CORNERS

Most plastic parts have corners. And most corners are radiused. Designers often seek sharp corners or more properly, corners with very small radii. Aesthetics is often cited as the reason for this. But aesthetics is not the only reason. Often the container must contain material of a specific volume. For a given dimensioned container, the internal volume decreases with increasing corner radii. Con-versely, for a given volume, the overall dimensions of the container (and thus the amount of plastic needed to make the container) increase with increasing corner radii. In this lesson, we consider the concept of the corner.

Can a Part Have More Than One Type of Corner?

Of course. Consider the simplest type of corner, being the place where two planes intersect. Picture the bottom edge of an axisymmetric part as a drink cup or a can, for instance. The vertical or near-vertical side of the container intersects the bottom of the container at a right or near-right angle, thus forming the corner, in this case, a bottom two-dimensional or 2D corner. Of course, any good thermoformer worth his or her salt would not make a sharp angle at the intersection. The reason for this is intuitively obvious but will be explained in a little more detail later.

Is there more than one type of corner on a five-sided box? Sure. There's the intersection between the vertical wall and the bottom. And the intersection between one vertical wall and another. And what about the intersection between two vertical walls and the bottom? So we have bottom two-dimensional or 2D corners, vertical 2D corners, and in the last case, three-dimensional or 3D corners. And, as with the cup or can example, corners should have radii.

We must keep in mind that the plastic stretches from the sheet that is not contacting the mold surface. As more and more of the plastic sheet contact the mold surface, the sheet not contacting the mold becomes thinner and thinner. For a part such as a cup or can, the plastic stretches into the bottom 2D corner last. As a result, the material in the corner is usually the thinnest. Although mechanical and pneu-matic assists help redistribute the sheet during stretching, the part wall is usually thin in the corners. And smaller corner radii usually lead to thinner part walls. In other words, sharp corners lead to thin-walled parts in corners.

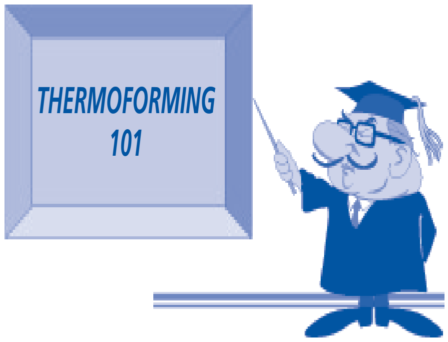
Wall Thickness in 2D Corners

The wall thickness in the bottom 2D corner of a five-sided box is proportional to the corner radius to about the 0.4-power. If the design calls for a radius in one area of the bottom of the part that is 50% of that in another area of the bottom of the part, the part thickness in that area will have about 75% of the thickness of the other area. If the design radius is 25%, the thickness in that area will be about 55% of that of the other area.

Interestingly enough, wall thickness in vertical 2D corners is about equal to wall thickness of surfaces adjacent to the corners. This is probably because the part walls in the vertical corners are formed at the same time the part walls of adjacent surfaces are formed and not afterwards, as is the case with bottom 2D corners.

Wall Thickness in 3D Corners

The wall thickness in the 3D corner of a five-sided box decreases in proportion to the corner radius to the 1.0-power. If a design calls for a 3D radius in one corner of the part that is 50% of that in another corner of the part, the part thickness in that corner will have 50% of the thickness in the other corner. If the corner design radius is 25%, the part thickness will be 25% of that in the other corner.



Why are we concerned about part wall thickness in 3D corners? Because many of our parts are similar to the five-sided box we've used as an example. And five-sided boxes are often filled and handled during shipping, installation, and use. And 3D corners of five-sided boxes are most susceptible to impacting. In an earlier lesson we discussed that when we stretched a sheet, we thinned it. We needed greater forces to stretch the sheet to greater and greater extent. And when we cooled the sheet we locked in the stresses we used to stretch the sheet. So when we impact the 3D corner of the formed part, we are applying stress on top of those already frozen into the corner. On top of this, the 3D corner is very thin. In short, sharply-radiused corners are often desired by designers but of great concern to thermoformers. As a result, the designer must often accept greater radiuses than he/she desires.

In a subsequent lesson, we consider alternative designs for corners, as well as other product features. ■

Keywords: vertical 2D corner, bottom 2D corner, 3D corner, corner radius

[This is one in a series of articles introducing general concepts in thermoforming.]