Types of 3D Surfaces

Creating a three-dimensional surface in any solid modeling program is accomplished in a set number of ways. This document is designed to familiarize you with the various methods of creating three-dimensional surfaces. The Product Realization Lab uses the CAD package SolidEdge for creating such 3D models. We use the CAM package Virtual Gibbs to process these models and produce toolpaths to cut on the CNC milling machines.

Surfacing has only recently become a relatively accessible machining process for novice machinists. The CAD/CAM software available up until very recently has been complicated, involved, and confusing. Now, with some perseverance and a little time, you can achieve full 3-D machining.

2 1/2 D surfaces vs 3D surfaces

You might hear somebody saying that a particular machine is not a "full 3-axis machine, but only a 2 1/2-axis machine." A full 3-axis machine is capable of moving all three axes of the machine simultaneously. A 2 1/2-axis machine will fix one of the axes while the other two are machining. Although it may appear to be machining in all three axis, the x axis may be fixed while the Z and Y move. 2 1/2 D surfaces get their name from how they are cut on a CNC machine. They are composed of contours in one plane, stacked on top of, or next to, each other to build the surface. Understanding this distinction is not really that important.

Revolved Surfaces

Revolved surfaces are the simplest to create and understand. They are 2 1/2 D surfaces, created by rotating a contour about an axis. For example, you can create a sphere by rotating a semi-circle around a straight line.

Swept Surfaces

Swept surfaces are 2 1/2 D surfaces as well. They are created by taking a drive curve and pushing it along a base curve. For example if you pushed a small circle (drive curve) in the XZ plane through a larger circle (base curve) in the XY plane, you would create a donut.

Extrusions

An extruded body is created by taking a closed shape and "extruding" it along a straight line, much like dough is extruded through a hole to make spaghetti pasta.

Lofted Surfaces

If you want a curve that is more swoopy or organic, you will probably need to create a lofted surface. A lofted surface takes dissimilar surfaces and blends them together. A simple example would be creating a square in one plane and a circle in a different plane directly above the square. If you create a lofted surface between the two, a surface will be generated that begins at one end as a square and gradually transitions to a circle on the other end. A lofted surface can be created between numerous shapes - you can see that the possibilities for lofted surfaces are quite vast.

Coons Patch
A closed shape that is defined by either three or four curves, lines, or arcs anywhere in space can be used to create a Coons patch. The simplest example of this is four lines of equal length, in a single plane that are joined at the ends. This creates a shape that is square. These may be used to define a Coons patch. The lines/arcs/curves can be located anywhere in three-dimensional space as long as they create a closed shape.

Ruled Surface
A ruled surface is similar to a lofted surface. They are created by blending two or more two-dimensional entities. (A lofted surface blends surfaces to create an entity with volume, where as a ruled surface blends lines/arcs/curves to create a surface.) For example, if you blended multiple circles of different sizes, you could create a peanut. The arcs used to create a ruled surface do not need to be closed or similar in any way.

Most of the examples given are very simple to help you visualize the different types of surfaces. Any bizarre surface can be created by one of or a combination of the surface types listed here. With a solid understanding of these different surfaces, you are ready to get started machining in three dimensions!

revision history :

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