Extended Reality in Industry 4.0 (ERI)

Lecture 3: Introduction to 3D Creation

Dr. Kalpana Shankhwar, kalpana@iiitd.ac.in
Assistant Professor
Department of Human Centered Design,
IIIT Delhi

Introduction

- A picture over words
- Language of drawing to convey the ideas
- “Standardized” drawing language (Engineering drawing)
- Application in product development
- Two important steps in product development: 1. product specification and 2. product drawing
- “Engineering drawing” is an effective language of communication between engineers
- Geometric theorems are essential in Engineering drawing

What is 3D modeling?

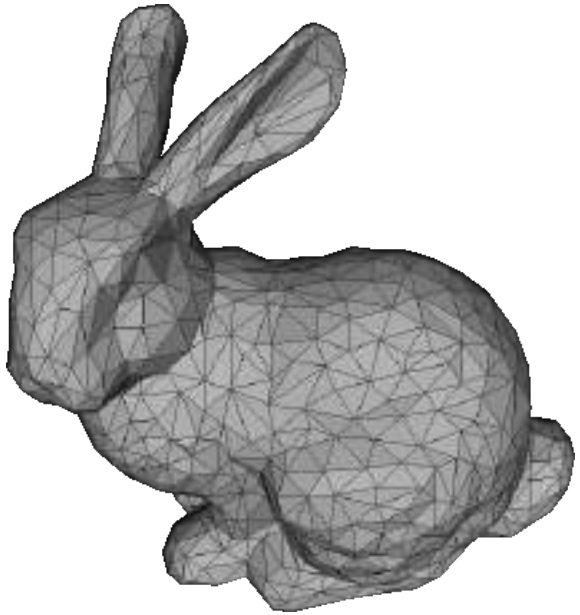
- The process of constructing the drawings on the computer screen with the help of specially developed software and hardware is called “Computer Aided Drafting (CAD)”. Also known as “3D modeling”.
- CAD drawings are clearer and more exact than manual drawings.
- It can be used to create an interactive design of an object that represents a real-life design.
- For example, a part of a physical object can be created quickly, its physical properties analyzed, and then the model updated as needed.
- 3D modeling software allows designers and companies to model products and present them, internally or to clients, before a final product is created. It can be both time and cost-efficient.

What is 3D modeling?

3D modeling is visually represented as a 2D image using 3D rendering or visualization techniques.

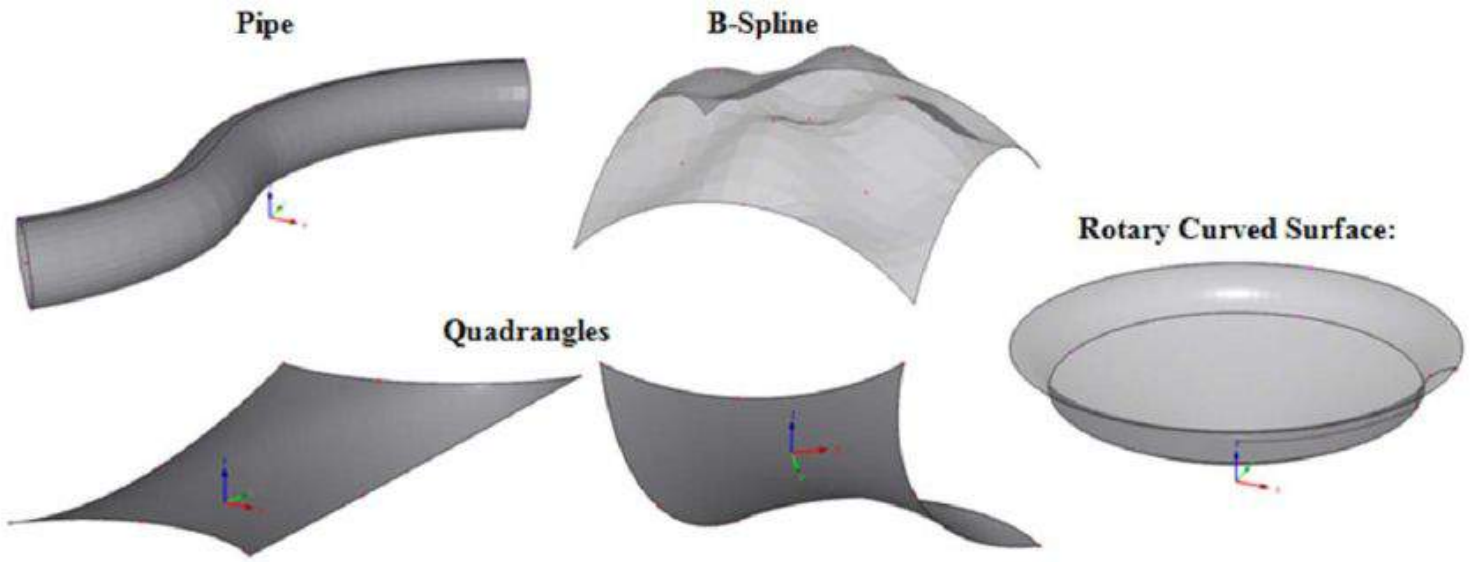
3D modeling methods

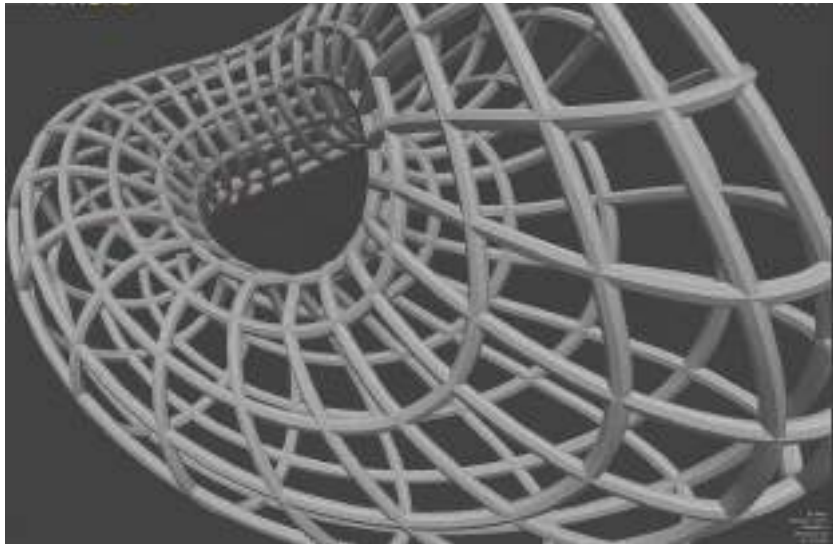
- *Polygonal modeling:* A polygonal model represents points in 3D space connected by line segments to form a polygon mesh.



What is 3D modeling?

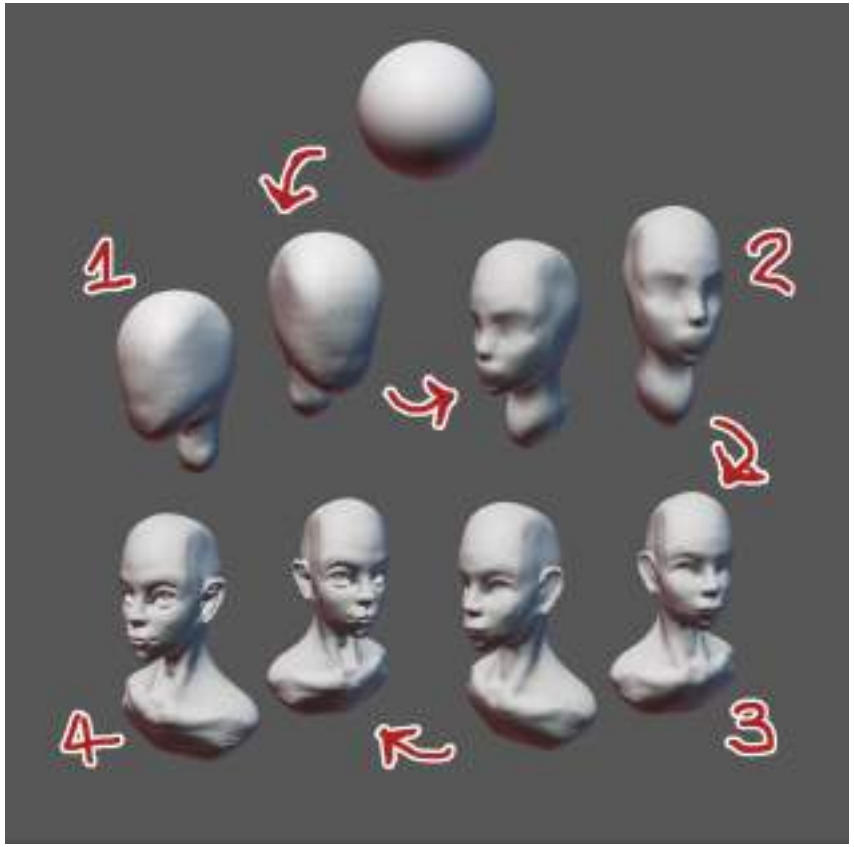
- *Curve modeling:* Another type of modeling that relies on curves to generate surface geometry.
- Curve modeling can be both parametric (based on geometric and functional relationships) or freeform to describe surface forms. The curves are driven by mathematical equations that are influenced by the designer using weighted control points.





What is 3D modeling?

•*Digital Sculpting:* This is a relatively new type of 3D modeling where the user interacts with the digital model as you would be modeling clay. Users can push, pull, pinch, or twist virtual clay to generate their model.



Importance of Computer Graphics

- The CAD system is based on what is called interactive computer graphics (ICG).
- ICG helps to convert the data entered by the user in the form of graphics.
- The input data entered in the form of commands using hardware is converted into graphics by software.
- With CAD, the user can create new drawings, modify the existing ones, store the drawings and explore further.

Importance of Computer Graphics

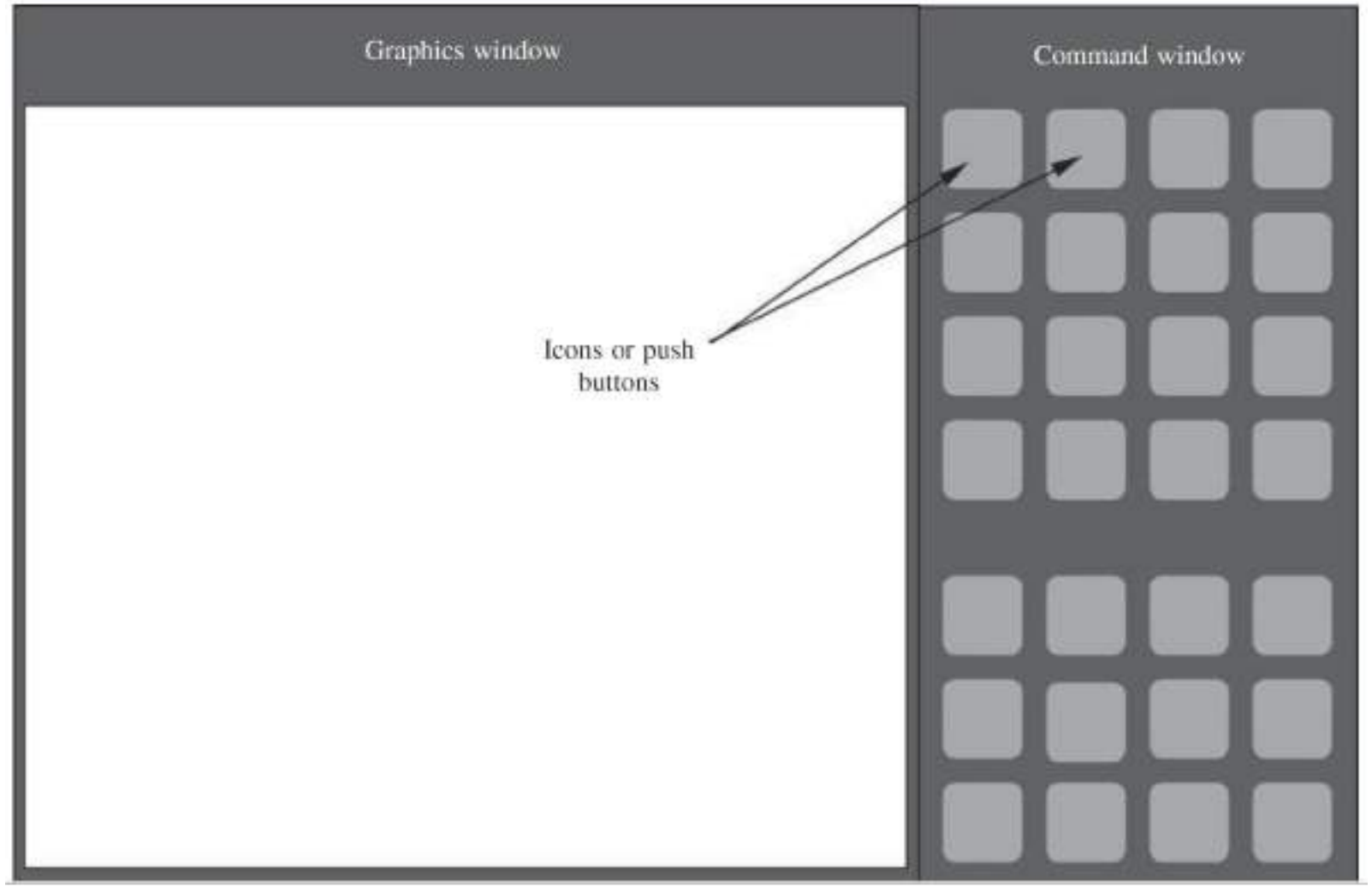
- It also forms an important ingredient in Computer-Aided Manufacturing (CAM) wherein graphical data of the object is converted into machining data to operate a CNC machine for production of a component.

- Two primary constituents of computer graphics are the *hardware* and the *software*.

Importance of Computer Graphics

- 3D modeling software is designed to be primarily interactive, intuitive and user-friendly.
- Front end of a software is a graphical user interface.
- Back end comprises computation and database management routines.
- In most 3D modeling software, the GUI is divided into two parts (or windows) that appear on the display device: (i) the visual manifestation or the Graphics Window and (ii) the Command window.
- The Graphics window provides the visual feedback to the user detailing desired information about an object being designed.

Importance of Computer Graphics



Generic appearance of the Front end of a CAD software

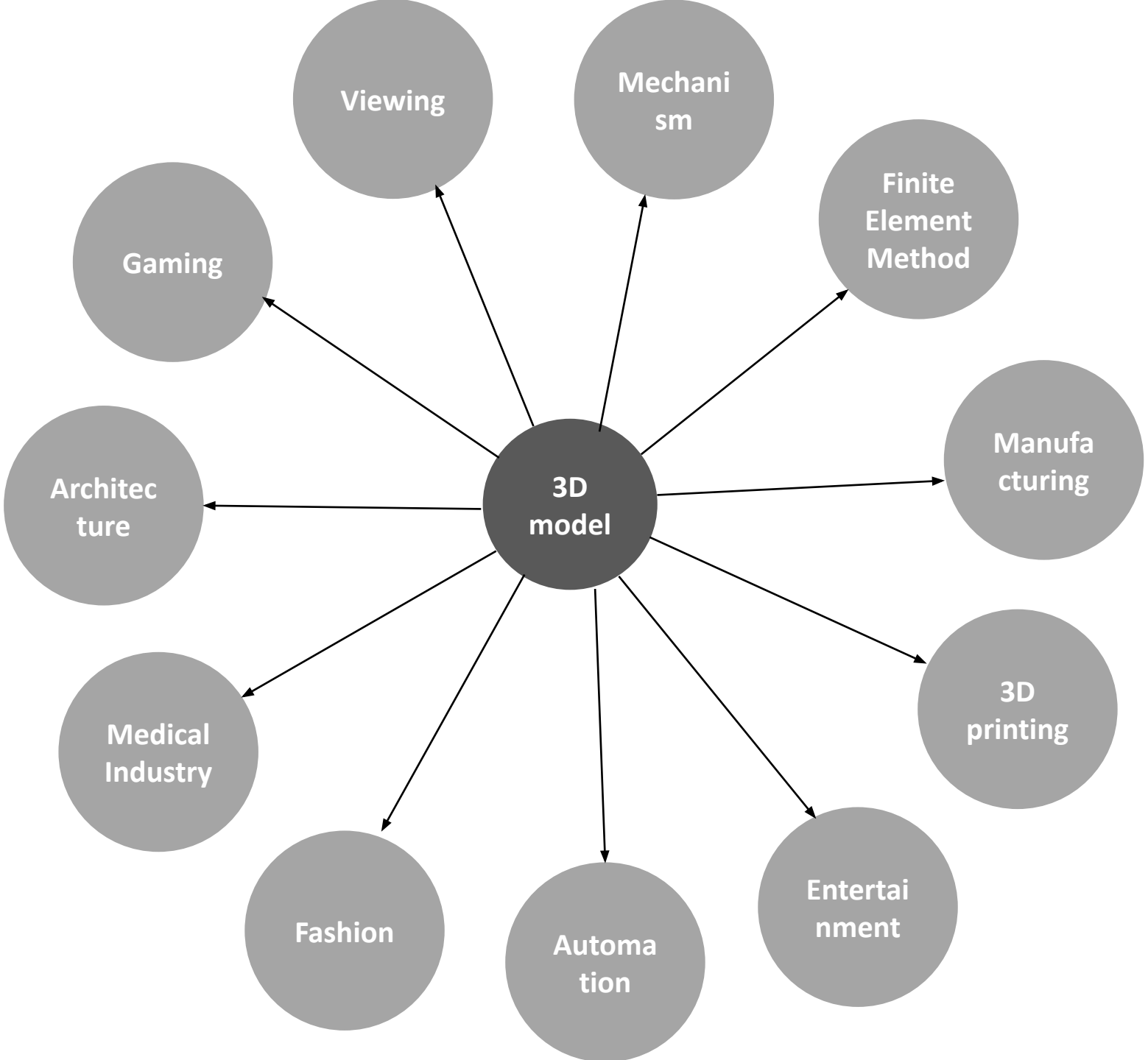
Advantages of CAD

- **Accuracy** – CAD helps in achieving very high degree of accuracy compared to manual drawing.
- **Speed** – Swift creation of drawings, similar object creation with copy, mirror and array options. Automatic hatching, texting and dimensioning
- **Easy editing** – Constructed drawings can be easily edited, and modified. Component drawings from one file can be inserted into another.
- **Standard libraries** – Libraries containing standard parts such as gears, valves, electrical, electronic, civil and architectural components.

Advantages of CAD

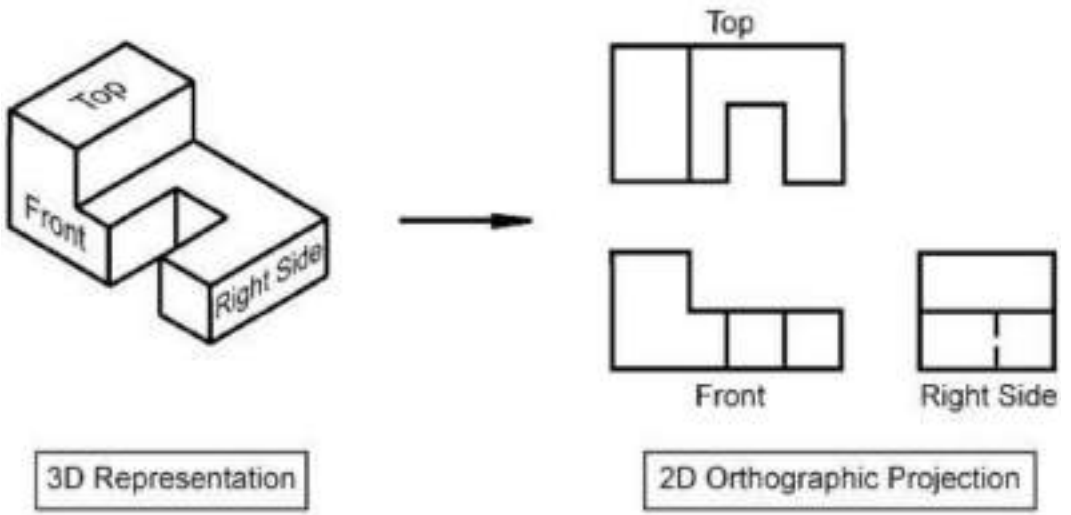
- **Scaling** –Drawings can be enlarged or reduced by any scale factor. Automatic dimensioning
- **Better visualization**
- **Freedom** from using instruments
- **Space effectiveness**

Applications of 3D/CAD modeling



Viewing

- 3D components used to be drawn manually.
- Drawing skills required and time consuming
- Mainly orthogonal views were drawn.
- 3D model of almost any object is possible.
- Model can be rotated and different views can be generated.
- Sectional views can be analyzed.
- 2D drawing in hard copies (used in manufacturing shop floors).
- Multiple iterations possible
- 3D components are always made in true scale.

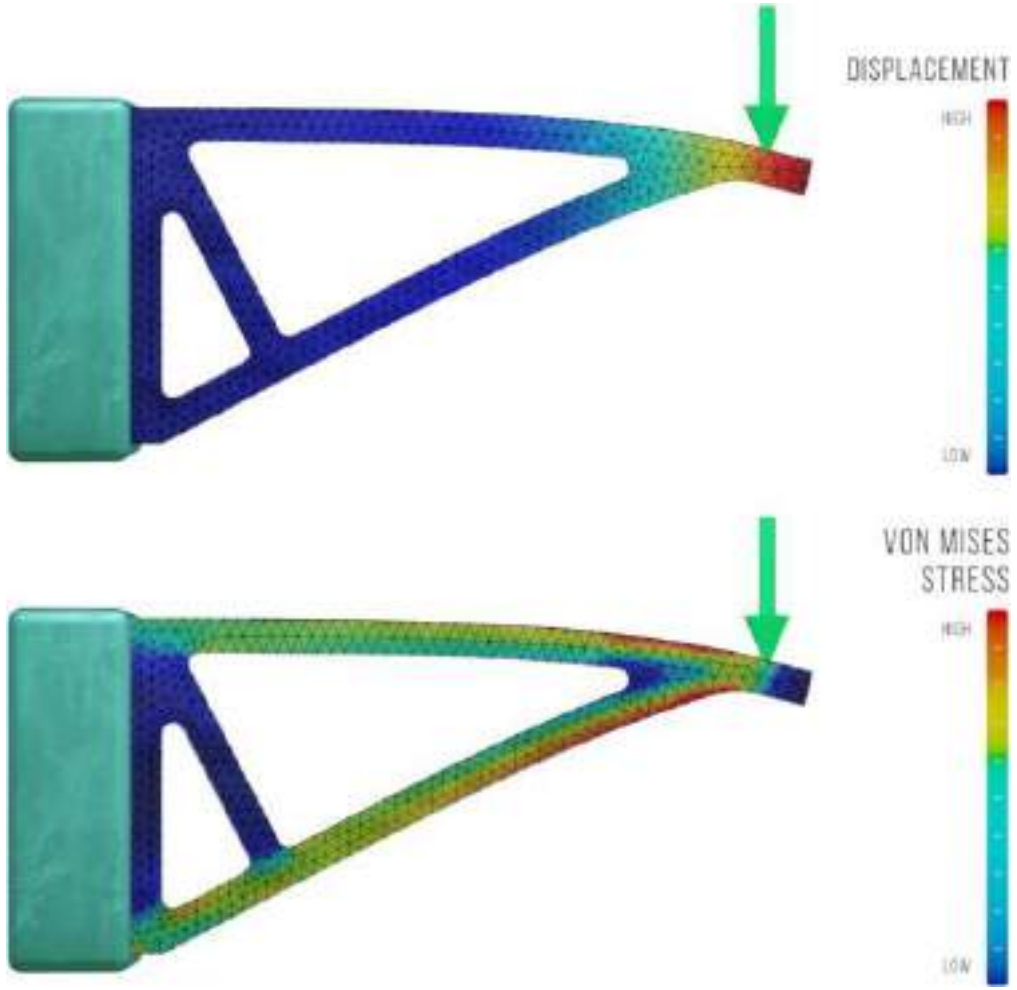


Mechanism

- Designers can create 3D model of each component to create the mechanism.
- All the links can be assembled one by one with certain joint configuration to simulate the real condition.

Finite Element Method

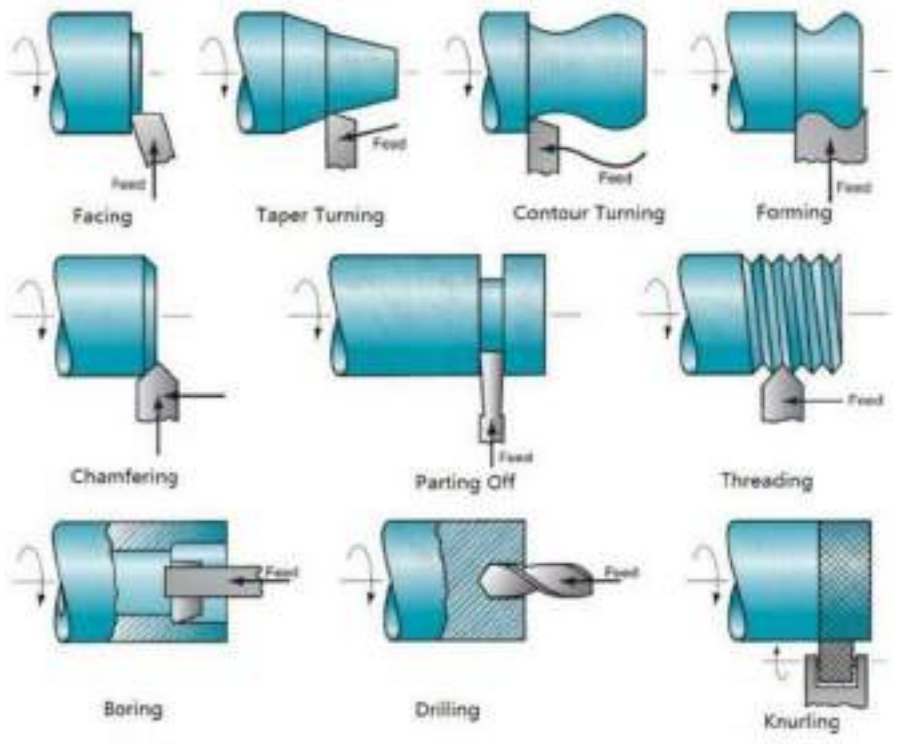
- Finite element method (FEM) is a numerical method to solve differential and integral equations. Since the behavior of physical systems can be represented by differential equations, FEM can be used to analyze a number of physical problems.



Manufacturing

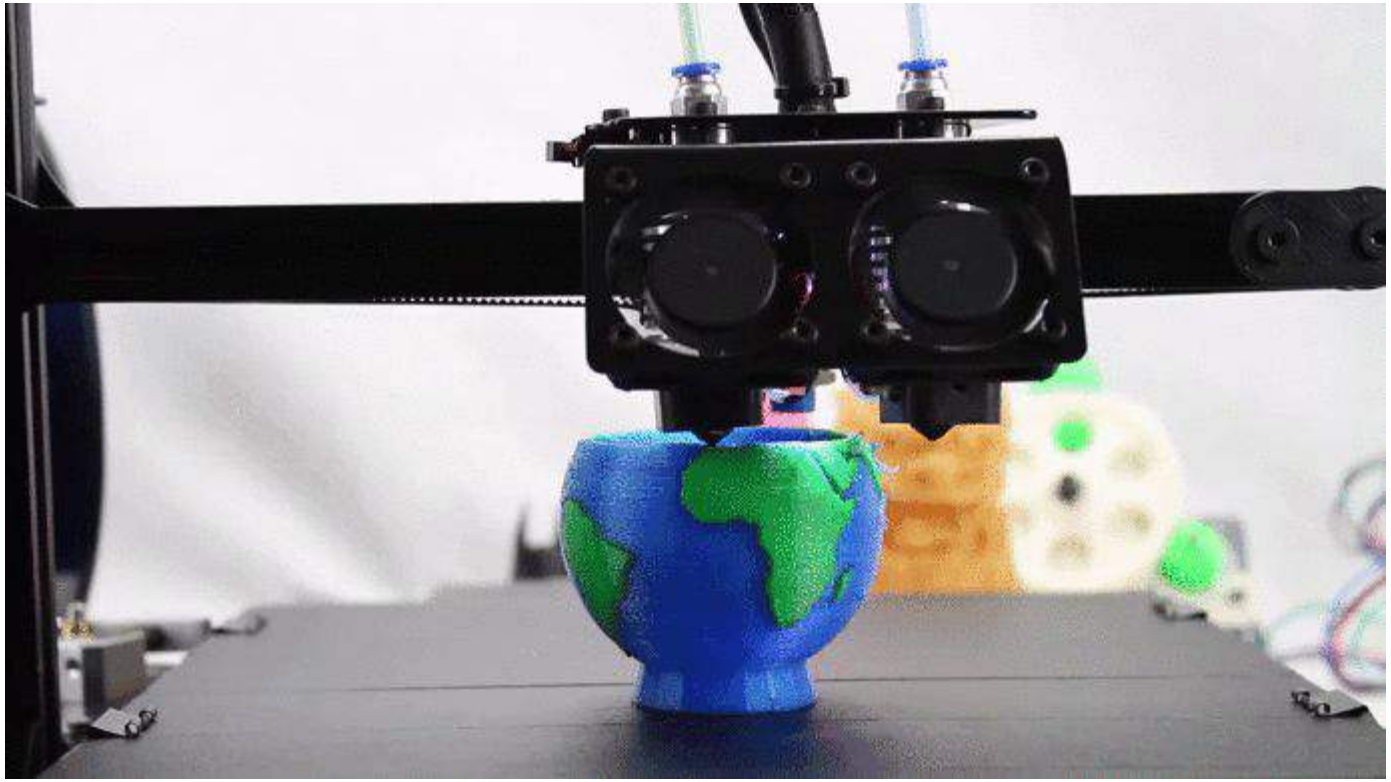
The extent of use of CAD in the production or manufacturing is computer-aided manufacturing (CAM).

1. Manufacturing through CNC machines
2. Computerized measuring and inspection
3. Computerized robotic applications



3D Printing

3D printing is the process of creating physical object from a geometric model by successive addition of material. The material is deposited, joined and solidified under computer control.



Entertainment

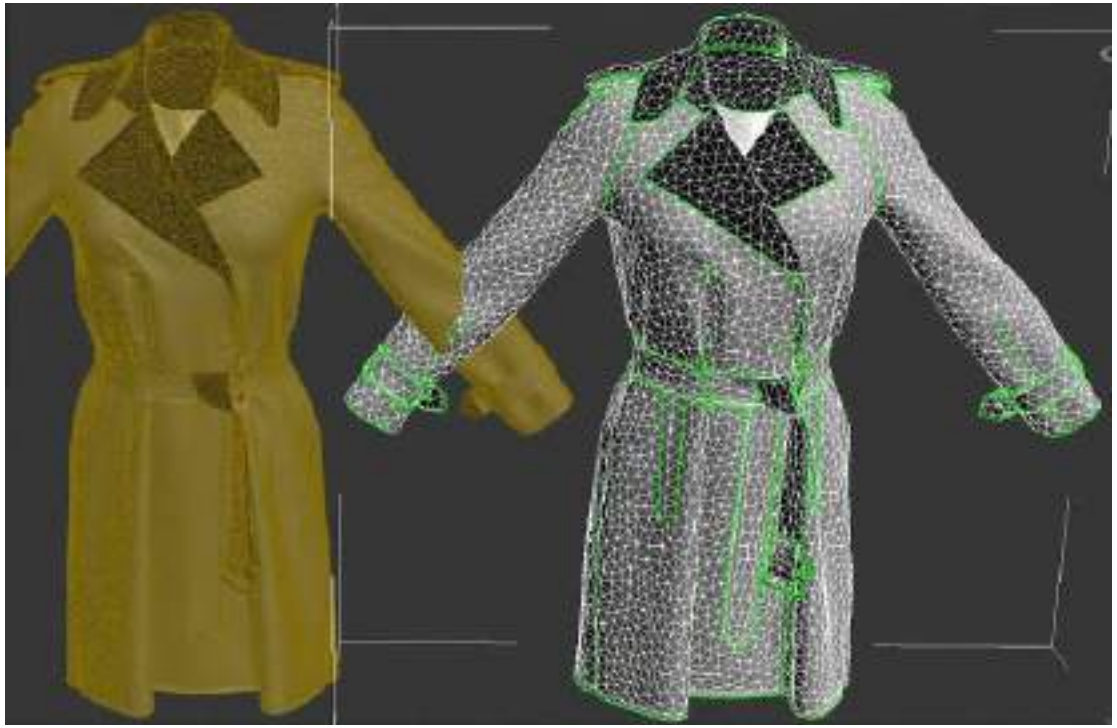
3D sculpting is used for creating characters that are used in films and TV programs.

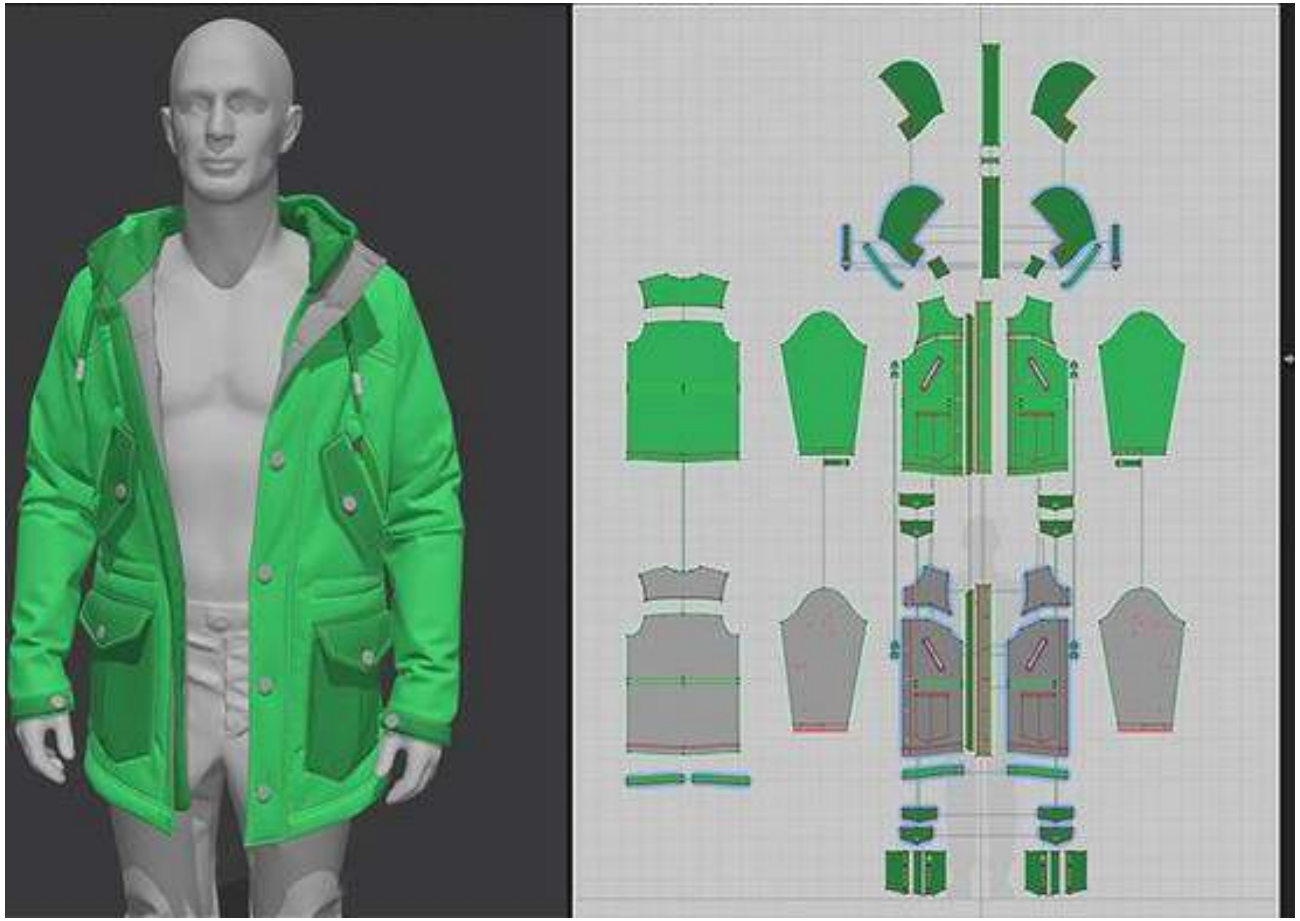
Automation

- If sufficient programming can be made on CAD, automatic component generation is possible. There are some standardized rules which can be imposed in CAD model.
- The real variables are kept open to variation and all dimensions are related to those variables.
- In this way, the model can be regenerated with different values of open variables and thus a new product shape is formed.

Fashion

Designers use 3D modeling to see the complications in clothes before they are physically created. It is also used to design dynamic clothes for virtual catalogs.



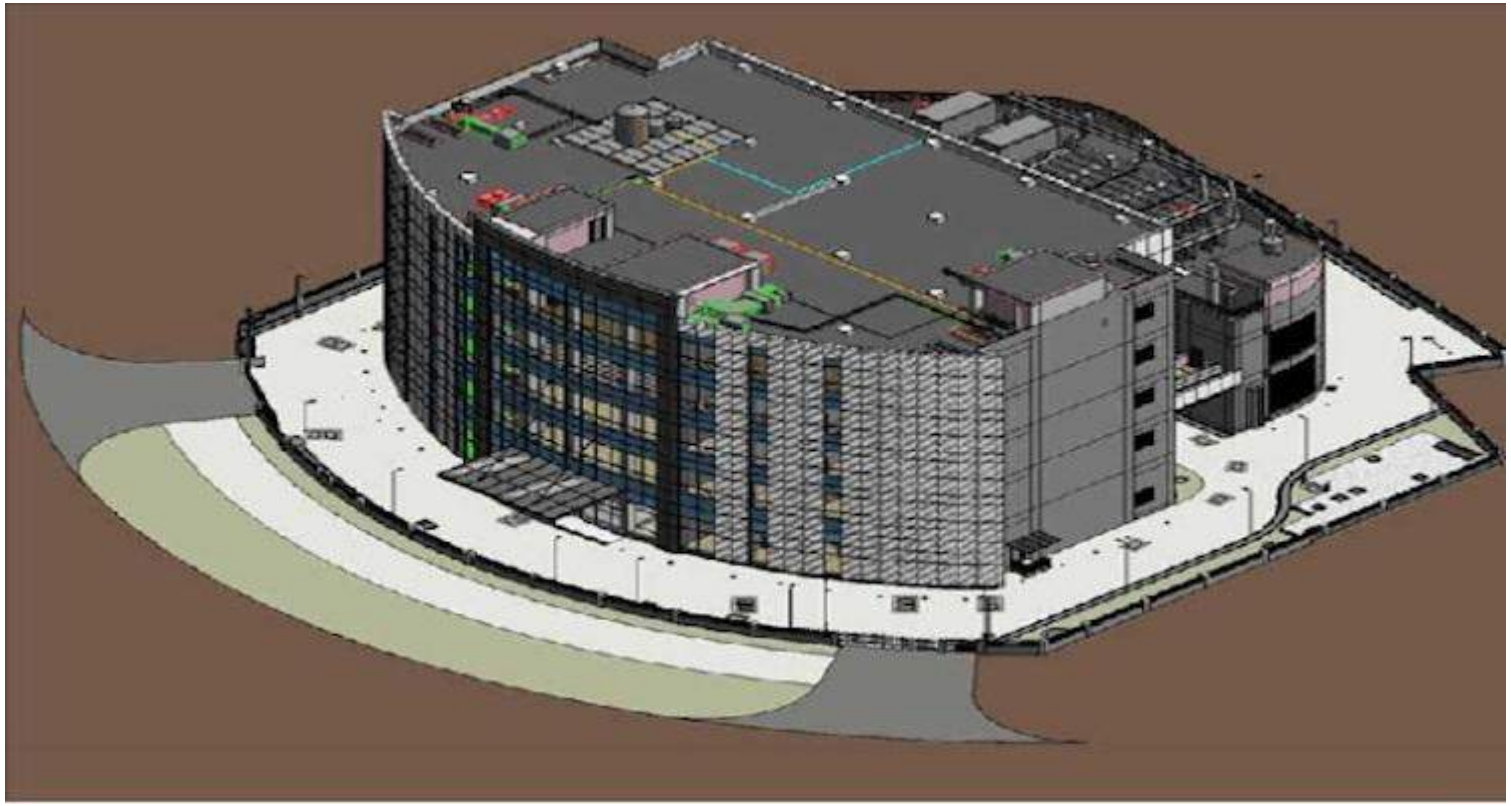


Medicine

3D modeling is used to design prosthetics, parts to repair damaged organs. 3D sculpting is useful in medical field.

Architecture

3D modeling is used to visualize buildings that are yet to be constructed, often using surface modeling. **AutoCAD**, **SketchUp** and **ArchiCAD** are some popular programs.



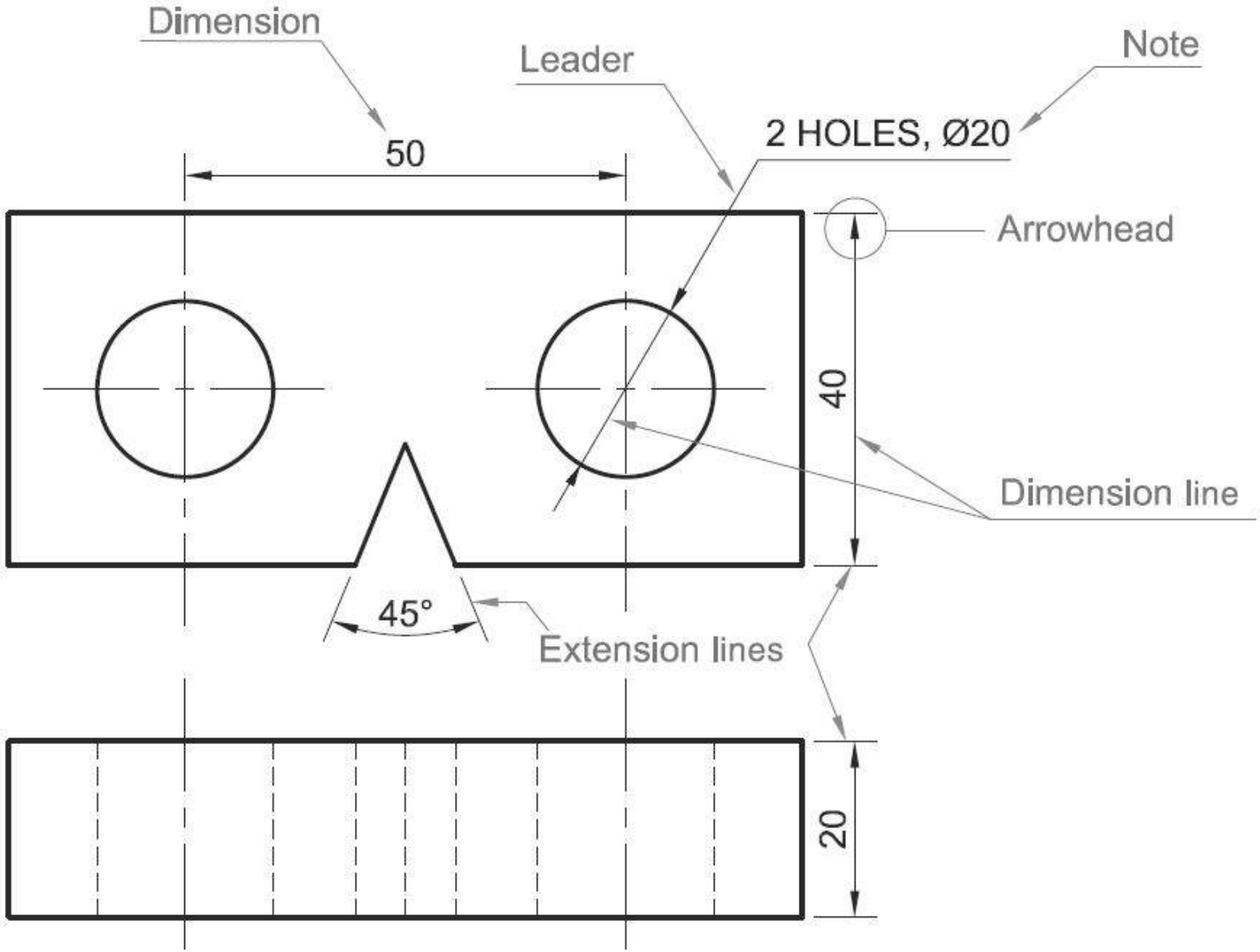
Gaming

3D modeling is used to create game characters and scenes. A combination of 3D modeling and animation makes games more realistic. Sculpting and surface modeling techniques are the ones that are mostly used in this industry.

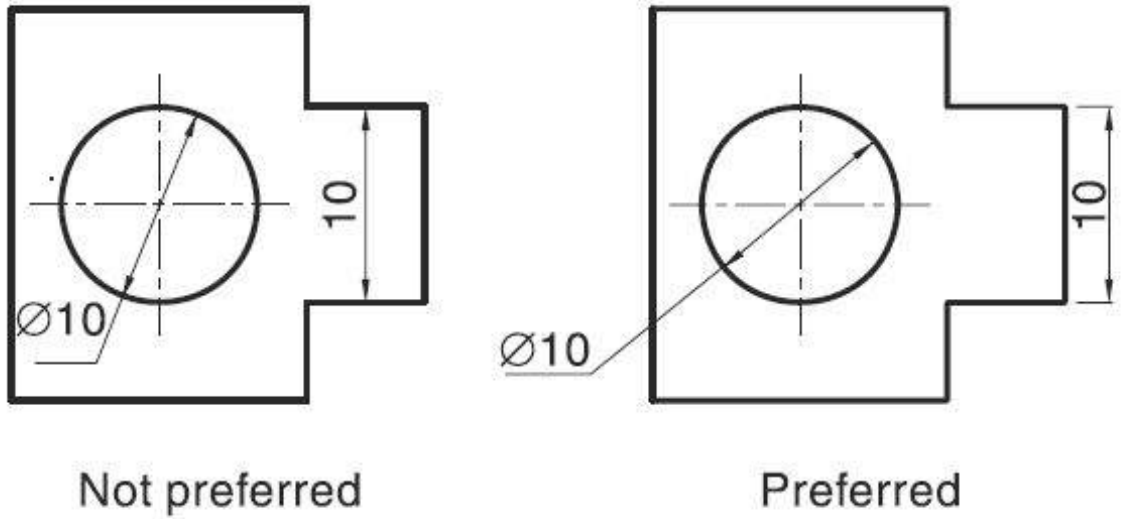
Dimensioning

- Dimensions are necessary to show the exact size of an object.
- It refers giving dimensions i.e. length, width, height, diameter etc. on the drawing.
- Dimension is a numerical value expressed in appropriate units of measurement and indicated graphically on technical drawings with lines, symbols and notes.
- **Units of measurement –** On technical drawing we need to show length and angles. The most convenient unit is mm.
- **Symbols –** Symbols are incorporated to indicate specific geometry wherever necessary.

Dimensioning



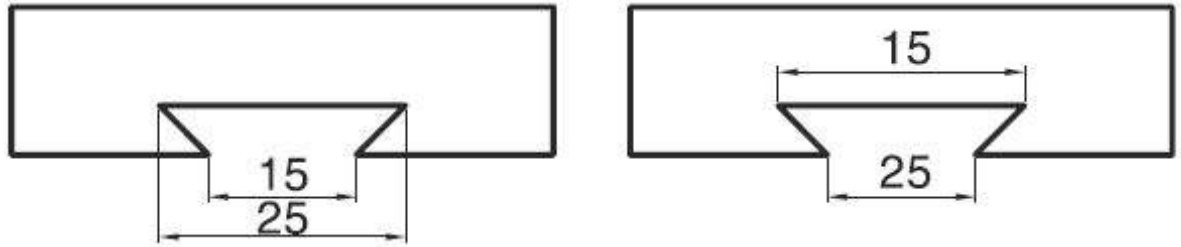
Rules of dimensioning



Not preferred

Preferred

(a)

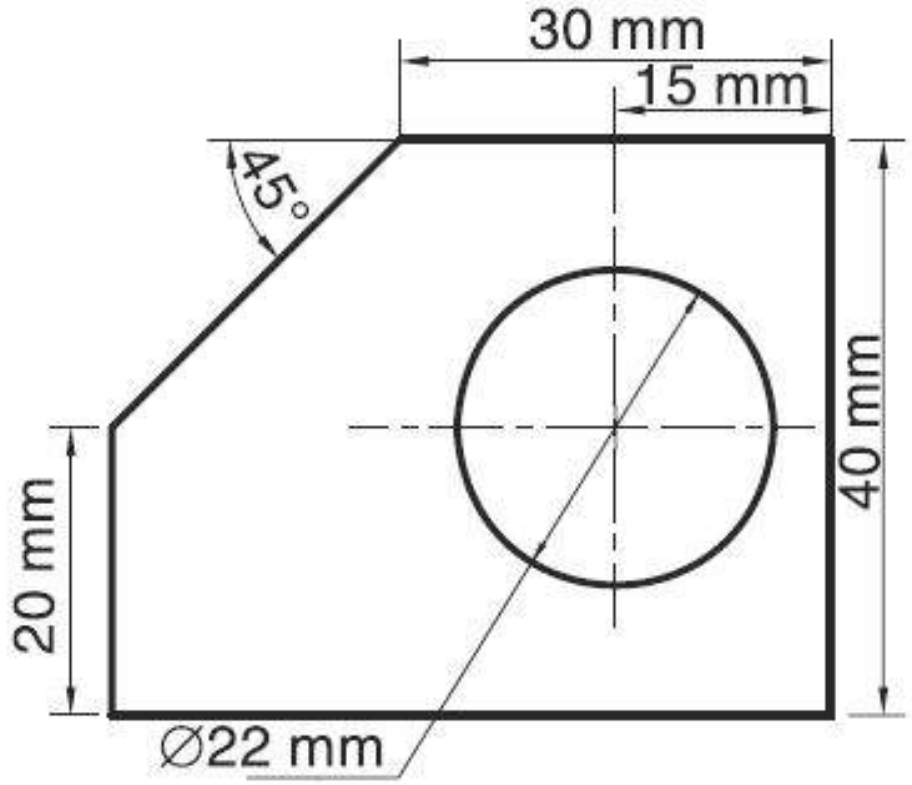


Not preferred

Preferred

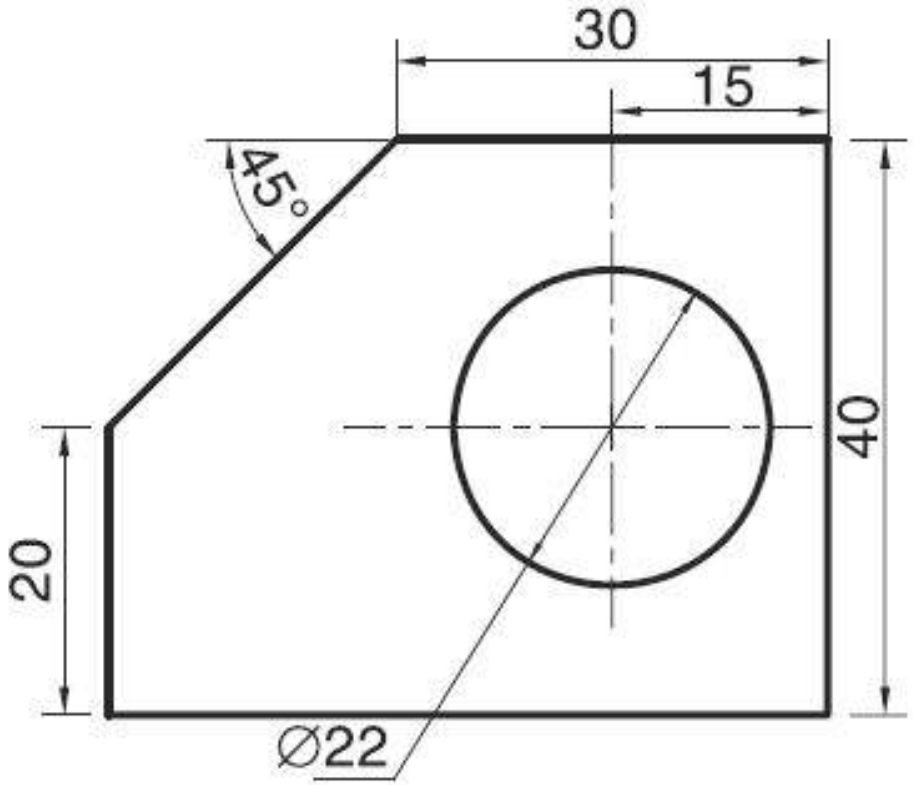
(b)

Rules of dimensioning



Wrong

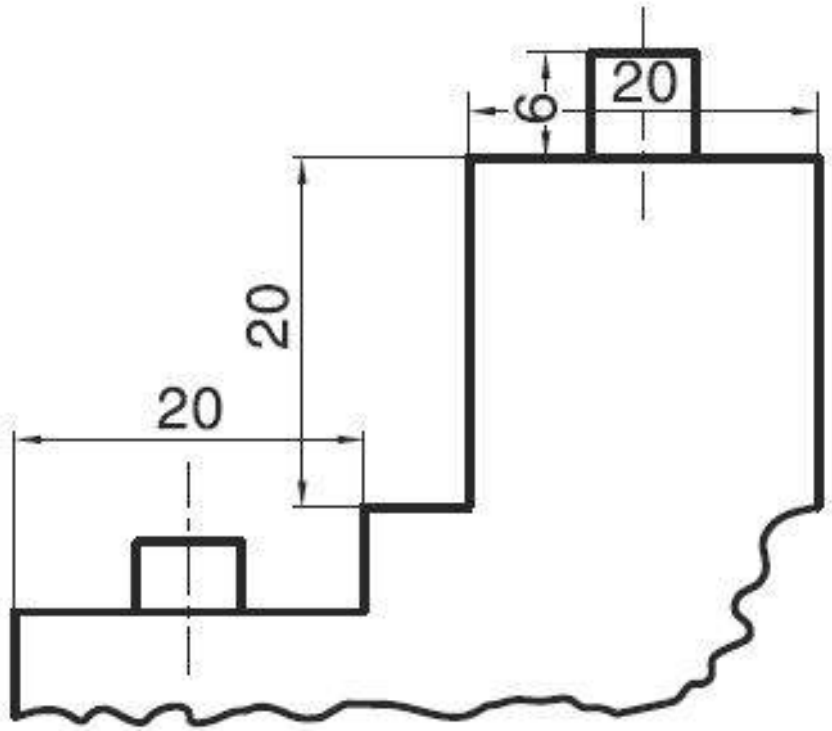
Align system and bidirectional system are mixed



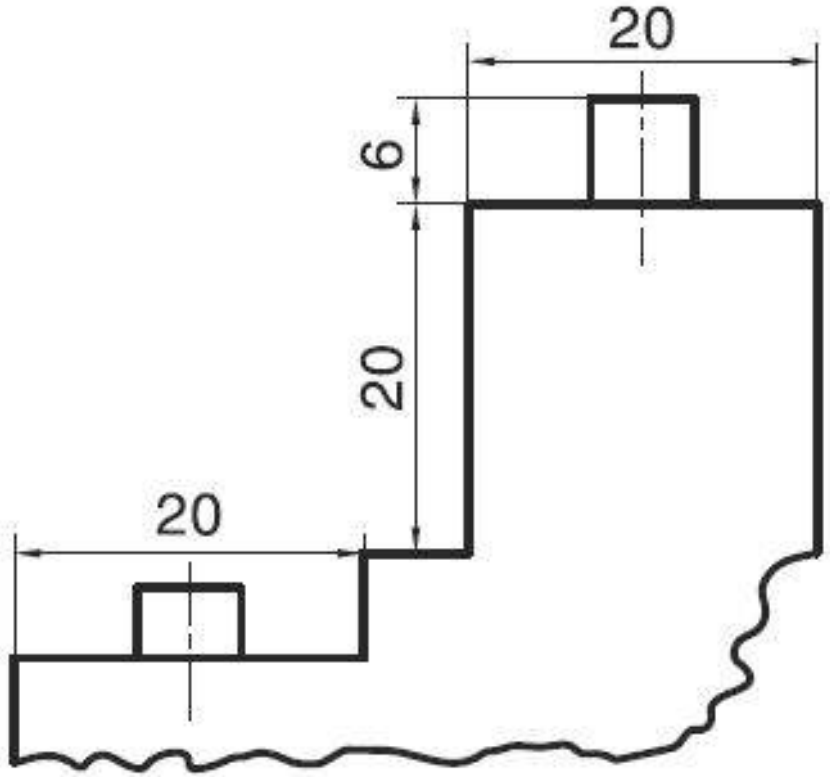
ALL DIMENSIONS IN MM

Correct

Rules of dimensioning



Wrong



Correct

Rules of dimensioning

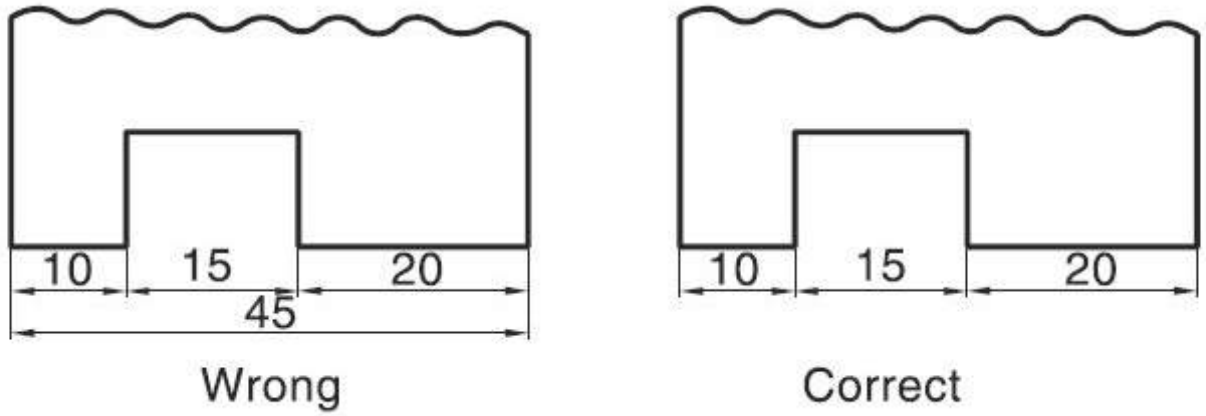
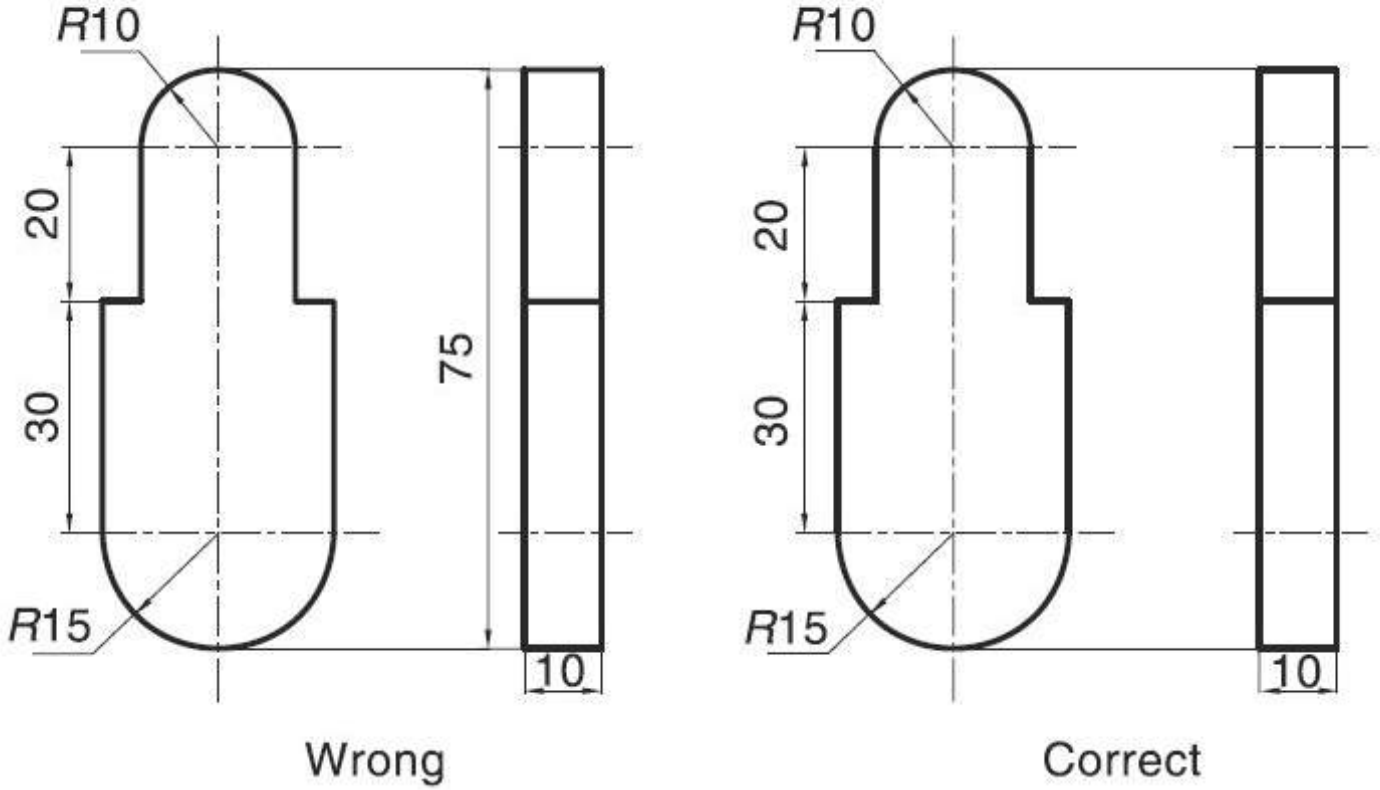
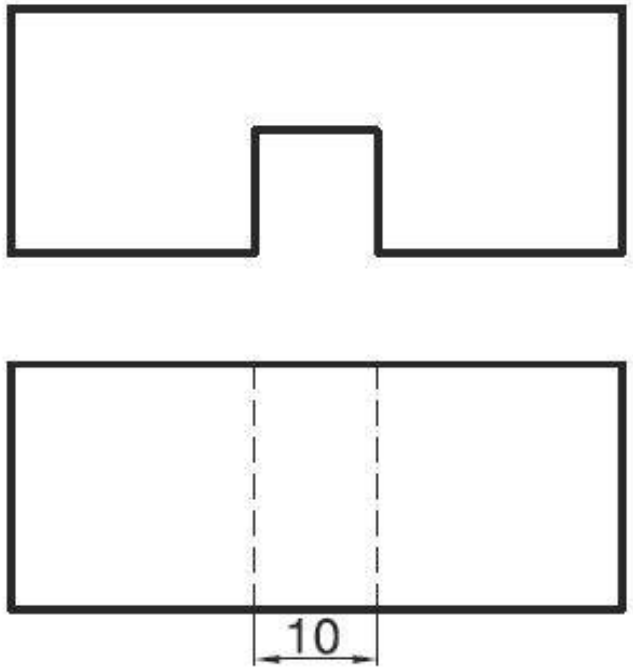


Fig. 3.9(a)



Rules of dimensioning



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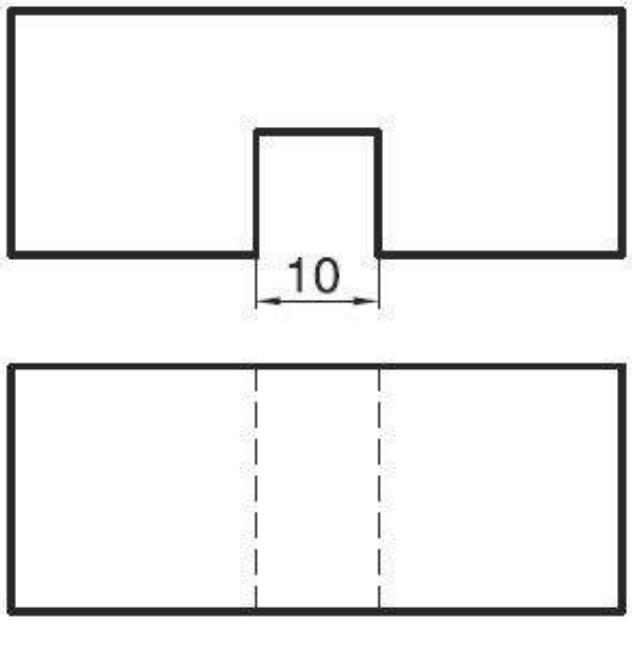
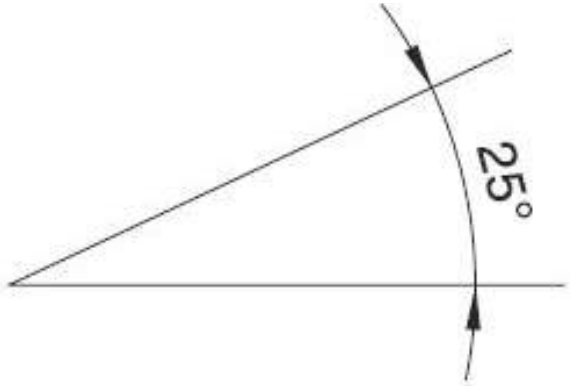
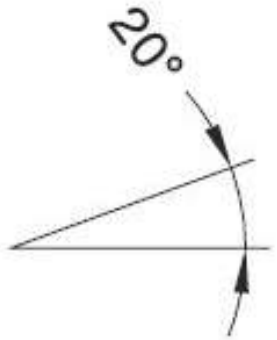
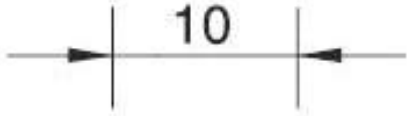


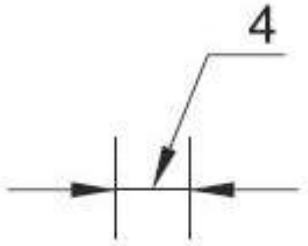
Preferred

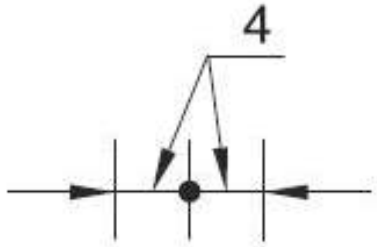
Rules of dimensioning



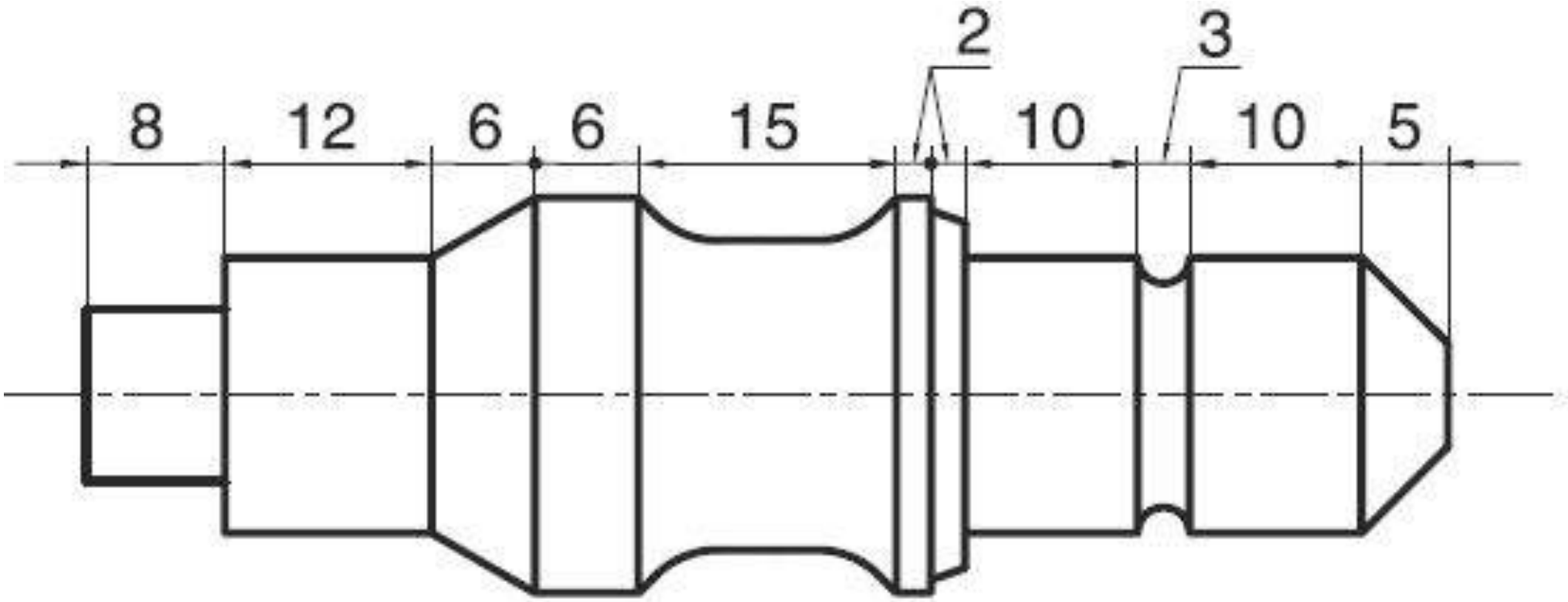






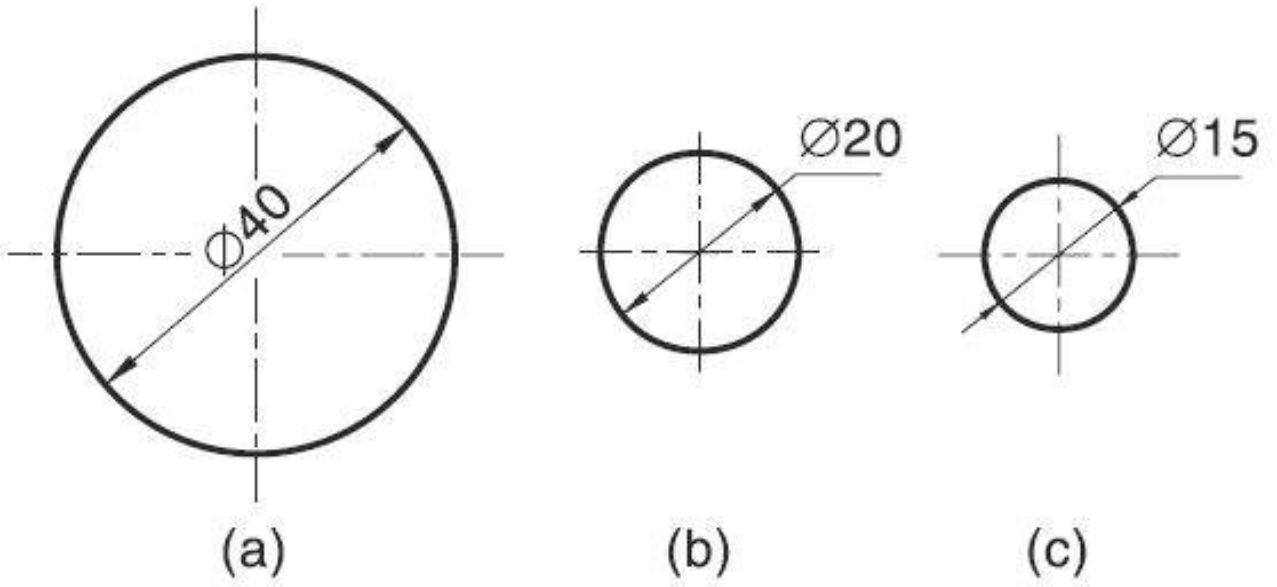


Rules of dimensioning



Dimensioning of special features

Symbol/Abbreviation	*Meaning*
ϕ	Diameter
$S\phi$	Spherical Diameter
R	Radius
SR	Spherical Radius
□ or SQ	Square
CYL	Cylinder or Cylindrical



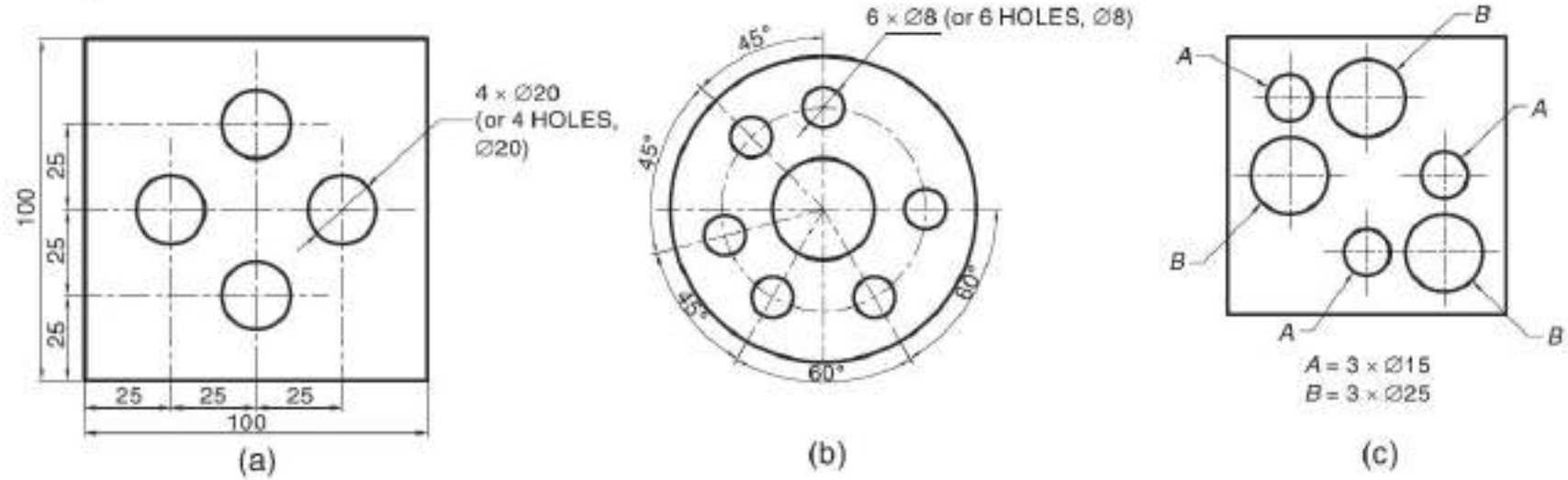
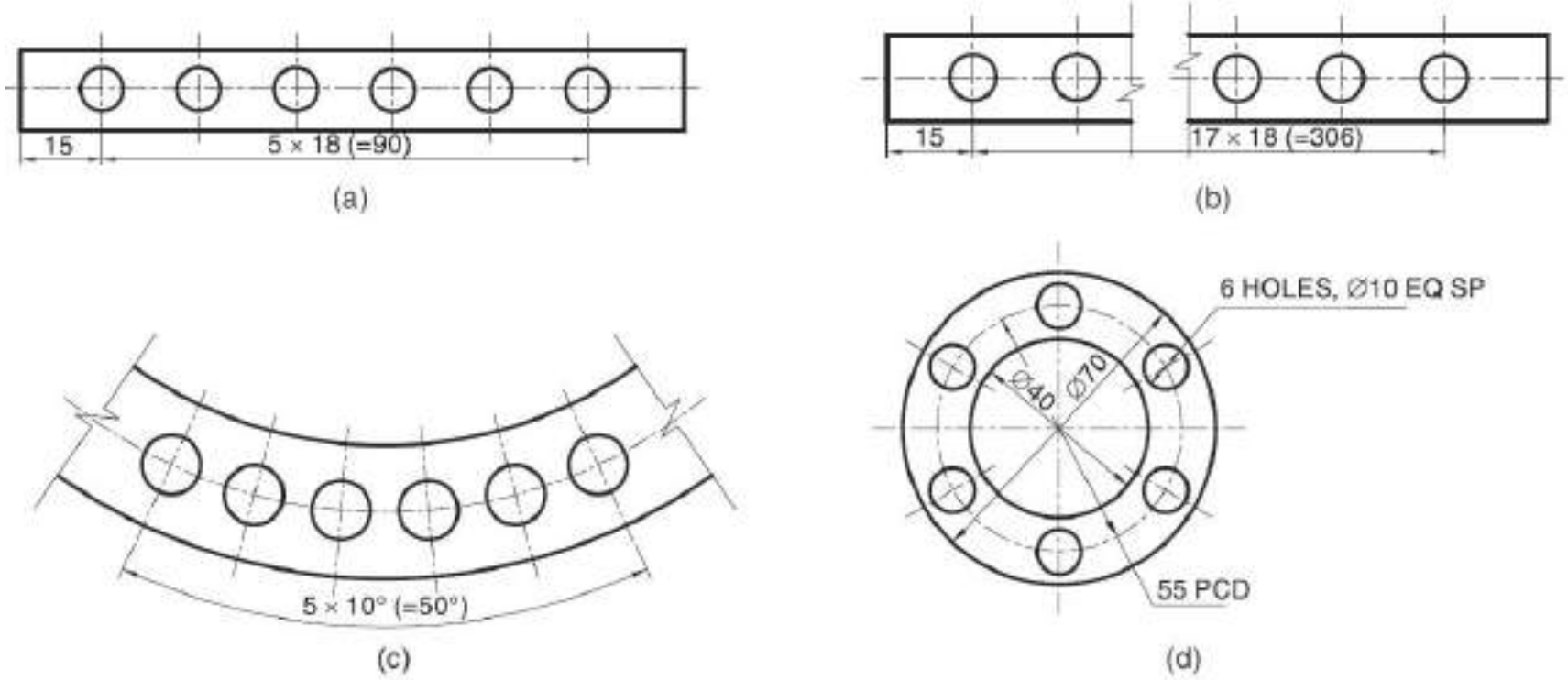

4 × Ø20
(or 4 HOLES,
Ø20)
100
25
25
25
25
25
25
100
(a)
6 × Ø8 (or 6 HOLES, Ø8)
45°
45°
45°
60°
60°
(b)
A
B
A
B
A
B
A = 3 × Ø15
B = 3 × Ø25
(c)

Fig. 3.15


15
5 × 18 (=90)
(a)
15
17 × 18 (=306)
(b)
5 × 10° (=50°)
(c)
6 HOLES, Ø10 EQ SP
Ø40
Ø70
55 PCD
(d)

Scales

- While drawing these objects on paper, one needs to enlarge or reduce them depending on their actual sizes.
- The proportion by which the drawing of a given object is enlarged or reduced is called the scale of the drawing.

Representative fraction

- The scale of a drawing is indicated by a ratio, called the Representative Fraction (RF) or Scale Factor.
- RF is a ratio of the length of an object on a drawing to the actual length of the object.
- RF = (Length on drawing)/(Actual length)
- If a 1.5 m long steel bar is shown by a 15 cm long line on a drawing, then RF = 15 cm/1.5 m = 15 cm/150 cm = 1/10.

Thankyou!