



Comparing Manufacturing Methods for the Morgan Plus Four Lower Control Arm

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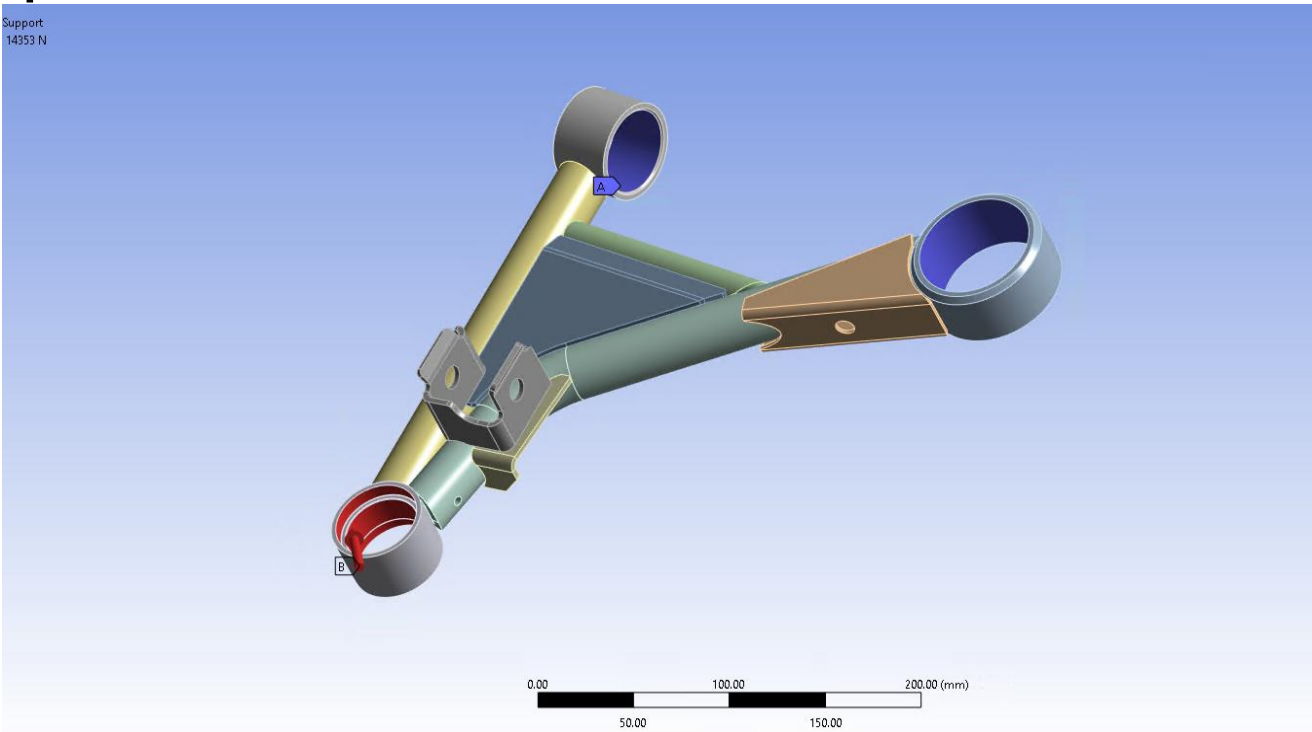
BEng (Hons) Mechanical Engineering



Morgan Plus Four [Morgan Motor Company]

Introduction

Morgan Motor Company has a long tradition of hand-crafted automotive production. However, the hand-fabricated steel lower control arms (LCAs) used in the Morgan Plus Four are heavy, labour-intensive to produce, and limit scalability. This project explored advanced manufacturing alternatives—casting, additive manufacturing (AM), and CNC billet milling—to reduce component cost, improve performance, and align with Morgan’s bespoke low-volume production model.



Existing Steel Welded Lower Control Arm [Morgan Motor Company]

Project Aim and Objectives

This project aims to assess alternative manufacturing methods for the LCA using generative design and FEA simulation to compare structural performance, cost, and feasibility.

Objectives:

- Evaluate traditional, cast, additively manufactured, and CNC-milled LCAs
- Use generative design to optimise components for mass and stiffness
- Perform FEA simulations under realistic automotive load cases
- Conduct a full cost and manufacturability analysis
- Recommend a suitable production method for Morgan

Methodology

Generative designs for the Lower Control Arm were created in Fusion 360 with constraints specific to casting, additive manufacturing, and CNC milling. Each design was analysed in ANSYS using Finite Element Analysis (FEA) to evaluate stress, strain, and deformation under realistic load cases. A manufacturability assessment considered tooling, material use, and production suitability, while a cost analysis compared unit prices for low-volume manufacturing.

Simulation

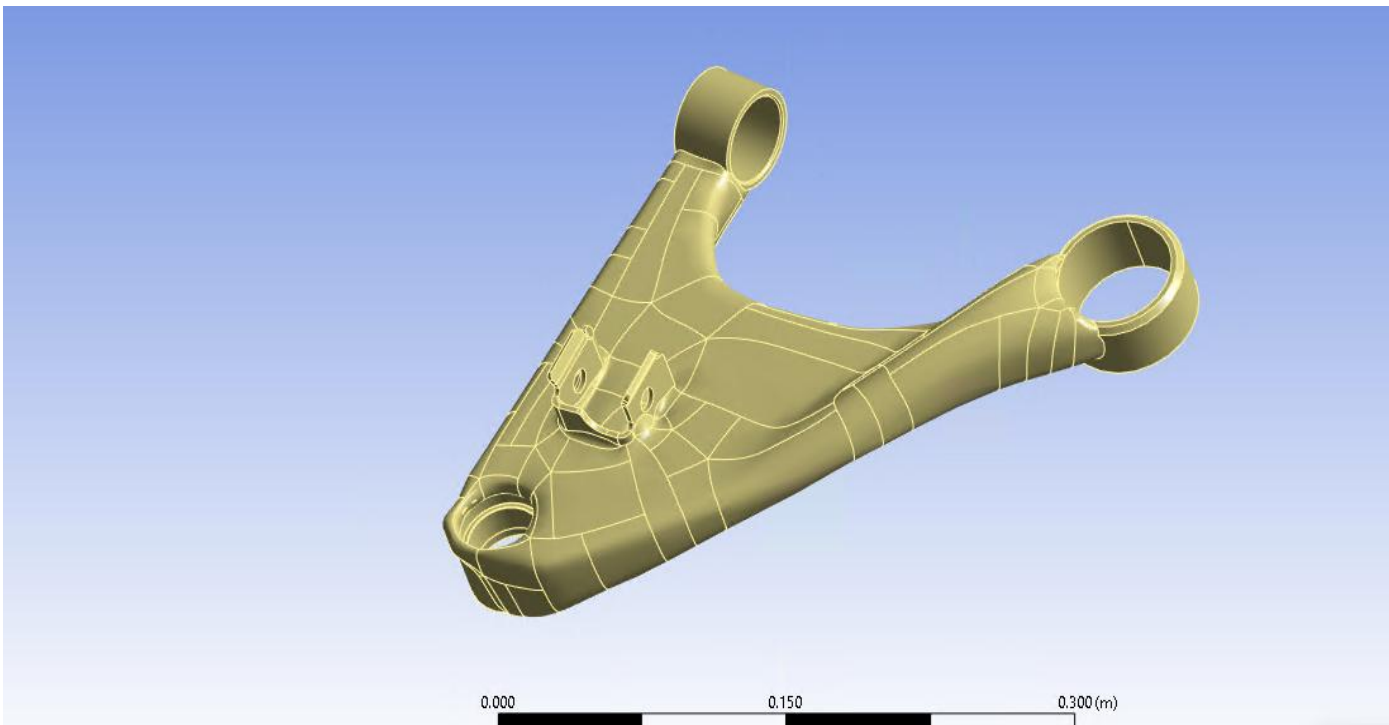
Finite Element Analysis (FEA) was used to evaluate the structural performance of each Lower Control Arm design under realistic automotive loads, including braking, cornering, and bump impacts. Simulations were carried out in ANSYS, focusing on total deformation, Von Mises stress, and elastic strain. The relevant materials were selected to match each manufacturing method. Generative designs showed improved stress distribution and reduced mass, while all concepts were validated to remain within safe limits under worst-case loading conditions.

Table comparing the maximum deformation and maximum stress of each manufacturing method

Method	Maximum Deformation (mm)	Maximum Stress (Mpa)
Hand-fabricated Steel	5.39	27.34
Cast	0.64	98.86
Additive Manufactured (LBPF)	1.77	128.78
5-axis Milled	2.05	128.78
2.5-axis Milled	1.04	19.51

Manufacturability

Each Lower Control Arm design was evaluated for production feasibility within Morgan’s low-volume, bespoke manufacturing environment. The cast aluminium design offered a strong balance of performance and cost with minimal tooling. Additive manufacturing allowed highly optimised geometries but required extensive post-processing and had high material costs. CNC milling provided excellent precision and repeatability, with the 2.5-axis version being more cost-effective than the fully optimised 5-axis design.



Generatively Designed Cast LCA

Final Recommendations

While additive manufacturing achieved the best strength-to-weight performance, its high cost and long production times limit its practicality. CNC milling offered excellent precision but higher material waste. Casting provided the best balance of performance, cost, and manufacturability for Morgan’s low-volume production. Therefore, casting is recommended as the optimal method for future Lower Control Arm production, offering reliable performance with reduced weight and improved production efficiency.

Acknowledgements

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References

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