Product Planning & Development (21-423)

Advanced Manufacturing Laboratory

Department of Industrial Engineering

Sharif University of Technology

Session #7

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%)*

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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*

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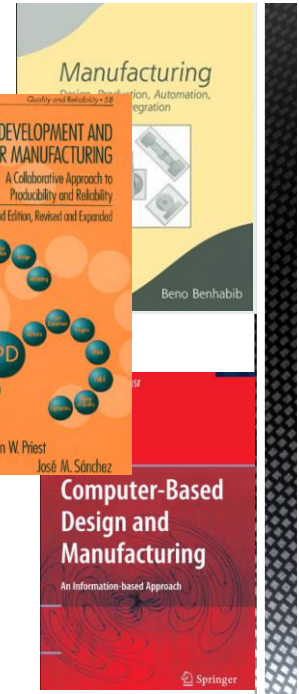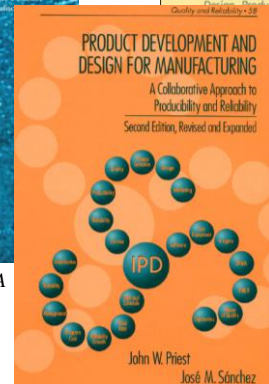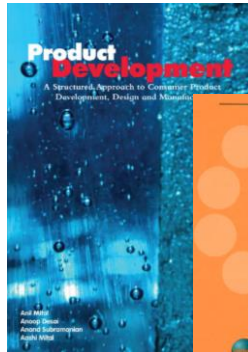
## *Course Description* *(Continued..)*

- ***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*

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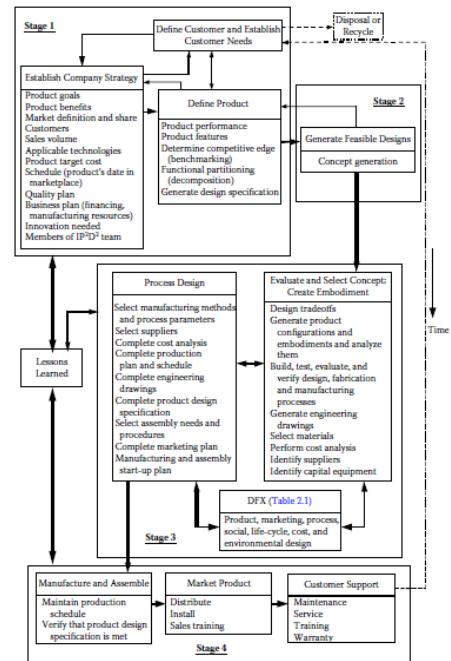
Session reference

- *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*
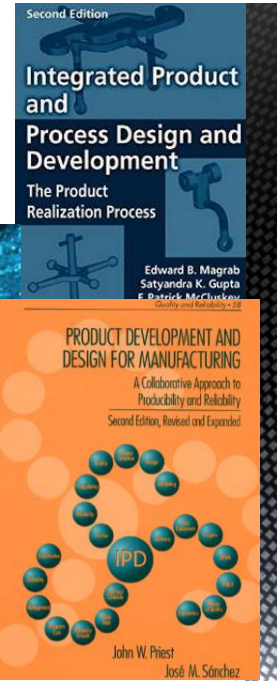
Trade-off analyses: Optimization using cost and ...

- *Early Design:*

Trade-off analyses: Optimization using cost and utility Metrics

▪ *Product Cost Analysis*

Stage 1

Define Customer and
Establish Customer Needs

Establish Company
Strategy

Define Product

Process Design

Evaluate
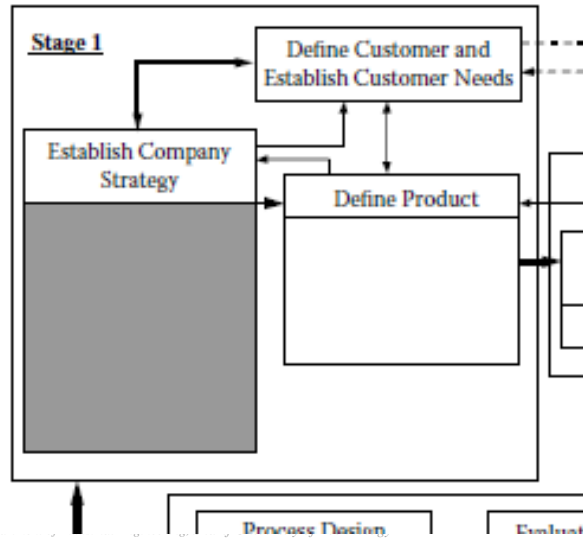
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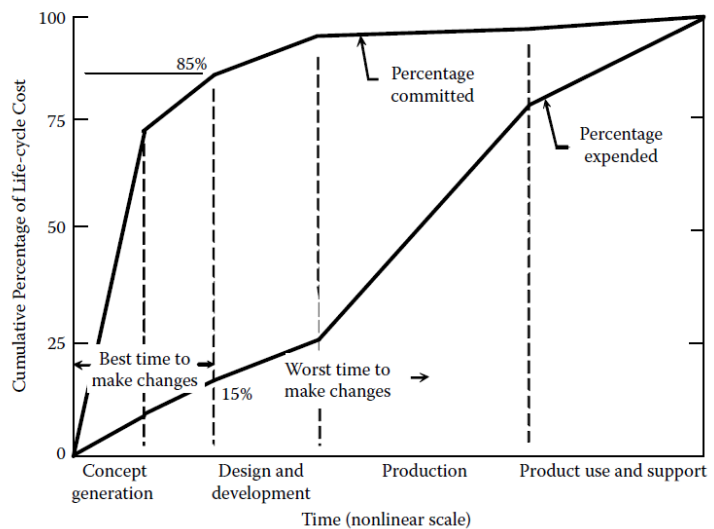
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Trade-off analyses: Optimization using cost and utility Metrics

▪ *Product Cost Analysis*

　▪ *The value of a product is the ratio of perceived quality to its cost.*

　▪ *The goals of design activities are to create a product that satisfies the customers' requirements and to maximize profit.*

Cumulative Percentage of Life-cycle Cost

100

85%

Percentage
committed

75

Percentage
expended

50

25

Best time to
make changes

Worst time to
make changes

15%

0

Concept
generation

Design and
development

Production

Product use and support

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Product P...

Time (nonlinear scale)

Trade-off analyses: Optimization using cost and utility Metrics

- *Product Cost Analysis*
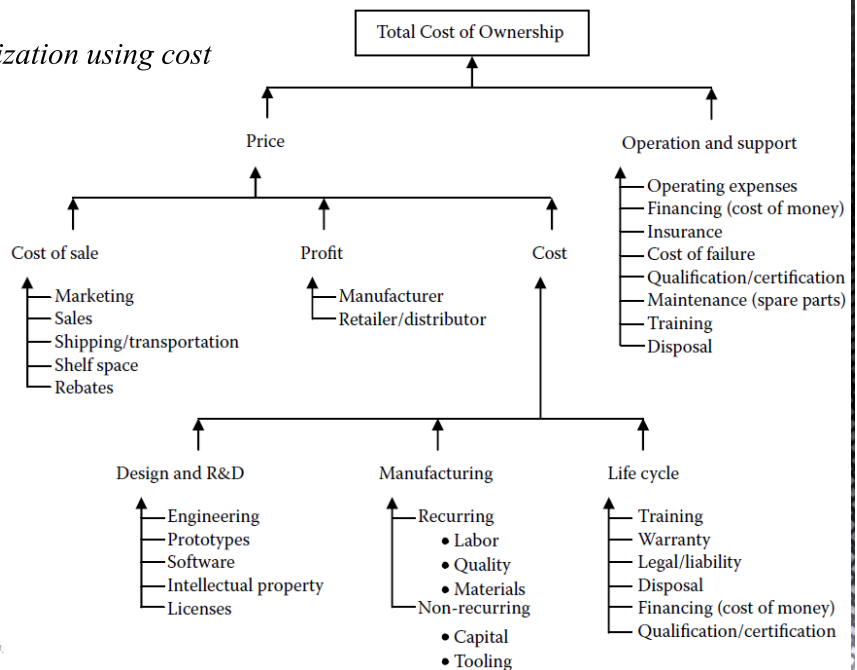 - *Engineering Economics and Cost Analysis*
    - *Engineering economics is the application of accumulated knowledge in engineering and economics to identify alternative uses of resources and to select the best course of action from an economics point of view.*

    - *Resources refer to time, labor, expertise, materials, money, equipment, …*

    - *Common key attributes of engineering economics are the time value of money, evaluation of assets, depreciation, taxes, and inflation*

Trade-off analyses: Optimization using cost and utility Metrics

- *Product Cost Analysis*

Total Cost of Ownership

Price → Cost of sale, Profit, Cost

Operation and support
- Operating expenses
- Financing (cost of money)
- Insurance
- Cost of failure
- Qualification/certification
- Maintenance (spare parts)
- Training
- Disposal

Cost of sale
- Marketing
- Sales
- Shipping/transportation
- Shelf space
- Rebates

Profit
- Manufacturer
- Retailer/distributor

Cost → Design and R&D, Manufacturing, Life cycle

Design and R&D
- Engineering
- Prototypes
- Software
- Intellectual property
- Licenses

Manufacturing
- Recurring
  - Labor
  - Quality
  - Materials
- Non-recurring
  - Capital
  - Tooling

Life cycle
- Training
- Warranty
- Legal/liability
- Disposal
- Financing (cost of money)
- Qualification/certification

Trade-off analyses: Optimization using cost and utility Metrics

- *Product Cost Analysis*
  - *"Total cost of ownership" VS "life-cycle cost"*
  - *The total cost of ownership includes not only the cost of purchasing the product, but the cost of maintaining and using the product, which for some products can be significant.*

    - *For products such as aircraft, the operation and support costs can represent as much as 80% of the total cost of ownership of the product.*

Trade-off analyse

- *Product Cost Ana*
  - *Cost modeling*

Cost Contribution	Description	Relevancy	
		High-Volume Consumer Products[a]	Low-Volume Complex System[b]
Overhead and indirect manufacturing costs	Accumulated costs of running a business	Medium	Low
Hidden	Costs that are difficult to quantify	High	Low
Design and development	Non-recurring costs of product development	Low	Medium
Manufacturing	Recurring costs: labor, materials, tooling, and capital	High	Low
Quality	Costs that account for manufactured items that do not meet specifications	Low (depends on product)	Medium
Test, diagnosis, and rework	Recurring costs of detecting and fixing defects during manufacture	Low	High
Spare parts, availability, and reliability	Costs of maintaining a product after it is delivered to the customer	Low	High
Warranty and repair	Cost of providing warranty coverage	High	Not applicable[c]
Qualification and certification	Cost of obtaining and maintaining required certifications	Low (depends on product)	High
Cost of money	Cost of the money needed to finance manufacture of products	Low	High

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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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