DEFORM™ Application #107

# Automotive Hot Forging

## Background:

UEF Automotive has used metal-forming simulation software for the past couple of years at both basic and advanced levels for process optimization of forged components. Utilization of such tools has enabled the forging process to be exploited without the costly, iterative and time consuming approach previously employed before such systems were available. This example outlines the application of DEFORM™-3D to the development of an automotive forging application.

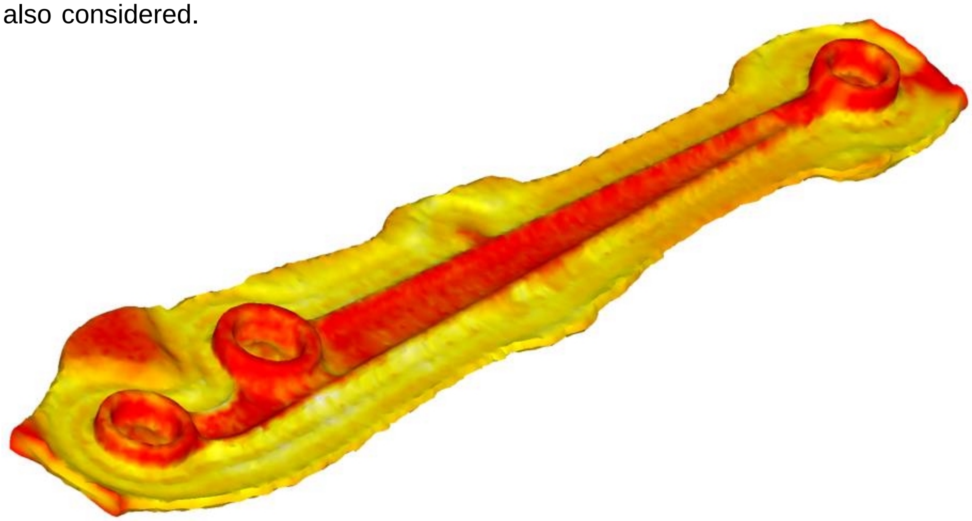
## Process Physics:

Since material behavior can be highly temperature sensitive, the changing thermal conditions in hot forging often need to be modeled. This may include the effects of adiabatic heating in the workpiece due to deformation and friction, and heat transfer to the dies and environment. Surface chilling effects can be a very important influence on material flow and therefore the transient temperatures in the die are also considered.

When heat transfer to the dies between forming operations is significant, such as chilling on a bottom die after movement of the workpiece between operations, these intervening stages of the manufacturing process are simulated as well.

## Component Simulation:

A temperature sensitivity study was conducted at UEF using DEFORM™-3D on a large hot forged suspension component. This part is produced on a 6000 ton press suite in three stages from an initial preform. Layout of the press is such that the billet, on leaving the heater, has a twenty second transfer time through a system of conveyors before it reaches a manually operated reducer roll. The time taken for the billet to pass through the rolls varied depending upon which operator was on the machine. The resulting drop in billet temperature was measured as the preform was placed at the first forging operation.



The final geometry predicted by DEFORM™ showing temperature gradients on the surface.

Design Environment for FORMing

## The Analysis:

The die and initial preform geometry were imported from the CAD system in STL format, taking advantage of symmetry in the plane perpendicular to the forging direction to minimize computational time. After determining a suitable friction factor to closely represent the lubrication conditions, the initial workpiece temperature in the simulation model was varied to match temperature readings recorded from the actual forging operation.

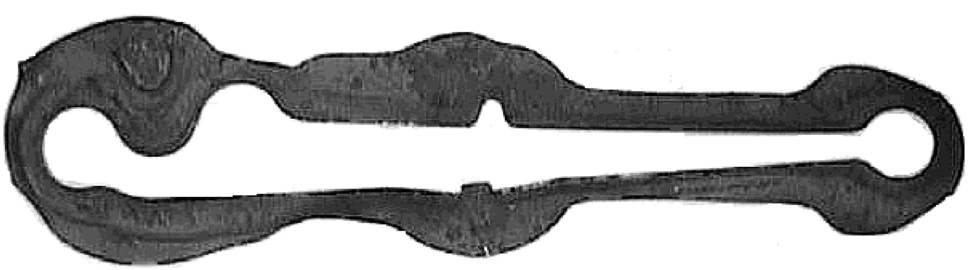
## Results:

The outline of the final simulated geometry can be seen to agree well with the actual trimmed flash shown below, which is a good test of accurate material flow prediction. The load stroke graphs produced from the simulations showed a peak forging load close to the press capacity.

Taking these predicted loads into consideration, and the fact that the block and finish operations are completed within a few seconds of each other, there was a danger of stalling the press due to the 8 second flywheel energize time. As a result of this, measures were taken to ensure billet temperature remained high enough to minimize the risk of overloading the press.

## Conclusions:

Process simulation has found many uses within UEF. Process optimization can be achieved quickly and efficiently through the use of simulation software. Reduced product development costs and more 'right first time' tooling can provide significant savings. State of the art process simulation can enable designers to explore and evaluate more challenging components that would otherwise have been possible in the past without the cost, time and risks associated with full scale, physical forging development trials.



Photograph of actual flash outline.

*Courtesy of: Chris Wheelhouse, United Engineering Forgings Ltd, Bromsgrove, UK*

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