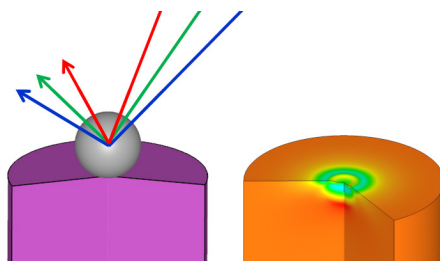# DEFORM® News

Shot Peening Modeling in DEFORM V12.0

SFTC recently took part in a research project to develop modeling methods for shot peening processes. A deliverable from this work was the new Shot Peening Template, which streamlines the setup and simulation of this complicated process.

Shot peening is a beneficial surface treatment used in a wide range of industries. It induces a compressive residual stress on the surface of a metal component via cold working. This is accomplished by firing spherical shot onto a part at high velocity. The resulting compressive stress state counteracts tensile stresses experienced during in-service operation. This can greatly increase a part's fatigue resistance.

Engineers stand to benefit from modeling shot peening during development. Of particular interest is the prediction of surface residual stresses. Another important use is the prediction of shot peening coverage. This helps users understand whether any surfaces were missed during peening. It also predicts whether the peening was applied uniformly on the surface or was instead concentrated within local regions.
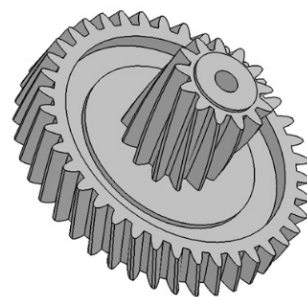
Simulating the shot peening process is challenging because multiple size scales are involved. The new Shot Peening Template addresses this by offering a process-specific workflow and unique shot peen modeling tools within the DEFORM multiple operation environment.

At a small scale, surface stresses caused by the contact of a single shot must be determined. Pellet size, impact velocity and impact angle are taken into account to accurately capture local stress response.
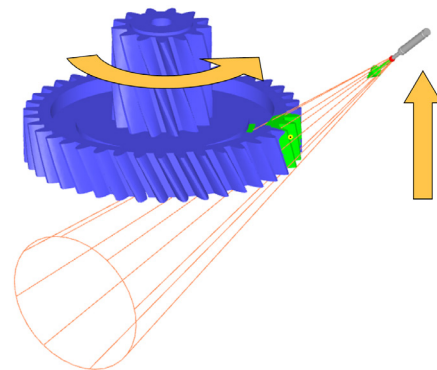

At a larger scale, process parameters such as workpiece rotation, the shot spray zone and movement are considered. All of this information is utilized to predict residual stress response and shot peening coverage at the part level.

The helical gear shown below is an automotive component that might typically be shot peened.

It is common for such a gear to spin during the peening process, with the spray nozzle moving up and down while firing the shot.

The shot peening of this gear can be modeled by following an easy-to-use, wizard-based template. The user is guided through the workflow to import CAD models and mesh the gear geometry. Objects that might impede the shot hitting the gear, providing a shadowing effect, could also be added.

The template incorporates terminology familiar to those in the shot peening industry. Users define process parameters such as the rotation of the workpiece, nozzle specs (like diameter and cone angle) and the nozzle movement.
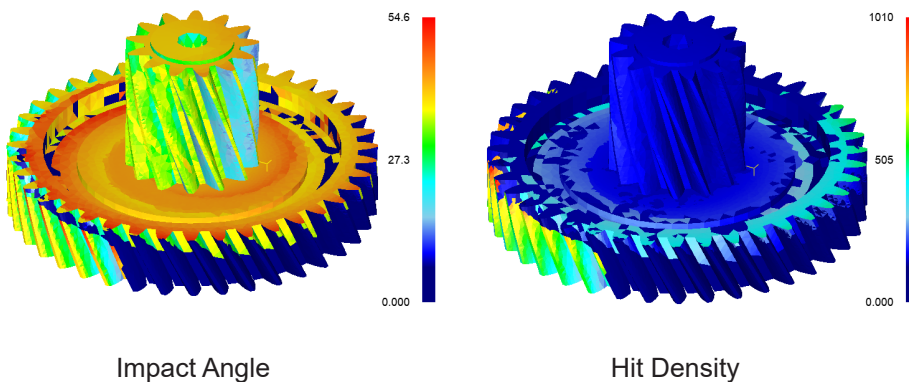
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Two approaches are available for running the shot peening simulation. Exactly which analysis method a user chooses will depend on their goals and time requirements.

The first approach is an advanced "particle simulation", where the workpiece is hit with discrete particles shot from the nozzle. This method handles particle ricochets and accurately predicts when individual elements only experience partial coverage.
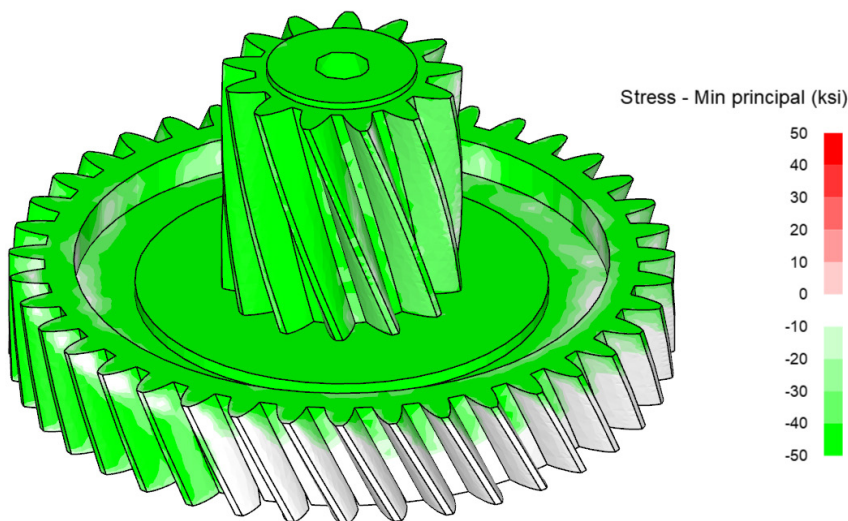
The second approach is a basic "impact analysis", where the workpiece-shot interaction is calculated in a simplified and more efficient manner. This method is fast, but does not consider ricochets or partial element coverage.

Both of these approaches reveal how well the surface of the part was shot peened. Output information includes average impact angle, hit count, surface hit density, percent coverage and exposure time.

Results from the helical gear simulation are shown below. This example modeled a non-uniform peening process to demonstrate its detrimental effect on residual stresses. Plots of impact angle and hit density highlight the nonuniformity. Dark blue regions, associated with low impact angle or near zero hit density, were not adequately peened.

Impact Angle   Hit Density

The shot peening conditions influence the final residual stress state of the part, as shown below. Well peened regions are in a state of residual compression (green) while unpeened regions are essentially stress-free (white). With this nonuniformity identified, DEFORM could then be used to evaluate alternate process designs. These simulation studies will allow users improve coverage and make residual stresses more homogeneous.

Users interested in shot peening may contact their local DEFORM distributor for more information.