Fall, 2004

Volume 2, No. 4

DEFORM™ News

Events:

- The Fall DEFORM Users Group Meeting in North America will be held on November 3 & 4, 2004 in Columbus, Ohio. During this meeting, SFTC staff will present highlights from current and future developments. We will also conduct hands-on breakout workshops for users to test our new capabilities.

Training:

- October 26 & 27, 2004: 2D training will be conducted at SFTC in Columbus, Ohio.
- October 28 & 29, 2004: 3D training will be conducted at the SFTC office.
- Advanced training (general topics) will be held on Friday, November 5, 2004 at the SFTC office, in conjunction with the fall DEFORM Users Group Meeting.
- December 7 & 8, 2004: 2D training will be conducted at SFTC in Columbus, Ohio.
- December 9 & 10, 2004: 3D training will be conducted at the SFTC office.

DEFORM™

Design Environment for FORMing

DEFORM-HT

A typical heat treatment process of a carbon steel part includes austenizing, quenching and tempering. DEFORM-HT can predict phase transformation, volume fraction of metallic phases, carbon content and hardness. Distortion and residual stresses can also be predicted.

An example of a carbon steel bevel gear is shown. During austenizing, the gear was heated above its critical temperature of 1500F. The gear was then heated to 1675F in a carburizing

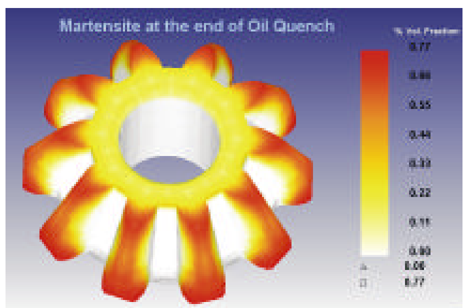

Figure 1: Red indicates a higher volume fraction of martensite after oil quench.

furnace and was held at that temperature for 2 hours. During carburizing, carbon is added to the surface of the gear through a controlled diffusion process. DEFORM-HT predicted the carbon case depth in the gear and optimized the carburizing time and the carbon potential environment needed to achieve the required case depth.

Hardening was achieved by quenching in oil. Figure 1 (above) shows the gear teeth with a martensitic volume fraction of 0.66 to 0.77. The heat treat model predicted Rockwell C hardness of 47 to 51 for the teeth. After the oil quench, residual compressive hoop stresses near the surface of the gear teeth were as high as 210 ksi, while

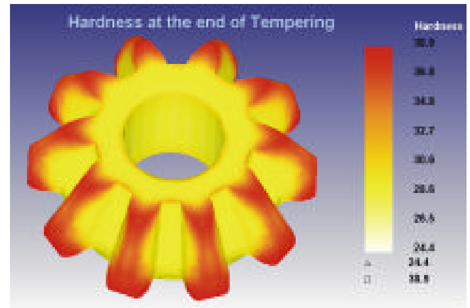

Figure 2: Hardness is displayed after tempering (red is higher).

the core of the gear had a tensile residual stress of 160 ksi.

During tempering, the gear was heated to 475F and was cooled in static air. Tempering increases toughness and ductility while reducing residual stresses in the gear. Figure 2 shows that the hardness of the gear teeth was reduced to 39 Rockwell C. Figure 3 shows a considerable reduction in the residual stresses. After tempering, the residual stresses in the gear were in the range of 99 ksi compressive to 130 ksi tensile. Distortion in subsequent machining operations is reduced as residual stress is lowered.

DEFORM-HT is a powerful tool to optimize the heat treatment process. Crack-free parts can result, which meet property requirements and have lower distortion and residual stress.

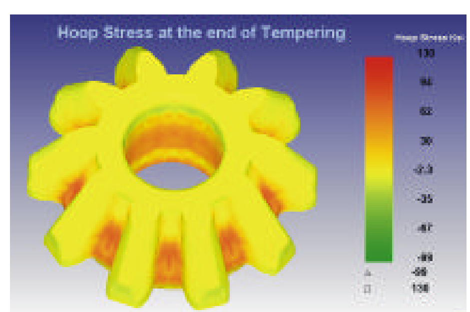

Figure 3: Residual hoop stress after tempering is shown (red is tension).

Shape Rolling

DEFORM-3D users have simulated shape rolling processes for years. Several papers were published on the topic. While the results have been valuable, the CPU time requirements were extensive. Additionally, small element size and time steps were required to avoid artificial 'slipping'.

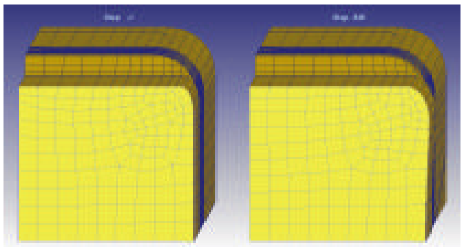

Figure 4: An initial guess is shown on the left. The spread based on actual velocity fields is shown on the right.

Recent developments have resulted in a system to simulate shape rolling using an Arbitrary Lagrangian Eularian (ALE) method. The resulting system will allow users to run single or multiple pass shape rolling simulations efficiently. This system will analyze roll pass design, roll gap detail and allow a wide range of parametric studies.

In a Lagrangian solution, the mesh moves with the workpiece. The Eularian scheme uses a fixed grid in space and time. In the ALE method, the mesh is neither restricted to follow the material, nor fixed in space. In the current implementation, the side spread during rolling can be predicted, while the planes perpendicular to the rolling direction remain planar and perpendicular to the rolling direction.

The speed and stability is impressive. A simple example was run where a 6" RCS was flat rolled using 30" diameter rolls at 50 RPM. With 4356 brick elements in the workpiece (quarter symmetry), the solution for a 0.7" thickness reduction was developed on a 1.6 GHZ PC in 2.3 hours. The contours of effective strain are shown at three time steps as the workpiece reaches a steady state solution in Figure 6.

A specialized preprocessor was developed to facilitate efficient input data preparation. This 'wizard-style' preprocessor guides the user through the process with less input than the 'open' system would require. Figure 5 illustrates a typical input screen. A comprehensive roll pass design system provides a library of common shapes in the form of user-definable primitives. Geometry for custom shapes can be imported from CAD models.

More details will be published in an upcoming DEFORM Application, which will be available upon request. We plan to demonstrate this system in a hands-on workshop format at the upcoming Users Group Meeting. As always, enhancements will be based on user requirements.

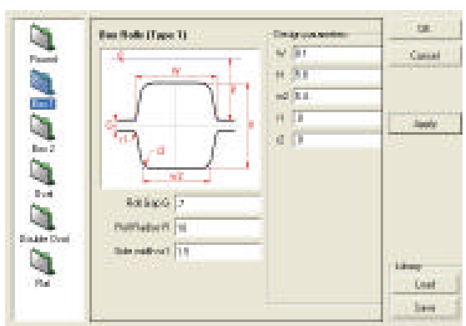

Figure 5: An image of the preprocessor shows a crossection through the rolls including the roll gap. This roll is based on a user-defined primitive.

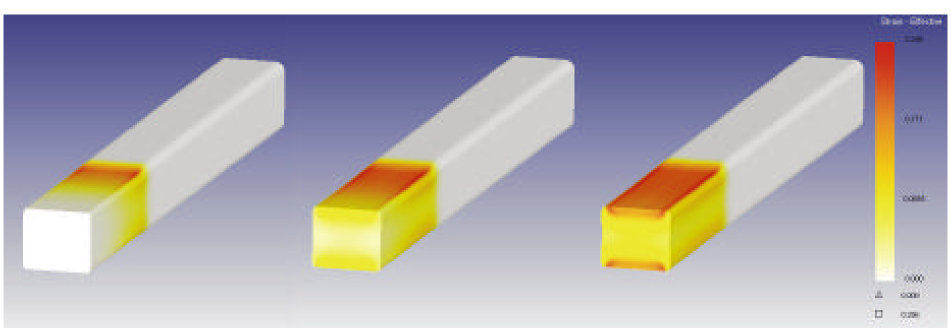

Figure 6: Contours of effective strain are shown as the roll pass progresses (from left to right). Red indicates a higher level of effective strain in this image.

Releases

DEFORM-2D version 8.1 was released in early September. At the same time, we released DEFORM-F2, which will replace DEFORM-PC. As part of this transition, DEFORM-PC PRO users will migrate to DEFORM-2D. DEFORM-F2 shares all core functions with DEFORM-2D. The GUI is similar to DEFORM-F3. The version number for DEFORM-F2 will be the same as DEFORM-2D.

DEFORM-3D and DEFORM-F3 version 5.1 is planned for release in the fall. Highlights of the DEFORM-3D release will be presented at the upcoming DEFORM Users Group Meeting.

At the Users Group Meeting, the second day will be dedicated to training workshops with a focus on new developments. Workshops will cover 2D and 3D multiple operations, DEFORM-F2, DEFORM-F3, inverse heat transfer calculations, rolling, preform design and enhancements to the preprocessor and postprocessor. These are not demos, but 'hands-on' workshops.

Compatibility Issue

The Microsoft WINDOWS versions of DEFORM run under 2000, XP Professional and XP Home. These are all 'workstation versions' of the operating systems. Some users have experienced instability when attempting to run on WINDOWS 2003, which is not supported at this time. Terminal server operating systems are not supported. Contact SFTC technical support if you have any questions.

Scientific Forming Technologies Corporation

5038 Reed Road
Columbus, Ohio
43220-2514
Tel: (614) 451-8330
Fax: (614) 451-8325

www.deform.com email: sales@deform.com