

## Chapter 7: Edit Curves and Surfaces

The editing operations in this section break objects apart, cut holes in them, and put them back together. Some of these commands connect curves to curves or surfaces to surfaces or polysurfaces and break a composite curve or polysurface into its components.

The commands: **Join**, **Explode**, **Trim**, and **Split** apply to curves, surfaces, and polysurfaces.

The **Rebuild**, **ChangeDegree**, and **Smooth** commands alter the shape of a curve or surface by changing its underlying control point structure.

In addition, objects have properties that are assigned to them such as color, layer, rendering material, and other attributes depending on the object. The **Properties** command manages these properties.



### Join

The **Join** command connects curves or surfaces together into one object. For example, a polycurve can consist of straight-line segments, arcs, polylines, and free-form curves. The **Join** command also connects adjacent surfaces into a polysurface.



### Explode

The **Explode** command removes the connection between joined curves or surfaces. For polysurfaces, this is useful if you want to edit each individual surface with control points.



### Trim and



### Split

The **Trim** and **Split** commands are similar. The difference is when you trim an object, you select the parts to remove and they are deleted. When you split an object, all parts are left.

The **Split** command will split a surface with a curve, surface, polysurface, or its own isoparametric curves.

The **Untrim** command removes a surface's trimming curve, with an option to keep the curve so you can re-use it.

## Control-point editing

You can make subtle changes in the shape of a curve or surface by moving the location of its control points. Rhino offers many tools for editing control points. Some commands such as **Rebuild**, **Fair**, and **Smooth** offer some automated solutions for redistributing control points over a curve or surface. Other commands, such as control point dragging and nudging, **MoveUVN**, and **HBar** let you manually control the location of individual or groups of control points.

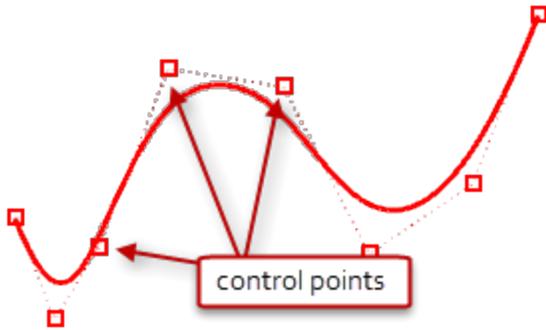


### Control point visibility

To edit curves and surfaces by manipulating control points, use the **PointsOn** command to turn the control points on.

When you are finished with control-point editing, use the **PointsOff** command or press **Esc** to turn them off.

Control points of polysurfaces cannot be turned on for editing. Editing the control points of polysurfaces could separate the edges of the joined surfaces creating "leaks" in the polysurface.



## Change control point locations

When you move control points, the curve or surface changes, and Rhino smoothly redraws it. The curve or surface is not drawn through the control points rather it is attracted to the new positions of the control point. This allows the object to be smoothly deformed. When control points are on, Rhino's transform commands can manipulate the points. You can also rebuild surfaces to add control points and redistribute them.

## Add, delete, or redistribute control points

Adding control points to a curve gives you more control over the shape of the curve. Manipulating control points also lets you remove kinks, make curves uniform, and add or subtract detail. The **Delete** key erases curve control points. This changes the shape of the curve.

## Curve and surface degree

A polynomial is a function like  $y = 3x^3 - 2x + 1$ . The "degree" of the polynomial is the largest power of the variable. For example, the degree of  $3x^3 - 2x + 1$  is 3; the degree of  $-x^5 + x^2$  is 5, and so on. NURBS functions are rational polynomials and the degree of the NURBS is the degree of the polynomial. From a NURBS modeling point of view, the (degree - 1) is the maximum number of "bends" you can get in each span.

For example:

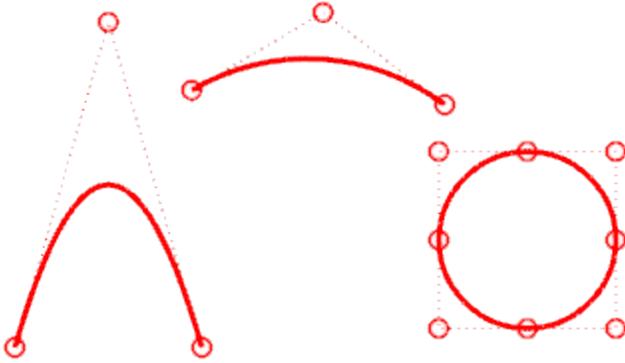
A degree-1 curve must have at least two control points.

A line has degree less than 1. It has zero bends.



A degree-2 curve must have at least three control points.

A parabola, hyperbola, arc, and circle (conic section curves) have degree less than 2. They have one bend.



A degree-3 curve must have at least four control points.

A cubic Bézier has degree less than 3. If you arrange its control points in a zig-zag shape, you can get two bends.

