[
k_0 \text{ through } k_3 = \text{cost coefficients (see article)}
\]

\[
a = 1/3
\]

\[
\Delta_D = \text{Tolerance diameter}
\]

\[
L = \text{Length}
\]

\[
D = \text{Diameter}
\]

Trade-off analyses: Optimization using cost and utility Metrics

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  ■ Models provide information to the design team.

■ The quality of the model and its parameters determines the quality of the information provided.

■ Large and colleagues (1975) developed a series of parametric equations for estimating the overall aspects of aircraft airframe costs based on performance. Their estimate for the total cost of aircraft airframes based on a sample of 25 military aircraft with first flight dates after 1951

\[
C_{100} = 4.29W^{0.73}S^{0.74}
\]

Where:

\[
C_{100} = \text{total cost for } 100 \text{ airframes}
\]

\[
W = \text{airframe unit weight (lb.)}
\]

\[
S = \text{maximum speed (knots)}
\]

With the

\[
R^2 = 0.88 \text{ and } F = 79.
\]

Both parameter coefficients were significant at the 1% level.