CAD/CAM (21-342)
Advanced Manufacturing Laboratory
Department of Industrial Engineering
Sharif University of Technology

Session # 15

Course Description

- Instructor
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- Class time
  - Saturday-Monday 10:30-12:00

- Course evaluation
  - Mid-term (25%)
  - Final exam (40%)
  - Quiz (5%)
  - Exercise (30%)
Course Description (Continued ...)

- **Mid-term session:**
  - Monday: 8th Ordibehesht 1393, 10:30 ~ 12:30
- **Final Exam:**
  - Saturday: 24th Khordad 1393, 15:00 ~ 17:30
- **Reference:**
  - Benhabib, Beno; “Manufacturing: Design, Production, CAD/CAM, and Integration”, 2003, Marcel Dekker Inc, New York

Course Description (Continued..)

- **Contents:**
  - Introduction to CAD/CAM/CAE systems (5 sessions)
  - Components of CAD/CAM/CAE systems (2 sessions)
  - Geometric modeling systems (3 sessions)
  - Optimization in CAD (5 sessions)
  - Rapid prototyping and manufacturing (3 sessions)
  - Virtual engineering (2 sessions)
  - Product Life Cycle Cost Model (2 sessions)
  - Computer-Based Design and Features/Methodologies of Feature Representations (5 sessions)
  - Feature-Based Process Planning and Techniques (3 sessions)
  - Collaborative Engineering (2 sessions)
Course Description (Continued..)

- Contents:
  - Product Life Cycle Cost Model (2 sessions)
  - Cost Breakdown in Manufacturing Systems
  - Computer-Aided Cost Estimating in Manufacturing

Introduction to CAD/CAM/CAE systems
Product Life Cycle Cost Model

- **Introduction**
  - *Today's manufacturing environment should:*
    - *Increased product variety*
  
    - *Reduced product life cycle*

- *Changed cost structures*

- *Hardly estimate the costs and benefits of computer integrated manufacturing (CIM) technology.*

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Product Life Cycle Cost Model

- **Introduction**
  - *Today's manufacturing environment should:*
    - *Increased product variety*

    - *Reduced product life cycle*
      - *Design stage.*

    - *Manufacturing stage.*

    - *End-of-life stage*
Product Life Cycle Cost Model

Introduction

Today's manufacturing environment should:

- Increased product variety

- Reduced product life cycle

- Changed cost structures

  Manufacturing costs conventionally have been classified into three items:

  - Material
  - Labor
  - Overhead costs

Hardly estimate the costs and benefits of computer integrated manufacturing (CIM) technology.

- The conventional investment appraisal techniques are invalid for a CIM environment.
- CIM equipment is extremely flexible and it is hard to evaluate its capabilities and define its application.
- Economic justifications are proper when a company is involved in replacing old equipment with new equipment.
Product Life Cycle Cost Model

- Product Life Cycle Cost Analysis
  - Total System Cost \((C)\)

\[ C = (C_r + C_i + C_o) \]

where

- \(C_r\) = R&D cost
- \(C_i\) = investment cost
- \(C_o\) = operations and maintenance cost

Product Life Cycle Cost Model

- Product Life Cycle Cost Analysis
  - Total System Cost \((C)\)
    - Advanced Research and Development \((Cr)\)

\[ C_r = (C_{rm} + C_{rt} + C_{re} + C_{rt} + C_{rd}) \]

where

- \(C_{rm}\) = program management cost
- \(C_{rt}\) = advanced R&D cost
- \(C_{re}\) = engineering design cost
- \(C_{rt}\) = equipment development and test cost
- \(C_{rd}\) = engineering data cost
**Product Life Cycle Cost Model**

- **Product Life Cycle Cost Analysis**
  - **Total System Cost (C)**
    - **Advanced Research and Development (Cr)**
    - **Equipment Development and Test (Crt)**

\[
C_{rt} = (C_{rm} + C_{rr} + C_{re} + C_{rt} + C_{rd})
\]

where

- \(C_{rm}\) = program management cost
- \(C_{rr}\) = advanced R&D cost
- \(C_{re}\) = engineering design cost
- \(C_{rt}\) = equipment development and test cost
- \(C_{rd}\) = engineering data cost

\[
C = (C_r + C_i + C_o)
\]

where

- \(C_r\) = R&D cost
- \(C_i\) = investment cost
- \(C_o\) = operations and maintenance cost

\[
C_{rt} = \left[ C_{rdf} + C_{rdm} + \sum C_{rdt} \right]
\]

\(C_{rdf}\) = cost of prototype fabrication and assembly labor
\(C_{rdm}\) = cost of prototype material
\(C_{rdt}\) = cost of test operations and support associated with specific test
\(N\) = number of identifiable tests

- **Investment (Ci)**

\[
C_i = (C_{im} + C_{ic} + C_{il})
\]

where

- \(C_{im}\) = system/equipment manufacturing cost
- \(C_{ic}\) = system construction cost
- \(C_{il}\) = cost of initial support
Product Life Cycle Cost Model

- Product Life Cycle Cost Analysis
  - Total System Cost (C)
    - Investment (Ci)
    - Manufacturing (Cim)

\[ C_i = (C_{im} + C_{ic} + C_{il}) \]

where
- \( C_{im} \) = system/equipment manufacturing cost
- \( C_{ic} \) = system construction cost
- \( C_{il} \) = cost of initial support

\[ C = (C_r + C_i + C_o) \]

where
- \( C_r \) = R&D cost
- \( C_i \) = investment cost
- \( C_o \) = operations and maintenance cost

- Product Life Cycle Cost Analysis
  - Total System Cost (C)
    - Investment (Ci)
    - Manufacturing (Cim)

\[ C_i = (C_{in} + C_{ir}) \]

where
- \( C_{in} \) = nonrecurring manufacturing cost
- \( C_{ir} \) = recurring manufacturing cost

\[ C = (C_r + C_i + C_o) \]

where
- \( C_r \) = R&D cost
- \( C_i \) = investment cost
- \( C_o \) = operations and maintenance cost

\[ C_i = (C_{im} + C_{ic} + C_{il}) \]

where
- \( C_{im} \) = system/equipment manufacturing cost
- \( C_{ic} \) = system construction cost
- \( C_{il} \) = cost of initial support

\[ C_{im} = (C_{in} + C_{ir}) \]

where
- \( C_{in} \) = nonrecurring manufacturing cost
- \( C_{ir} \) = recurring manufacturing cost

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Product Life Cycle Cost Model

* Product Life Cycle Cost Analysis
  * Total System Cost (C)
  * Investment (Ci)
    * Manufacturing (Cim)

\[ C_{ir} = [C_{ire} + C_{ir1} + C_{irim} + C_{ir2} + C_{ir3}] \]

where
- \( C_{ire} = \) recurring manufacturing engineering support cost
- \( C_{ir1} = \) production fabrication and assembly labor cost
- \( C_{irim} = \) production material and inventory cost
- \( C_{ir2} = \) inspection and test cost
- \( C_{ir3} = \) packing and initial transportation cost

\[ C = (C_r + C_i + C_o) \]

where
- \( C_r = \) R&D cost
- \( C_i = \) investment cost
- \( C_o = \) operations and maintenance cost

\[ C_i = (C_{im} + C_{ic} + C_{il}) \]

where
- \( C_{im} = \) system/equipment manufacturing cost
- \( C_{ic} = \) system construction cost
- \( C_{il} = \) cost of initial support

\[ C_{im} = (C_{in} + C_{ir}) \]

where
- \( C_{in} = \) nonrecurring manufacturing cost
- \( C_{ir} = \) recurring manufacturing cost

Product Life Cycle Cost Model

* Product Life Cycle Cost Analysis
  * Total System Cost (C)
  * Investment (Ci)
    * Construction Cost (Cic)

\[ C_{ic} = (C_{icp} + C_{icot} + C_{icma} + C_{icm}) \]

where
- \( C_{icp} = \) manufacturing facilities cost
- \( C_{icot} = \) test facilities cost
- \( C_{icma} = \) operational facilities acquisition cost
- \( C_{icm} = \) maintenance facilities acquisition cost
Product Life Cycle Cost Model

* Product Life Cycle Cost Analysis
  * Total System Cost \( (C) \)
  * Investment \((C_i)\)
  * Initial Logistic Support Cost \((CH)\)

\[
C_i = (C_{im} + C_{lp} + C_{ls} + C_{il} + C_{ld} + C_{lt} + C_{ly})
\]

where
- \(C_{im}\) = logistic program management cost
- \(C_{lp}\) = cost of provisioning
- \(C_{ls}\) = initial spare/repair material cost
- \(C_{il}\) = initial inventory management cost
- \(C_{ld}\) = cost of technical data preparation
- \(C_{lt}\) = cost of initial training and training equipment
- \(C_{ly}\) = acquisition cost of operational test and support equipment
- \(C_{ly}\) = initial transportation and handling cost

\[
C = (C_r + C_i + C_o)
\]

where
- \(C_r\) = R&D cost
- \(C_i\) = investment cost
- \(C_o\) = operations and maintenance cost

Product Life Cycle Cost Model

* Product Life Cycle Cost Analysis
  * Total System Cost \( (C) \)
  * Operator Personnel Cost \((Co)\)

\[
Co = (C_{oo} + C_{om} + C_{on} + C_{op})
\]

where
- \(C_{oo}\) = cost of system/equipment life cycle operations
- \(C_{om}\) = cost of system/equipment life cycle maintenance
- \(C_{on}\) = cost of system/equipment modifications
- \(C_{op}\) = cost of system/equipment phase-out and disposal