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Manufacturabilty evaluation in free-form bending

Development of an assistance system for the evaluation of manufacturing of free-form bending components

Motivation

The free-form bending process opens new scenarios concerning the complexity of the allowable shapes, reducing concurrently the process times and configuration efforts. Arbitrarily complex bending geometries, consisting of variable bending radii and angles as well as spline-based geometries, can be obtained with the employment of a single tool. Nevertheless, the assessment of the feasibility of the design and the manufacturability of the part is currently affected by inefficient and non-systematic trial-and-error procedures.

Fig. 1: Free-form bending MOS machine by J.Neu GmbH

The aim of this work is to develop a modular assistance system for the evaluation of the manufacturability of round tubes, which can assist the designer from the early design-phase.

Approach

First, it is necessary to implement an efficient tool allowing to extract automatically the bending line from a CAD .step file and to translate it into machine instructions. At this stage, the compensation of geometrical deviations must be addressed and the kinematics of the tool can be adapted on basis of an optimised compensation algorithm.

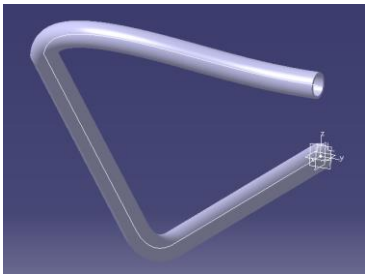

Fig 2: Test geometry including lines arcs and splines

Concurrently, the bending process must be supported by a reliable simulation model, allowing to efficiently identify the most important influencing factors in free-form bending. Finally, the analysis of process-induced material properties is carried out. This requires an accurate modelling of the elasto-plastic behaviour of the materials as well as the investigation of typical defects. In addition, the effect of batch fluctuations of the raw material is investigated and their consequences on the following processes, such as hydroforming, welding and cutting are explored.

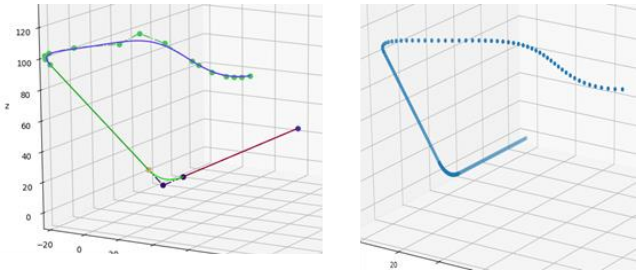

Fig 3: Parametric (left) and discrete (right) bending line.

Conclusion

The developed framework constitutes an intelligent interface between the user and the machine, and is devoted to optimise the process in the spirit of the Industry 4.0 concept. The outcome of the work is a wider diffusion and increased production volumes of free-form bent parts.

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