COMPUTER AIDED ENGINEERING DESIGN (BFF2612)

PART DESIGN
Wireframe and Surface Design

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INTRODUCTION

- The shape of products are managed using the surface modelling techniques.
- Surface models are the three-dimensional models with no thickness and do not have mass properties.
- Surface creation usually begin with data points or curves.
- A surface might requires two boundary curves and guide curves as well.

3D GEOMETRIC MODELS

- **Wire-frame (line model):** simples to create, but contain only information about part edges and corners. Represents an object by its bounding edges. No explicit face (surface) or volume information in the model.
- **Surface:** precisely define the outside envelop of part geometry, but contain no data on interior properties.
- **Solid:** overcomes these limitations by representing the solid nature of the object in the computer.

SURFACE GEOMETRY

- Constructed from surfaces such as planes, rotated curve surfaces and complex surfaces.
- No information regarding the interior of the solid model is available which can be relevant for generating the NC cutter data.
- Calculation of properties such as mass and inertia is difficult.
- Use when a surface is present in the product for design.
- Mathematical techniques for handling surfaces are: Bezier and B-splines.

Example:

Making sculptured surfaces such as car body and ship hull.

FREE-FORM SURFACES

Modelled by series of control points and other boundary conditions.

1. **Planar surface:** a flat 2D surface.
2. **Curved surface:** the two types of curved surfaces are the following:
   - Single curved surface: cylindrical surface, conical surfaces, surfaces of pyramid, prism and conic.
   - Double curved surface: spherical, torus, ellipsoid and hyperboloid.

SURFACE ENTITIES

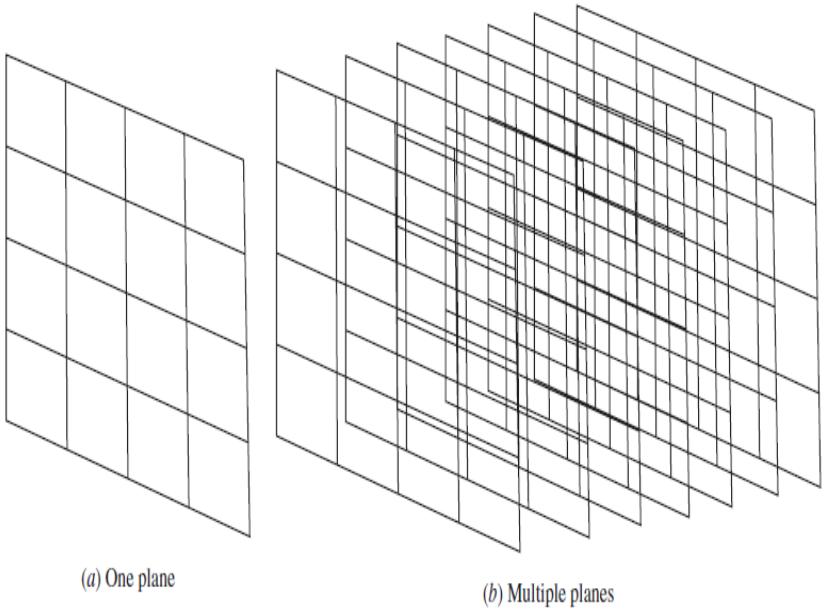


Figure 7.3 Plane surface.

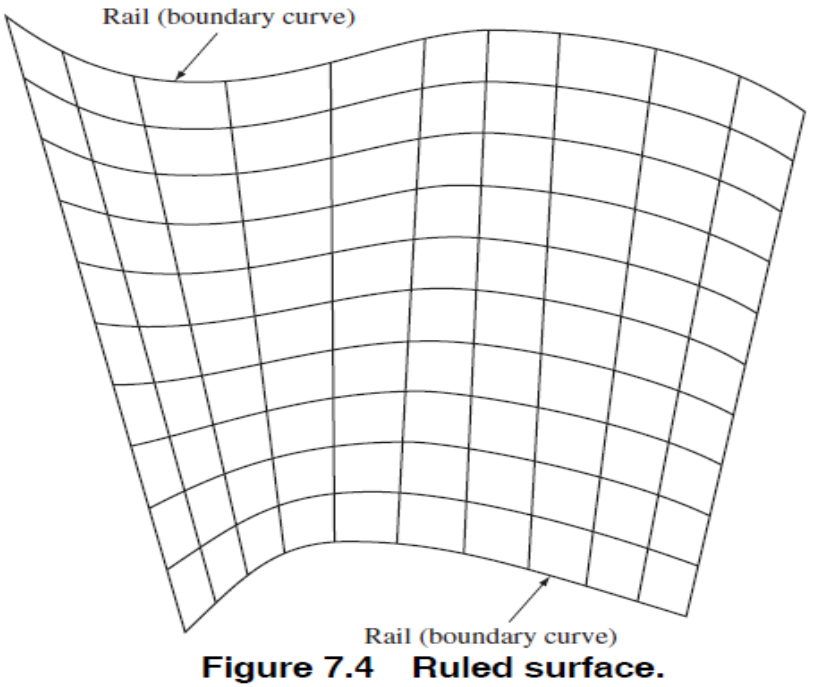
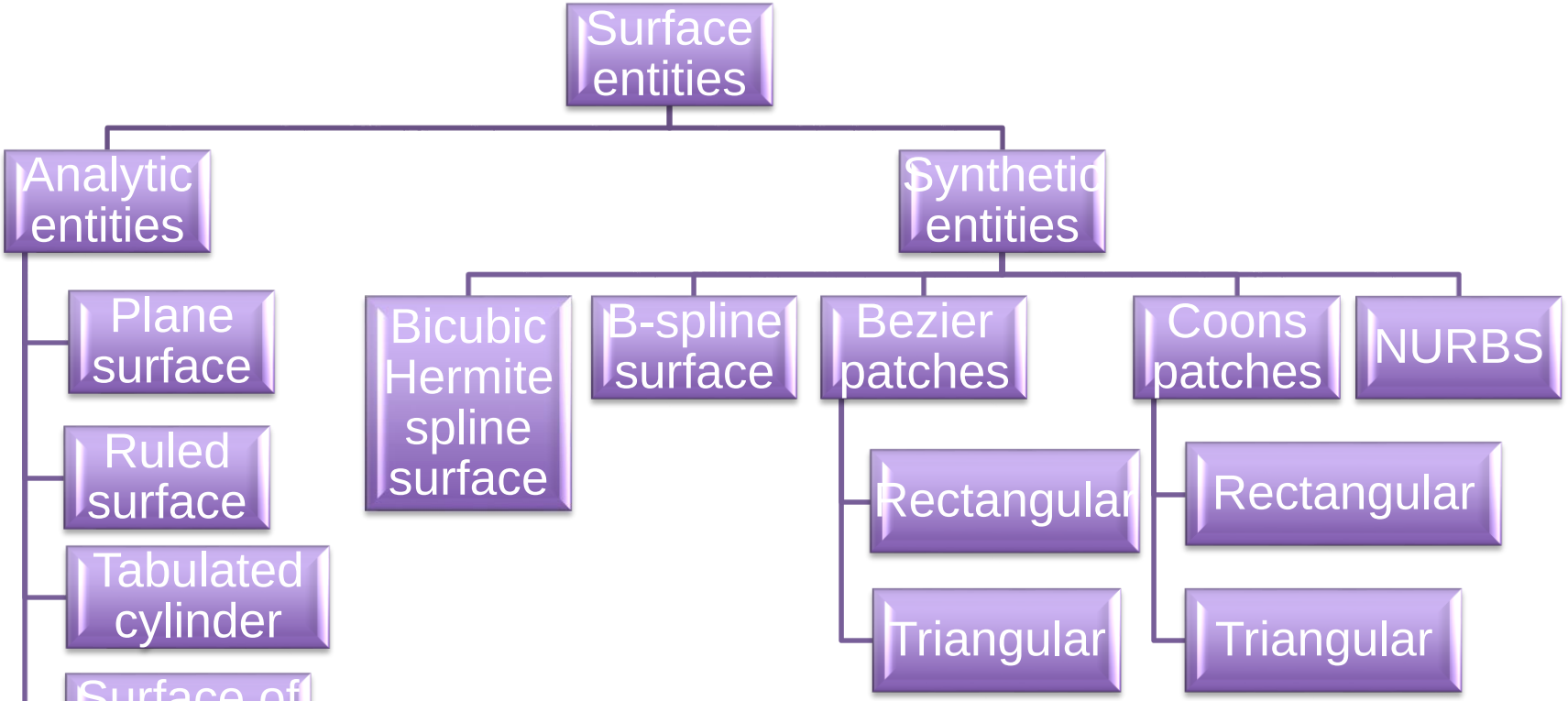


Figure 7.4 Ruled surface.

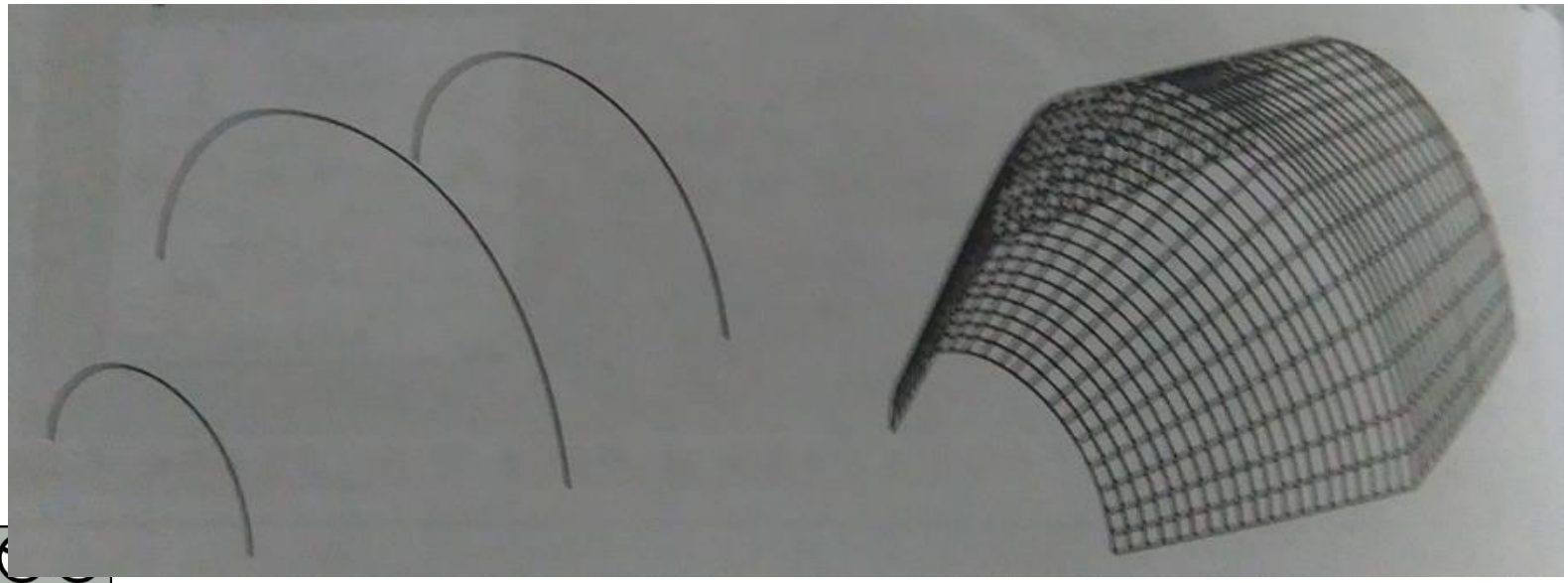
SURFACE ENTITIES

Construction methods for the surfaces.



SURFACE ENTITIES

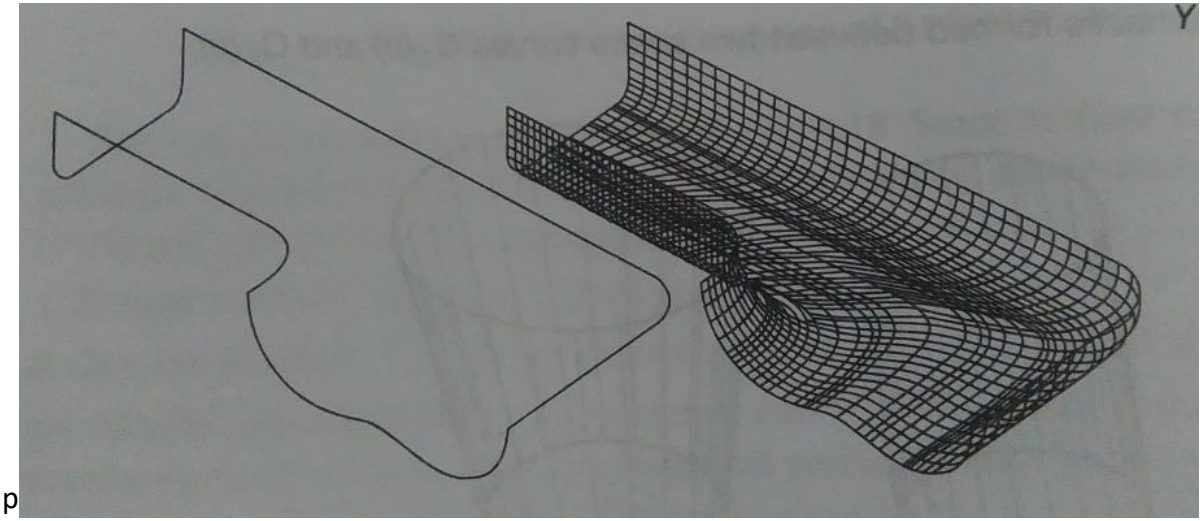
- **Ruled surface:** a surface constructed by transitioning between two or more curves by using linear blending between each section of the surface.



Design: Dr Nizar

SURFACE ENTITIES

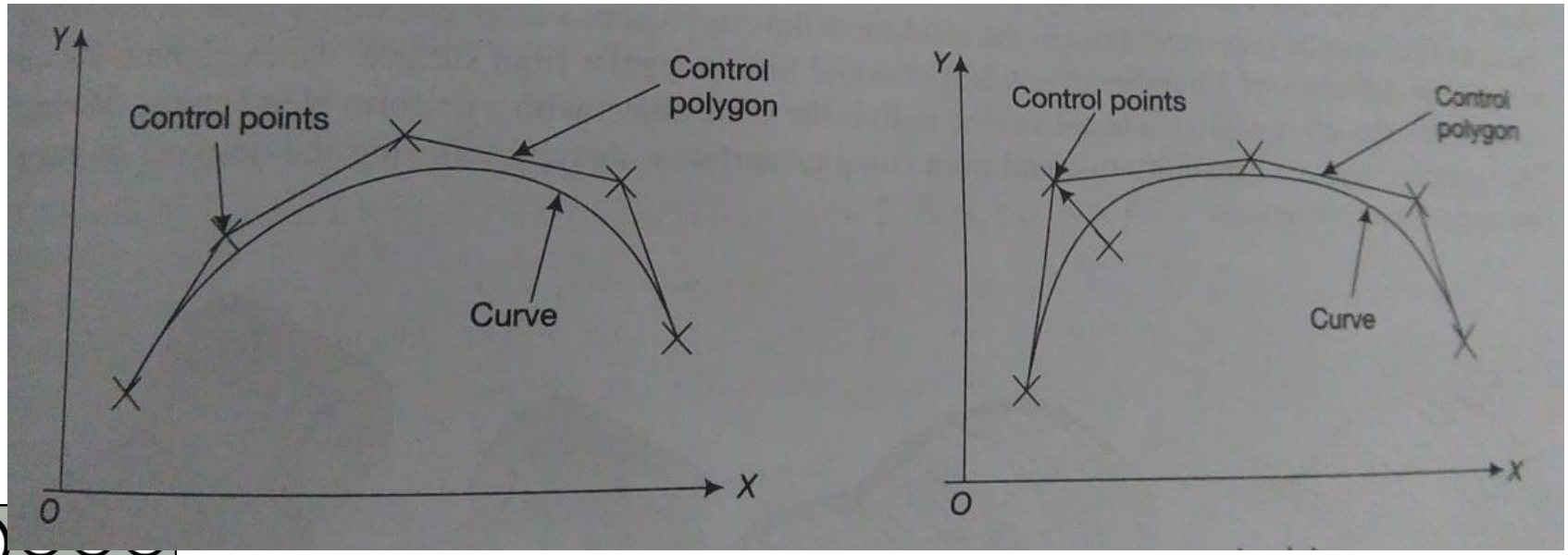
- **Coons surface:** a surface obtained by blending four boundary curves. it can fit to a smooth surface through digitised points in space such as those used in reverse engineering.



SURFACE ENTITIES

- **Bézier curves:**

Ssurface obtained by flexibility for changing the shape. Uses the vertices as control points for approximating the generated curve.

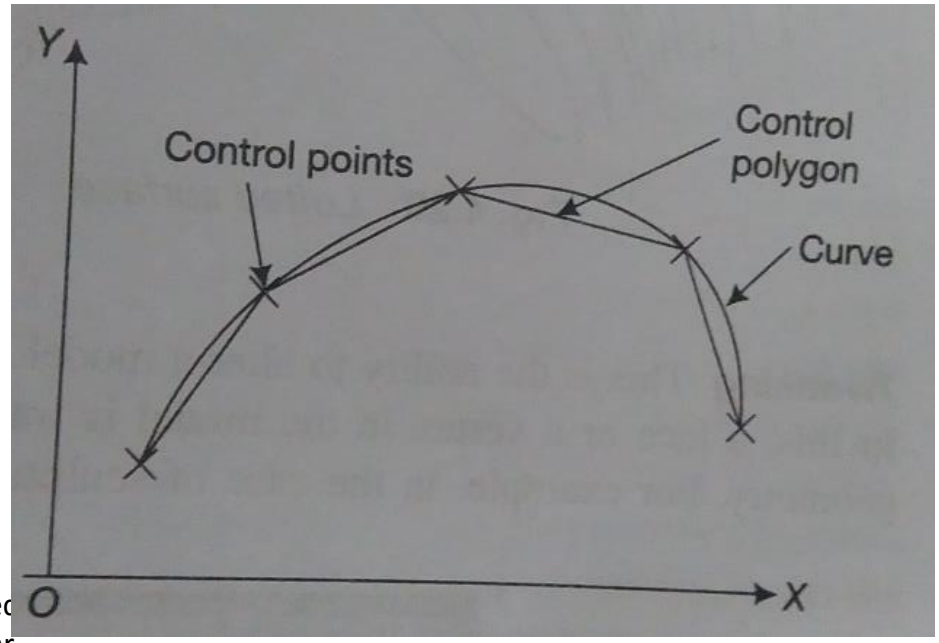


Design: Dr Nizar

SURFACE ENTITIES

- **B-spline:**

Generate a single piecewise parametric polynomial curve through any number of control points with the degree of the polynomial selected by the designer.



SURFACE ENTITIES

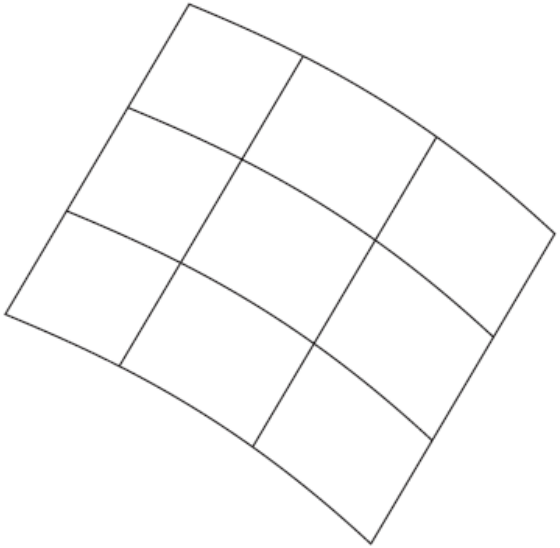


Figure 7.7 Bezier surface.

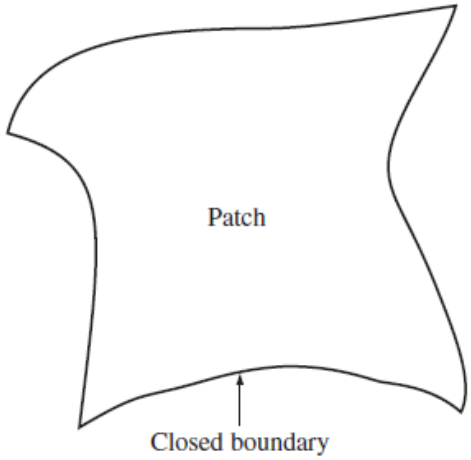
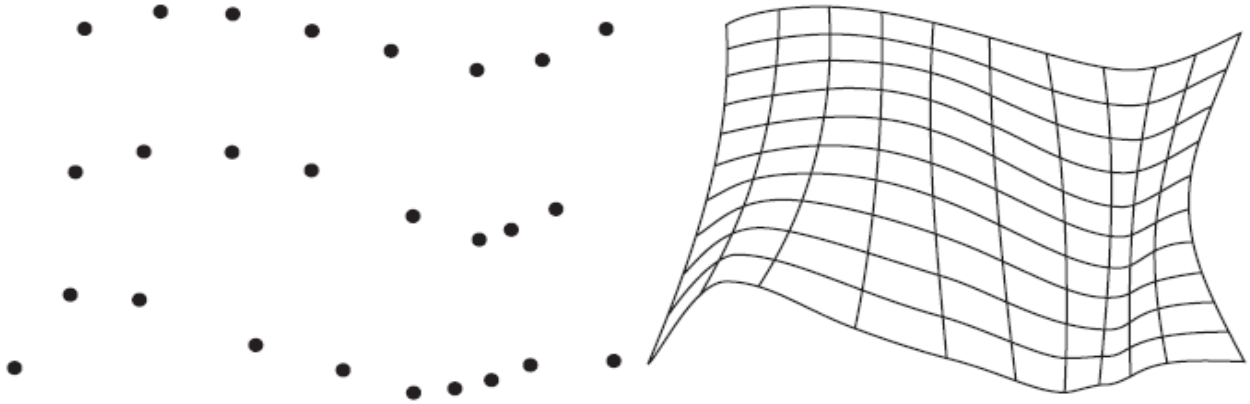


Figure 7.9 Coons surface.

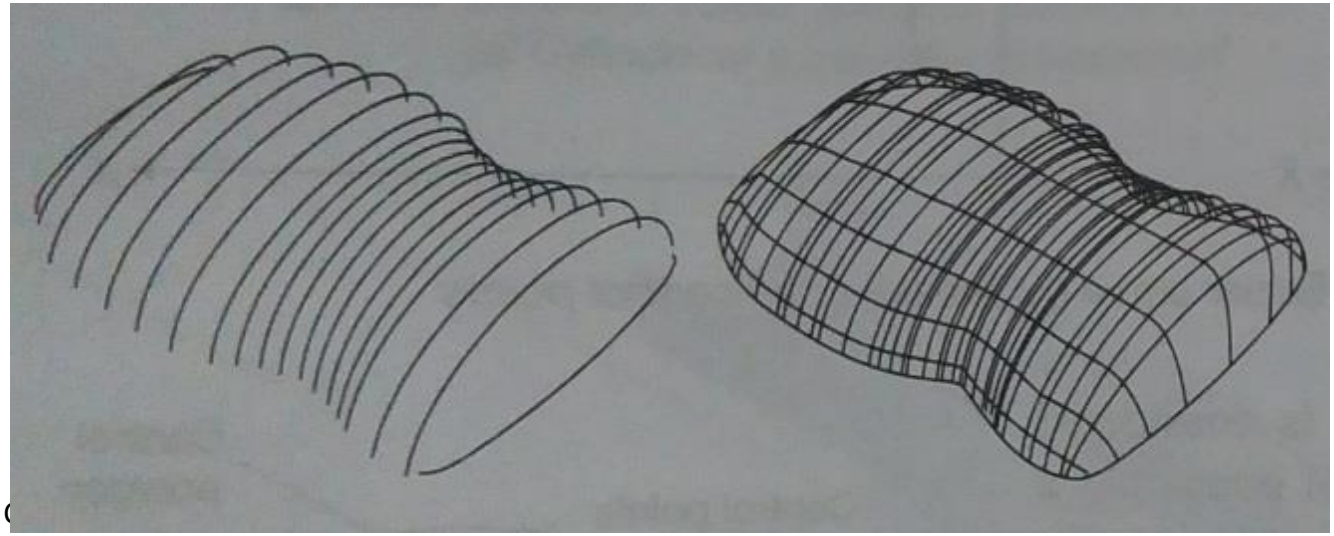


(a) Data points (b) B-spline surface

Figure 7.8 B-spline surface.

SURFACE ENTITIES

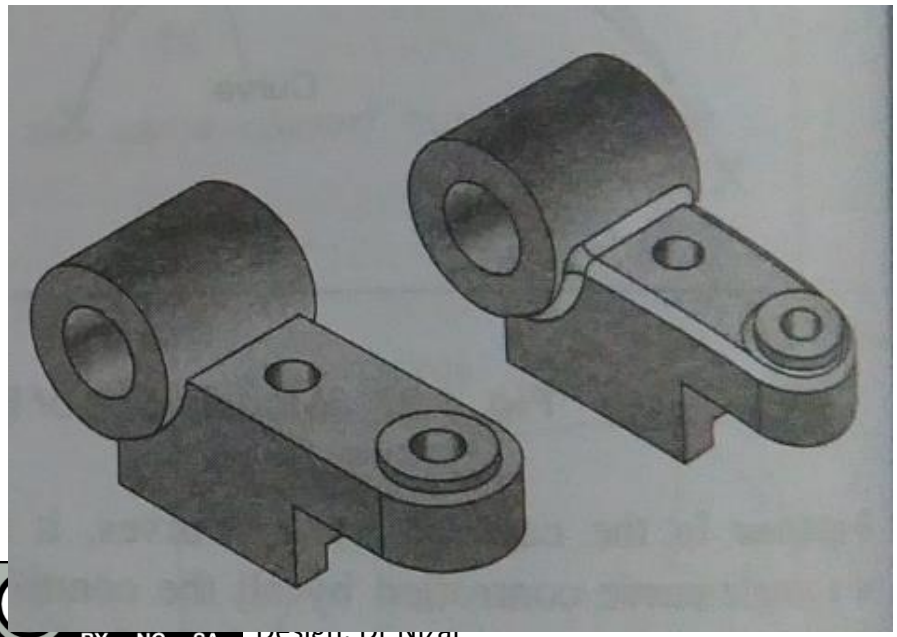
- **Lofted surface:** constructed by transitioning between two or more curves similar to a ruled surface by using a smooth (higher order) blending between each section of the surface.



Design: Dr Nizar

SURFACE ENTITIES

- **Surface fillet:** has the ability to automatically generate the fillet radius between two surfaces, either analytical or sculptured.



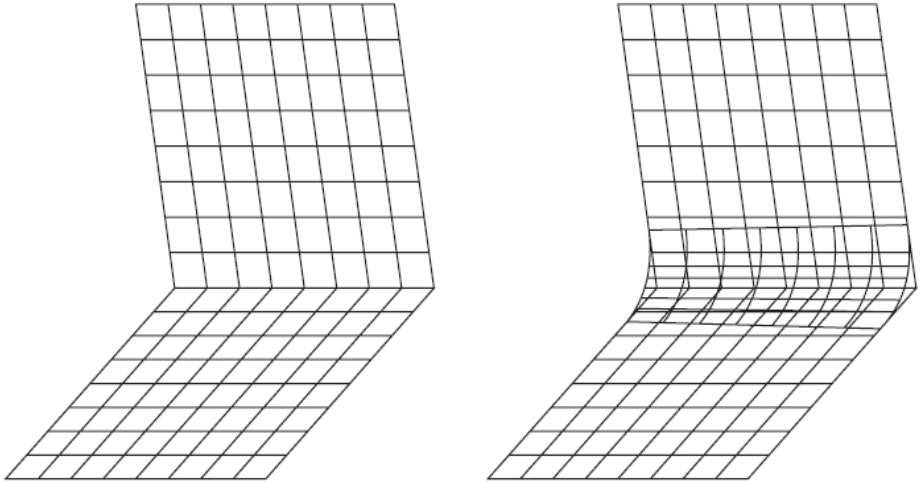


Figure 7.10 Fillet surface.

SURFACE ENTITIES

- **Tweaking:** ability to alter a model already created using any of the earlier approaches described.
- A group of operations used to make local modifications to a solid model.
- Tweaking operations include stretching, moving holes, bosses, or other features of a face; splitting a face into two faces; and dragging an edge or vertex.

SURFACE ENTITIES

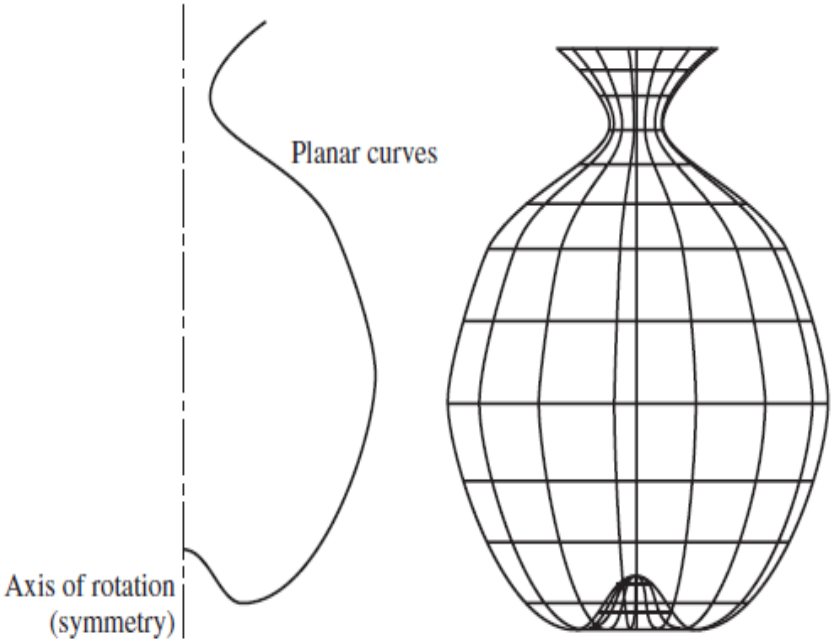


Figure 7.5 Surface of revolution.

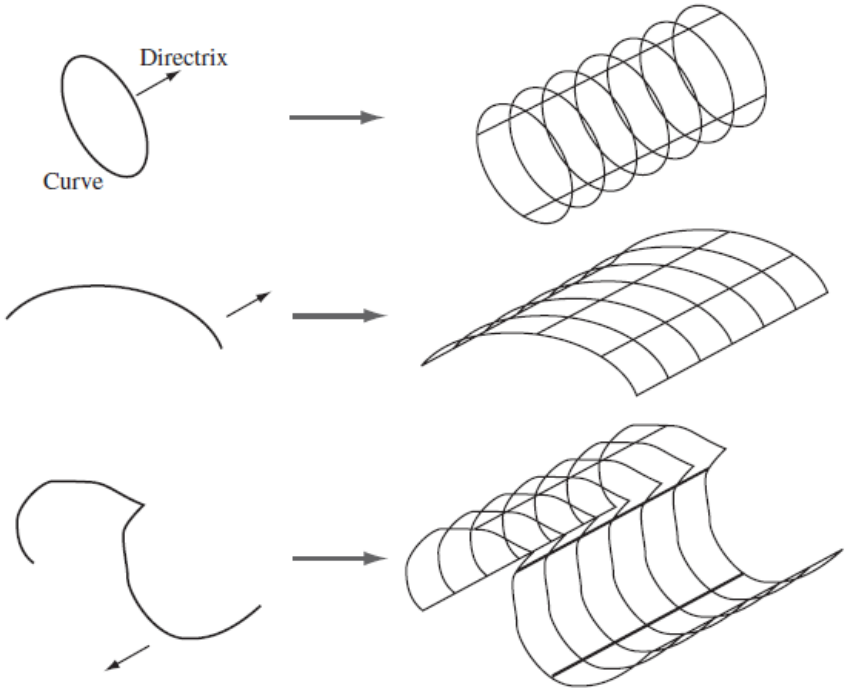


Figure 7.6 Tabulated surface.

SURFACE ENTITIES

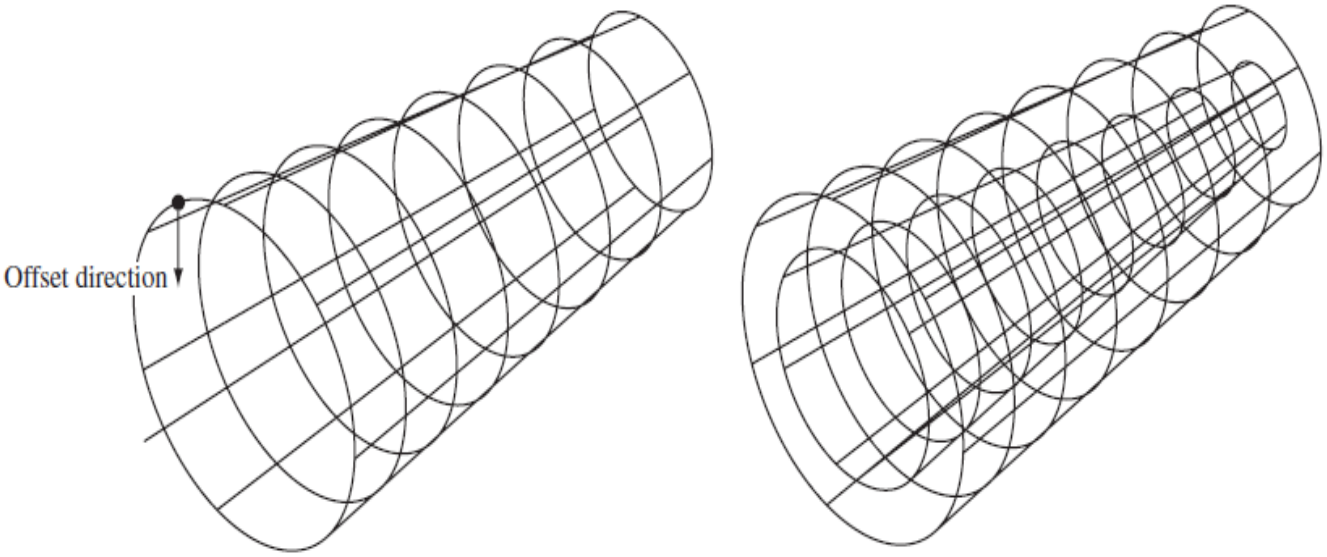
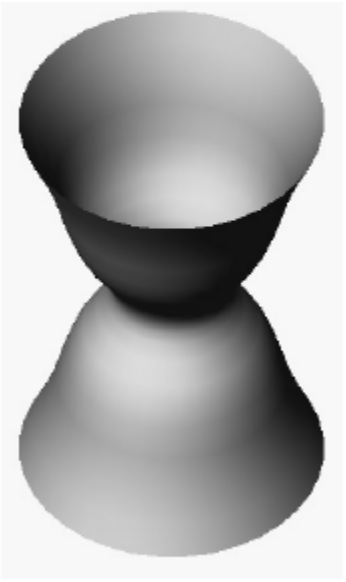


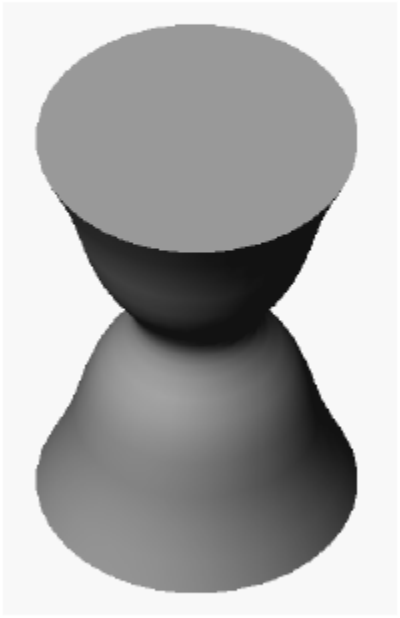
Figure 7.11 Offset surface.

EXAMPLE

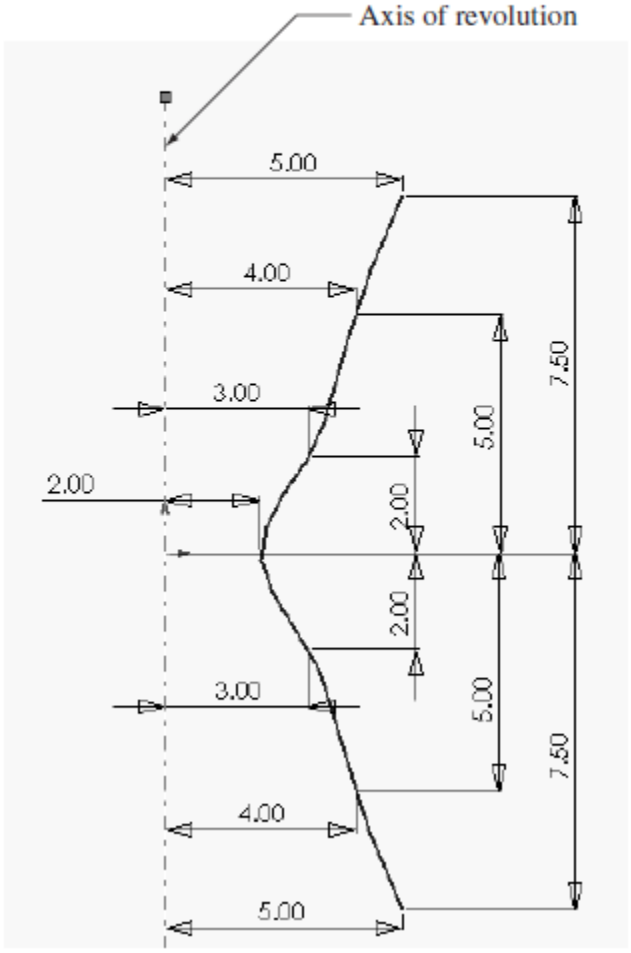
This tutorial shows how to create the surface of revolution shown below, using a B-spline curve. We also create a solid of revolution using the same curve. We create the spline curve using the seven circular cross sections shown below. All dimensions are in inches.



Surface of revolution



Solid of revolution

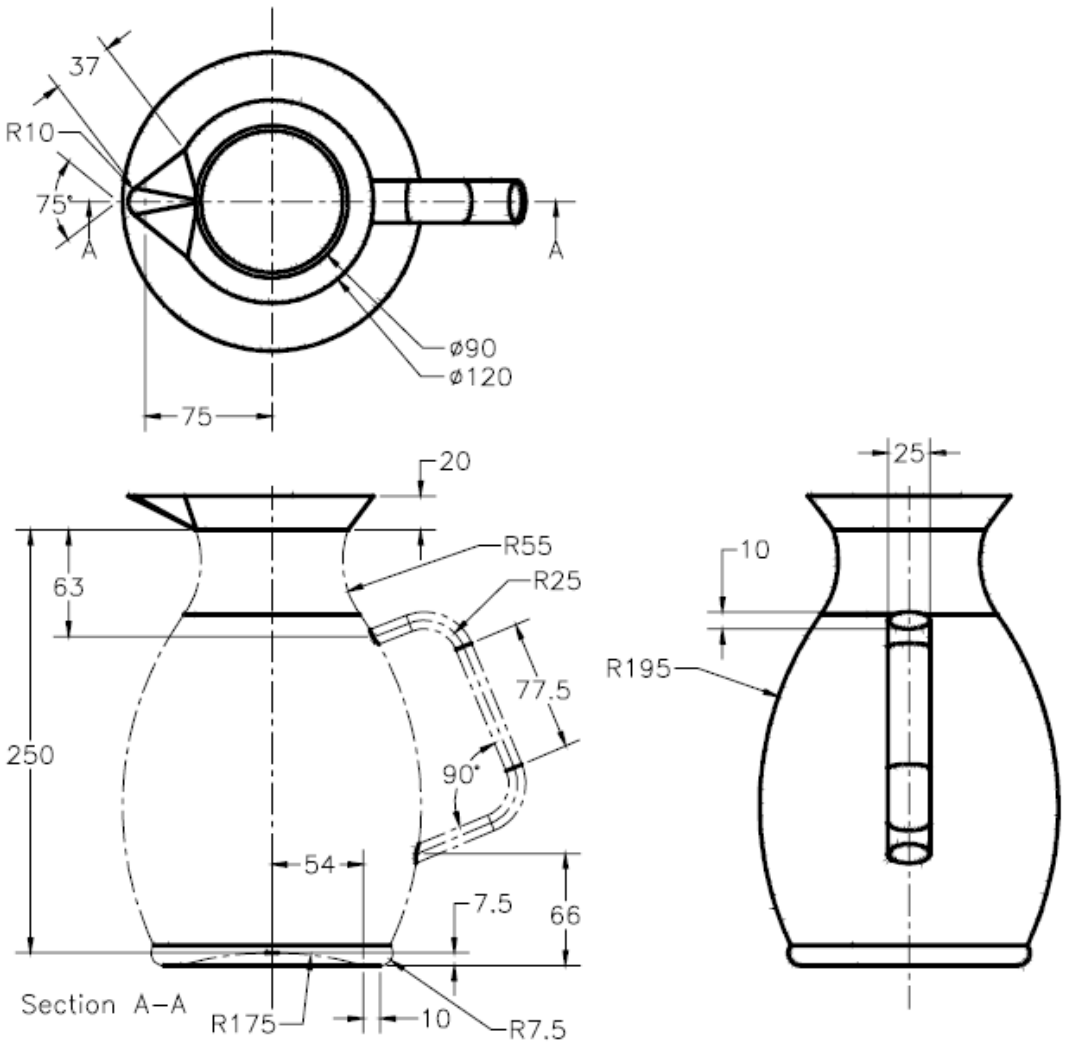


Modeling strategy:

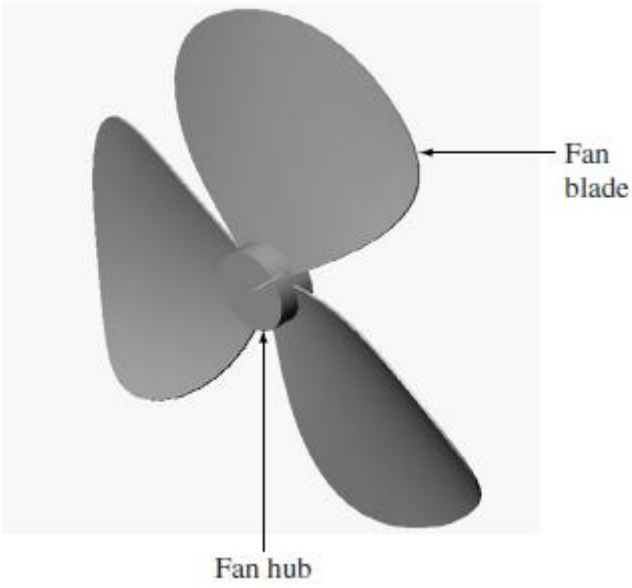
1. **Create the B-spline curve.** Select the `Front` sketch plane. Construct the curve using the seven points shown on the foregoing sketch.
2. **Create the axis of revolution.** Use an `axis` command to create a vertical axis passing through the origin as shown on the foregoing sketch.
3. **Create the surface of revolution.** Use a surface of revolution operation to revolve the curve 360° around the axis of revolution for a full revoultion.
4. **Create the solid of revolution.** Repeat step 3, but use the revolution operation to create solids instead of surfaces. The solid is shown in the foregoing screenshot.

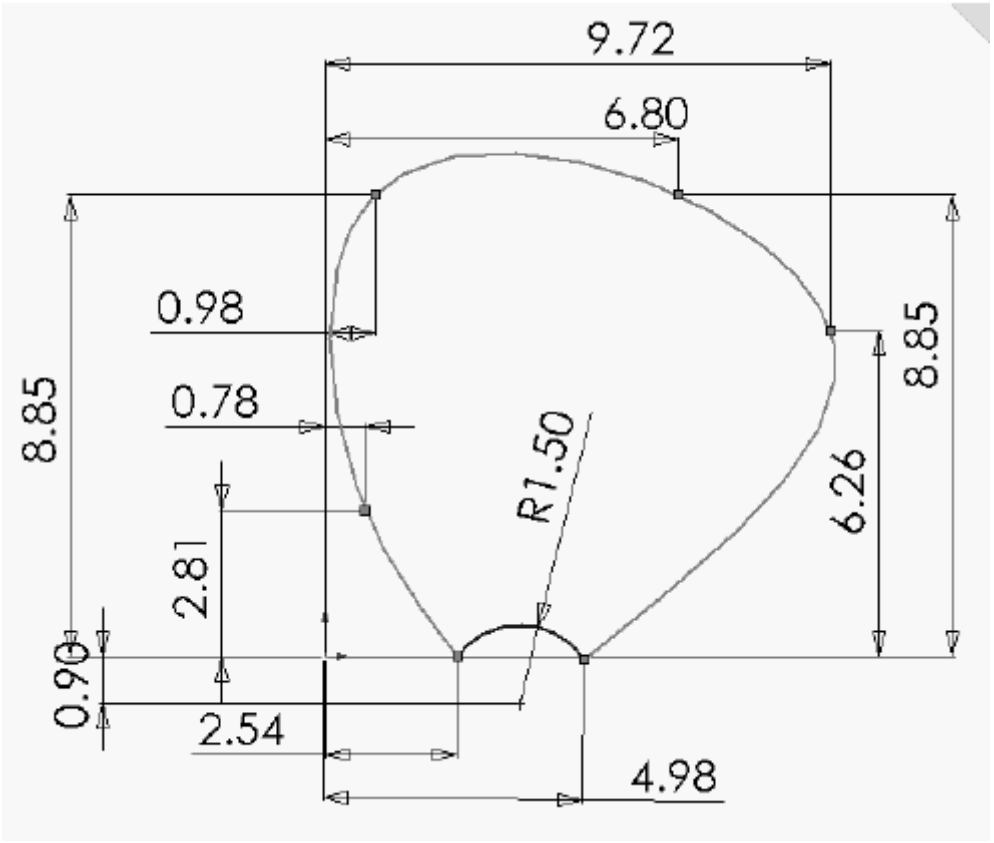
For more details of the CATIA guides, please refer to slides: CATIA V5 – 4 wireframe and surface design.

LAB EXERSICE 4 (Water Pitcher)

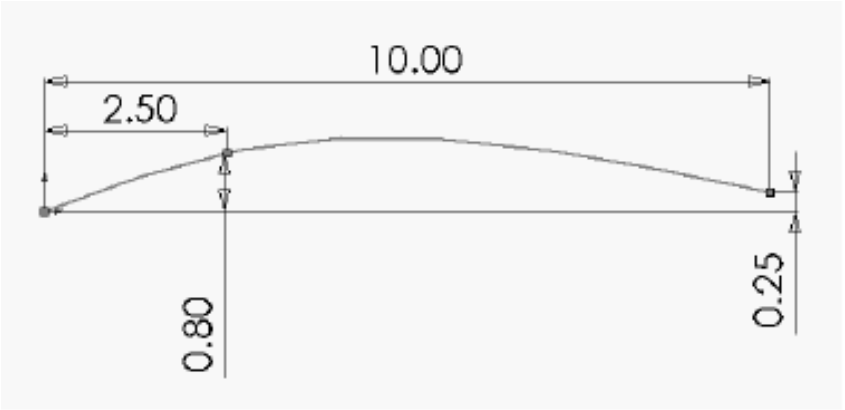


SELF PRACTICE

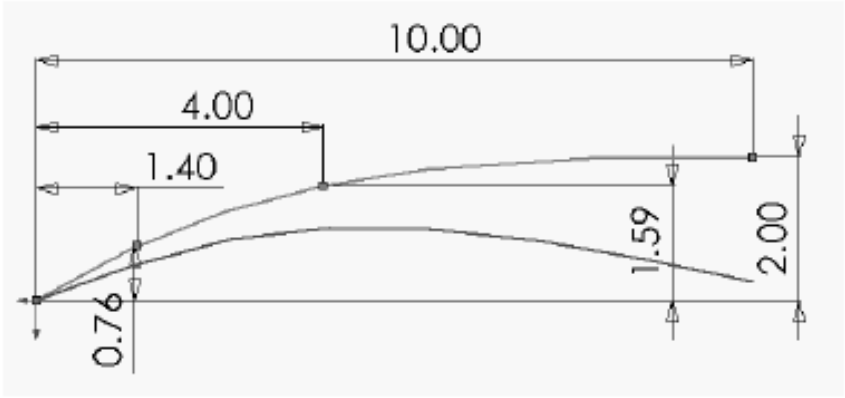




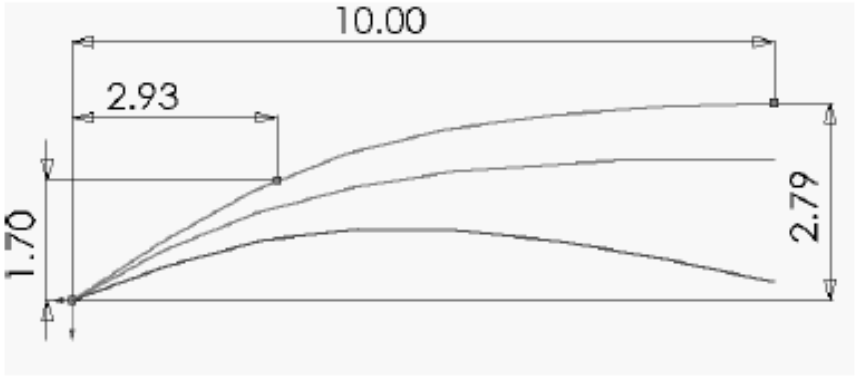
SELF PRACTICE ~ continue



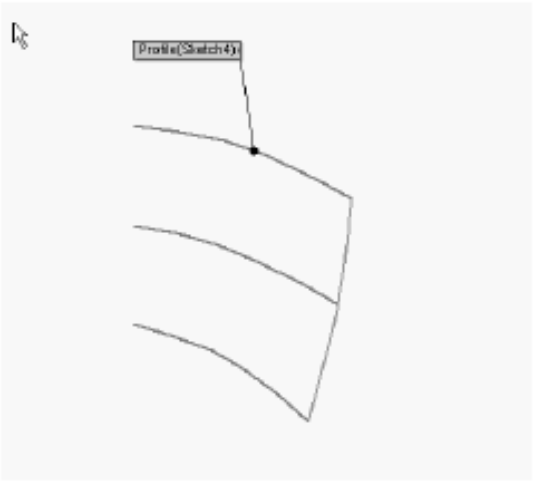
Top sketch plane



5 inches above Top sketch plane



10 inches above Top sketch plane



Lofted surface

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