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Optimising Formability and Sustainability in AA6082 Stamping: A Numerical Approach Using AutoForm Simulations

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Introduction

High-strength aluminium alloys such as AA6082 are used commonly for lightweighting in the automotive industry. With the recent development of **FAST technology**, this study aims to compile a manufacturing process optimising the **cost and sustainability** of the resulting part, without compromising the strength or quality of the formed part.

Objectives

- Maximise part strength and surface quality
- Minimise production cost and CO2 emissions

Methodology

1. An AutoForm CAE model of a testing part was used as a base result for this investigation
2. Various parameters of the model were changed including forming **Temperature, Blank Shape, Blank Holder Force and Forming Speed**
3. Numerical data is extracted from simulations using a drawn section plot across the part
4. Data is analysed to find optimal processing parameters for strength and surface quality
5. Optimised presets were compared in a **cost and sustainability analysis** using calculations considering the carbon emission factors and costs of material and manufacture

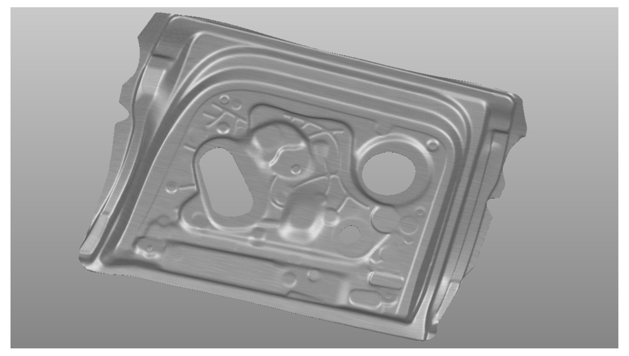

Figure 1: Example of CAE model in AutoForm.

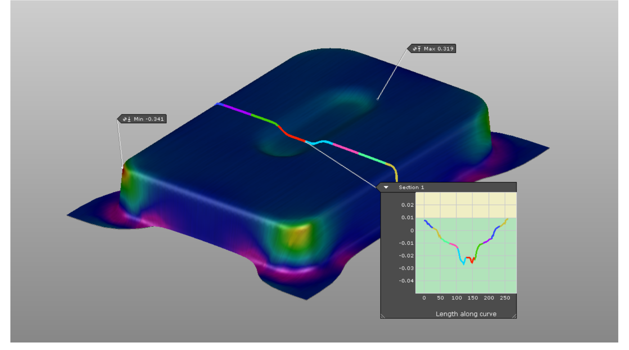

Figure 2: Example of data collection.

Results

Thickness Distribution

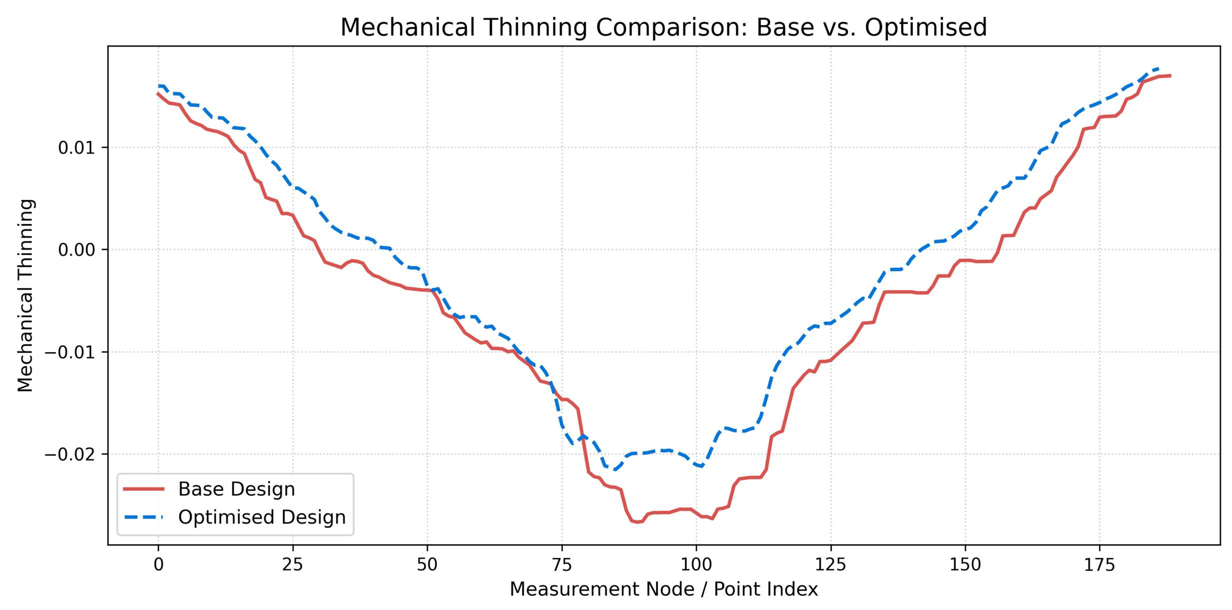

Figure 3: Variance of thickness across part, comparing the base stamping process (solid red) to the optimised process (dashed blue).

Springback Angle

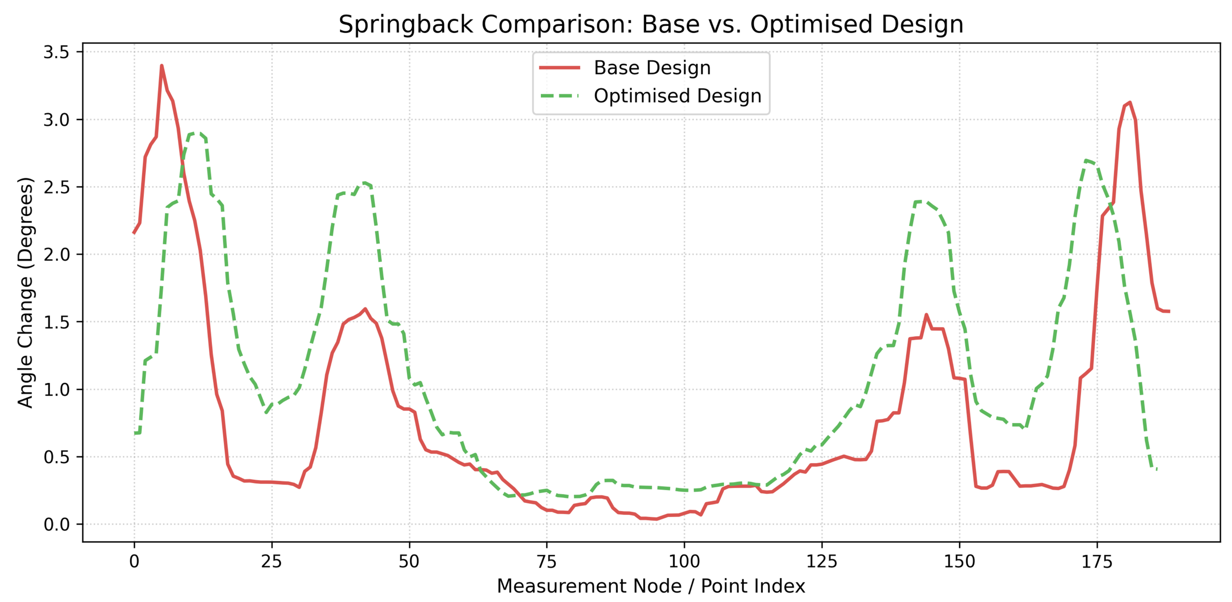

Figure 4: Springback across part, comparing the base stamping process (solid red) to the optimised process (dashed blue).

Wrinkling

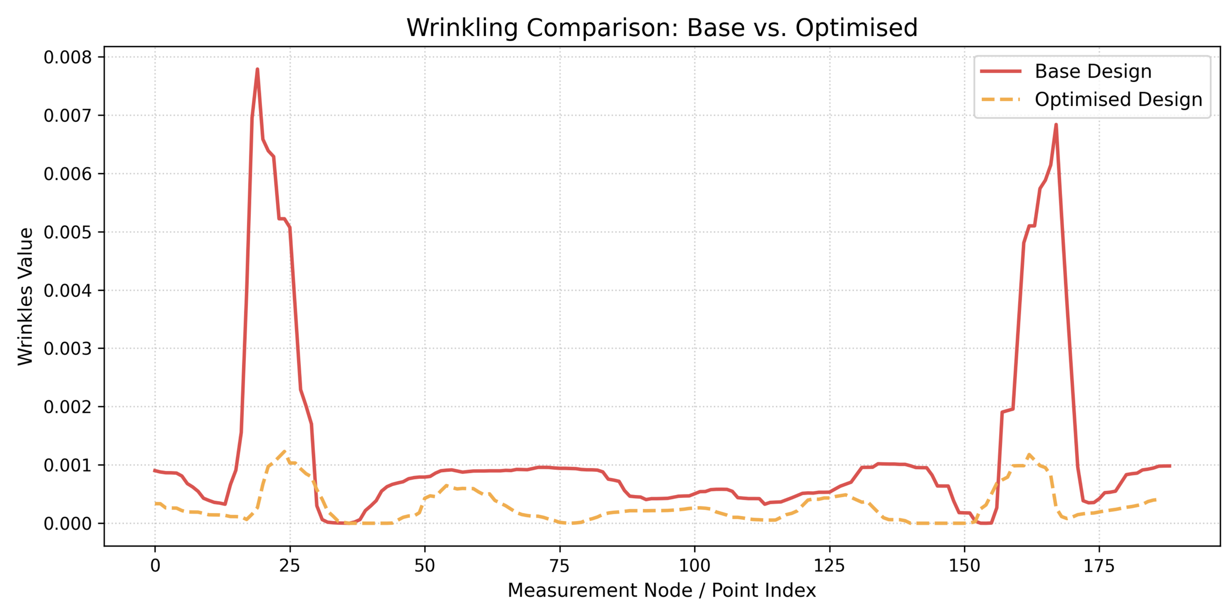

Figure 5: Wrinkling across part, comparing the base stamping process (solid red) to the optimised process (dashed blue).

Global values from the base result and optimised result were compared and populated in the table below

Table 1: Relative change in global values between the two manufacturing processes tested.

	% change
Max Thickness	2.1
Min Thickness	6.5
Max Springback	-18.3
Medium/High Wrinkling	-82.8
Cycle time	-42.0

Cost

The price of manufacturing a single part in GBP were calculated by considering the cost of material and energy for machinary in Ningbo, China [1, 2].

Table 2: The cost of manufacturing a single part broken down to the cost of aluminium and required energy for machinary. Costs included for both base and optimised setups based on material and energy costs in Ningbo, China.

	Base	Optimised
Material	1.69	1.41
Energy	1.23	0.62
Total	2.92	2.02

Sustainability

CO2 emissions in kg were calculated for a single part by considering the carbon emission factor for both material manufacture and power generation. [3, 4]

Table 3: Emitted CO2 in kg for manufacturing of aluminium and generation of power for factory use. CO2 emissions included for both base and optimised setups based on carbon emission factors for Ningbo, China.

	Base	Optimised
Material	2.69	2.23
Energy	10.58	5.29
Total	13.27	7.52

Discussion and Conclusion

The study successfully proved that common hot forming practices can be optimised for **reduced costs, cycle times and CO2 emissions** whilst producing similar mechanical properties.

Key findings include an estimated reduction in costs by **30.9%**, a reduction of manufacturing cycle times by **42.0%** and an

Estimated reduction in CO2 emissions by

43%

*Assumptions were made during the calculation for simplification

Future Research

Despite the success of this study at meeting the objectives, further research is required in several areas. Most notably, experimental validation is required to support the current numerical results.

Affiliations and References

[1] Department of Mechanical Engineering, Imperial College London

[1] Aluminium Warehouse, 2500mm x 1250mm x 4.0mm 6082 Aluminium Sheet Technical Specifications, 2026.

[2] GlobalPetrolPrices.com, China Electricity Prices, June 2019, 2019.

[3] Decarbonizing China's Grid: Provincial Grid Carbon Footprint Factors and Export-Embedded Electricity Emissions from 2020 to 2060, Carbon Footprints, vol. 4, no. 4, 2025. doi:10.20517/cf.2025.61

[4] Gleich Aluminium, EN AW-6082 Material Data Sheet, p. 1, 2024.

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