Shape Drawing

The Process:

Wire and bar drawing has been the subject of simulation and analysis for decades. Publications using slab method, upper bound analysis and FEM were available in the 1960's and 1970's. This was possible because of the two-dimensional axisymmetric nature of the process. Additionally, deformation gradients were small and geometry was simple for typical round to round drawing.

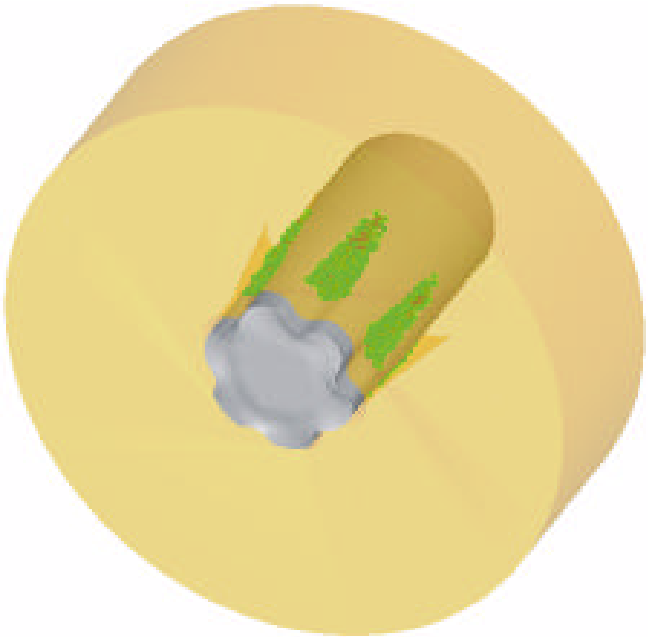
Problems associated with drawing include chevron cracks, excessive strain gradients and wire breaks. Process simulation can be used to study the effect of process and die design modifications on the final product.

Shape Drawing Simulation:

DEFORM™-3D has been used to simulate the behavior of shape drawing processes since the mid-1990's.

Additional considerations for shapes include filling the intended shape, pealing behind the smallest geometric features on the input side of the die and overstressing the die in corners. One die geometry, provided by Plymouth Extruded Shapes is used to illustrate how process simulation is used during the development of a shape drawing process. Variables in the process include the number of operations and how the cross-section changes through the process.

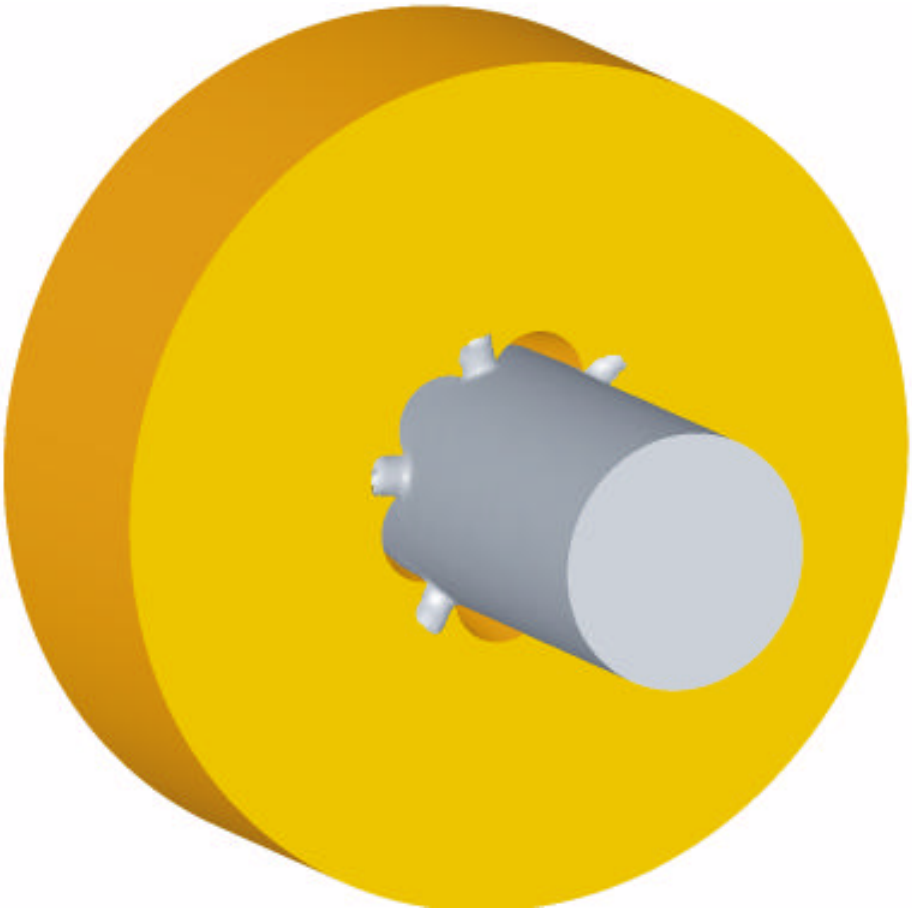
Above, a cross-section through the bearing area is shown. The underfill is visible on the corners in white.



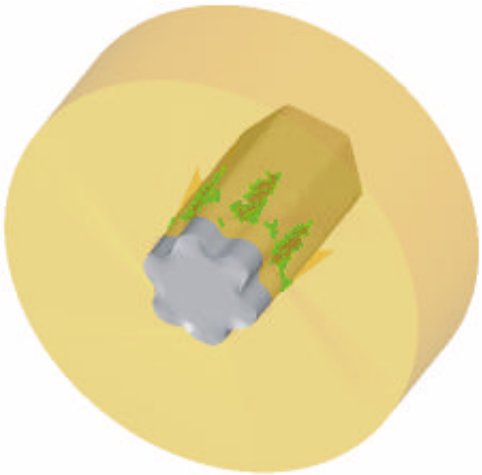
The original design was based on drawing a round shape through this shaped draw die. The result is an underfill on the drawn shape. This image shows contact with the draw die as green dots. The die is displayed as a transparent geometry.

DEFORM™

Design Environment for FORMing



The first design change to avoid underfill is a larger input stock diameter. This will increase the effective reduction and backpressure required to fill die corners. Unfortunately, this resulted in pealing the input stock as shown above.



The final process was developed using a hexagonal input stock. This resulted in a product that filled the die geometry, as shown.

Industrial Application:

Shape drawing simulations of complex three-dimensional shapes can be run in minutes for simple shapes to hours for very complex processes. A wide range of critical process information can be obtained from this type of analysis. At the quotation phase, the correct number of drawing operations requiring shaped dies can be determined. Stress analysis can be performed on the die to ensure that low cycle fatigue fractures do not form on the inside corners. A prediction of pull loads can be used to minimize wire breaks. All of this can be accomplished without spending the time and money for shop trials.

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