Fall, 2015

Volume 13, No. 4

DEFORM™ News

Training:

- October 13-16, 2015: DEFORM training will be conducted at the SFTC office in Columbus, Ohio.
- December 8-11, 2015 DEFORM training will be conducted at the SFTC office in Columbus, Ohio.
- February 16-19, 2016 (tentative) DEFORM training will be conducted at the SFTC office in Columbus, Ohio.

Events:

- November 3-4, 2015: DEFORM UGM in Columbus, Ohio.

Design of Experiments

The DEFORM DOE (Design of Experiments) module offers a systematic approach to investigate a system or process. Structured changes are made to one or more input variables. Optimization is available to adjust input variables to minimize or maximize a specific objective. Once the inputs are defined, the system generates the databases, runs the simulations, and extracts data from the files. Charts and graphs in the DOE postprocessor may be used to determine patterns and relationships between variables.

Design of Experiments (DOE) was introduced with the Multiple Operations (MO) environment in DEFORM V11.0. Traditionally, varying processes data has been time consuming. Database files were created and post-processed manually. Often, variables would be evaluated one at a time or in limited combinations. Alternatively, the DOE implementation in DEFORM enables a great number of simulations to be set up in minutes, run a reasonable amount of time, and be evaluated quickly.

DOE applications include:
- understanding process variation
- determining optimum process settings
- determining optimum designs

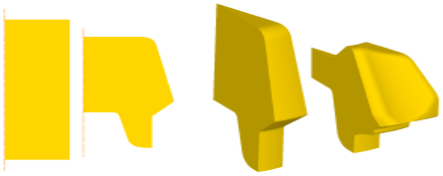
It has become common practice in modeling to simulate the as-designed process parameters. Optimal positioning, lube distribution, temperature, transfer time, etc. are assumed. Any variation from these ideal conditions may result in a defect. Using DOE to include process variation allows the risk of undesirable effects to be predicted in advance. Process tolerances can be determined to ensure a robust process.

DOE may also be used to fine tune simulation input parameters to better match processes. An example of this is modifying friction to match a known forging shape. Various parameters can be altered at the same time. State variables can then be extracted from the simulations to determine the best match.

Additionally, optimum settings and designs can be developed using DOE. Optimum designs must satisfy competing objectives. Therefore it is necessary to consider several variables when determining an optimal design. DOE tools make it easy to compare several outputs at once. The correlation of all variables is shown on a single tornado chart. Surface and contour plots show the response of an output variable as a function of two input variables. Effects of additional variables can be included with the use of weighted slider tools. Several output variables can be plotted at the same time as a weighted sum.

Example: Gear Forging

A two-hit gear forging was studied with the goal of reducing tool stress in the final operation. The nominal process was set up in DEFORM MO by defining a series of operations. The 1st operation was run as 2D axisymetric. This provided a fast run time and easy to modify geometry. The workpiece was converted to an 18 degree section to take advantage of the 1/20th symmetry of the gear. Using symmetry allowed more resolution with a faster run time. A die stress operation was included to determine the stress state of the top die at the end of the 2nd operation. Once the setup was complete, all operations ran sequentially without user intervention.

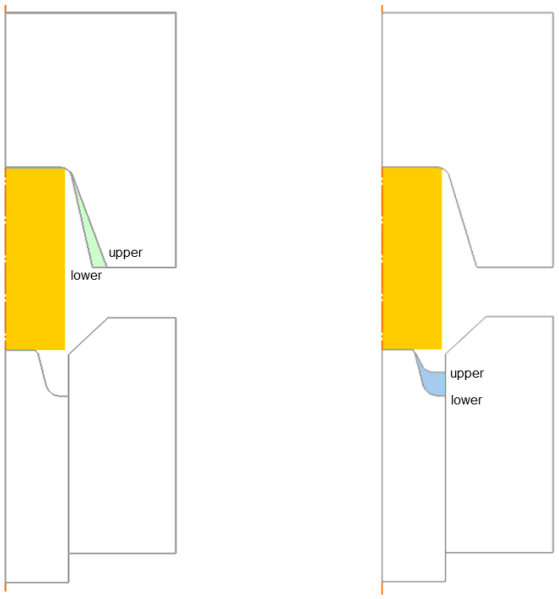


Operation 1 *Operation 2*

1/20th of 10 tooth

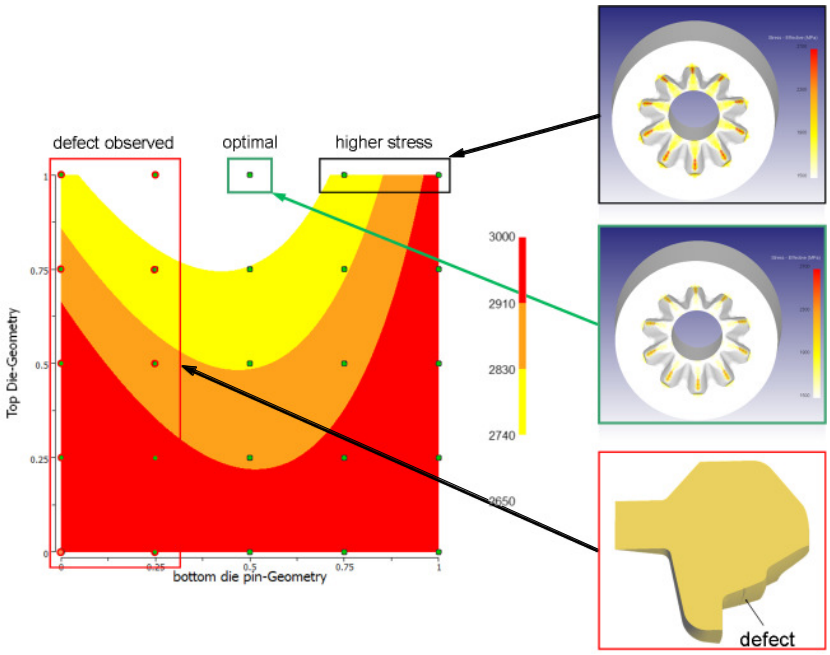
DEFORM™
Design Environment for FORMing

Preform top and bottom die geometry features were varied in DOE. The top die angle and the recess depth of the bottom ejector pin were both modified. Five samples were defined for both variables, and full factorial sampling was applied. Full factorial looks at every possible combination of the defined variables (5 x 5 samples = 25 simulations).



Variable 1 *Variable 2*

Maximum effective tool stress for the top die was output onto a contour surface (below). Increasing the top die angle in the first operation (upper row), yields a lower tool stress in the second operation. Very small folds were observed in the simulations with the lowest pin recess shapes (1st and 2nd columns). The top middle sample represents the lowest tool stress without forming a defect in the part. However, this optimal value is adjacent to runs that may have defects in the forging. If process control is not tight, the pin recess may be decreased slightly to find the lowest stress without forging defects.



V11.1 Release

DEFORM V11.1 is targeted for a winter 2015 release. New DOE features include:

- Additional DOE/OPT creation options
- Support of CAD assemblies
- Discrete DOE variables available
- Geometry importing for morphing
- Additional fill constraints
- Multiple object variable output
- Additional min/max output options
- Midpoint variable in Latin Hypercube
- Multi DB view in DOE post
- Composite surfaces in DOE post
- Simulate DOE on multiple computers
- Taguchi sampling
- Continue run option

Other major improvements in V11.1:

- Numerous enhancements and fixes
- Shape rolling added to MO
- New Cutting template
- Inverse HTC module
- Copy/mirror functionality added
- Enhanced PIP and multi-viewports
- Brick remeshing improvements
- Rotational symmetry enhancements
- New dual mesh solver
- Addition of a dual mesh system
- 64 bit 2D FEM engine
- Enhanced 2D editor
- Shrink fit boundary condition variation
- Improved 2D to 3D converter
- Pall all object to next operation option
- Stand alone **FORMING EXPRESS**
- Batch queue supports multiple servers
- ALE built in flownet
- New domain decomposition solver

DEFORM V11.1 will contain the integrated 2D/3D and F2/F3 GUI. These will be phased out and replaced by the Multiple Operations GUI over time.

Scientific Forming Technologies Corporation
2545 Farmers Drive
Suite 200
Columbus, OH 43235
Tel: (614) 451-8330
Fax: (614) 451-8325
www.deform.com