CAD/CAM (21-342)

Advanced Manufacturing Laboratory
Department of Industrial Engineering
Sharif University of Technology

Session # 16

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*
- *Class time*
  - *Saturday- Monday   10:30-12:00*
- *Course evaluation*
  - *Mid-term   (25%)*
  - *Final exam   (40%)*
  - *Quiz   (5%)*
  - *Exercise   (30%)*

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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:*
  - *Lee, Kunwoo; "Principles of CAD/CAM/CAE systems", 1999, Addsion Wesley*

  - *Abouel Nasr, Emad; Kamrani, Ali K.; "Computer-Based Design and Manufacturing: An Information-Based Approach", 2007, Springer, New York*

  - *Benhabib, Beno; "Manufacturing: Design, Production, CAD/CAM, and Integration", 2003, Marcel Dekker Inc, New York*

  - *Radhakrishnan, P.; Subramanian, S.; Raju, V.; "CAD/CAM/CIM", 3rd edition, 2005, New age international (P) limited publishers, New York*
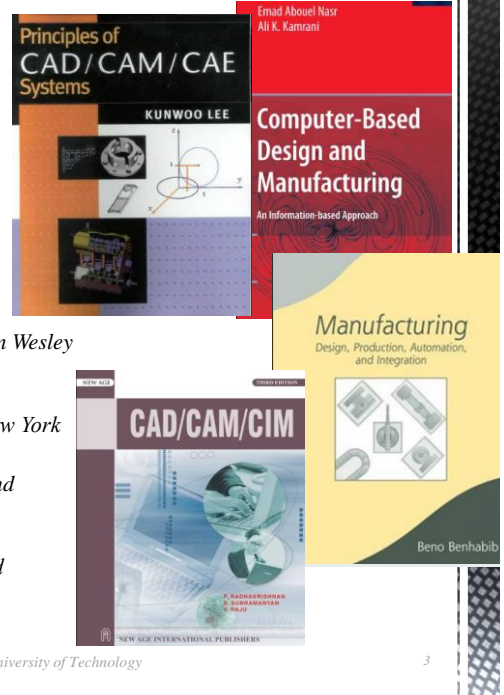
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Course Description *(Continued..)*

- *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)*

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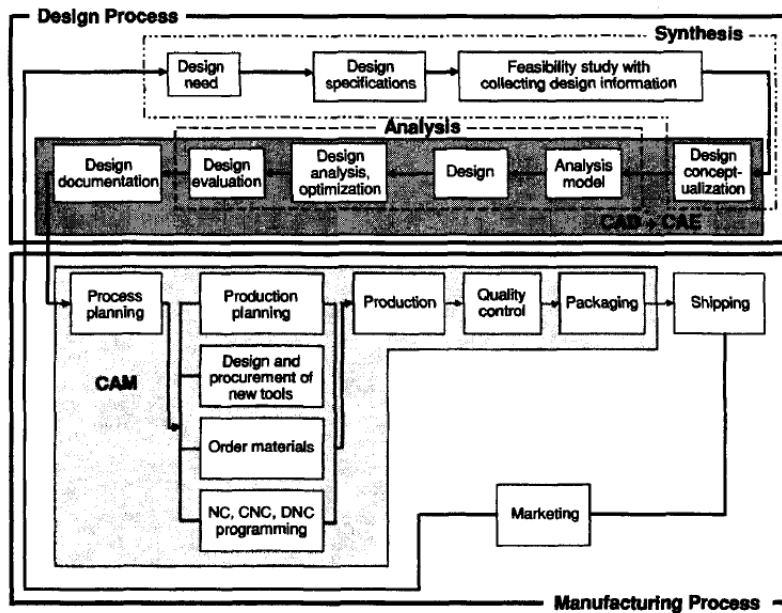# *Course Description* *(Continued..)*

- *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

- *Computer-Aided Cost Estimating in Manufacturing*
  - *Cost estimating is the mission of determining and evaluating the costs involved in an engineering product or a system using scientific and engineering laws and methods.*

  - *The area of engineering practice where engineering judgment and experience are utilized in the application of scientific principles and techniques to the problems of cost estimating, cost control and profitability*

  - *Classifications for cost estimating:*
    - *Screening estimate*
    - *Budget estimate*
    - *Definitive estimate*

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Product Life Cycle Cost Model

- *Computer-Aided Cost Estimating in Manufacturing*
  - *Objective of Cost Estimating:*
    - *Assist in Submitting Bids*

    - *Revise Quotations*

    - *Assist in Evaluating Alternatives*

    - *Control of Manufacturing Expenses*

    - *Assist in Make or Buy Decisions*

    - *Establish Ground for a Selling Price*

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Product Life Cycle Cost Model

- *Computer-Aided Cost Estimating in Manufacturing*
  - *Methods of Cost Estimating*
    - *The Opinion Estimates Method*
    - *The Conference Estimating Method*
    - *The Comparison Method*
    - *The Unit Estimate Methods*
    - *The Cost and Time Relationship Method*
    - *The Power Law and Sizing Model Method*
    - *Probabilistic Approaches*
    - *Statistical Methods*
    - *Simulation*
    - *The Factor Method*
    - *The Detailed Computerized Method*

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Product Life Cycle Cost Model

- *Computer-Aided Cost Estimating in Manufacturing*
  - *Methods of Cost Estimating*
    - *The Comparison Method*

$$C_2 (D_2) \leq C_1 (D_1)$$

$$C_3 (D_3) \leq C_1 (D_1) \leq C_2 (D_2)$$

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Product Life Cycle Cost Model

- *Computer-Aided Cost Estimating in Manufacturing*
  - *Methods of Cost Estimating*
    - *The Unit Estimate Methods*

$$C_u = \sum C_i / U_i$$

where

C_u = average cost per unit of design i
C_i = dollar value of design i
U_i = unit of design i

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Product Life Cycle Cost Model

- *Computer-Aided Cost Estimating in Manufacturing*
  - *Methods of Cost Estimating*
    - *The Cost and Time Relationship Method*
    - *The Power Law and Sizing Model Method*

$$C = C_j (Q_i / Q_j)^m$$

where

C = cost value for design of size Q_i
C_j = known cost of design with size Q_j
Q_i, Q_j = design sites
m = correlating exponent, m within [0, 1].

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Product Life Cycle Cost Model

- *Computer-Aided Cost Estimating in Manufacturing*
  - *Methods of Cost Estimating*
    - *Probabilistic Approaches*

$$C\,(i) = \{p \cdot x_{ij}\}$$

where

    $C\,(i)$ = expected value of the cost of design i

    P   = probability that x takes on a value x

    x_{ij} = design event

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Product Life Cycle Cost Model

- *Computer-Aided Cost Estimating in Manufacturing*
  - *Methods of Cost Estimating*
    - *Statistical Methods*
      - *Estimating by confidence intervals*
      - *Estimating by tolerance intervals*
      - *Estimating by prediction intervals*

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Product Life Cycle Cost Model

- *Computer-Aided Cost Estimating in Manufacturing*
  - *Methods of Cost Estimating*
    - *Simulation*
    - *The Factor Method*

$$C = (C + \sum f_i * C_e))(f_I + 1)$$

where
C = estimated value of project
C_e = cost of major equipment
F_i = factor for estimating capital (buildings, equipment, etc.)
f_I = factor for estimating of indirect cost
i = factor index
The factors f_i and f_I are determined by historical data, experience, or policy.

Product Life Cycle Cost Model

- *Computer-Aided Cost Estimating in Manufacturing*
  - *Methods of Cost Estimating*
    - *The Detailed Computerized Method*
      - *Computerized cost estimating takes advantage of the digital computer to automate the detailed manual cost estimating method.*
      - *It is required that these estimates fall within an acceptable range; the need for accuracy is evident.*
      - *Estimating errors can be categorized as controllable and uncontrollable errors.*

Product Life Cycle Cost Model

- *Computer-Aided Cost Estimating in Manufacturing*
  - *Methods of Cost Estimating*
    - *The Detailed Computerized Method*
      - *Estimating errors can be categorized as controllable and uncontrollable errors.*
        - *Controllable errors may be caused by:*
          - *Failure to develop detailed data necessary for the cost estimate*
          - *Errors in interpreting information*
          - *Making wrong assumptions*
          - *Use of poorly documented data*
          - *Failure to spend the time necessary for accurate estimations*
          - *Poor analysis of the problem in hand*
          - *Lack of experience*

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Product Life Cycle Cost Model

- *Computer-Aided Cost Estimating in Manufacturing*
  - *Methods of Cost Estimating*
    - *The Detailed Computerized Method*
      - *Estimating errors can be categorized as controllable and uncontrollable errors.*
        - *Uncontrollable errors are usually due to:*
          - *Unpredictable change in equipment*
          - *Unexpected conditions such as fires, storms, and industrial accidents Labor strike*
          - *Decline in productivity levels due to employee attitudes and low morale*

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Product Life Cycle Cost Model

- *Computer-Aided Cost Estimating in Manufacturing*
  - *Methods of Cost Estimating*
    - *Cost estimate is the summation of various costs involved in the estimation of cost for a product, project, or a system.*
    - *These costs are classified into two groups:*
    - *Direct costs*
      - *Direct material: Materials that are an integral part of the finished product*
      - *Direct labor: Costs that can be traceable directly to the making of the product*
    - *Indirect costs*
      - *Manufacturing overhead: All manufacturing costs except direct material and labor costs*
      - *Indirect materials*
      - *Administrative overhead*

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Product Life Cycle Cost Model

- *Computer-Aided Cost Estimating in Manufacturing*
  - *Computer-aided cost estimating (CACE) is the use of computers to estimate costs of products, projects, or systems.*

  - *CACE is an important tool to:*
    - *Develop cost estimates in shorter time.*
    - *Improve estimate accuracy by minimizing the human interface.*
    - *Improve cost data availability and security.*
    - *Evaluate more alternatives.*
    - *Improve management morale.*

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Product Life Cycle Cost Model

- *Computer-Aided Cost Estimating in Manufacturing*
  - *Structure of a Computer-Assisted Cost Estimating System*
    - *Costs beyond the manufacturing stage include the costs of engineering, marketing, and administrative-related activities:*

      - *Material cost:*
      - *Material is defined as substance being transformed or used in a manufacturing transformation. Materials are classified as:*
      - *1. Raw materials*
      - *2. Commercial products*
      - *3. Subcontract products*
      - *4. Inter-department transfer products*

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Product Life Cycle Cost Model

- *Computer-Aided Cost Estimating in Manufacturing*
  - *Structure of a Computer-Assisted Cost Estimating System*
    - *Costs beyond the manufacturing stage include the costs of engineering, marketing, and administrative-related activities:*

      - *Labor Cost:*
      - *Labor cost estimating constitutes the second part of the direct cost. This cost is important because of the extensive attention it gets from management, government and researchers*
      - *1. Identify the operation.*
      - *2. Determine the labor time.*
      - *3. Identify hourly rates.*
      - *4. Determine the labor overhead rate.*
      - *5. Determine the cost of fringe benefits.*
      - *6. Tabulate the total cost of labors.*

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Product Life Cycle Cost Model

- *Computer-Aided Cost Estimating in Manufacturing*
  - *Structure of a Computer-Assisted Cost Estimating System*
    - *Costs beyond the manufacturing stage include the costs of engineering, marketing, and administrative-related activities:*

      - *Machinery and Tools Cost:*
      - *Tools can be classified as hard or soft tools. Hard tools are those that are designed and manufactured specifically for a certain manufacturing operation. On the other hand, soft tools are conventionally used in common manufacturing operations.*
      - *1. To determine the investment necessary for tools within a time frame during the planning phase.*
      - *2. To evaluate alternative tooling combinations and select the combination incurring the least cost.*

Product Life Cycle Cost Model

- *Computer-Aided Cost Estimating in Manufacturing*
  - *Structure of a Computer-Assisted Cost Estimating System*
    - *Costs beyond the manufacturing stage include the costs of engineering, marketing, and administrative-related activities:*

      - *Operation Cost:*
      - *An operation involves material, labor, and equipment.*
      - *The estimator must have the necessary cost estimating data in the form of trade books, handbooks, and various data sources about the operations involved in the design.*
      - *1. Part design*
      - *2. Production plans*
      - *3. Material specifications*
      - *4. Tooling specification*
      - *5. Standard time sheets*

Product Life Cycle Cost Model

- *Computer-Aided Cost Estimating in Manufacturing*
  - *Structure of a Computer-Assisted Cost Estimating System*
    - *Costs beyond the manufacturing stage include the costs of engineering, marketing, and administrative-related activities:*

      - *Overhead Cost:*
      - *Overhead cost in present cost accounting practice is the portion of total cost that cannot be directly traced to particular operations, products, or projects.*
      - *The problem with allocating overhead charges is that these costs often exist even if the product is not produced.*
      - *Overhead charges may be determined in different ways including:*
      - *1. Overhead as a ratio of direct labor dollars*
      - *2. Overhead as a ratio of direct labor hours*
      - *3. Overhead as a ratio of prime cost*

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