DEFORM™ Application #124

Rolled Preforms for Forging

Background:

Forgers have increasingly turned to rolled preforms as starting stock in their forging processes. Preforms are an alternative to simple, cut billets. They allow manufacturers to optimize material use by improving yield, thereby reducing overall raw material costs.

Preforms are typically roll formed on a hammer. Multiple blows and rotations are used to gather material to a desired shape. The drawback to this technique is that every part comes out slightly different.

Newer methods have evolved for producing preforms, including reducer rolling and cross rolling. These methods will precisely distribute volume along the length of the part.

Reducer rolling involves a billet that is pulled, lengthwise down its axis, through rolls. Cross or transverse rolling, involves a billet that is rolled around its axis by multiple tools. These tools can be shaped as straight dies or cylindrical rolls.

There are benefits to rolled preforms beyond basic material cost savings. Complex preforms can pave the way for more aggressive forging designs. Also, rolling equipment can be added in line with forging operations to improve overall cycle time.

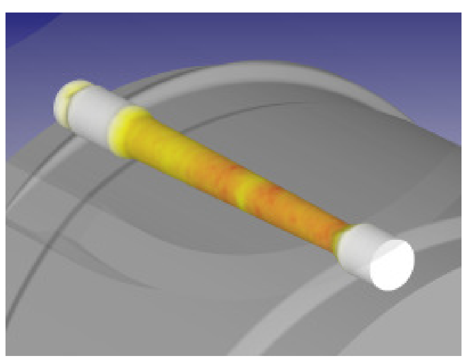
DEFORM™

Design Environment for FORMing

Process Simulation:

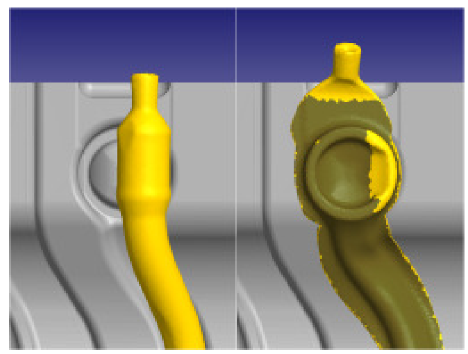
LC Manufacturing LLC of Lake City, Michigan produces steel, closed die forgings for the automotive, aerospace and defense industries. The company was chosen to supply a critical suspension component to a major automotive manufacturer. The part was to be produced by a forging hammer. Initial development used a straight, cut billet as the starting stock to the process. The downside to this conservative forge approach was that it produced excessive waste in the form of flash and machining scrap. The company looked to improve competitiveness by reducing billet weight. Thus, they decided to create preforms for the forging process using cross rolling technology.

Implementing the cross rolling process and integrating it into the forging flow-path was an extensive effort. LC Manufacturing utilized DEFORM simulations in the later stages of development to optimize their cross roll and forging designs. Simulations considered part cooling after the furnace to ensure accurate material flow.



A cylindrical-die cross rolling process showing accumulated strain (red is higher) is shown above.

Cross rolling simulations modeled the deformation of a preheated billet between two cylindrical rolls. Analysis of various design iterations allowed designers to verify rolled cross-sections and ensure proper gathering of material. Causes of surface defects were also identified and redesigned. DEFORM was even used to eliminate occurrences of internal Mannesmann defects, also called “center-burst” or “piping” defects.



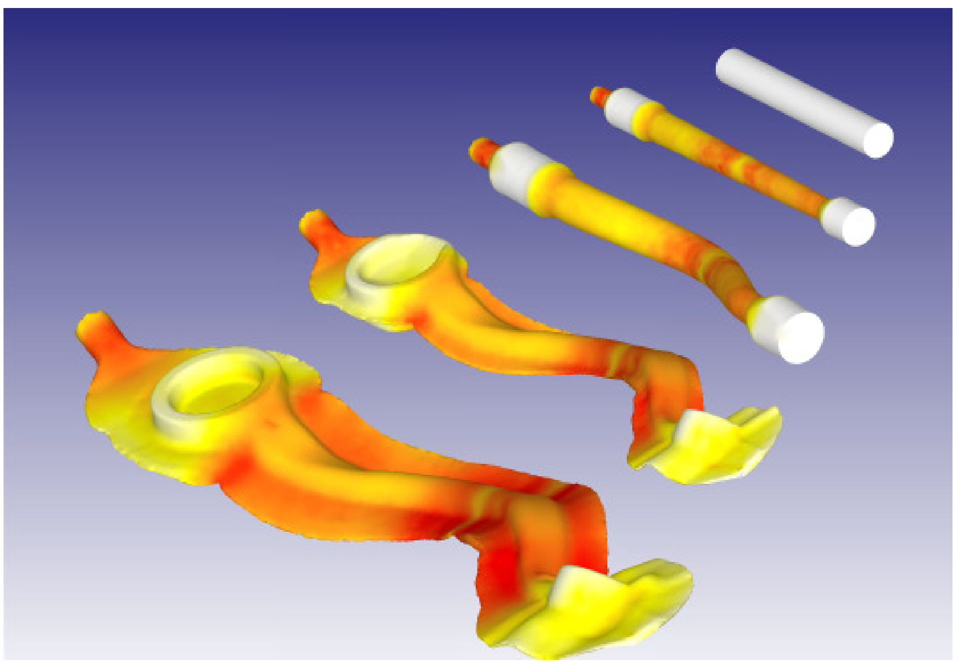
One end of the forging “kicked” to the opposite side of the cavity during the blocker operation. This resulted in nonfill on the right side of the part.

Forging simulations modeled a three-impression die on a power-assisted hammer. Multiple blows, using various applied energy levels, were simulated for most of the cavities. The output of the preform operation was used as input to the hammer sequence in a verification simulation. Drop positioning was used to position the part in each cavity, while taking into account the likely forging operator placement. Designers evaluated results to help them eliminate defects such as laps and nonfill. Die designs were adjusted to improve initial spotting, reduce part kick and tailor a bend in the forging. Finally, die stress analyses were performed to help identify ways to optimize die life.

Summary:

LC Manufacturing found excellent correlation between DEFORM simulation results and actual parts. For example, nonfill was correctly predicted in a particular blocker design. The analysis indicated that this was caused by a substantial part “kick” that occurred during the operation. As the blocker dies hit the part, one end of the forging would move drastically and create uneven fill around a boss. Experiences described by hammer operators confirmed the difficulty of keeping the part in proper position during the blocker operation.

Photograph of the actual cross rolling and hammer forging outputs.



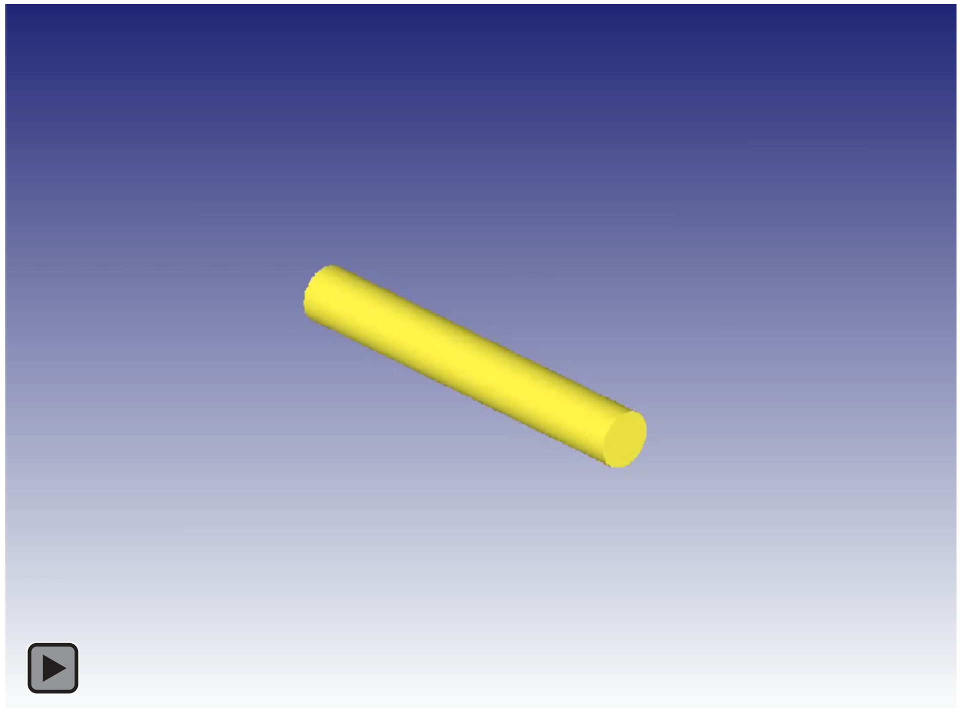
Predicted results of the cross roll and hammer forging operations are shown above. Strain (red is higher) accumulated from cross roll through forge. Strain represents accumulated work hardening, which was essential to capturing accurate material flow.

DEFORM simulations provided LC Manufacturing with a means to optimize part shape and avoid defects in both cross rolling and forging. For the first time ever, they were able to predict cross roll output and redesign these complex tools before physical trials. Simulation enhanced their ability to create complex preforms that could be utilized in down-stream forging sequences.

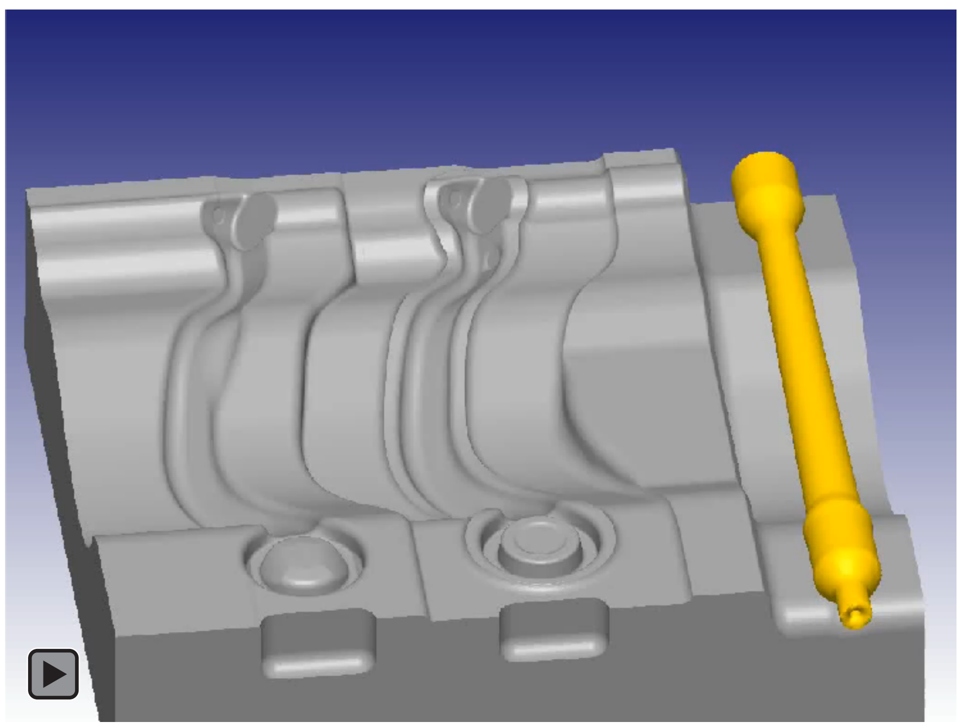
Continuous process improvement, with the aid of process simulation, resulted in a very successful product. Material use was reduced by over 30% in going from a straight cut bar to an optimized preform. LC Manufacturing has won substantial new business from their customer as a result of this success.

Scientific Forming Technologies Corporation

2545 Farmers Drive
Suite 200
Columbus, OH 43235
Tel: (614) 451-8330
Fax: (614) 451-8325
www.deform.com



A preheated billet is transferred from the furnace and then cross-rolled into the preform shape. The rolled preform is then forged to final shape on a hammer. Contours of temperature are shown.



Die contact (brown) highlights an area of nonfill that develops in the blocker operation of this forging sequence. Nonfill is caused by excessive movement of one end of the preform during the initial blocker blow.

.

DEFORM™

Design Environment for FORMing

***Adobe® Reader® X** required to play animations*