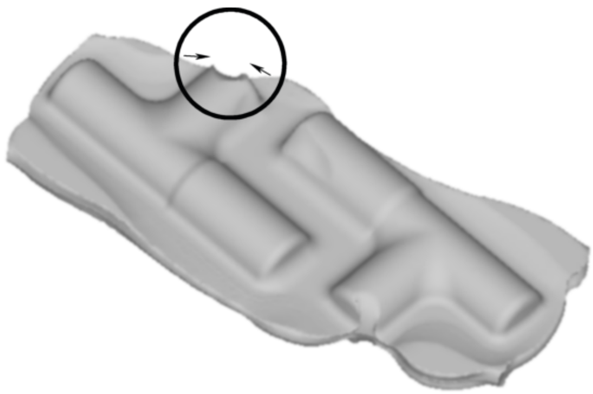
DEFORM™ Application #101

Lap Formation In A Hot Forging

Forged parts are typically used for critical or severe service applications. Such components as high pressure fittings, automotive suspension components, drive train parts, gears, bearings, aircraft landing gear and turbine disks are subject to a challenging service life. The customer's expectation of a forged part involves strength, toughness and geometry. These are established in a base specification. Additionally, requirements for grain flow and freedom from defects is common. Forging defects can include laps (folds), underfills, suck-ins, internal shear bands, end grain perpendicular to a stress concentration and fractures. The root cause of these defects is not always apparent at the design stage. In fact, many defects aren't observed or don't appear until after the completion of pre-production trials. The ultimate customer is frequently not in a position to accept common forging defects, thus the burden on the forger is to develop processes that are free of these flaws regardless of the inevitable variation in the process. Process simulation has proven to be a powerful tool in assisting the forging engineer with the blocker and forging design process.

The Process:

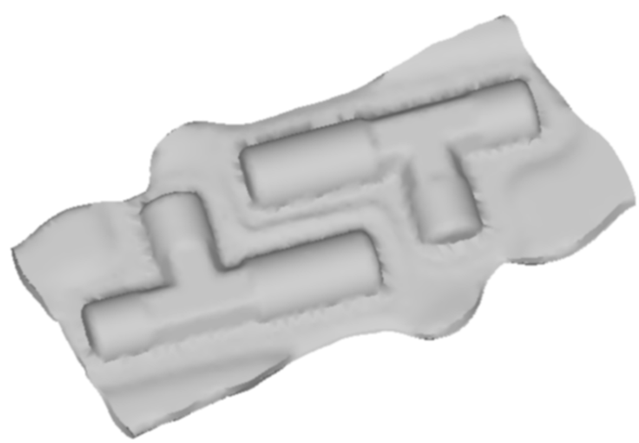
In hot forging, it is common to form multiple parts in a single platter with flash. The forging of 300 series stainless steel tees was analyzed with and without the bust operation. Without the bust operation, a forging lap was observed, as shown.



The simulated process using a block and finish operation shows a forging lap. The lap area is highlighted with the dark circle and the arrows represent material movement just prior to the lap closing. The lap was observed when this part was manufactured.

The Analysis:

DEFORM™-3D was used in these process simulations to analyze and understand the process. The results correlated well with actual production experience. Adding the bust operation eliminated this defect as a result of better volume distribution going into the blocking operation as shown. Process simulation can be used to understand the influence of volume distribution on both defect formation and product cost. A flash region that is wide in one region and thin in another indicates a less than optimum preform design.



The simulated shape with a bust/block/finish operation is shown. No lap is predicted with this process. Actual manufacturing practice verifies the result.

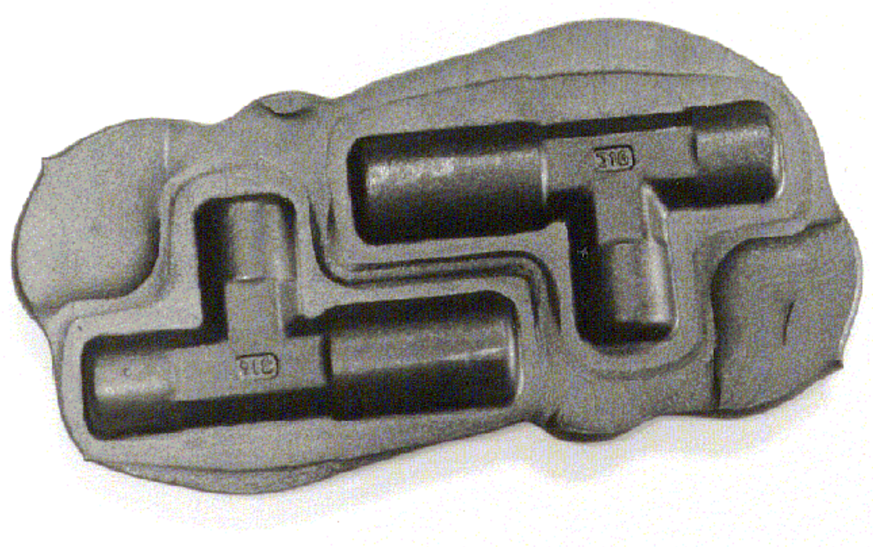
DEFORM™

Design Environment for FORMing

The Opportunity:

Process simulation is routinely used to optimize volume distribution, resulting in a high quality, low cost process without defects. The cost of traditional process development is high. Developing a process might take days or weeks of engineering time. Building a full-scale die set and preparing for a trial run costs thousands of dollars.

Running the trial can take hours or even days of production time. Trial run cost can be staggering when all components are considered. Even worse, the lead-time for shop trials rarely meets the customer requirements and expectations. DEFORM™ is a 'state of the art' process simulation tool that is faster, less costly and provides far more information about a proposed process than shop trials.



This figure is a photograph of an actual forging.
Note how the flash shape matches the simulation prediction.

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