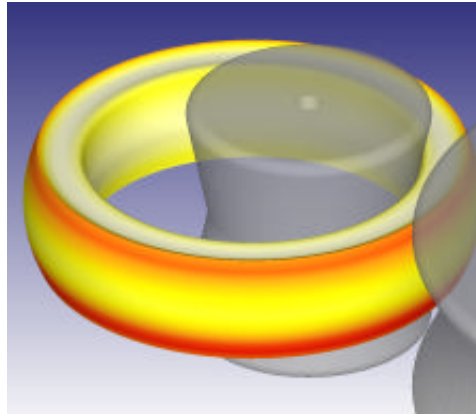


DEFORM Modules

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.

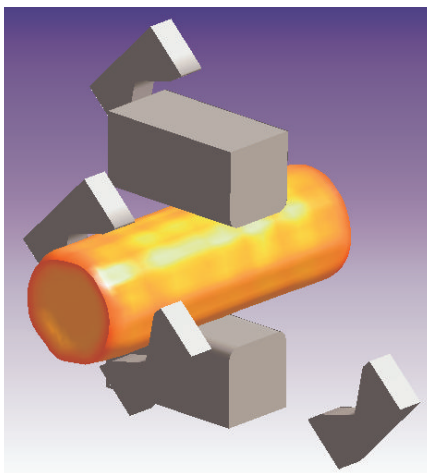
SFTC is pleased to announce this capability is now available in DEFORM, after a multi-year development effort. The FEM engine is extremely efficient, as it was specifically designed for ring rolling. Simulations that have taken weeks in the past, now run in hours to days.

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 this complex simulation 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 the complete cogging simulation without user intervention.

This module is extensively used by leading material suppliers to analyze the ingot conversion process. Cogging simulation provides critical process information, which is used to determine optimum process parameters. This leads to 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.
- Minimum hardware recommendations are:
 - 2GB RAM,
 - 100 GB free disk space,
 - read/write DVD.
- The current isothermal implementation supports a workpiece, drive roll and mandrel.

Cogging

- The Cogging module runs in conjunction with DEFORM-3D.
- Minimum hardware recommendations are:
 - 2GB RAM,
 - 100 GB free disk space,
 - read/write DVD.

Shape Rolling

- The Shape Rolling module runs in conjunction with DEFORM-3D.
- Minimum hardware recommendations are:
 - 2GB RAM,
 - 100 GB free disk space,
 - read/write DVD.

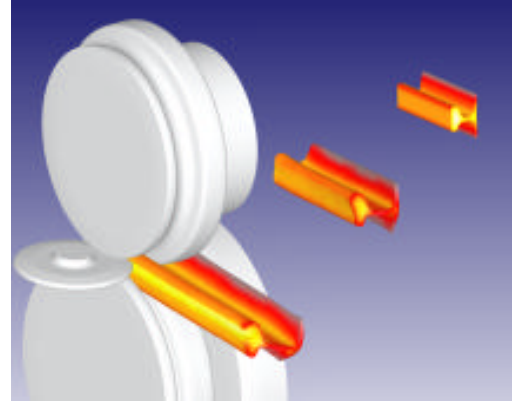
Geometry Tool

- The Geometry Tool is a stand-alone module.
- Inputs include STL, IGES and STEP.
- Capabilities include geometry repair, translation from IGES/STEP to STL and boolean operations.
- Minimum hardware recommendations are:
 - 1GB RAM,
 - 10 GB free disk space,
 - color monitor.

Inverse Property Extraction (2D)

- The Inverse Property Extraction (2D) module runs in conjunction with DEFORM-2D.

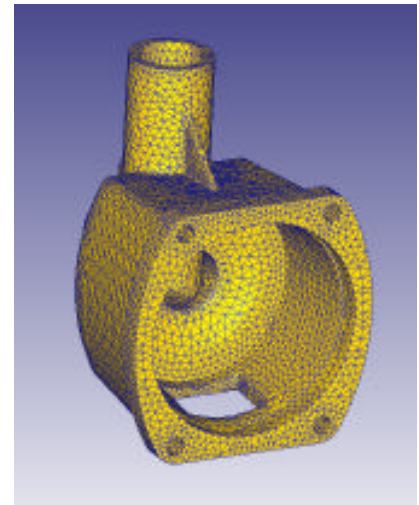
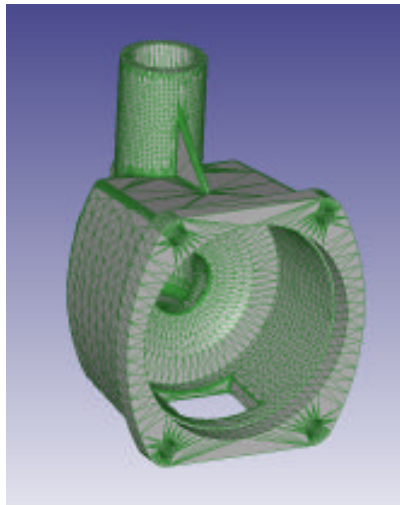
DEFORM has been used to simulate **Shape Rolling** processes to predict material folds, underfill, spread, bowing, end effects and torque. A typical shape rolling process has several rolling passes with various roll geometries and processing conditions. Process parameters such as roll reduction, progression 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 simulation speed. A Lagrangian solver is available to study the transient effects throughout the process, while an ALE option predicts the 'steady state' behavior.



A **Geometry Tool** is available to supplement the capabilities of many CAD systems when producing STL files. While some systems produce water-tight STL models with no folds, cracks or illegal polygons, this is not always the case. The Geometry Tool is capable of automatically repairing a wide range of illegal STL geometry. For severe cases, a user can detect and repair geometry interactively.

Some CAD systems have very limited STL generation capabilities, but can output a reasonable IGES or STEP file. When these neutral formats are based on a surface geometry definition, the resulting STL file is unlikely to be water-tight and legal. In these cases, the Geometry Tool can be used to import IGES or STEP. The CAD geometry can be converted to an STL file and exported to DEFORM after repairing any deficiencies resulting from the original surface definition. A DEFORM-3D mesh is shown (right) on a model that was imported in a STEP format, converted to STL (left) and repaired.

The Geometry Tool can perform boolean operations on STL files, unlike most CAD systems, which are generally limited to operations on 'native' CAD data.



Inverse Property Extraction (2D): Accurate definition of local heat transfer coefficients as a function of temperature is required to accurately model transient thermal processes. DEFORM provides an optimization-based inverse module that extracts heat transfer coefficients from experimental thermocouple data. This user-friendly module guides the user through data preparation and post processing. Modeling results include a set of heat transfer coefficients and temperature validation plots.

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