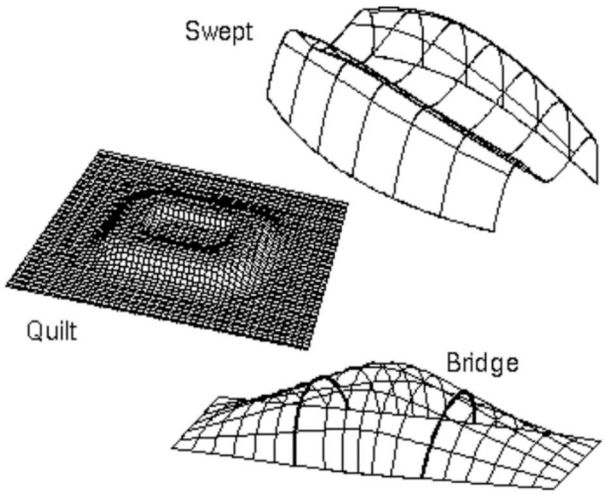
CHAPTER 7 – FREEFORM SURFACE MODELING

In this chapter, you will learn how to create freeform surfaces in NX 12. Up to this point, you have learned different ways to create models by using *Form Features* or by *Sketching*. *Freeform surface* modeling involves creating models in the form of surfaces for aesthetic or functional purposes, such as car bodies and turbine blades. A few freeform features are shown below.



To create *Freeform Features*, you first need a set of points, curves, edges of sheets or solids, faces of sheets or solids, or other objects. The following sections cover some of the methods that you can use to create models using freeform features.

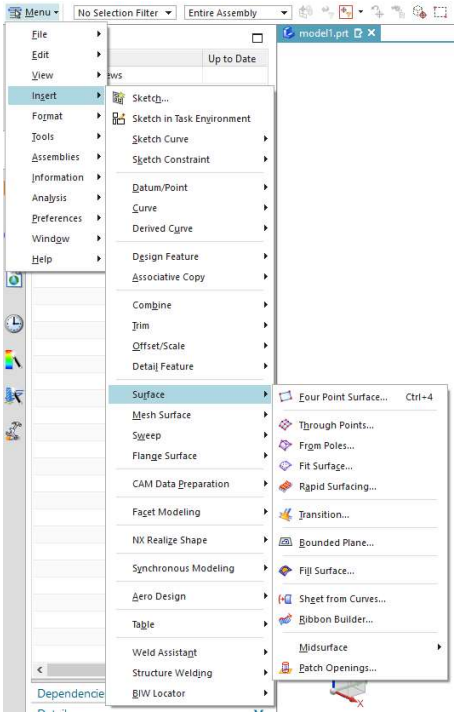
7.1 OVERVIEW

In NX 12, the *Freeform Features* options are located at various places like *Menu* → *Insert* → *Surface/Mesh Surface/Sweep/Flange Surface* and *Menu* → *Edit* → *Surface* for more advanced operations. There are a lot of ways in which you can create *Freeform Features* from the existing features you have like points, edges, curves, etc. A few of commonly used functions are discussed in the following sections.

7.1.1 Creating Freeform Features from Points

In the case where the geometry you are constructing or pre-existing data includes only points, you can try using one of the following three options to build a surface from the given points.

➢ From **Menu**, click on **Insert → Surface**



Four Point Surface: if you have four corner points.

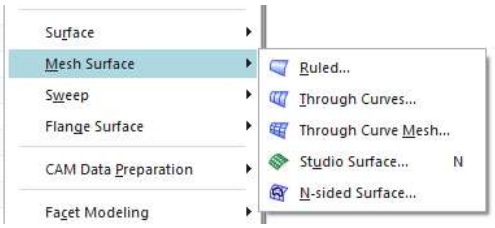
Through Points: if the points form a rectangular array.

From Poles: if defined points form a rectangular array tangential to the lines passing through them.

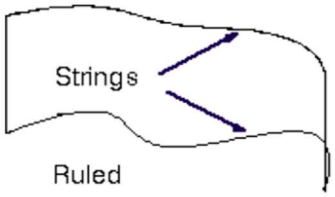
7.1.2 Creating Freeform Features from Section Strings

If construction geometry contains strings of connected objects (curves and edges), you can use one of the following two options to create a freeform surface.

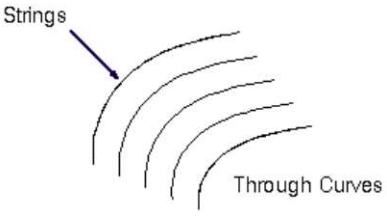
➢ From **Menu**, click on **Insert → Mesh Surface**



Ruled: if you have two strings which are roughly parallel.

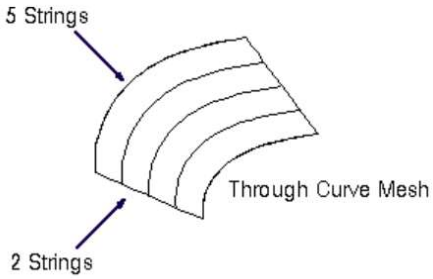


Through Curves: if three or more strings are roughly parallel.

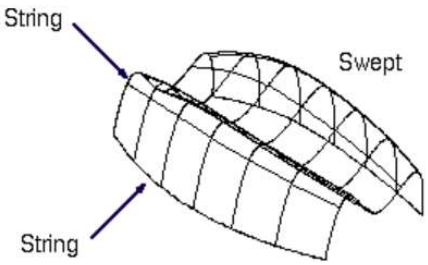


If the construction geometry contains two or more strings (curves, faces, edges) that are roughly parallel to each other, and one or more section strings that are roughly perpendicular to the first set of curves (guides), you can try using one of these following options to build a freeform surface.

Through Curve Mesh: used if at least four section strings exist with at least two strings in each direction (parallel and perpendicular).



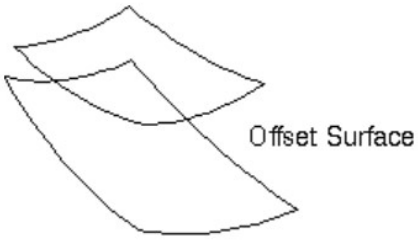
Swept: used if at least two section strings are roughly perpendicular (from **Menu**, choose **Insert →Sweep**).



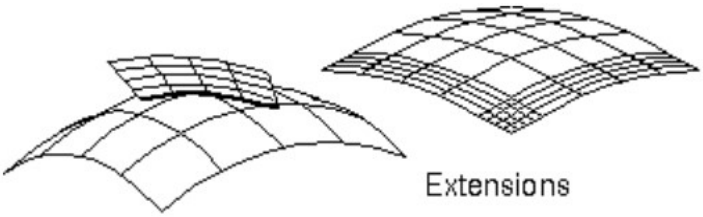
7.1.3 Creating Freeform Features from Faces

If the construction geometry contains a sheet or face, you may be able to use one of the following two options to build the freeform surface.

Offset Surface: use this option if you have a face to offset. (From **Menu**, click on **Insert →Offset/Scale)**



Extension: use this option if you have a face and edges, edge curves, or curves on the face. (Click on the **Insert →Flange Surface →Extension**)



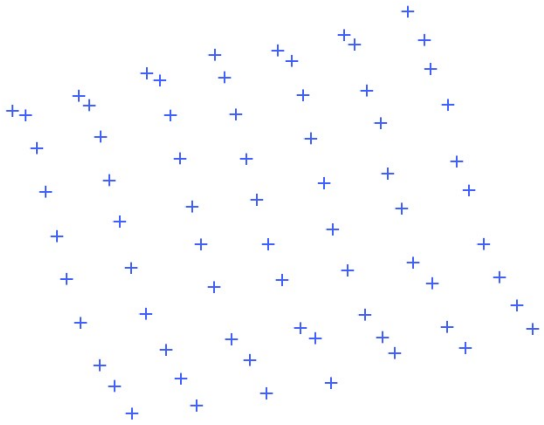
7.2 FREEFORM FEATURE MODELING

Let's do some exercises on freeform modeling with structured points, a point cloud, curves and faces. Structured points are a set of point's defined rows and columns. A point cloud has a set of scattered points that form a cloud.

7.2.1 Modeling with Points

- Open the file **freeform_thrupoints.prt**
- Right-click on the **Toolbars** and make sure the **Surface Toolbar** is checked

You will see seven rows of points.

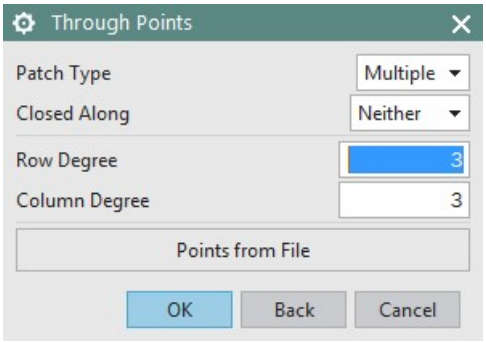


- Choose **Insert →Surface →Through Points**

OR

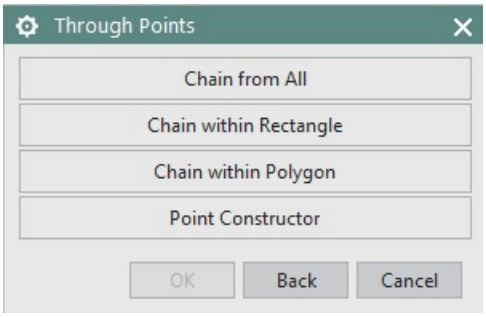
- Click on the Icon  in the Toolbar

The dialogue box will pop up as shown in the right.

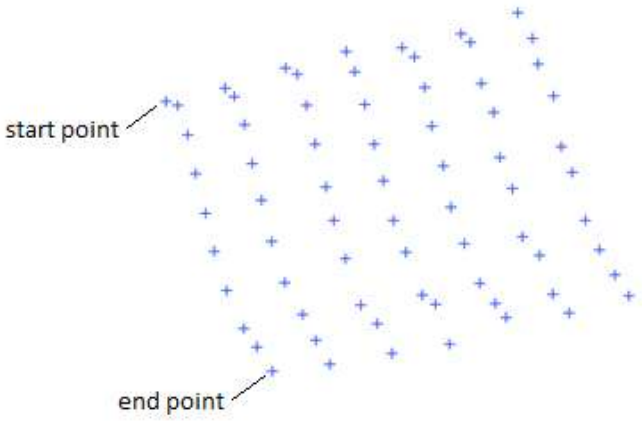


- For **Patch Type**, select **Multiple**
- For **Closed Along**, select **Neither**
- For **Row Degree** and **Column Degree**, enter **3.**
- Click **OK**

The next dialogue box will be as shown in the right figure.



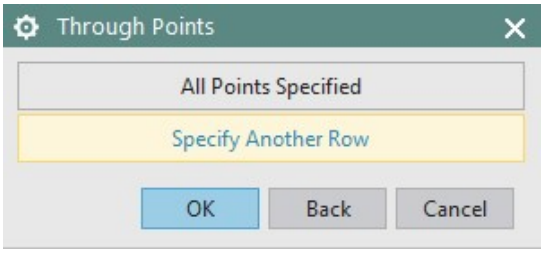
- Click **Chain from All**
- Select the top starting point and the bottom ending point of the left most row as shown in the following figure



The first row of points will be highlighted.

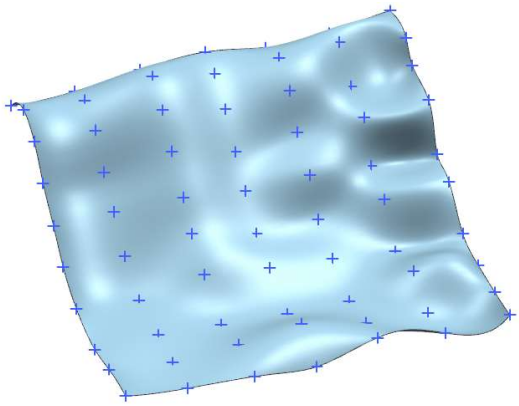
- Repeat the same procedure to select the first four rows of points.

After that, a window should pop-up asking if all points are specified or if you want to specify another row.



- Select **Specify Another Row** until all rows are specified
- When all the rows are specified, choose **All Points Specified**
- Click **Cancel** on the **Through Points** window

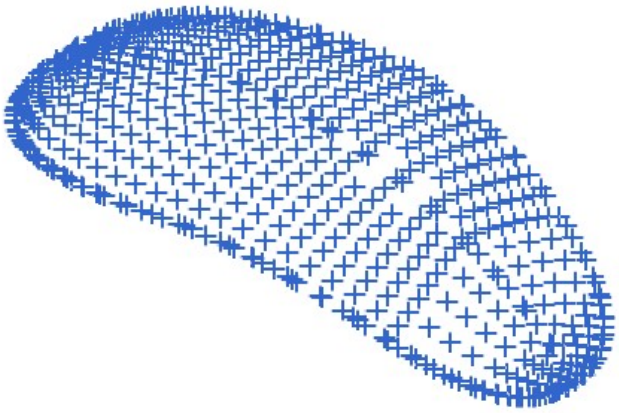
You will see the surface as shown below.



7.2.2 Modeling with a Point Cloud

- Open the file named **freeform_cloud.prt**

The point cloud will be seen as follows.

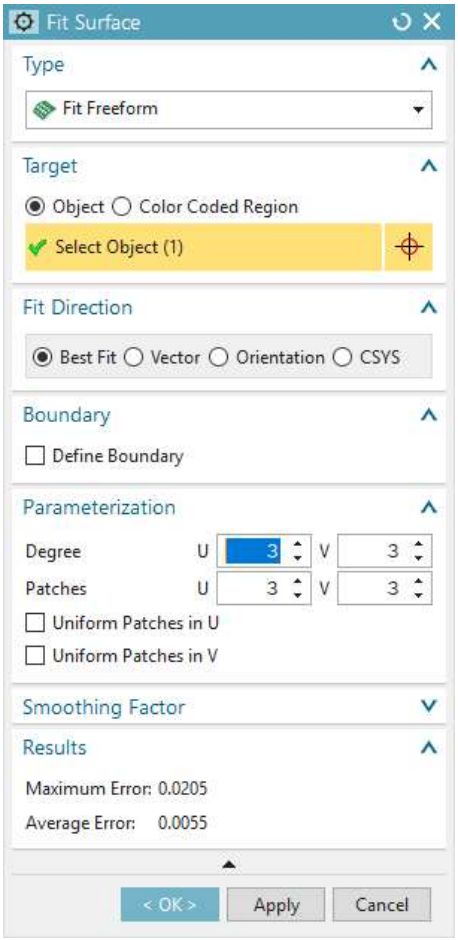


- Choose **Insert → Surface → Fit Surface**

OR

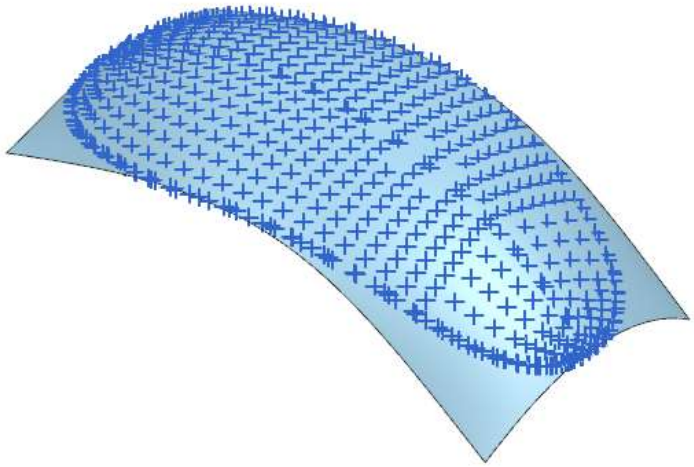
- Click on this icon  on the **Surface Toolbar**

The following dialogue box will appear.



- Select all the points on the screen by clicking on the point cloud.
- In the **Fit Direction** drop-down menu, choose **Best Fit** for. This matches the point cloud coordinate system with original system
- Change the default values for **U** and **V** degrees to 3
- Click **OK**

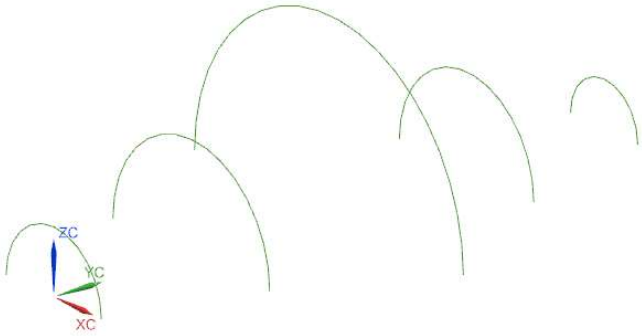
The final surface will look like the following.



7.2.3 Modeling with Curves

- Open the file named **freeform_thrucurves_parameter.prt**

The curves will be seen as in the figure below.

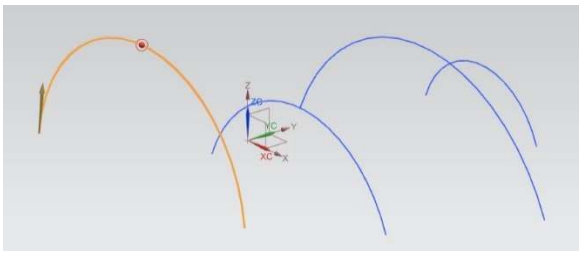


- Choose **Insert → Mesh Surface → Through Curves**

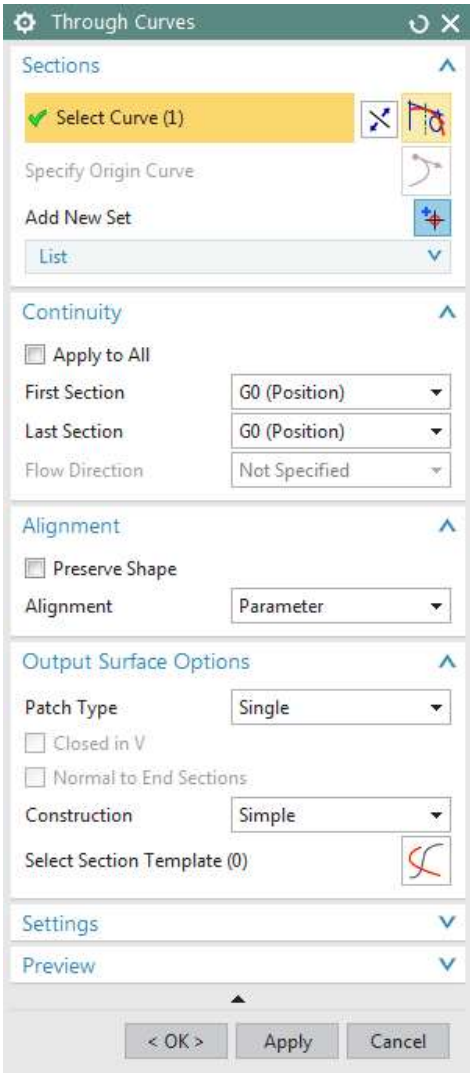
OR

- Click on this Icon  on the Toolbar
- Select the first **section string** as shown below. Be sure to select somewhere on the left side of the arc.

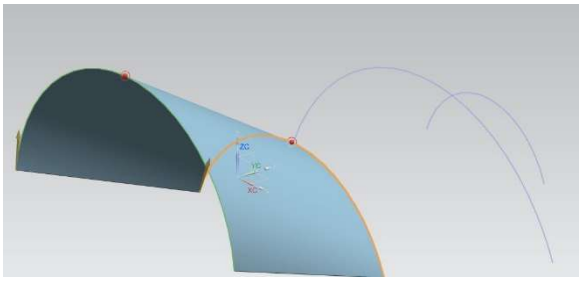
A direction vector displays at the end of the string.



- Click the middle mouse button **MB2** or click **Add New Set** 



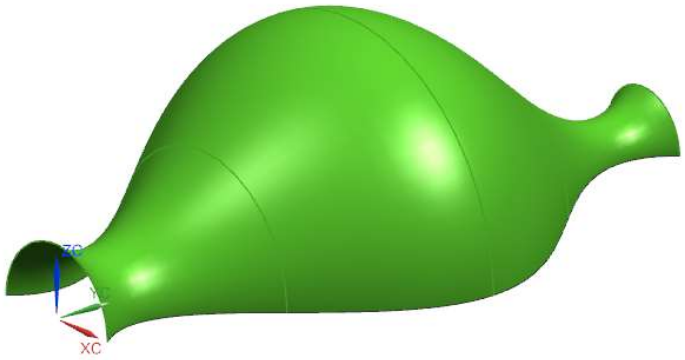
- Click on the next curve similar to first one and click the middle mouse button **MB2**. You can see a surface generated between the two curves as shown in the figure



- Repeat the same procedure to select the remaining strings. Remember to click **MB2 (or Add New Set)** after selecting each curve.
- For **Alignment**, choose **Parameter**
- For **Patch Type**, choose **Single**
- For **Construction**, choose **Simple**

When the *Simple* option is selected, the system tries to build the simplest surface possible and minimize the number of patches.

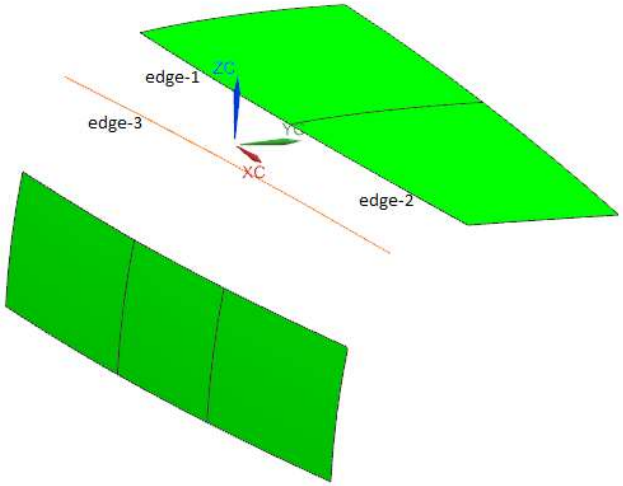
- Click **OK**



7.2.4 Modeling with Curves and Faces

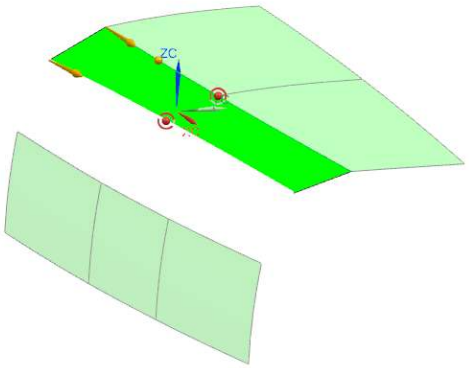
- Open the file named **freeform_thrucurves_faces.prt**

The curve and faces will be seen as shown on the right.



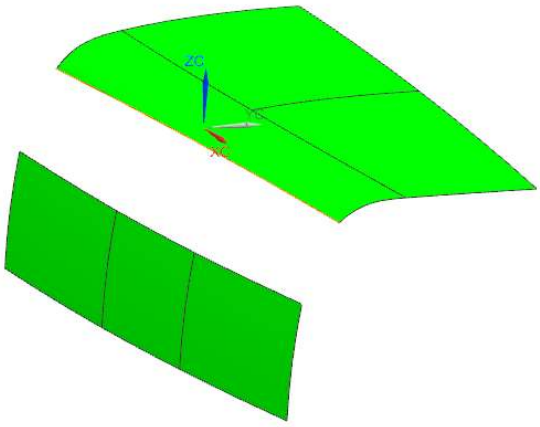
- Choose **Insert →Mesh Surface →Through Curves**
- Select edge-1 of the top plane
- Select edge-2 and click **MB2**
- Select edge-3
- In the Dialog box, under the **Alignment** section, uncheck the **Preserve Shape** check box

You would get the following shape displayed on your screen.



Make sure that all the arrows are pointing in the same direction (if they are not, double click on either of the arrows to flip its direction).

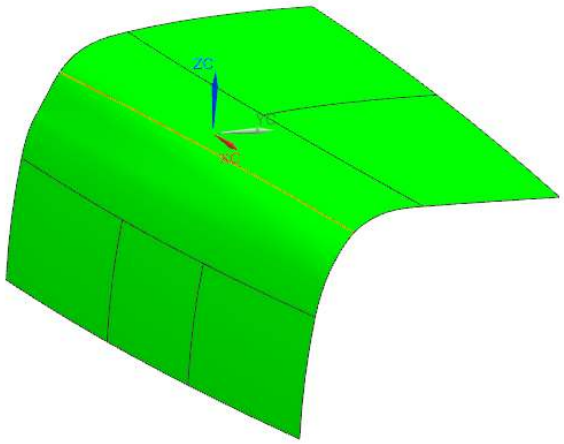
- In the **Alignment** dialog box choose **Parameter**
- In the **Continuity** dialog box, **for First Section**, select **G2 (Curvature)** option and select the two patches of the top surface
- Click **APPLY**



- Now select edge-3 and click **MB2**
- Select the three edges of the lower plane
- Change the option to **G2 (Curvature)** in the **Continuity** dialog box for **First Section**
- Select the surface you just created and click **MB2**

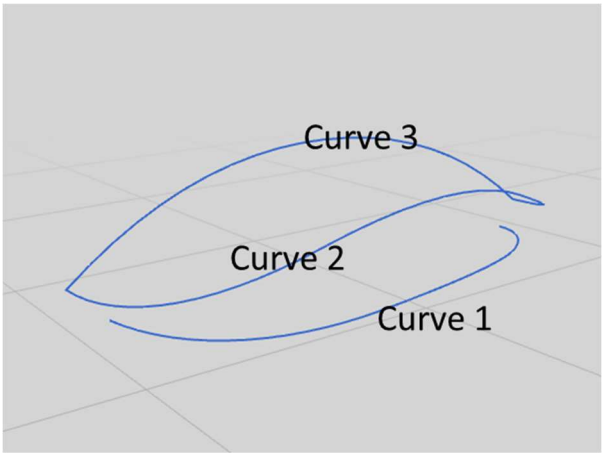
- For **Continuity** of the **Last Section**, choose **G2 (Curvature)** and then select the bottom three patches as references
- Click **OK** to exit

The final freeform surface should be seen as shown below.



7.3 EXERCISES

7.3.1 An Exercise on Curves



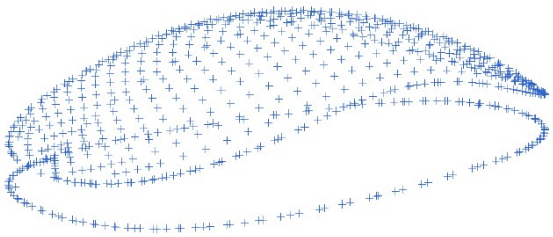
The above figure shows three curves created using points as “Control Points” or “Through Points”. The corresponding points and modeling type of each curve are listed in the following table.

	Curve 1	Curve 2	Curve 3
Points	(0, 0, 0) (0.117, -0.765, 0) (1.953, -0.525, 0) (2.5, -0.196, 0) (2.5, 0, 0)	(-0.191, 0, 0.181) (-0.191, -0.757, 0.181) (1.435, -0.709, 0.577) (2.609, -0.415, 0.147) (2.610, 0, 0.147)	(-0.191, 0, 0.181) (0.591, 0, 0.596) (1.632, 0, 0.622) (2.610, 0, 0.147)
Type	Control Points with 2nd degree		Through Points with 2nd degree

(a) Create the ruled surface between Curve-1 and Curve-2.
(b) Extrude Curve-3 along the +Y direction to create a reference surface. Then create the surface between Curve-2 and Curve-3, this surface should have G1 (Tangent) continuity to the reference surface you just extruded.

Tips: You can import those points from a text file to NX. First, save the points coordinates into a text file. Then, use NX File -> Import -> Points from File to import it.

7.3.2 An Exercise on Surfaces



Given 2 points sets that stored in the files of "Fit curve.pts" and "Fit surface.pts" (available in the file folder).

(a) Import those two sets of points into NX. (Figure above shows the expected result)
(b) Create a spline curve based on points in the file of "Fit curve.pts". You can use **Fit Curve** to create it, adjust the number of **Degree** and **Segments** to get a better fitting.
(c) Create a freeform surface based on points in the file of "Fit surface.pts". You can use **Fit Surface** to create it, adjust the number of **Degree** and **Patches** to get a better fitting.
(d) Use the spline curve as the boundary to trim the freeform surface along Z direction. The expected result is like the upper surface of a computer mouse.

7.3.3 Design a Computer Mouse

Model a computer mouse similar to the one shown below (feel free to search for more images as references), or you can come up with a new design and then model it. As a hint, create some boundary curves on different datum planes and use them to create freeform surfaces.

7.3.4 Design a Sport Water Bottle

Design a sport water bottle and use freeform features in NX (curves and surfaces) to model it.