AUTHORS

Muhammad Saeed, Ayesha Quddus, Hamas Khan, Hadia Zulfiqar, Racim Radjef, Boris Eisenbart, Matthias Kreimeyer

OPTIMISING FORMING PROCESS BEHAVIOR USING ARTIFICIAL INTELLIGENCE

01. Motivation and Research Objectives

Forming process - used to shape flat sheets of material into three-dimensional components

- **Stamp Forming** - using a stamping press as in Fig 1
- **Diaphragm Forming** - using a diaphragm or flexible membrane

Artificial Intelligence - to increase the simulation accuracy of forming process

- **Optimisation** - to improve simulations and time for computations, while reducing the cost
- **Defect Detection** - to overcome defects by detecting them at early stage of design, using point cloud as shown in Fig 2

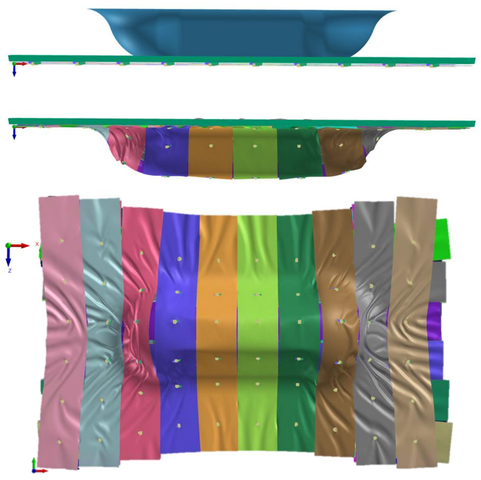


Fig 1: Stamp Forming

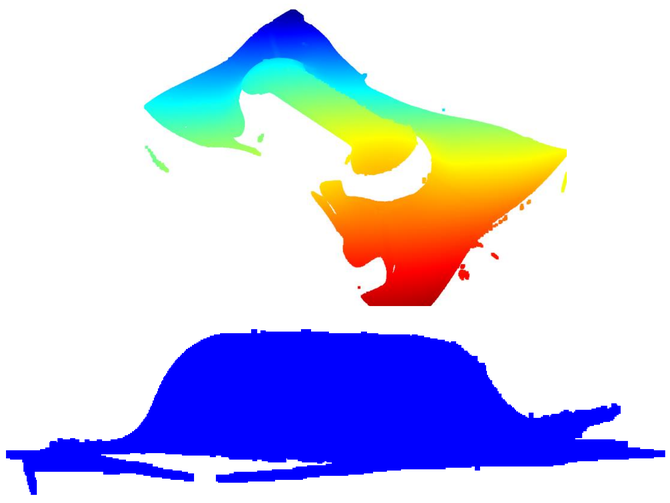


Fig 2: Point Cloud Scanned

02. Introduction

- Simulation-driven evaluations help in reducing the cost of forming processes by various Artificial Intelligence based optimisation steps as illustrated in Fig 3.
- Several Machine Learning techniques such as Genetic Algorithm are used to predict and classify forming behavior.
- Induced forming defects, such as wrinkles, bridging, voids, are optically inspected using point cloud-based system.

03. Initial Evaluation

Optimisation - Multiple Linear Regression (MLR) is implemented for curve fitting and Multi-objective Genetic Algorithm (GA) for finding optimas. Pareto plots and Open-source tools like Para View and HDF View are used for visualisations of simulations as seen in Fig 4.

Defect Detection - Defects are detected by analysing the surface normal. The normal vectors for the simulation and point cloud are compared and visualised as in Fig 5.

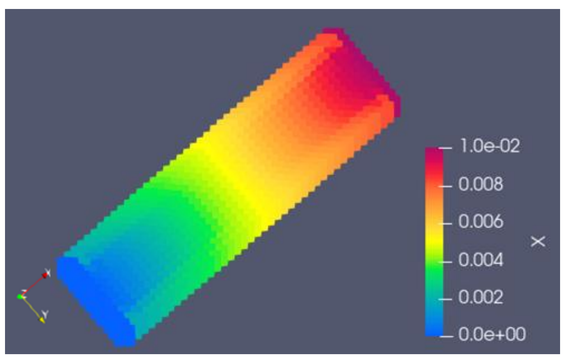


Fig 4: Beam Visualisations

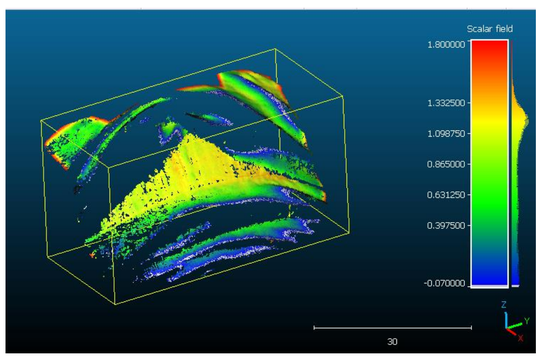


Fig 5: Cloud Compare

04. Results and Future Outlook

- The optimisation tool has been deployed for a beam model, now it is being validated on a Double Dome geometry as displayed in Fig 6.
- The scanned points are being removed based on an angle threshold as in Fig 7. Additionally, preprocessing techniques such as Octrees, multithreading, KNNs, and distance threshold are used.

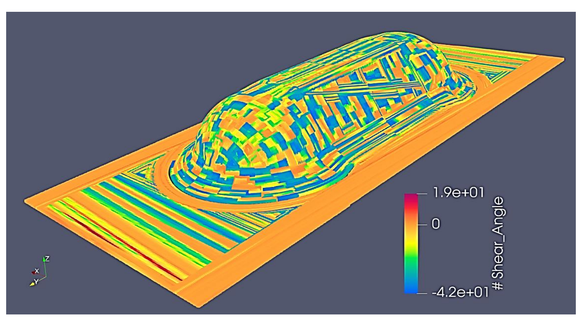


Fig 6: Double Dome Visualisation

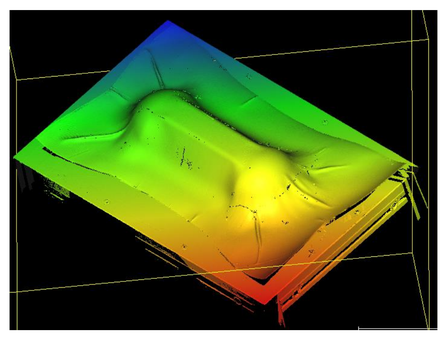
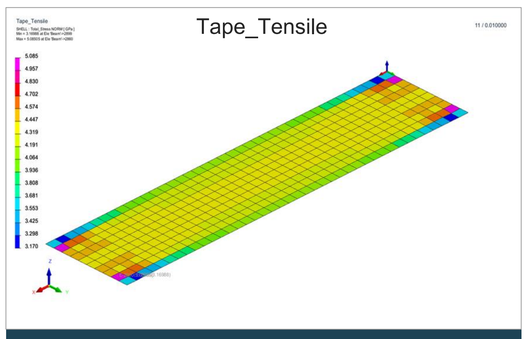
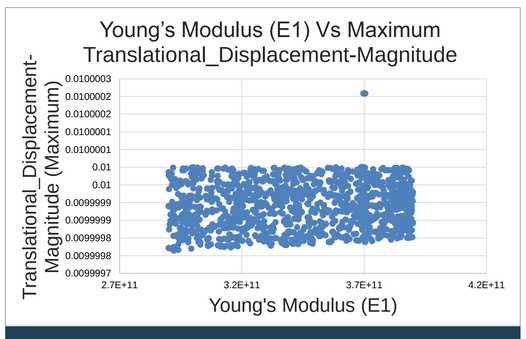


Fig 7: Point Cloud Visualisation



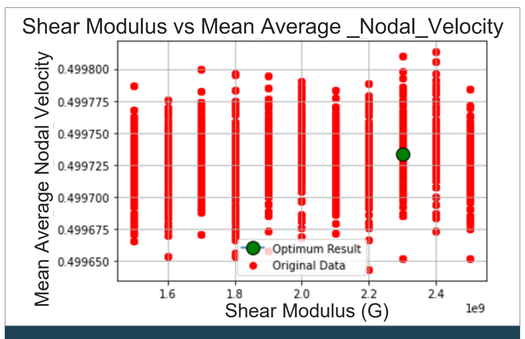
Geometry

A beam model for initial testing



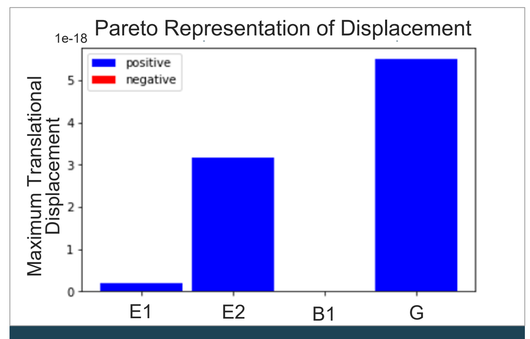
Parameterisation

Parametrise the material parameters such as young's modulus and shear modulus



Genetic Algorithm

Minimise or maximise the parameters to get the optimum results



Analysis

Pareto plots to depict the relationship between different parameters

Fig 3: Process Chain

Muhammad Shahrukh Saeed
University of Stuttgart / Swinburne University of Technology
msaeed@swin.edu.au (+49 176 36356049)

SWINBURNE UNIVERSITY OF TECHNOLOGY

University of Stuttgart
Germany