Success Story
COMET

XTribology
Excellence Centre of Tribology
Programme: COMET – Competence Centers for Excellent Technologies
Program line: K2-Centers
COMET subproject, duration and type of project:
Holistic modelling, 04/2015 – 03/2020, multi-firm

Digital twin for the production of cardboard “cans”

Cylindrical food cans made of decorative cardboard represent a functional and ecologically sensible form of packaging, and at the same time give the product an individual and visually appealing look. To connect the packaging base and wall, the tubular wall is crimped in a forming tool and glued to the base.
The geometric contour of the forming tool was optimized in a combined experimental and numerical approach in terms of extended tool life and increased product quality.

Problem definition and goal

Cylindrical food cans made of decorative cardboard offer a functional and ecologically sensible type of packaging with a wide range of individual design options.

Appropriate finishing techniques, such as film lamination or offset printing, can be used to give these packages additional functionality and the packaged product an optically appealing look.

In a typical manufacturing process, the protruding end of an initially cylindrical tube of laminated cardboard is bent radially inwards in a rotationally symmetrical forming tool and glued to an inserted circular base (Fig. 1).

In this process, the so-called flanging, the board is plastically deformed, and considerable forming and friction forces have to be transferred between the forming tool and the board. In addition, the flanging process causes tool wear and large strains in the product, which can lead to damage to the board surface under unfavourable process conditions.

Fig. 1: Bottom of a cylindrical food can formed by flanging (© V-Research GmbH)

The aim of this project was therefore to optimize the geometric design of the mould in order to extend the service life of the mould itself on one hand, and to increase the quality of the final product on the other.

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Virtual optimization – real validation

In order to optimize the tool geometry in a time- and cost-efficient way, the flanging process was simulated using a computer model (based on the finite element method), which includes component movement (turning, closing, and opening), material behaviour (elasto-plastic material law), and contact conditions (frictional forces, surface roughness) as realistically as possible. With the help of this system simulation – subsequently called digital twin – geometry variations were studied in "virtual experiments". (Fig. 2)

Starting from the original geometry, a first set of geometry variations were determined using a design-of-experiment (DoE) approach and evaluated using the digital twin. Based on these findings, the geometry parameters were refined step-by-step so that a satisfactory result could be achieved in a few iteration steps – initially on the computer.

In addition, these virtual experiments were accompanied by laboratory tests with selected real form tools. This made it possible to check whether the model assumptions on which the digital twin was based were justified and to experimentally validate the computer calculations.

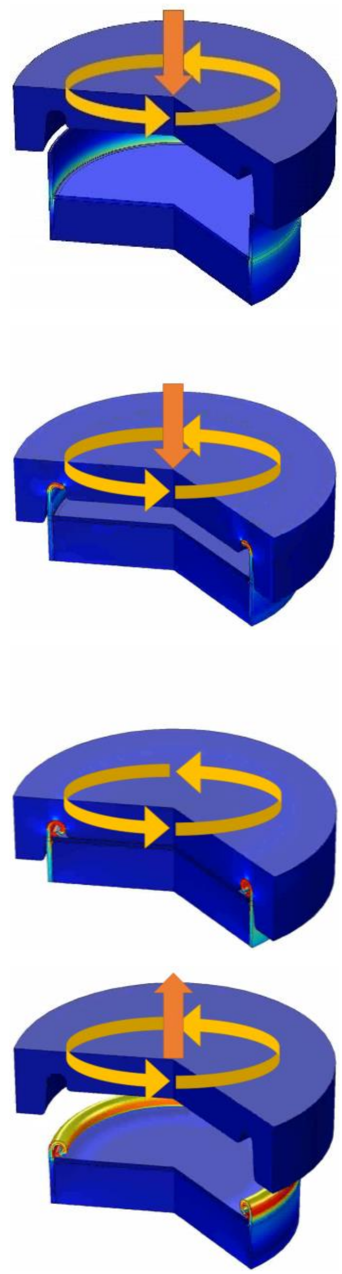

Fig. 2: Simulation of the flanging process using a digital twin (© AC2T research GmbH)

Impact and effects

The chosen procedure, namely the combination of design-of-experiment approach, realistic system modelling (digital twin), and experimental validation in laboratory tests, has significantly reduced the time and cost required for an optimized tool geometry. Based on the results of this work, a new tool was produced, which is currently being tested in the real production process.

Contact and information

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