Chair of Metal Forming and Casting
TUM School of Engineering and Design
Technical University of Munich

Development of an assistance system for the manufacturability evaluation in free-form bending

Final Report

Motivation

Free-form bending represents an attractive process for the manufacturing of complex structural components of arbitrary 3D-shape. Especially in the automotive sector, interests towards this technology is growing steadily, as it allows an unmatched geometrical flexibility at a reduced tooling cost. The desired geometry is obtained by feeding the semi-finished part into a movable bending head, which deforms the component depending on the applied kinematics. However, the process design and the derivation of the required kinematics to obtain the target geometry is a complex task, which is still affected by a lengthy trial-and-error process. The aim of this research project was to develop an assistance system software, which is able to support the user throughout the whole design phase and allows to evaluate the manufacturability of a given target geometry.

Method

The developed bending assistance system (BASY), also called *bendex*, is characterized by a modular structure, addressing every step of the process design singularly. First, the *Bending line module* is devoted to analyse a given geometry in form of a STEP-file or from a bending table, and to extract its bending line. This is stored as a NURBS-curve, for which several properties such as the curvature, the torsion, the Frenet- as well as the Parallel-Transport-Frame can be calculated. Successively, the *Calibration module* introduces the relation between the bending head degrees of freedom (DOFs) and the obtained bending properties, radius and angle. This information, coupled with the machine configuration stored in the *Tool module*, allows to retrieve the DOFs of the bending head in the *Kinematics module*. This can be directly exported in a bending programme or an NC-file (G-Code). Finally, the arising deviations in the part can be reduced making use of the *Compensation module*. This offers an automatic compensation strategy for geometrical deviations on basis of the kinematics and reconstructed bending line.

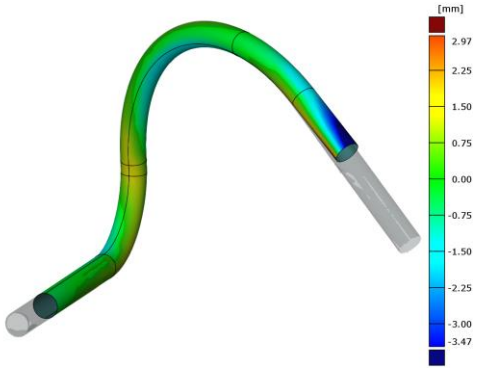

Figure 1. Compensated component using *bendex*

Results and Outlook

The implemented assistance system *bendex* successively allows to drastically reduce the effort and experience needed to design the free-form bending process.

Publications

- doi:10.1088/1757-899x/1284/1/012061
- doi:10.1007/978-3-031-18318-8_18
- doi:10.1007/978-3-031-06212-4_73

Project run time

11/2019 until 12/2022

Funding

Bilateral industrial project

Partnerships

Hörmann Automotive GmbH

Research done by
Lorenzo Scandola, M.Sc.