Design, Simulation and Optimisation of a Formula Student Upright

Pierce Levers K00278030

Aim of the Project

The Aim of this dissertation is to create from scratch an effective and efficient Formula Student Upright using a CAD-FEA-Simulation Loop

Objectives

- Objective 1: Research Formula Student Regulations and Guidelines to determine design constraints.
- Objective 2: Design a functional Suspension Upright for a Formula Student Car using SolidWorks while fulfilling Formula Student design constraints.
- Objective 3: Simulate the Upright's behavior under realistic loading using Ansys Workbench.
- Objective 4: Optimise and Iterate on the design based on Simulation Results with weight and manufacturability in mind.

Background

- Formula Student is a spec series racing competition where every car taking part is both designed and manufactured by teams of students.
- The Goal of Formula Student is to promote learning in new students and provide real world experience about the design process, project management and team work.
- Uprights are a key component in any wheeled vehicle, they serve as the attachment point between wheel, brakes and suspension.
- Upright construction determines many driving characteristics like Camber, Caster and Toe in/out.
- Uprights need to be as light and as stiff as possible to obtain the best performance from the car.

Figure 1: Example FSAE Upright. (Das, 2014)

Design

- Design for the upright was made in SolidWorks and informed through an Assembly Document from the Formula Student Team.

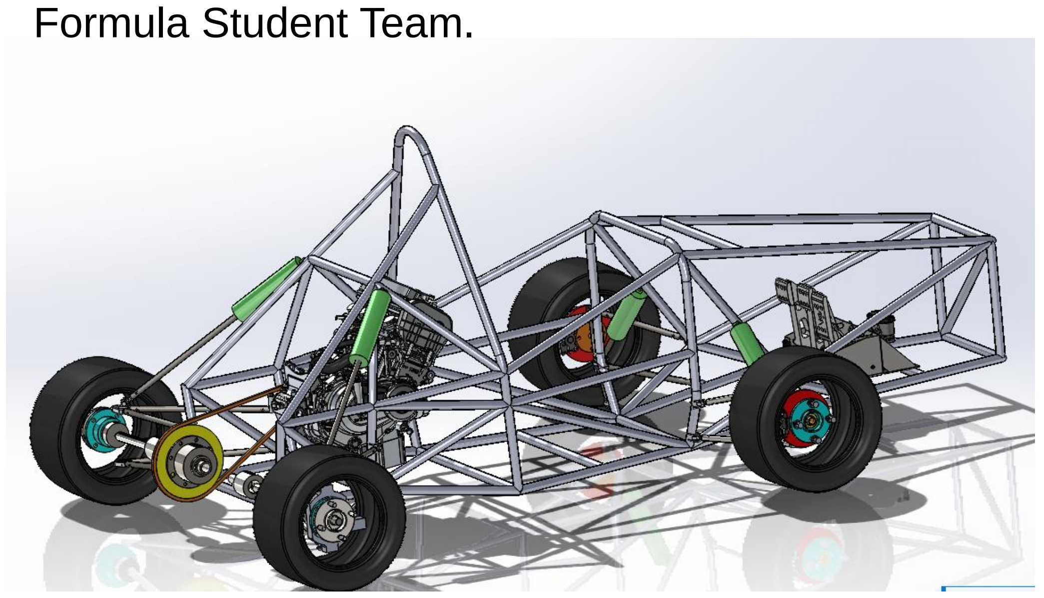

Figure 2: Formula Student Assembly Mockup.

- SolidWorks reference geometry and measurement tools allowed for a theoretical model that will fulfill all requirements without requiring a single prototype.

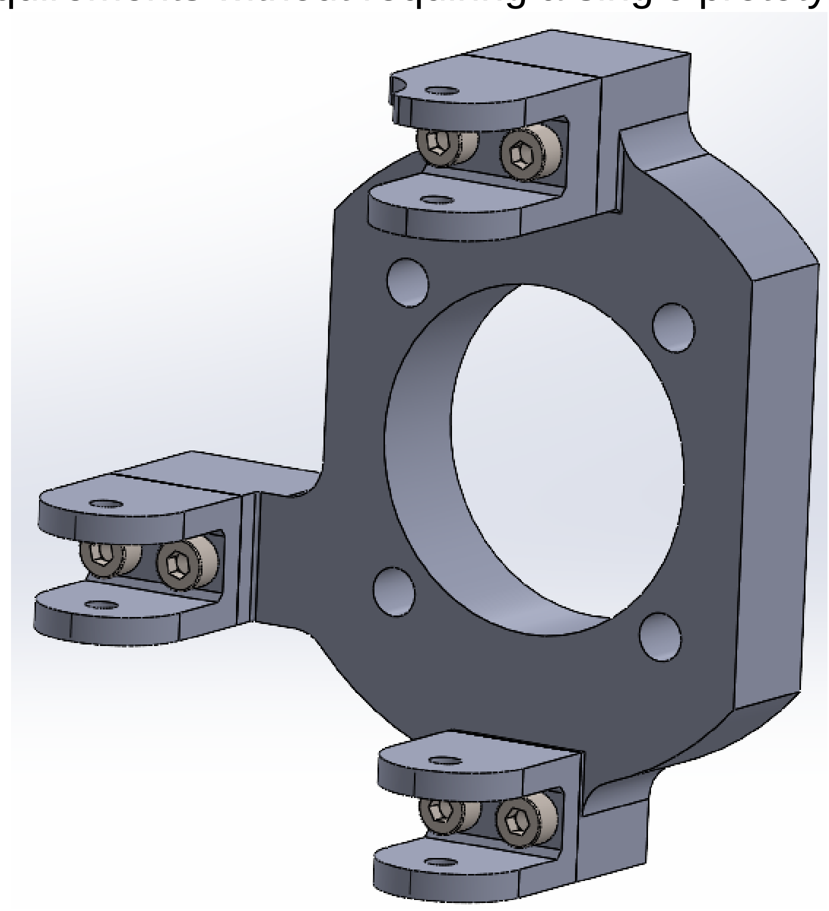

Figure 3: Rear Upright Subassembly.

- SolidWorks also allowed for quick design changes to suit constraints such as Double Shear bolts or maximum weight limits.

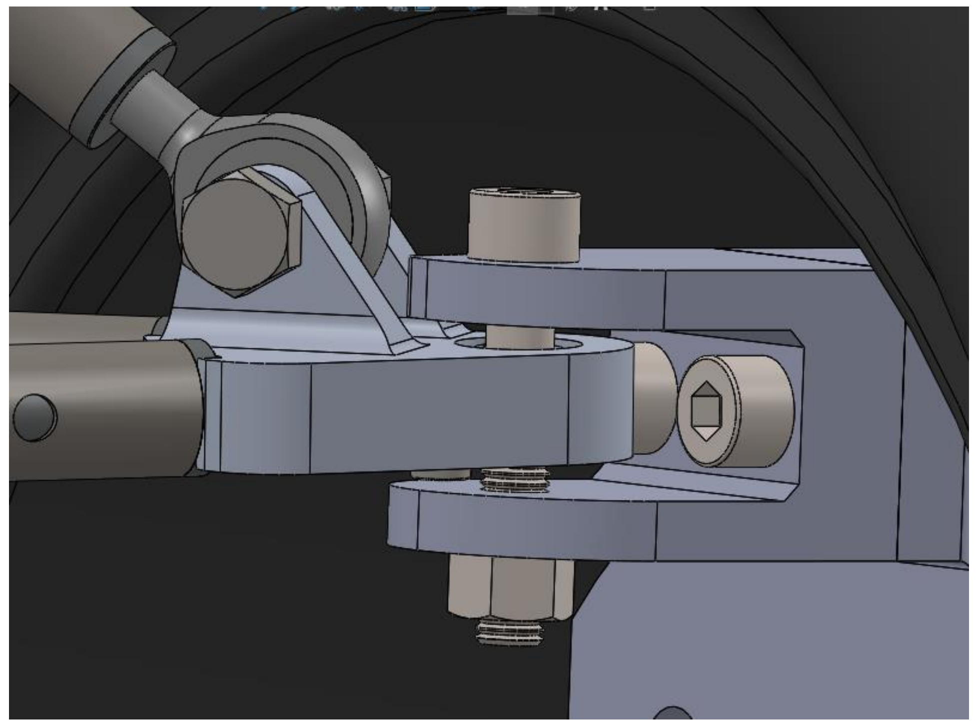

Figure 4: Upright Attachment to Suspension Arm.

- Ansys Granta was used to determine the most suitable material to manufacture the Uprights from.

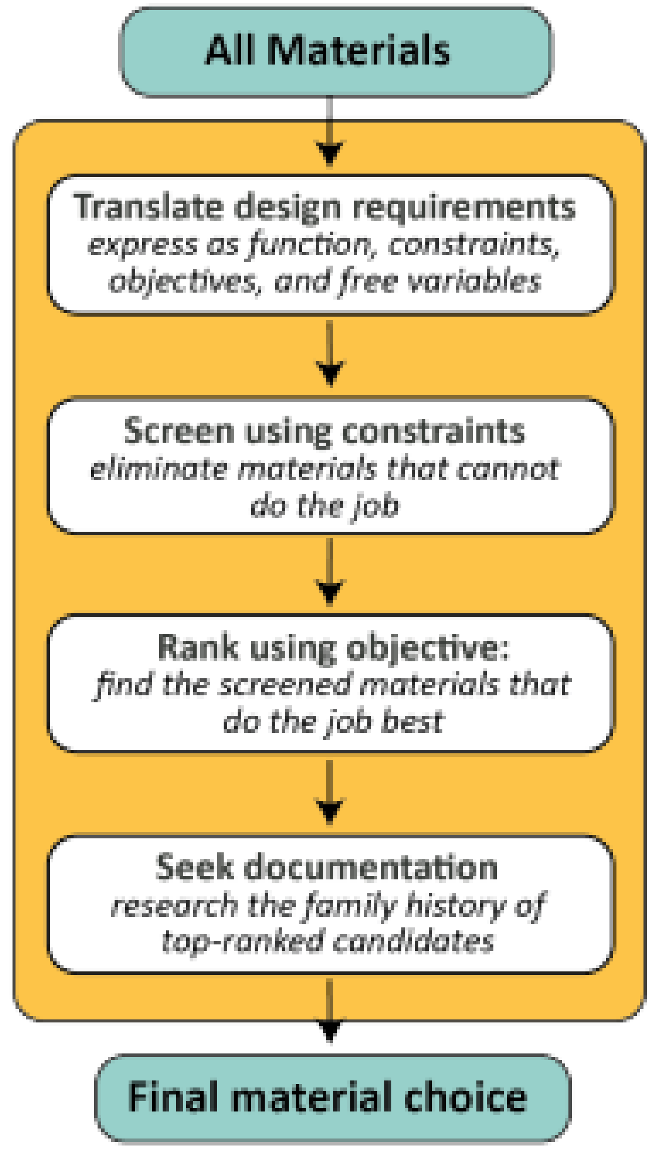

Figure 5: Materials Selection Screening Process.

- Final Material choice was 8090 T851 Aluminium, a high performance lithium based alloy known for its high stiffness and low weight.

Simulation

- Ansys Workbench was used to simulate the Upright under a realistic worst case loading, coming to a full stop from top speed in the middle of the sharpest turn on the track.

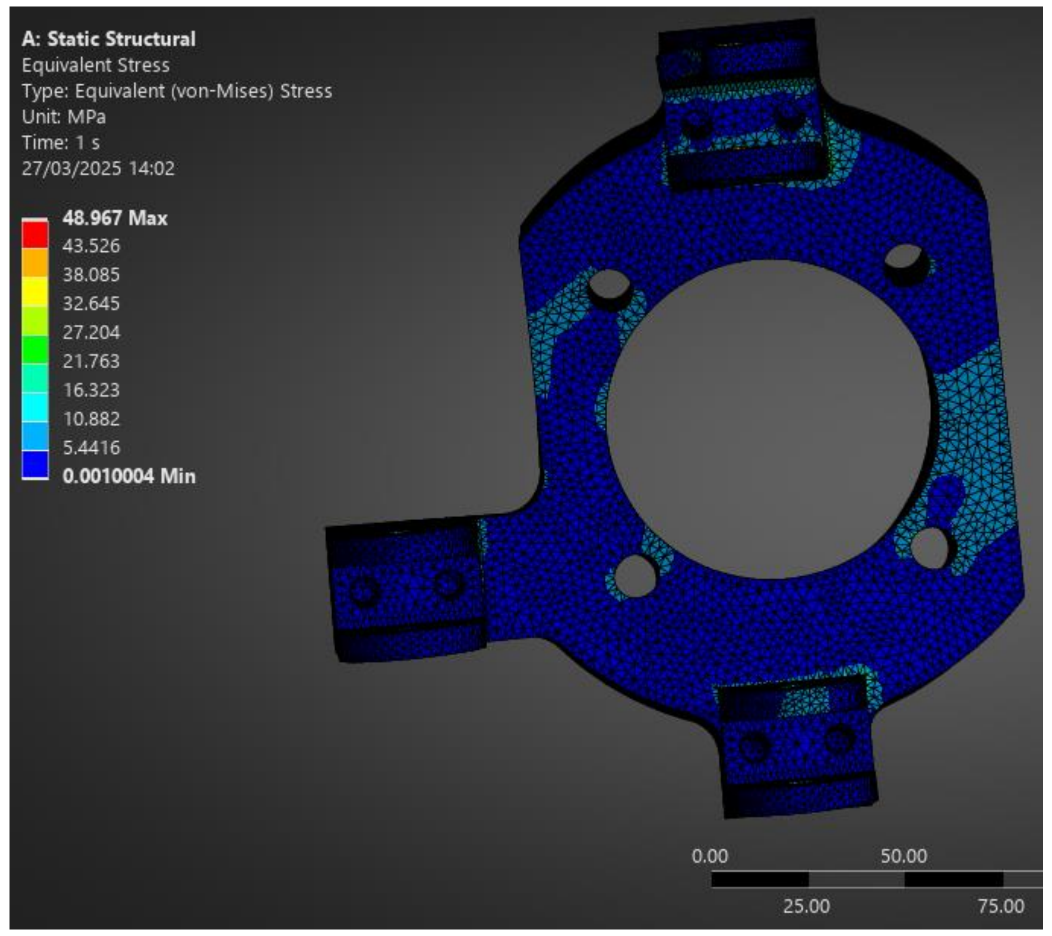

Figure 6: Finite Element Analysis of Rear Upright.

- Ansys Workbench was then used to perform topology optimisation to show where material can be removed to make the upright more efficient without losing performance.

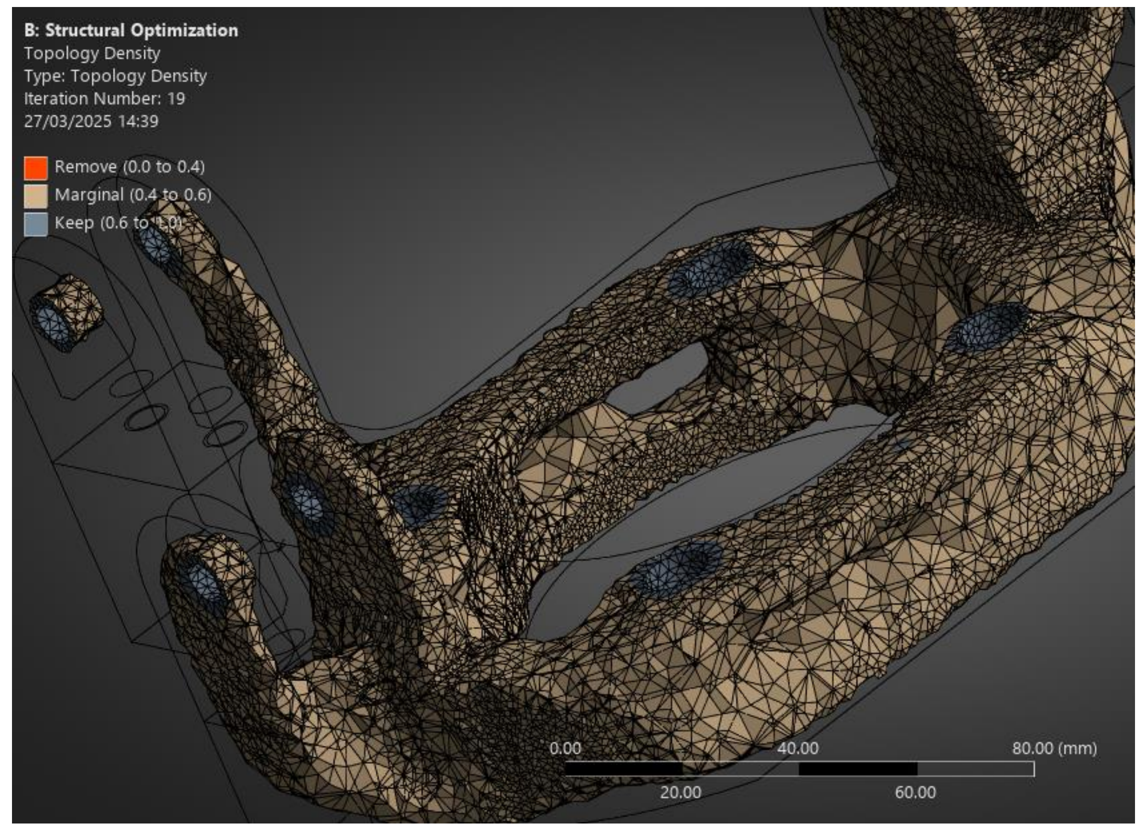

Figure 7: Ansys Topology Optimization 50% Retained.

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