Automation (21-541)
Advanced Manufacturing Laboratory
Department of Industrial Engineering
Sharif University of Technology

Session # 8

Session Schedule

- Computer-Aided Design (CAD)
  - Geometric modeling
    - Geometric modeling techniques
    - Geometric data exchange
Computer-Aided Design (CAD)

- Geometric modeling:
  - Computer representation of the geometry of a component using software is called a geometric model.

- Geometric modeling is done in three principal ways:
  - Wire frame modeling
  - Surface modeling
  - Solid modeling

- In wire frame modeling the object is represented by its edges.
- In the initial stages of CAD, wire frame models were in 2-D. Subsequently 3-D wire frame modeling software was introduced.
Computer-Aided Design (CAD)

- Geometric modeling:
  - Surface modeling
    - In this approach, a component is represented by its surfaces which in turn are represented by their vertices and edges.

- Standard surface types available for surface modeling:
  - box,
  - pyramid,
  - wedge,
  - dome,
  - sphere,
  - cone,
  - torus,
  - dish
  - and mesh
Homework: AT:G:04:#

- Extend the simple program of HW2 for interpreting simple following objects. You should use your CIM data base structure to maintain the geometric data.
  - A simple interface can be applied to plot a cub and a sphere.

- The HW should be sent to Fvalilai@Sharif.edu till Sunday, 25th of Aban (Nov, 16th, 2014)
- Email subject: “AT:G:04: #”

Computer-Aided Design (CAD)

- Geometric modeling:
  - Solid modeling
    - The representation of solid models uses the fundamental idea that a physical object divides the 3-D Euclidean space into two regions, one exterior and one interior, separated by the boundary of the solid.
Computer-Aided Design (CAD)

- Geometric modeling:
  - Solid modeling
  - There are six common representations in solid modeling.
    - Spatial Enumeration
    - Cell Decomposition
    - Boundary Representation
    - Sweep Methods
    - Primitive Instancing
    - Constructive Solid Geometry (CSG)

- Constructive Solid Geometry (CSG)
  - In a CSG model, physical objects are created by combining basic elementary shapes known as primitives like blocks, cylinders, cones, pyramids and spheres.
  - The Boolean operations like union ($\cup$), difference ($\setminus$) and intersection ($\cap$) are used to carry out this task.
Homework:

- Consider the following solid model. Use the CGS method and draw the CSG tree model based on the CSG primitive objects and operators.

- The HW should be sent to FValilai@sharif.edu till Tuesday, 27th of Aban (Nov, 18th, 2014)
- Email subject: "AT: I: **: StudentNumber"

Computer-Aided Design (CAD)

- Geometric modeling:
  - Solid modeling
    - Boundary Representation (B-rep)
    - Boundary representation is built on the concept that a physical object is enclosed by a set of faces which themselves are closed and oriented surfaces.

- Geometric entities -- Topological entities
  - Point -- Vertex
  - Curve, line -- Edge
  - Surface -- Face
Computer-Aided Design (CAD)

- **Geometric modeling:**
  - **Solid modeling**
    - Solid models differ from wire frame and surface models in the kind of geometric information they provide.
    - Wire frame models only show the edge geometry of an object. They say nothing about what is inside an object.
    - Surface models provide surface information, but they too lack information about an object's internal structure. Solid models provide complete geometric descriptions of objects.
  - Solid models can be used for quick and reliable design analysis.
  - Solid models apart from geometric information provide important data such as volume, mass, mass properties and center of gravity.
  - The designer can also export models created to other applications like
    - finite element analysis (FEA),
    - Rapid prototyping and other special engineering applications
**Computer-Aided Design (CAD)**

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

![Diagram of a part with features](image)

- Geometric 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.
Computer-Aided Design (CAD)

- Geometric 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:
  - 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.