Project

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Submitted: 11-Apr-2025

Description

MacID: buham

Motor location: Front (met in the drive system)

Gear ratio: 6:7 (met in the drive system)

Body shape: Car

Design

The top-level assembly file is named Project.iam. Other relevant files include Project.idw and Project.pdf (drawings); and Suspension.wmv, Battery Mount.f3d, and Centre Steering Rod.f3d (simulations)

The car is designed in a sports car style. This includes the use of a smooth contoured body.

The drive and steering systems are designed using bevel gears. These allow for the direction of the motor's output to be changed, which is needed unless 1 motor was used for every wheel, which is inefficient. Rear wheel steering is unstable, so the car implements front wheel steering using a simple double-crank four-bar linkage. The car has rear wheel drive to keep the front wheel mechanism simpler as it is already dealing with steering. Servo motor is for steering, provided motor is for drive, **rotate the rod the drive motor is connected to test out the drive system, and the gear the servo motor is connected to test out the steering system**.

The suspension is based on a MacPherson strut. Wheels, axles, and anything required to move or power the axles is mounted on the Bottom Frame. Everything else is mounted to the Top Frame. For simplicity, only up and down movement is controlled by the suspension, not rotational movement. **The suspension will not move if dragged, go into Full Suspension, then Suspension, then Actuator Casing, then the mate constraint with limits to test it out**.

The servo motor is in the middle, while the drive motor in the front right to avoid conflict with servo motor. The weight imbalance is slightly canceled out by bevel gear being on left side of Motor Lengthwise Transmission Rod.

Anything rotating around a fixed support is attached via a bearing to allow for relative motion, while set screws are used to fasten gears and driven wheels to axles.

The bearing consists of 2 segments, one being 1.38 mm long and one being 0.48 mm long. The presence of any such oddly specific dimensions in drawings, in particular any 1.4 mm (1.38 mm rounded to 1 decimal place), is to accommodate this.

Set screw: https://www.mcmaster.com/92015A011/

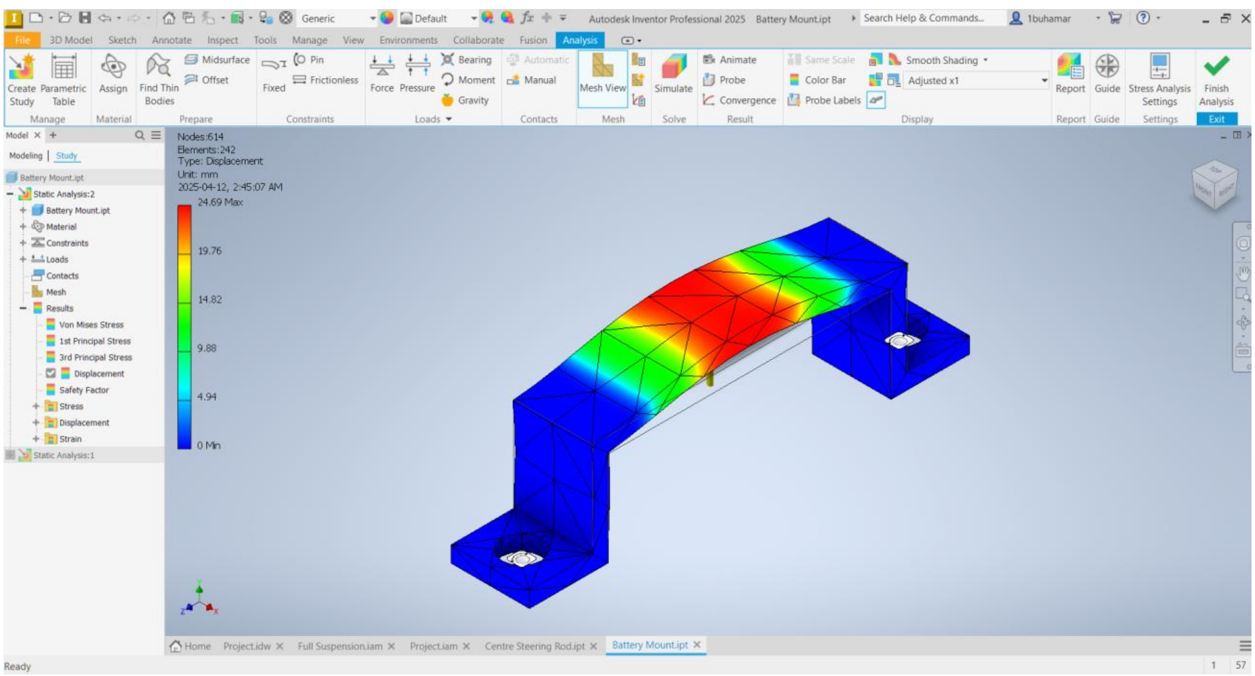
Servo motor: https://www.3dfindit.com/en/search?q=EMME-AS-40-S-LV-AS

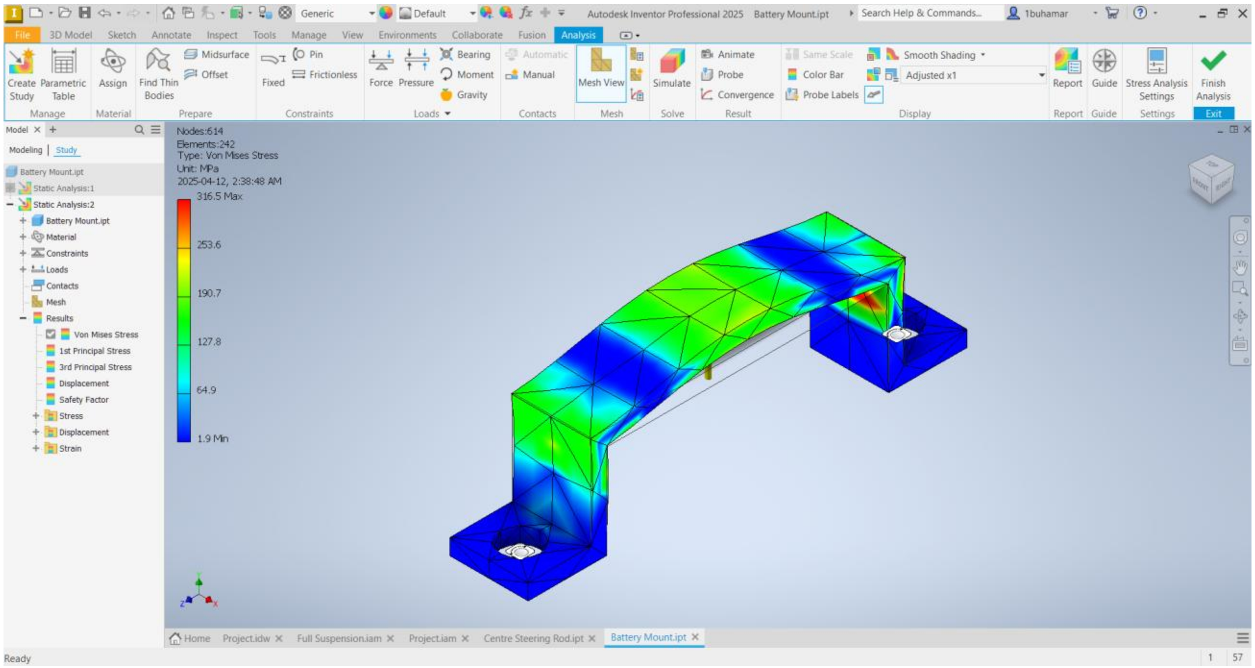
All other parts are original or from Inventor's Content Centre or Design Accelerator.

Stress

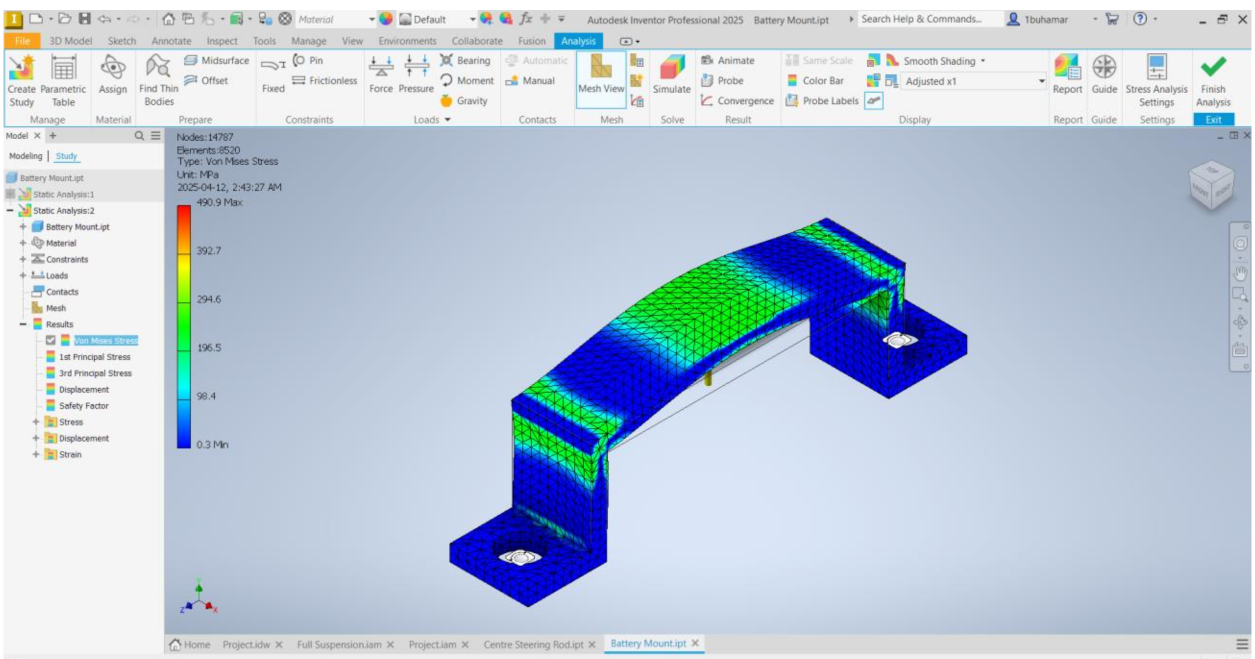
A stress simulation was conducted on the battery mount to simulate the battery bouncing and pushing up on the mount. A force of 1000 N was applied, the holes were set with pin constraints, and the material was set to PAEK plastic.

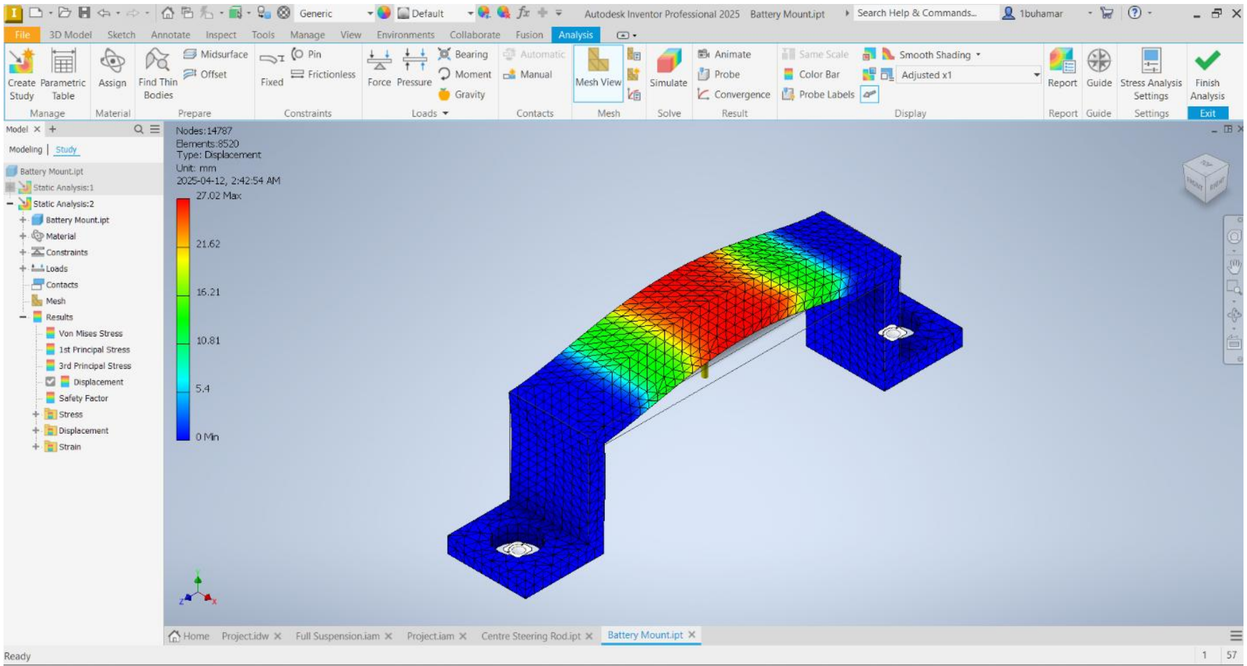
Average element size: 0.1



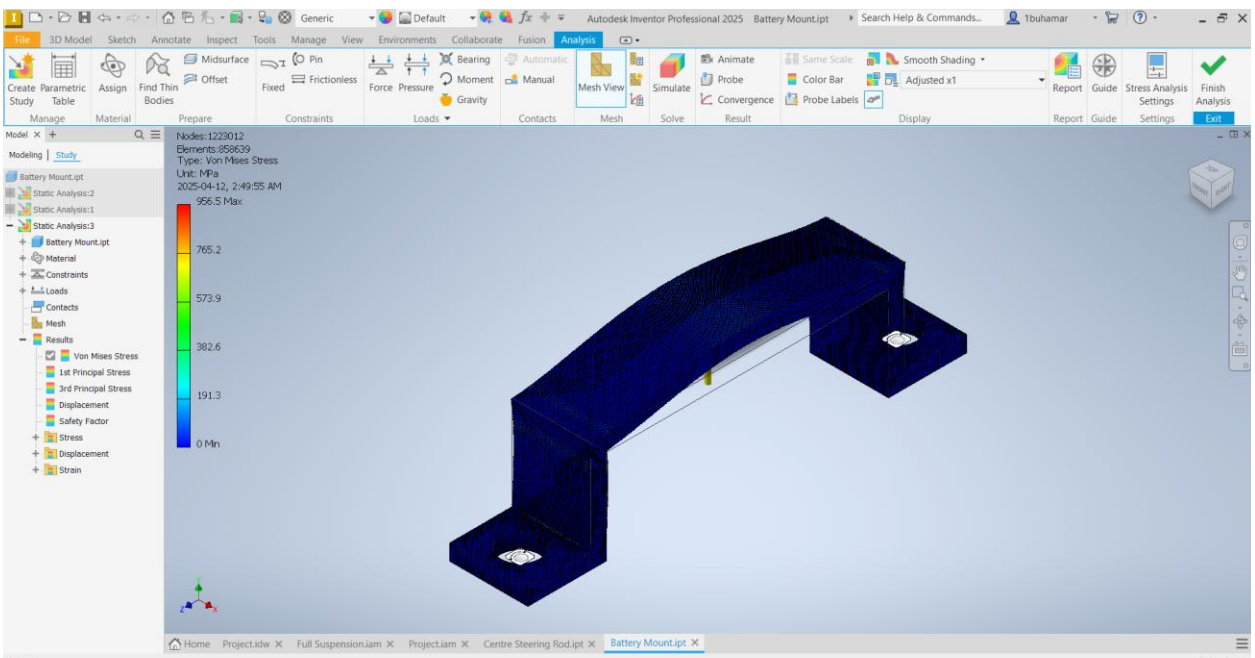


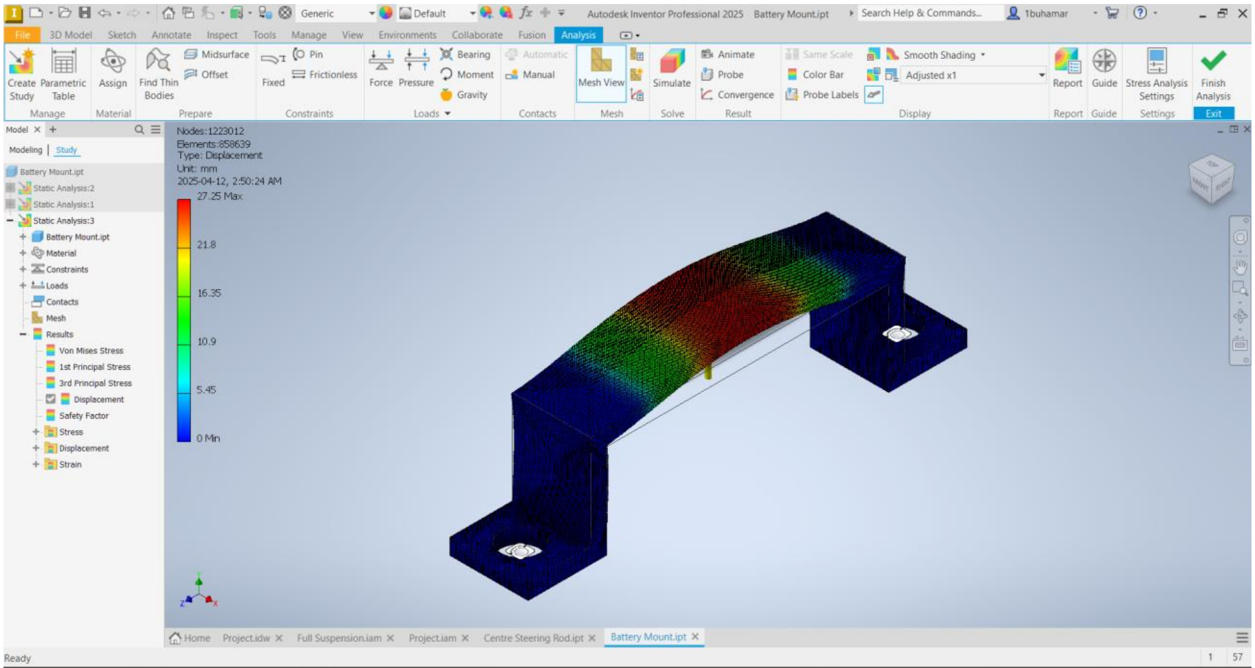
Average element size: 0.02



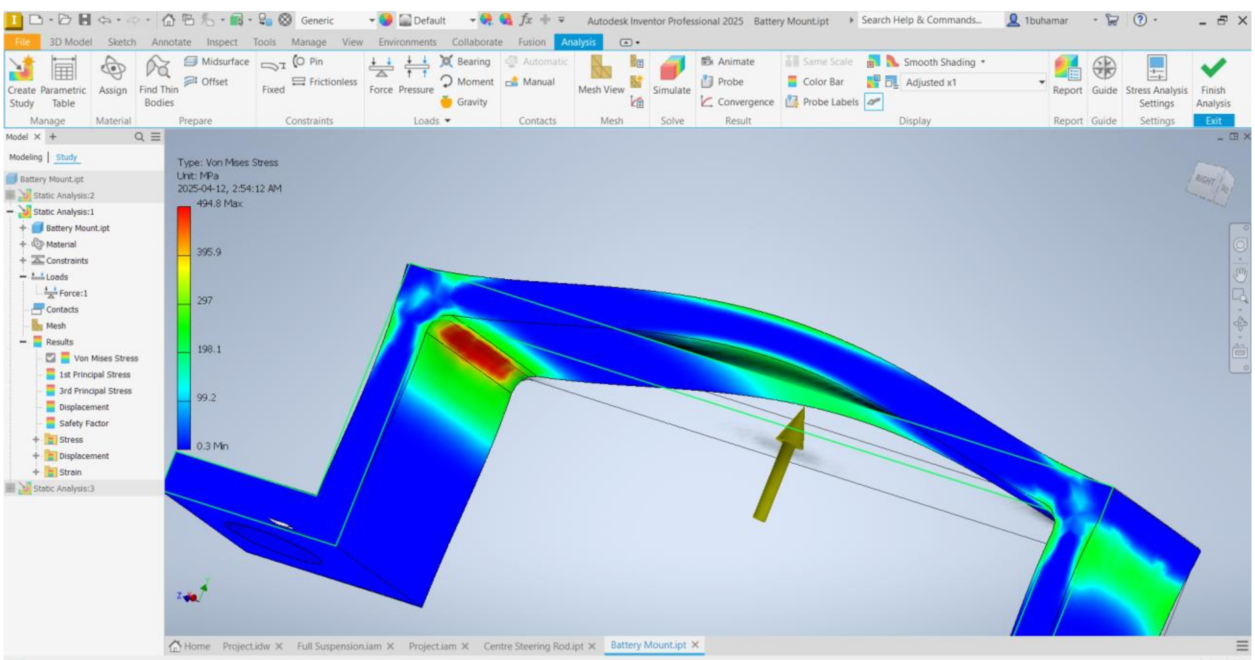


Average element size: 0.004



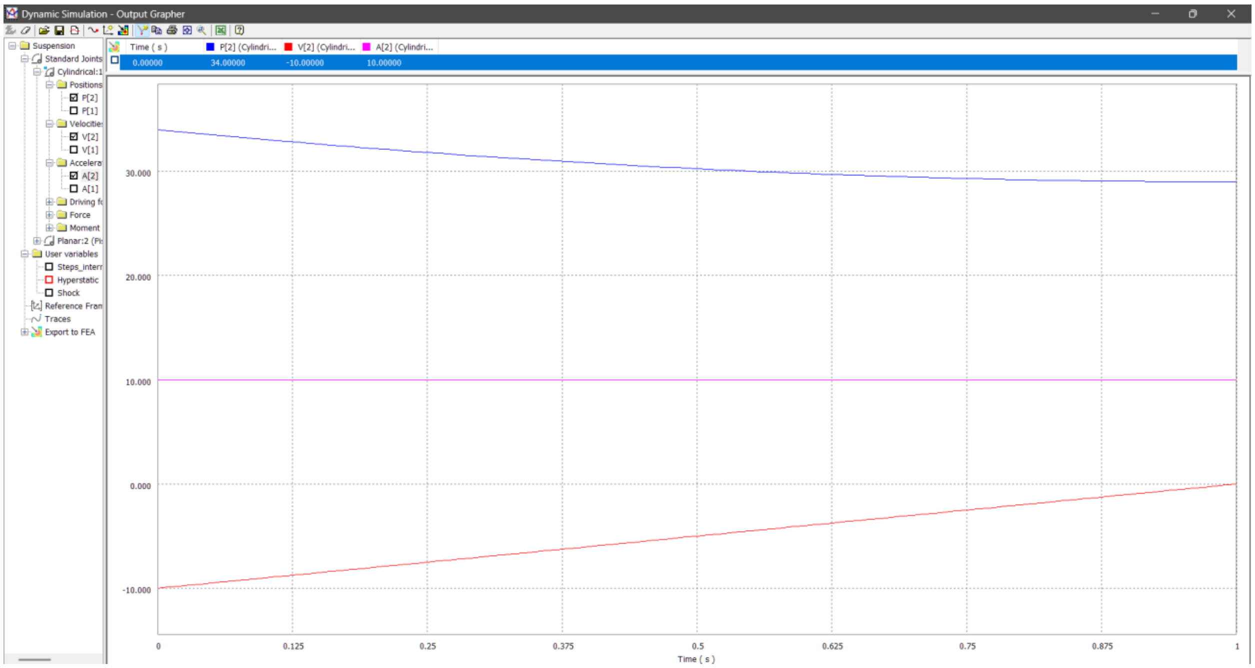


As can be seen, the displacement has more or less stabilized in the low 27 mm range, but there is a stress singularity that filleting does not fix (as shown below). The high deformation is indicative that a stronger material may need to be chosen, or the part made larger to more effectively handle the load without deformation.



Motion Study

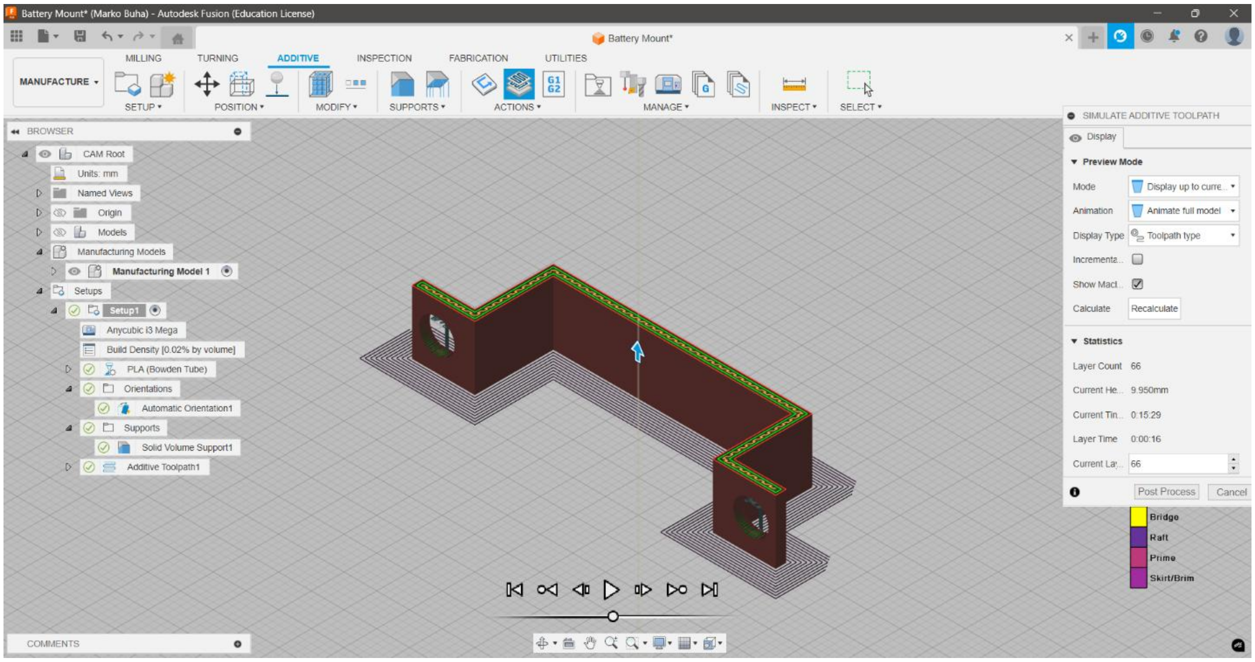
A motion simulation was conducted on the Suspension. It was started at the equilibrium position with a speed of 10 m/s. A constant acceleration was also set to allow for a simulation of the spring force, which broadly increases as the displacement increases.



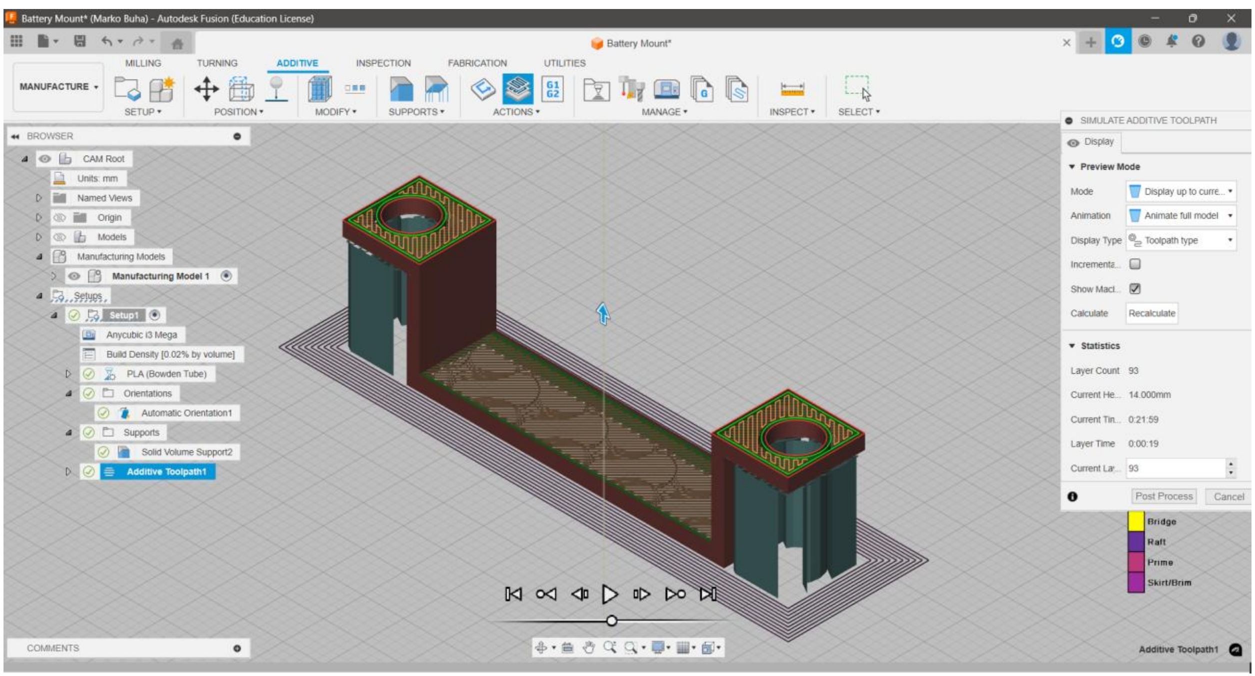
This demonstrates that the spring takes effect as the displacement continues to increase from equilibrium. The fact that the velocity gradually slows down is a sign that the suspension is making for a smoother ride as intended.

Additive Manufacturing Simulation

A 3D printing simulation was performed on the battery mount. Using this orientation, the print time was around 15 minutes.



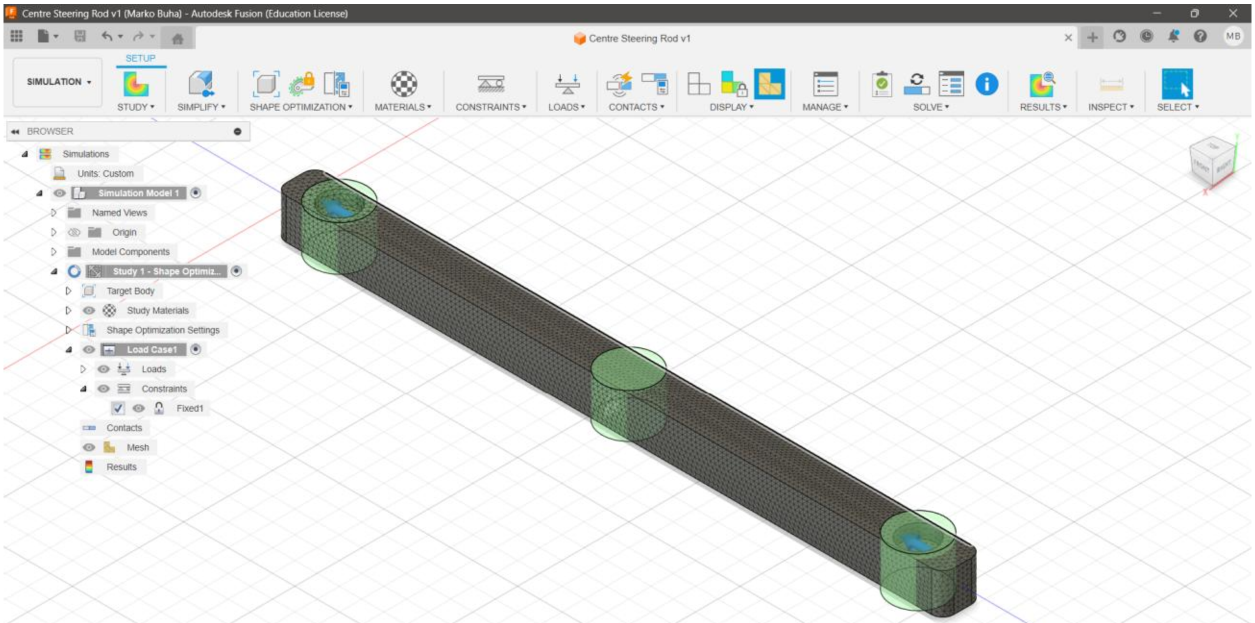
However, using this orientation, the print time increased to 22 minutes.

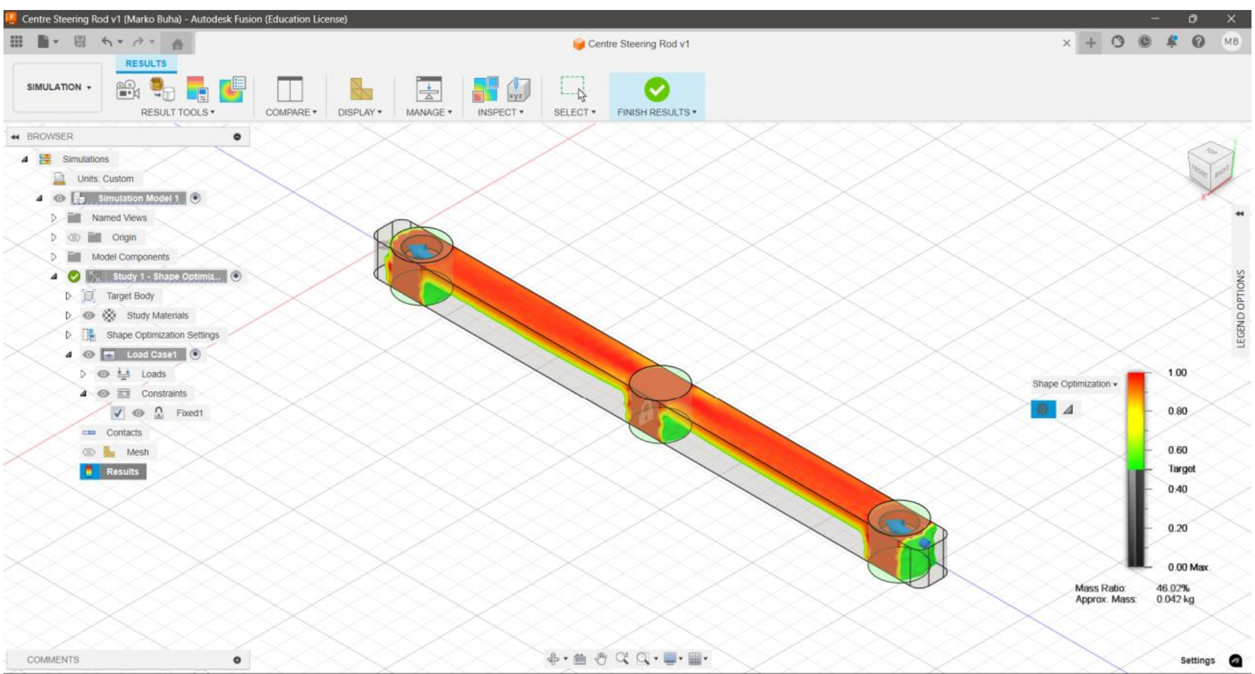


This shows how orienting parts to reduce support use can save on print time. Of note however because of the orientations and layer delamination, the first orientation causes the part to be weak to the battery moving front and back, while the second orientation is weak to the battery moving up. Therefore, it may be worth it to print in the second orientation if the battery moving front and back is expected to be the dominant form of movement.

Shape Optimization Simulation

A shape optimization simulation was conducted using the Centre Steering Rod. Forces of 1000 N were applied in the longitudinal direction to simulate the forces between the rod and the Rotating Rods + wheel as the rod moves longitudinally to steer the car. The rod was fixed at the centre where the gear connects to it.





The results show that the shape experiences the most stress at the top. This indicates that the bottom white areas could be cut away to create a much lighter Centre Steering Rod that is easier for the gear to move.