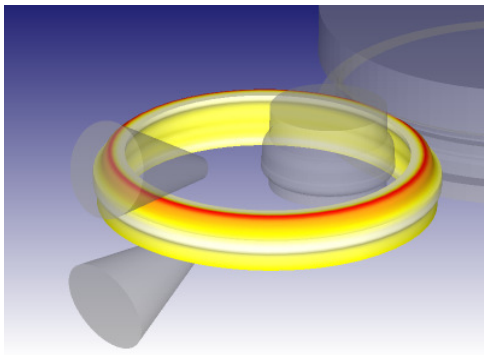
Forming Modules

Ring Rolling has been one of the most computationally demanding simulations in metal forming. Traditional metal forming codes, require days, weeks or months to simulate typical processes. Even with extremely fast hardware, the 'brute force' methods are impractical.

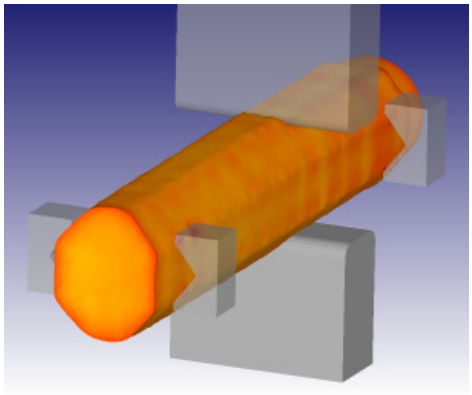
SFTC is pleased to announce this capability is now available in DEFORM, after a multi-year development effort. The FEM engine is extremely efficient, as it was specifically designed for ring rolling. Simulations that have taken weeks in the past, now run in hours to days.



This 'state of the art' system utilizes an ALE solver with automated time stepping. The model uses brick (8 node) elements and supports fully automatic adaptive remeshing. The updating and contact algorithms are optimized for ring rolling. The result is an accurate solution, without artificial constraints on the rotation axis.

DEFORM is the first code to deliver a ring rolling program capable of running on practical hardware in reasonable times. Test cases have been run with 15-20,000 brick elements running 25 to 75 revolutions in approximately an hour per revolution, on a single CPU PC!

Cogging is an open die forging process used to convert a cast ingot into forged billet. A typical process involves hundreds of local reductions, along the length of the billet, spanning several heats. The workpiece is typically rotated between or during passes. The ingot cross section is reduced as it changes shape to a round, hexagon or octagon. This thermo-mechanical processing refines the coarse ingot grain structure to homogenized, fine grained, recrystallized billet microstructure.



Process simulation can involve hundreds or thousands of deformation and heat transfer models. While possible, a manual setup is tedious and impractical. To address this challenge, SFTC developed and optimized the **Cogging Module** to enable a user to set up cogging simulations in minutes. Standard billet, die and manipulator geometries are included. Process parameters include number of heats, pass schedule, ingot rotation, bite size and the time between bites and passes. A simulation setup preview is provided to identify potential errors. This enables the user to run cogging simulations without user intervention.

This module is extensively used by leading material suppliers to analyze the ingot conversion process. Simulation provides critical information, which is used to determine optimum process parameters, resulting in improved material yield and fewer quality problems.

Ring Rolling

- Ring Rolling simulation is available as a module that runs with DEFORM-3D.
- DEFORM-RR is a stand-alone version of the Ring Rolling program.
- The current isothermal implementation supports a workpiece, drive roll and mandrel.

Cogging

- The Cogging module runs in conjunction with DEFORM-3D.
- Cogging models can involve hundreds of operations, thus disc requirements may be higher than most other applications.

DEFORM™

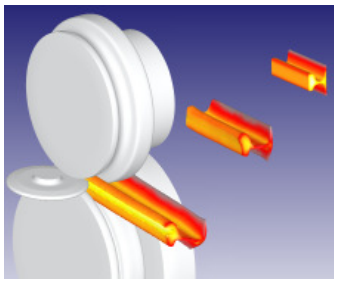
Design Environment for FORMing

Shape Rolling

- The Shape Rolling module runs in conjunction with DEFORM-3D.

Extrusion

- The Extrusion module runs with DEFORM-3D.
- The Geometry Tool is included to help create SS and ALE extrusion workpieces.
- UL extrusion simulations are computationally intense, thus fast computers are recommended.
- UL extrusion simulations tend to be very large, so a high-capacity disk drive is also recommended.
- UL extrusion simulations remesh frequently, so a high-speed or SSD disk drive is recommended.
- A new utility has been developed to mesh complex Steady State and ALE workpieces. The extrudate and container material can be elongated based on the mesh in the die.

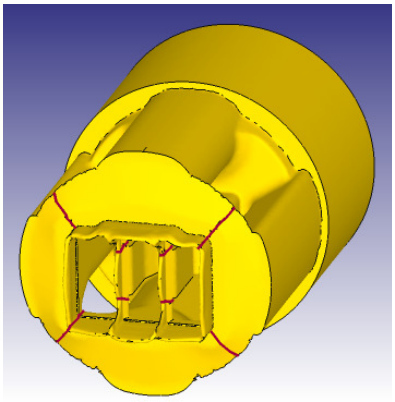


Shape Rolling in DEFORM has been used to predict folds, underfill, spread, bowing, end effects and torque. A typical process has several passes, with various roll geometries and processing conditions. Process parameters such as reduction, progression and rolling speed can be optimized. A 'wizard style' preprocessor simplifies the model setup. A library of common roll shapes and primitives is available to efficiently define roll and workpiece geometry. Processes can be modeled using a full model to study bowing or process variation. Quarter or half symmetry can be used to increase speed. A Lagrangian solver is available to study the transient effects throughout the process, while an ALE option predicts the 'steady state' behavior.

Flat dies **Extrusion** processes are challenging to simulate. Sharp entry into the bearing zone results in extremely localized deformation. When modeling extrusion, remeshing can be required at virtually every time step. With complex geometry, CPU times can become extended and model sizes can get large to capture critical effects.

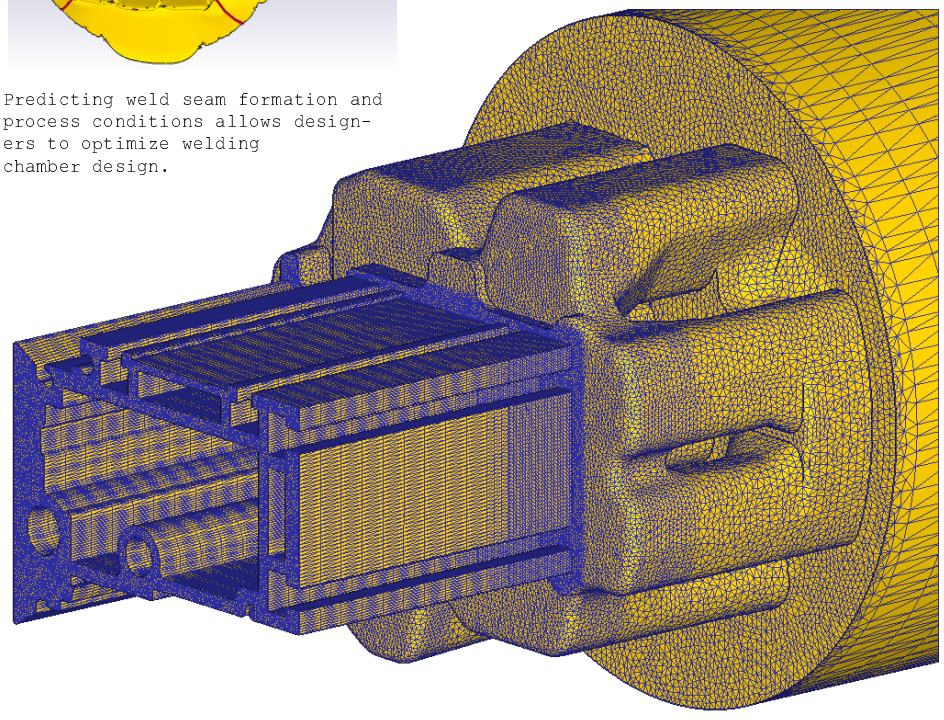
DEFORM has three approaches to modeling extrusion – Updated Lagrangian (UL), Steady-State (SS) and Arbitrary Lagrangian Eulerian (ALE). The UL analysis models the transient flow of the material during the process, as it would in a typical forging or cold forming simulation. The output shows how the die fill, the end effects, any weld seams, and the load variation during the process. SS and ALE provide information on the steady-state extrusion behavior, including load, temperature and profile deflection.

The **Extrusion Module** provides users with a streamlined GUI for setting up extrusion simulations to run using all three methods. The module is particularly useful when setting up and running steady state or ALE models. To facilitate specialized setup requirements, the Geometry Tool, is integrated into the Extrusion Module. This simplifies setting up the workpiece for steady-state and ALE simulations.



Predicting weld seam formation and process conditions allows designers to optimize welding chamber design.

Ongoing developments in mesh generation allow the creation of a structured mesh (shown below) that is optimized for extrusion, with excellent feature definintion.



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