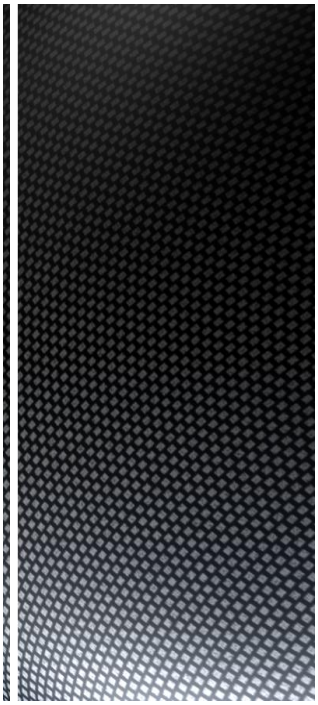


Product Planning & Development (21-423)

Advanced Manufacturing Laboratory
Department of Industrial Engineering
Sharif University of Technology

Session #8

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%)*

Course Description *(Continued ...)*

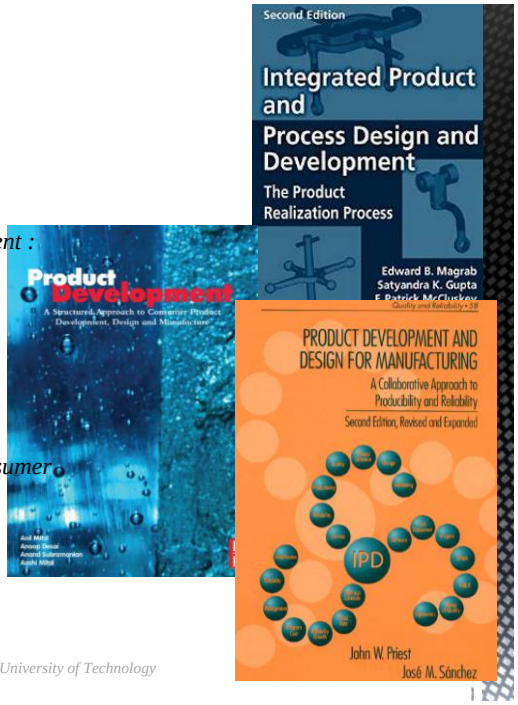
- *Mid-term session:*
  - *Wednesday: 9th Ordibehesht 1394, 16:30 ~ 18:30*
- *Final Exam:*
  - *Monday: 1st Tir 1394, 09:00 ~ 11:30*
- *Reference:*
  - *John Priest, Jose Sanchez; "Product Development and Design for Manufacturing: A Collaborative Approach to Producibility and Reliability, Second Edition", CRC Press, 2001*
  - *Mital et al. ,"Product Development A Structured Approach to Consumer Product Development, Design, and Manufacture", Butterworth-Heinemann, 2008*
  - *Benhabib, Beno; "Manufacturing: Design, Production, Automation, and Integration", 2003, Marcel Dekker Inc, New York*
  - *Abouel Nasr, Emad; Kamrani, Ali K.; "Computer-Based Design and Manufacturing: An Information-Based Approach", 2007, Springer, New York*

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*

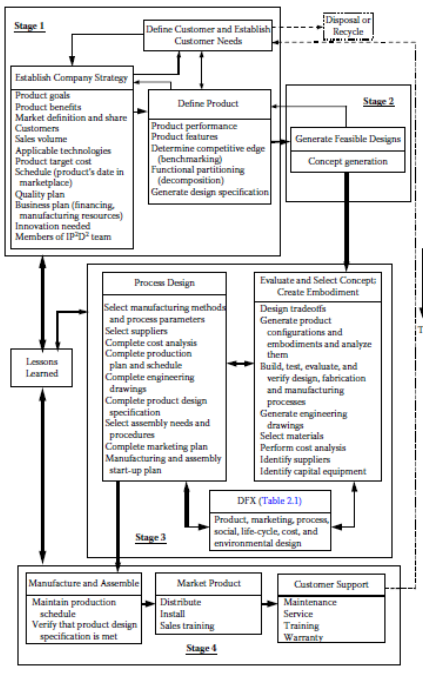
Session reference

- *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*



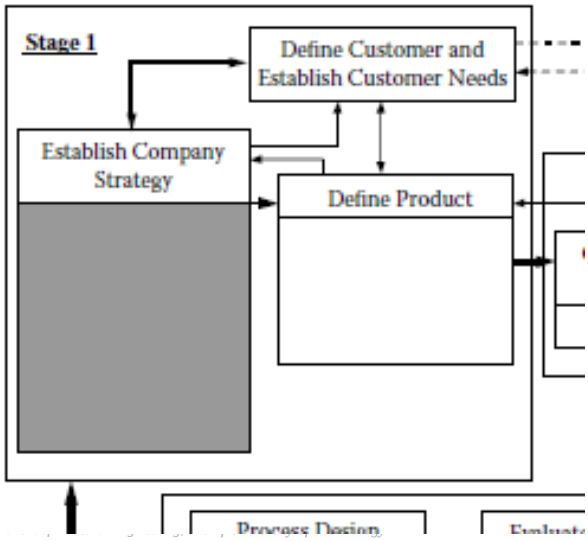
Trade-off analyses: Optimization using cost and

- *Early Design:*



Trade-off analyses: Optimization using cost and utility Metrics

- *Product Cost Analysis*



Trade-off analyses: Optimization using cost and utility Metrics

- *Product Cost Analysis*
  - *Determining the cost of products*

$$P = \frac{1}{N_{pm}}(C_{pm} + C_{sa} + P_r)$$

where

N_{pm} = Total number of units produced during the lifetime of the product
C_{pm} = Manufacturer's total cost to produce N_{pm} units
C_{sa} = Cost of making the sale to the customer; it includes the costs of marketing (advertising), transportation, shelf space, sales personnel salaries, and rebates
P_r = Accumulation of all the profits for all units charged by the individual entities involved in the distribution chain: manufacturer, distributor, and retailer

Trade-off analyses: Optimization using cost and utility Metrics

- *Product Cost Analysis*
  - *Determining the cost of products => Product total Cost*

$$C_{pm} = N_{pm}(C_M + C_L + C_c + C_W) + C_T + C_{OH} + C_D + C_{WR} + C_Q$$

where

C_M = Material costs on a per unit basis (Equation 3.6 summed over all activities associated with manufacturing the product)

C_L = Labor cost for manufacturing and assembly on a per unit basis (Equation 3.5 summed over all activities associated with manufacturing the product)

C_c = Capital costs on a per unit basis not included in overhead (e.g., equipment and facilities) (Equation 3.7 summed over all activities associated with manufacturing the product)

C_W = Waste disposition cost on a per unit basis, which includes the management of hazardous and nonhazardous waste generated during the manufacturing process

C_T = One-time costs not included in overhead costs (e.g., tooling costs)

C_{OH} = Overhead (indirect) costs; traditional cost accounting may include this in C_L or C_M (Equation 3.4a)

C_D = Design and development cost;

C_{WR} = Life cycle support costs;

C_Q = Qualification and certification costs (e.g., FCC certification, UL approval)

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Trade-off analyses: Optimization using cost and utility Metrics

- *Product Cost Analysis*
  - *Determining the cost of products => The product owner has a different view of the product's cost C_{pc}*

$$C_{pc} = N_{pc}(P + C_x + C_O + C_S) + C_{sp} + C_t + C_Q$$

where

N_{pc} = Total number of units purchased

P = Price on a per unit basis

C_x = Applicable taxes (sales tax, tariffs, import taxes, etc.)

C_O = Cost of operation on a per unit basis

C_S = Cost of support on a per unit basis (regular oil changes, maintenance contracts, etc.)

C_{sp} = Cost of spare parts to maintain N_{pc} units

C_t = Training costs

Trade-off analyses: Optimization using cost and utility Metrics

- *Product Cost Analysis*
  - *Determining the cost of products =>*
    - *Overhead or Indirect Costs*
      - *Overhead costs are the portion of the costs that cannot be clearly associated with particular operations, products, or projects and must be prorated among all the product units on some basis*
    - *Hidden Costs*
      - *Hidden costs are those costs that are difficult to quantify. They are not explicitly identified in C_{pm} and C_{pc}, and may even be impossible to connect with any one product*
      - *Future value of engineering, manufacturing, and support experience associated with using new technologies or materials in the current product.*
      - *Long-term health, safety, and environmental impacts that may have to be resolved in the future.*

Trade-off analyses: Optimization using cost and utility Metrics

- *Product Cost Analysis*
  - *Determining the cost of products =>*
    - *Design and Development Costs*
      - *Design and development costs are referred to as nonrecurring costs because they are a one-time charge no matter how many units of the product are manufactured*
      - *The specific elements of design and development costs that must be included are*
        - *Development of the product specification.*
        - *Conceptual design.*
        - *Intellectual property acquisition and protection such as licensing costs and patent filing costs.*
        - *Design of the product including the creation of engineering drawings.*
        - *Software development.*
        - *Creation of prototypes.*
        - *Functional testing.*
        - *Environmental testing to determine or verify reliability.*
        - *Product qualification and certification*

Trade-off analyses: Optimization using cost and utility Metrics

- *Product Cost Analysis*
  - *Making a Business Case*
  - *A business case is a structured proposal for new business or business improvement that is part of a decision-making process within an organization.*
  - *The purpose of a business case is to provide a comprehensive evaluation of the reasons that a proposed action should be considered.*
  - *One very important attribute of most business cases is the development of an economic justification.*

Trade-off analyses: Optimization using cost and utility Metrics

- *Product Cost Analysis*
  - *Two important attributes of an economic justification are:*
    - *Return on investment*
    - *The cost of money.*

Trade-off analyses: Optimization using cost and utility Metrics

- *Product Cost Analysis*
  - *Return on investment*
    - *In general, ROI is the ratio of gain to investment. One way of defining the ROI over a product's life cycle is given by either*

$$\text{ROI} = \frac{\text{Return} - \text{Investment}}{\text{Investment}}$$

$$\text{ROI} = \frac{\text{Avoided cost} - \text{Investment}}{\text{Investment}}$$

Trade-off analyses: Optimization using cost and utility Metrics

- *Product Cost Analysis*
  - *Return on investment*
    - *Return on investment (ROI) is a useful quantitative means of gauging the economic merits of a decision*
    - *ROI measures the cost savings, profit, or cost avoidance that result from a given use of money.*
    - *At the enterprise level, ROI may reflect how well an organization is managed with regard to specific organizational objectives such as gaining market share, retaining more customers, or improving availability.*
    - *The ROI allows for enhanced decision-making regarding the use of investment money and research and development efforts by enabling comparisons of alternatives.*

Trade-off analyses: Optimization using cost and utility Metrics

- *Product Cost Analysis*
  - *The Cost of Money*
    - *One way to determine the cost of money is to obtain its present value, and to compare this value to its value in the future.*
    - *The premise for computing the present value is that money available today can be invested and grow whereas money spent today cannot.*
    - *If the effects of inflation or deflation are ignored then the present value of an investment as V_n, in n_t time units from the present is given by:*

$$\text{Present value} = \frac{V_n}{(1+r)^{n_t}}$$