CAD/CAM (21-342)

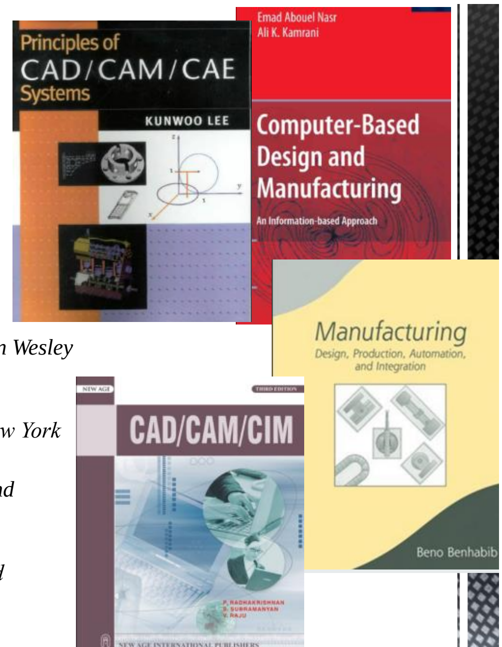
Advanced Manufacturing Laboratory
Department of Industrial Engineering
Sharif University of Technology

Session# 5

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%)

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*

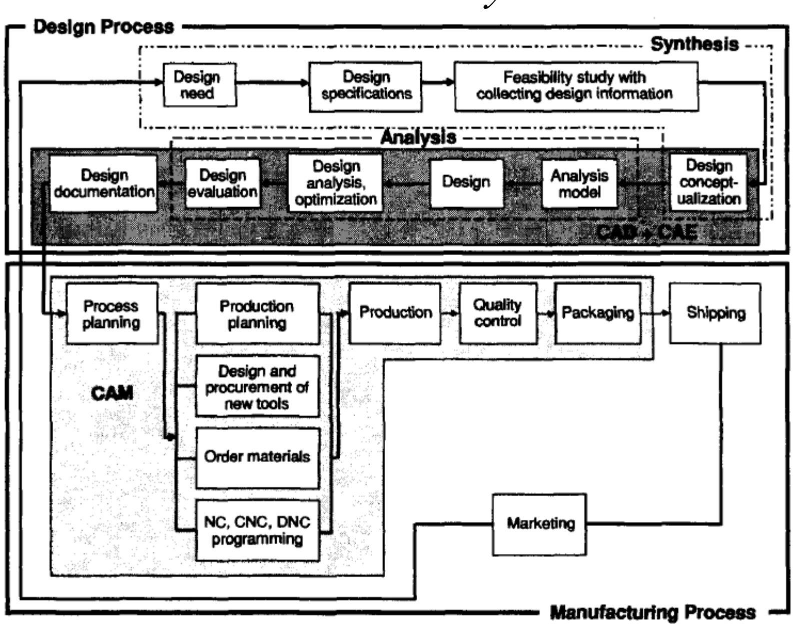
Course Description *(Continued..)*

- *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..)*

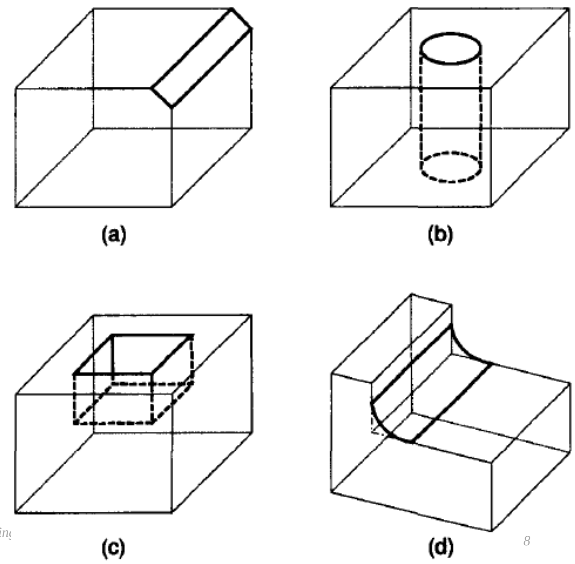
- *Contents:*
  - *Geometric modeling systems* *(3 sessions)*
    - *Wireframe modeling systems*
    - *Surface modeling systems*
    - *Solid modeling systems*
    - *Non-manifold modeling systems*
    - *Assembly modeling systems*

Introduction to CAD/CAM/CAE systems



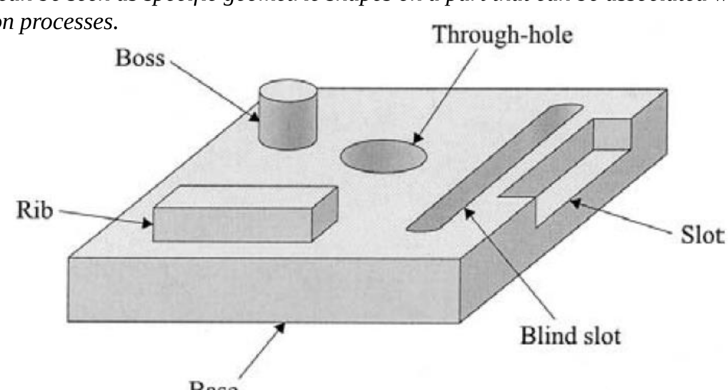
Geometric modeling systems

- Feature based modeling
  - Enables the designer to model solids by using familiar shape units.
  - " a hole of a certain size at a certain place"
  - " a chamfer of a certain size at a certain place"
  - Popular manufacturing features:
    - Hole
    - Fillet
    - Slot
    - Pocket
    - chamfer



Geometric modeling systems

- Feature based modeling
  - Feature-Based Design
    - Features can be seen as specific geometric shapes on a part that can be associated with certain fabrication processes.



Geometric modeling systems

- *Feature based modeling*
  - *Feature-Based Design*
    - *Features have been commonly classified as*
      - *Form,*
      - *Material,*
      - *Precision,*
      - *and technological features.*
    - *It has been long advocated that if these features were highlighted during the modeling phase of a product's design process, in the subsequent*
      - *production-planning phases,*

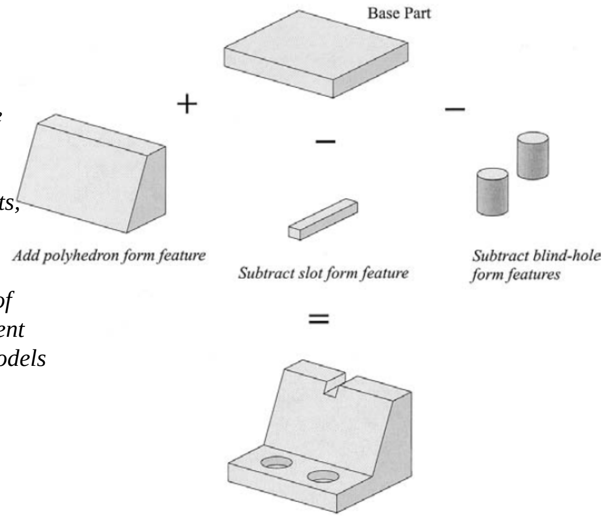
    engineers could take advantage of this information in accessing historical data regarding the production of these features.

Geometric modeling systems

- *Feature based modeling*
  - *Feature-Based Design*
    - *The objective of design by features is :*
      - *To increase the efficiency of the designer during the geometric-modeling phase*
      - *To provide a bridge (mapping) to engineering-analysis and process-planning phases of product development.*

Geometric modeling systems

- *Feature based modeling*
  - *Feature-Based Design*
    - *In feature-based design, parts' solid models are configured through a sequence of form-feature attachments (subtractions and additions) to the primary (base stock) representations of the parts, which can be as simple as a rectangular box.*
    - *These features could be chosen from a library of predefined (and sometimes application dependent features or could be extracted from the solid models of earlier designs.*

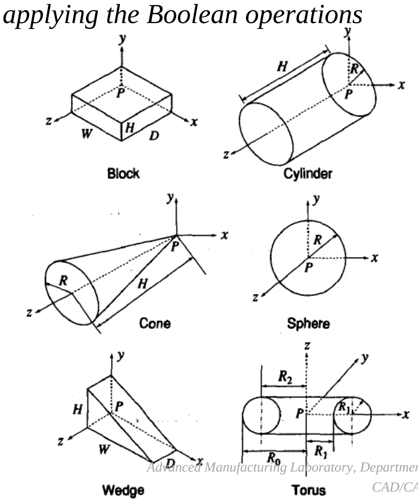


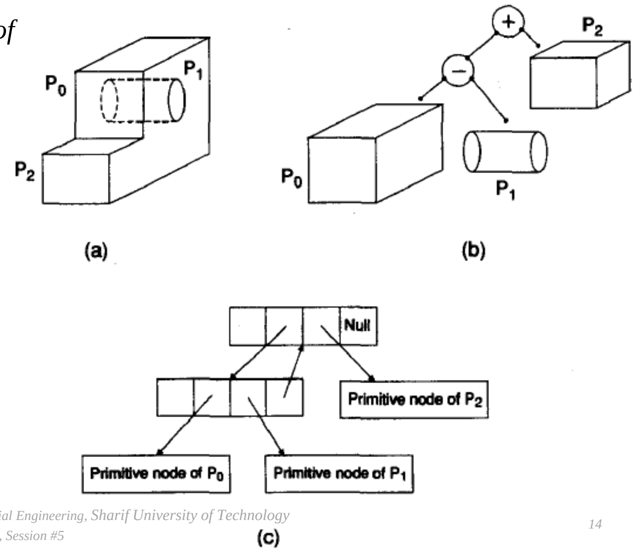
Geometric modeling systems

- *Data Structures*
  - *Trying to make a mathematical description of a solid geometry*
    - *CSG representation: a tree and the history of applying the Boolean operations*
    - *B-Rep: boundary information of a solid*
    - *Decomposition model: Aggregation of simple solids such as cubes*

Geometric modeling systems

- *Data Structures*
  - *CSG representation: a tree and the history of applying the Boolean operations*



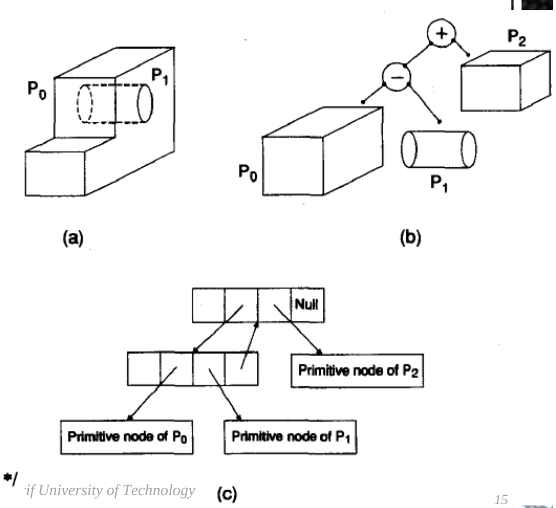


Geometric modeling systems

- *Data Structures*
  - *CSG representation: a tree and the history of applying the Boolean operations*

```
struct operator {
        int     op_type,        /* union, intersection or difference operator */
                L_type;         /* left node type: 0=operator, 1=primitive */
                R_type          /* right node type: 0=operator, 1=primitive */
        void    *L_ptr;         /* left node */
                *R_ptr;         /* right node */
                *p_ptr;         /* parent node */
}

struct primitive {
        int     prim_type;              /* type of primitive */
        double  pos_x, pos_y, pos_z;    /* position of instance */
        double  ori_x, ori_y, ori_z;    /* orientation of instance */
        void    *attribute;             /* the value of dimensions of the primitive */
}
```



Geometric modeling systems

- Data Structures
  - CSG representation: a tree and the history of applying the Boolean operations
    - It is simple and stores compact data
    - It always describe a valid solid
    - It can be easily converted
    - It supports the parametric modeling
    - It is limited by the defined Boolean operators (no lifting or other operator can be applied)
    - A great amount of computations is needed to discover the boundary information

Geometric modeling systems

- Data Structures
  - B-Rep: boundary information of a solid
    - The basic elements of the boundary are vertices, edges and faces
    - B-Rep needs to stores the abovementioned data and the interconnected information

Three tables for storing B-Rep

Face Table

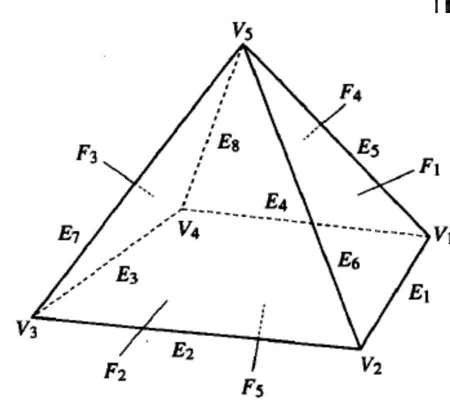
Face	Edges
F_1	E_1, E_5, E_6
F_2	E_2, E_6, E_7
F_3	E_3, E_7, E_8
F_4	E_4, E_8, E_5
F_5	E_1, E_2, E_3, E_4

Edge Table

Edge	Vertices
E_1	V_1, V_2
E_2	V_2, V_3
E_3	V_3, V_4
E_4	V_4, V_1
E_5	V_1, V_5
E_6	V_2, V_5
E_7	V_3, V_5
E_8	V_4, V_5

Vertex Table

Vertex	Coordinates
V_1	x_1, y_1, z_1
V_2	x_2, y_2, z_2
V_3	x_3, y_3, z_3
V_4	x_4, y_4, z_4
V_5	x_5, y_5, z_5
V_6	x_6, y_6, z_6



Geometric modeling systems

- *Data Structures*
  - *B-Rep: boundary information of a solid*
    - *Curved faces and edges are problems*
    - *External and internal boundaries for faces are problems*
    - *Number of the edges for faces may be different*
    - *Deriving the information among the tables may be difficult*