

# NURB SURFACE

## Objective:

The objective of this tutorial is to demonstrate the procedure for generating a NURB surface. The tutorial will begin with the making of a simple swept NURB surface and conclude with an example at the project scale focusing on the representation of a designed topographic feature with a NURB surface.

## Notes:

NURB entities can be derived from existing geometric entities (lines, polylines, b-splines, etc.). The advantage of the NURB surface is its predisposition to maintain smooth curvature and its potential for real-time manipulation. The NURB entity will appeal to anyone familiar with vertex-by-vertex manipulation of a ruled surface. The NURB surface entity consists of both a mesh and its control points. Real-time sculpting can be achieved through direct manipulation or spatial transformation of the control points. Control points can be manipulated individually or as groups. These actions do not yet mimic the real actions of digging or moving earth, but tools are currently under development that will help to make digital manipulations more like real-world sculpting.

## Inputs:

Software applications and input entities will influence how the NURB surface is generated. The chart below compares procedures and input entities that can be used for the generation of continuous terrain surfaces. The tutorial will focus on the "Rail Sweeps" and the "Drape" approaches.

| NURB Surface Type                         | Appropriateness for Terrain | Inputs   | Notes:   |
|---|-----------------------------|--|--|
| Surface from corner points                | Good                        | Snap to 3D Objects   | Surface generation can be time consuming.  |
| Surface from (2,3,4) Edge Curves          | Very Good                   | Contours, Ridge & Breaklines   | Suffers from the same awkwardness of the individual ruled surface objects.   |
| Direct Generation (through corner inputs) | Good                        | Coordinate input through keyboard or graphical input   | Best used for the modeling of simple planar surfaces. Can easily undergo geometric transformation (move, rotate, scale, shear).  |
| Extrusion                                 | Poor                        | Open or Closed Contours  | Does not result in a continuous surface.   |
| Loft                                      | Not Recommended             | Contours, Ridge & Breaklines can be used as inputs   |  |
| Surface from Curve Network                | Not Recommended             | A combination of Contours, Ridge and Breaklines  | Problems will occur with sinuous contours of great length and complexity.  |
| 1 Rail Sweep                              | Good                        | Ridge & Breaklines   |  |
| 2 Rail Sweep                              | Good                        | Ridge & Breaklines   |  |
| Revolve                                   | Not Recommended             | Axis of rotation and profile   |  |
| Patch                                     | Not Recommended             | Ridge & Breaklines and points.   |  |
| Drape                                     | Excellent                   | Solid or surface objects.  | The user draws a metaphorical NURB sheet over existing 3D objects. Mesh density and sheet size are determined by the user.   |
| From Image Map as Height Field            | Very Good                   | Gray scale image map   | Requires a gray scale image, and prior knowledge of bitmap pixel values e.g., White =0 Black=255. Image resolution determines precision, while pixel values influence smoothness.  |
| Surface from Point Grid                   | Very Good                   | Coordinate triplets (x,y,z) are input by the user sequentially or read directly from a point file. | User needs to determine best cell resolution. Works best when the application reads a text file of input points. This means that data can easily be exchanged between modeling applications (GIS, Rhino, Autodesk Land Development Desktop). |

## Generating a NURB surface through edge selection

### Input entities:

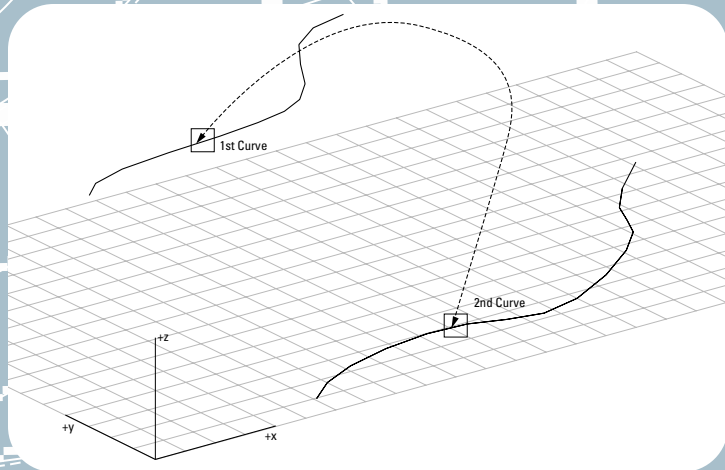
2, 3, or 4 edge curves. The curves can be parametric or linear.

### Overview:

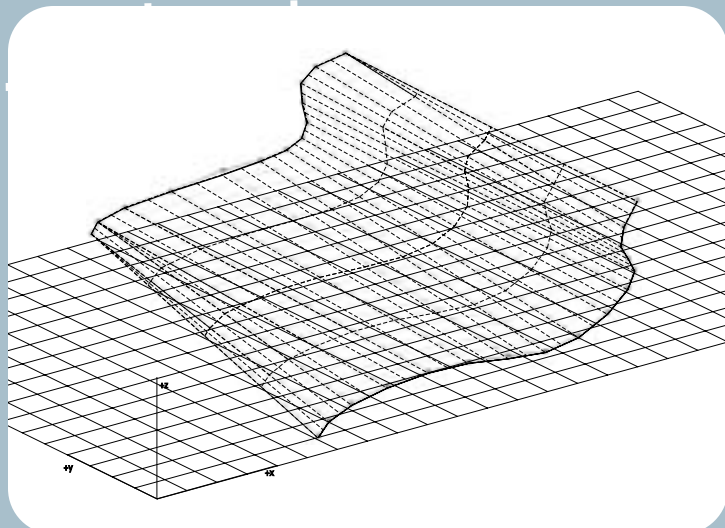
Similar to the ruled surface command. You can use anywhere from 2 to 4 curves to define this type of NURB entity. In this example the edge curves happen to be contours. As with the ruled surface commands, results might be unpredictable with long sinuous curves; therefore strategically breaking the input contours at breaklines or ridges is strongly recommended.

### Process:

1. Invoke the "Surface from Edge Curves Command."
2. Select the edge curves.



3. The resolution of the resulting surface can be manipulated in relation to purpose, as well as real-time deformation through the manipulation of control points.



## Generating a NURB surface through "Rail Surf"

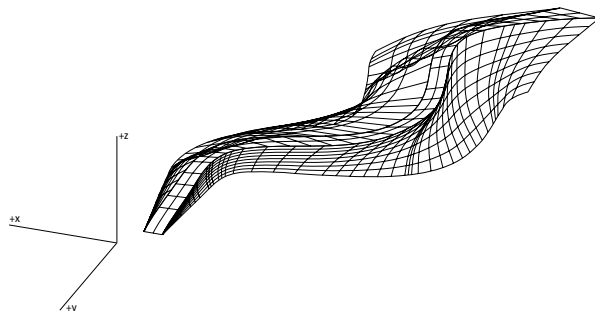
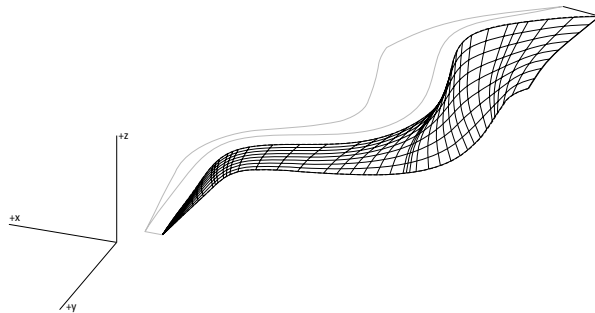
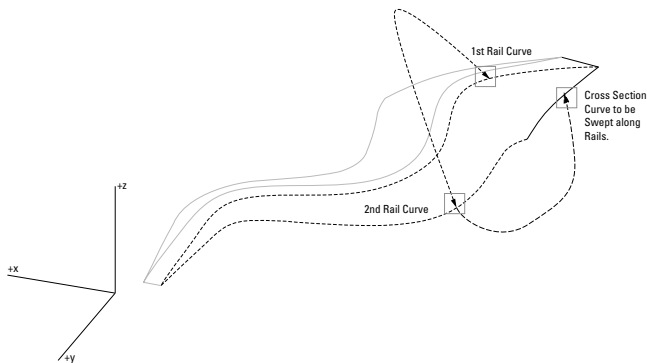
The two Rail Surf commands are related to the family of sweep commands.

### Input entities:

One section or profile that will be swept.  
1 or 2 edge curves.

### Overview:

The "rail surf" sweeps a geometric entity along one or between two edge curves. The act of sweeping defines a NURB surface between the two edge curves in the shape or profile of the swept entity.



### Process:

1. Invoke the "Rail Surf" command.
2. Select the edge curves.

3. Select the entity that is to be swept along the rail or rails.

Surface showing NURB surface, mesh, and control points.

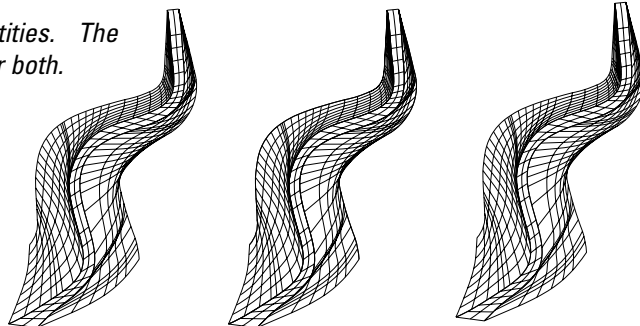
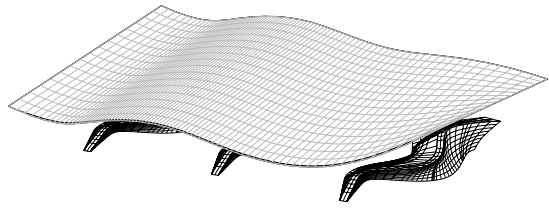
## Generating a NURB surface through "Drape"

### Overview:

The drape command metaphorically "drapes" a NURB surface over a set of existing 3 dimensional entities. The action is similar to floating a bed sheet over several solid objects, revealing their outline forms, somewhat smoothed.

### Input entities:

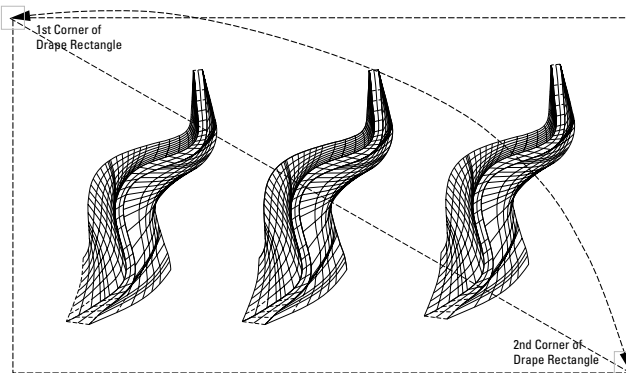
A set of existing 3 dimensional entities. The entities can be surfaces, or solids, or both.



3D Entities as inputs for the drape.

### Process:

1. Activate the drape command. Depending on the application you might be presented with a shaded view to illustrate the presence of surface or solid entities and to assist you in defining the limits of the new NURB surface.
2. Using the cursor, snap to the diagonal limits of the new surface. (This action is similar to defining a vector polygon.)



3. The resolution of the resulting surface can be adjusted depending on its specifications or intended use. You will notice a smoothing between the slopes.

