

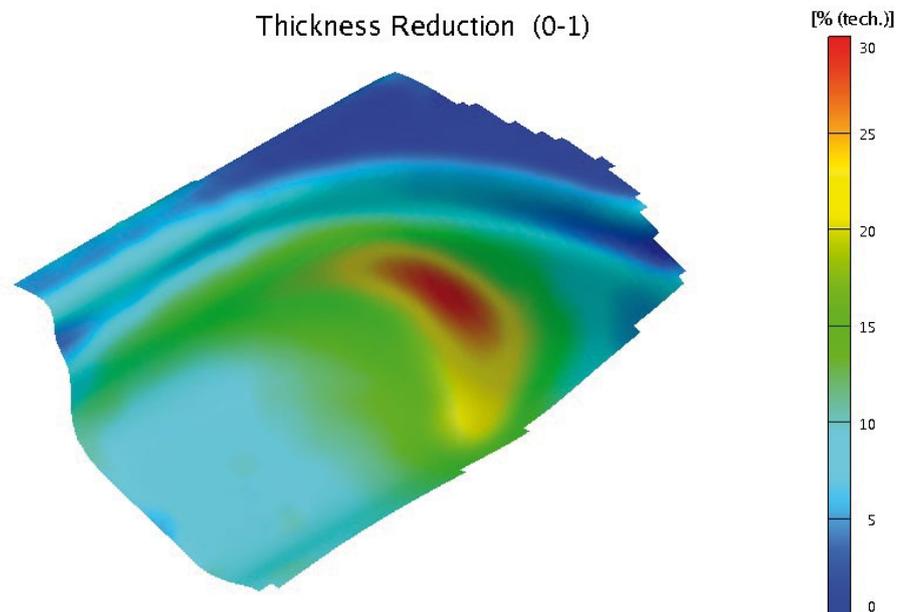
Application Example: Sheet Metal Forming

Optimization of Metal Forming Tools by Forming Limit Analysis

Measuring Systems: ARGUS

Keywords: Tool optimization, Forming Limit Diagram (FLC), Critical Forming Area

ARGUS is designed to measure the strain and thickness reduction in sheet metal caused by stamping, to detect hot spots in the validation process of new and reworked stamping tools and to measure the formability of sheet metal in stamping applications. The present example shows the successful modification of a stamping tool due to the ARGUS measurements.



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Sheet Metal Forming / Forming

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Fig. 1: Stamped part with point pattern

The stamping tool was designed and produced using standard techniques. After the first stamping tests, it became obvious that some areas were deformed close to or above their limits. In these regions, regular point patterns were etched onto the flat sheet metal. After stamping the problematic areas on the part were analyzed using the ARGUS system.

In Figure 1 a part is displayed with the deformed point pattern. Different views were captured using the high resolution ARGUS CCD camera. Then, the ARGUS software automatically defined the positions of all 3D points, corresponding to the point pattern found in the images. The 3D point cloud defines the form of the object after stamping.

As a regular grid was applied to the original sheet metal, the change of distances of the neighboring points define the strain in this area of the part. With the assumption that the point pattern moves in accordance with the material and the sheet is thinned, the reduction of the thickness of the part due to the deformation is displayed in Figure 2. The corresponding Forming Limit Diagram (FLD) in Figure 3.

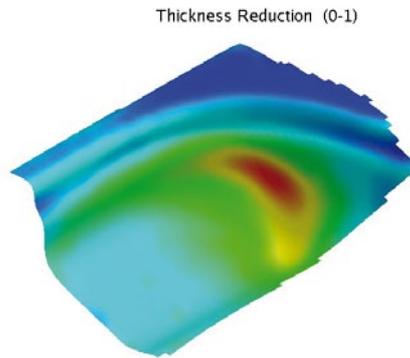


Fig. 2: ARGUS results - reduction of the sheet thickness due to the stamping

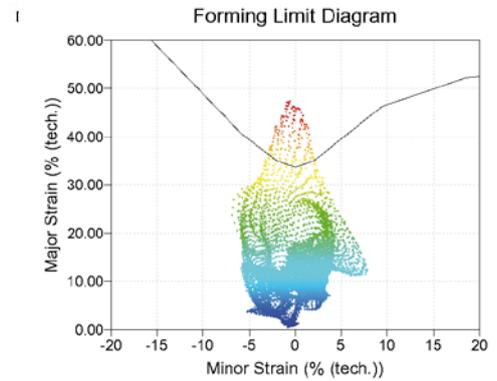


Fig. 3: ARGUS results - corresponding FLD

The FLD shows clearly that many measurement points are above the forming limit curve of the used material. In these areas the part will probably tear or is so weak that it can not be used at all. Using the additional information given by ARGUS (flow direction, display of the undeformed sheet with its expected reduction in thickness, major and minor strain) the tool was reworked and the stamping parameters were adapted. A new measurement was performed in some minutes to verify the changes. In Figure 4, the results of the second ARGUS measurement from a stamping test using the modified tool and adapted stamping parameters is shown. Displayed is the form after stamping, with color coded display of the thickness reduction of the sheet due to stamping. The corresponding FLD of all measured points is also displayed in Figure 5. The image shows that the stamping process is well in tolerance in this area.

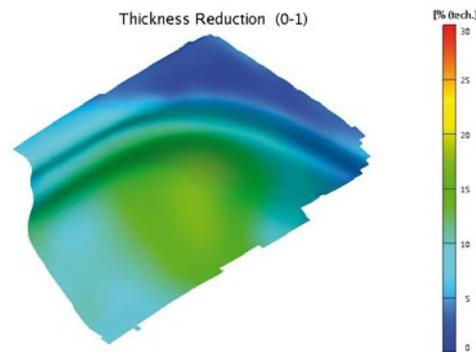


Fig. 4: Resulting thickness after modification

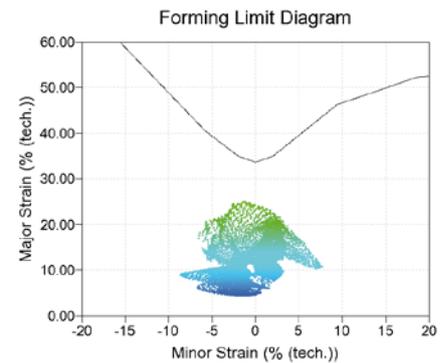


Fig. 5: Corresponding FLD after modification

Using the ARGUS stamping verification system, the tool and the process could be modified in an efficient manner, based on exact measurements. In the second measurement, the system was used to proof the stamping tool and the process and also used to document the results for further inquiries.

By courtesy of Renault.