

Polygon Normals in DataCAD

What is a polygon?

A 3D model in DataCAD is typically composed of basic 3D shapes called primitives, such as slabs, spheres, cones and polygons. Polygons are the most simplistic, as they are composed of only one surface. Visualize a polygon as a sheet of paper in space. In DataCAD, the polygon may have a minimum of 3 points and a maximum of 36. The surface may be perpendicular to the ground plane or inclined in space, but all the points must lie in the same plane. Higher level shapes, like spheres, are simply multiple polygons chained together into a single element. If you explode a sphere into polygons, the result will be a multitude of surfaces that form a spherical shape, any one of which may then be manipulated or deleted.

DataCAD also has the ability to mark or un-mark polygon edges. This affects whether a polygon edge is displayed or not. If you explode a shape and then pull its faces away from one another, you will find that where two polygon edges meet, one edge is hidden. This allows greater speed in screen refresh, as DataCAD does not have to draw the same edge twice. To see all the edges, choose Polygon/Partial/ MarkAll from the 3DEntity menu, and select the entities by group.

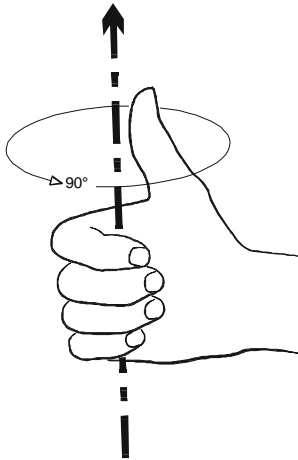
What is a normal?

Another characteristic of a polygon surface is its orientation, or normal. Think of a polygon as a sheet of paper that only allows you to write on one side. This side is the positive normal, while the other side is the negative normal. In a visual sense, polygons are one-dimensional, as they may only be seen from one side in a rendered view.

How can I see them?

Well, in DataCAD, you can't. While a normal is a condition of the coordinate points that describe a particular polygon, they really don't matter much in the DataCAD world. Whether you view, quick-shade or hide a polygon from either side, it will look and display exactly the same. The only way to know which way a normal faces is to remember how it was created. Did you define the polygon right to left counter clockwise, or left to right, clockwise? If you went counter-clockwise, then the normal faces towards you, or out of the screen. If you went clockwise, then it faces away from you, into the screen. This method of orientation is known as the right-hand rule. To further complicate things, if you mirror an entity, all of its normals will reverse.

What is the right-hand rule?



When rotating objects, the right hand rule will help you visualize the positive direction of rotation:

Hold your right hand in front of you, pointing your thumb in the positive axis of rotation. Your fingers will then curl towards 90 degrees. In the case of a plan view, Z-axis rotation, this is counter-clockwise. If you rotate instead about the X-axis, your fingers now curl towards you, and rotation will subsequently be out of the screen in the same direction.

In the case of normals, hold your right hand out with your fingers curling in the direction you created the polygon, either clockwise or counter-clockwise. Your thumb now points in the direction of the positive normal.

Why do normals matter?

While normals don't matter much in DataCAD, they can mean a great deal if you export your model to a rendering package like Renderize Live, Lightscape or 3D Studio, or save it in VRML format for browsing in a viewer like Cosmo Player for Netscape. Suddenly, you will find that all those invisible normals now wreak havoc because wherever they face away from your point of view, the polygon appears to be missing. This is because rendering packages only render the positive normal face of the polygon. Many rendering packages, including Renderize, allow you to ignore the normals and render both sides. This is appropriate for small models, but is not practical for large files and animations, because it can double the time required to process the rendering.

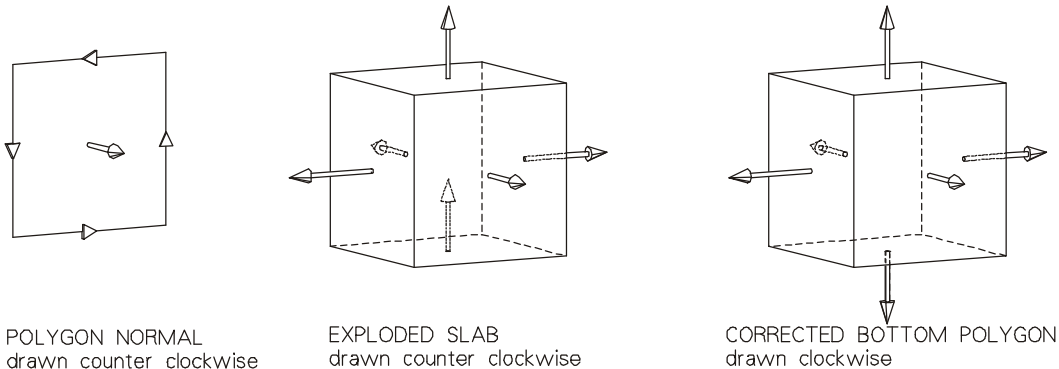
What can I do about normals in DataCAD?

Until recently, not much! When creating entities, visualize the normals and orient them in the direction you intend to render later. Be careful when mirroring objects, as it reverses the normals.

Some basic examples:

Consider an L-shaped floor plan. If you trace the polygon for the floor plane counter-clockwise, it will face towards you and render properly. When creating the ceiling from the same view, you must then trace it clockwise, as the rendered face should point away from you, towards the floor. Note that you can not simply copy the polygon for the floor up a distance and use it for the ceiling, as the normal will point in the wrong direction!

If you create a counter-clockwise slab and then explode it to polygons, its sides normals will point outwards. Its top and bottom will also point towards you. This will not render as a solid object, as the bottom normal faces the wrong way. It will have to be erased and recreated in the opposite direction, as shown below.



POLYGON NORMAL
drawn counter clockwise

EXPLODED SLAB
drawn counter clockwise

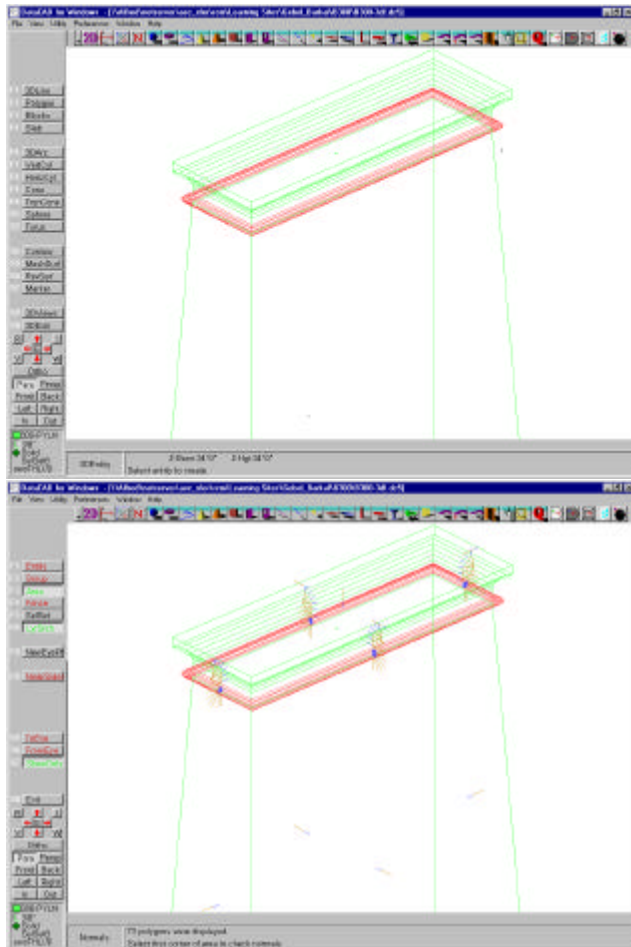
CORRECTED BOTTOM POLYGON
drawn clockwise

What is the normals Macro and what does it do?

The Normals Macro, created by Bill D'Amico of Unique Software, allows you to view and manipulate normals directly within DataCAD. Normals can be oriented towards or away from a 3D marker placed within the model.

After your model is created, place 3D markers within the model to orient the normals to. In the case of a square room, this would typically be in the absolute center of the room, at a Z-height halfway between the floor and the ceiling. For the room to render properly, all normals should face towards this point. Next, explode all slabs or other 3D primitives to polygons.

Launch the Normals macro, select a reference marker point, and pick the "Show Only" option. All the polygon normals will be indicated by "spikes" which protrude from the absolute center of the polygon. The yellow portion of the spike indicates the positive, rendered side and the blue portion the negative, non-rendered side. See illustrations below.



Model in DataCAD

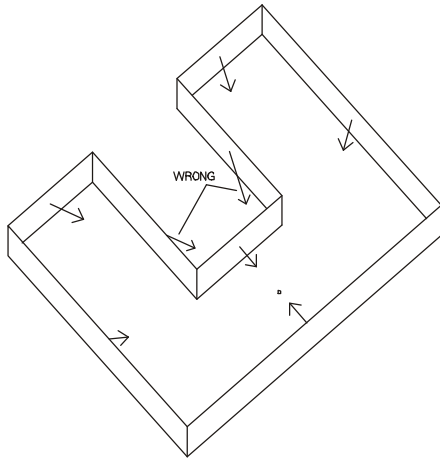
"Show Normals" Function

If changes need to be made, select "To Normal" or "From Normal" and then the entity, group, area or fence to change. The macro will then change the affected polygons accordingly, and tell you how many were reversed. Select "Show Only" again to refresh the display if you wish. A "Number Sides" option is also provided, which will show you the number and direction of points along a polygon face, indicating clockwise or counter clockwise orientation.

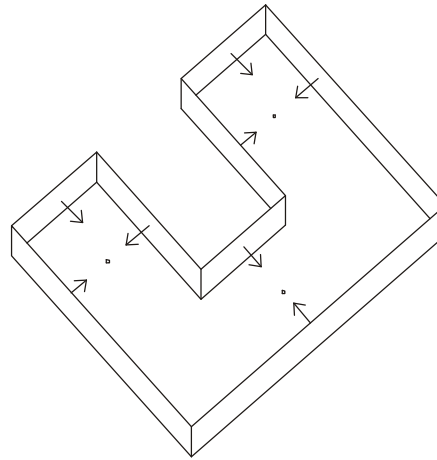
As with all of Bill D'Amico's macros, the interface is elegant and intuitive, and it functions flawlessly.

How should I model in DataCAD when intending to export and render the file?

You will find that polygons are more versatile and economical to use than the higher-level primitives in your DataCAD model. Create separate polygons and layers for the inner and outer faces of the building's walls. This will allow you to easily orient the normals properly later with the Normals Macro. Remember that a building's normals for the outside surface will point away from its center, while the inside surface will point towards the center. Rooms of complex shapes may need several reference marker points so that you may direct the normals properly. For example, in a U-shaped room, facing all normals to the center will not work because the inner sides will actually need to face away from the center point. Placing a marker in each leg of the U will allow you to orient the polygons in each leg towards that point.



ALL WALLS TOWARDS ONE MARKER
incorrect



INDIVIDUAL WALLS TO MULTIPLE MARKERS
correct

Thanks to Bill D'Amico of Unique Software for creating the Normals Macro. The macro is available for purchase from Unique Software's web site at:

<http://www.nxi.com/billd/normals/>