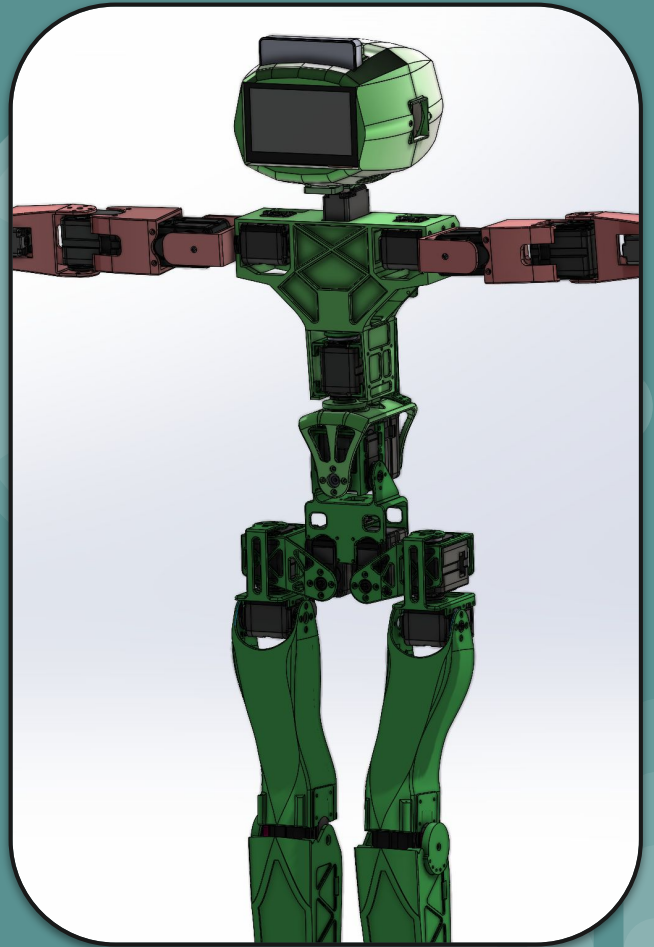


# Stress, Strain, and Deformation Analysis of the Chest of a Humanoid Robot

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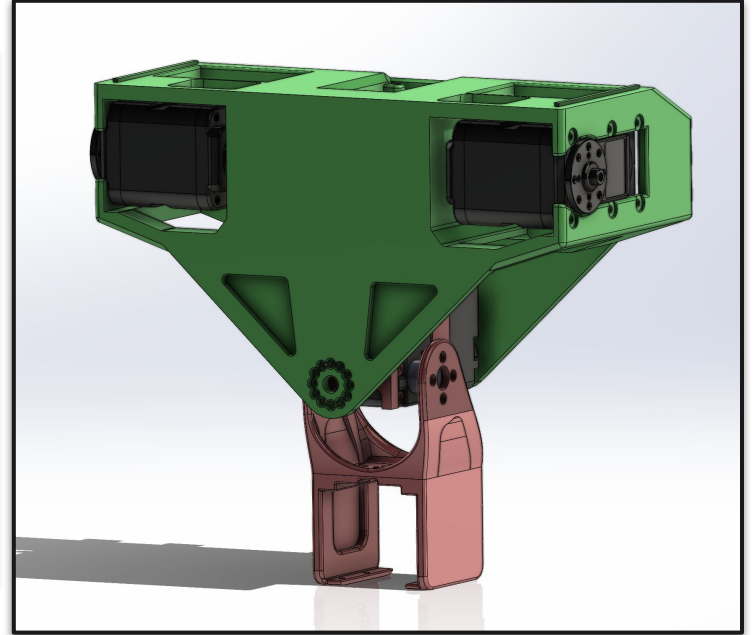
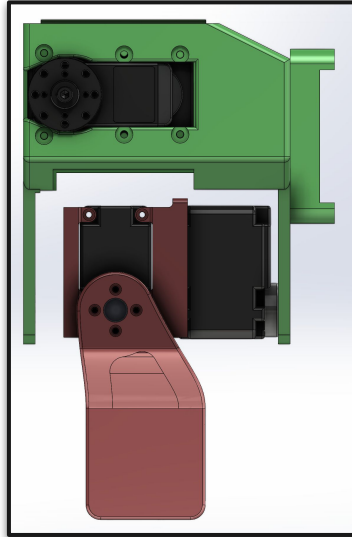


# Background

- The analyzed part is from the ongoing Humanoid Robot MQP
- The goal of the MQP is to improve the design of two robots, Ava and Finley, for at-home assistive care
- A key part, the "Chest/Back," combines the previously separate "Chest" and "Back" parts
- The combination eliminates unnecessary degrees of freedom, adds structural support, and reduces manufacturing time

# Old Design

We noticed that there was a motion the original design was allowing which wasn't entirely necessary for the tasks the robot was meant for, with that motion rendered useless there was really no reason for us to keep the back and chest as separate parts



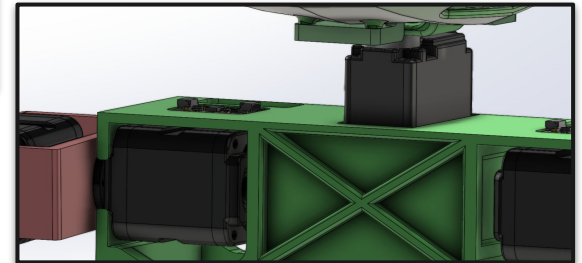
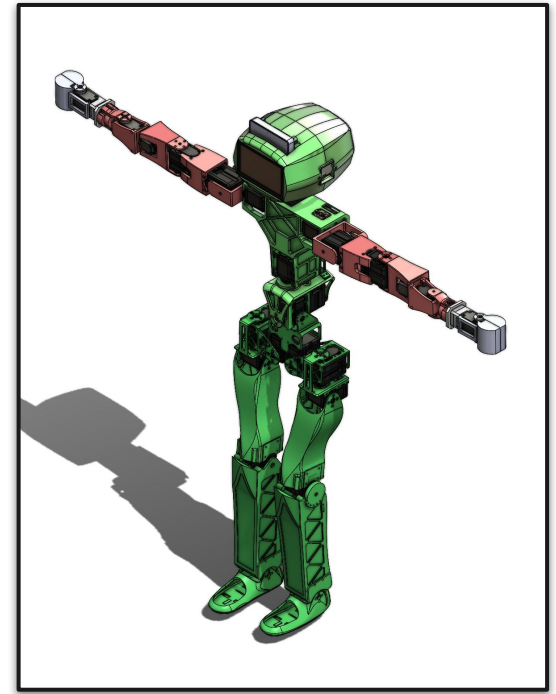
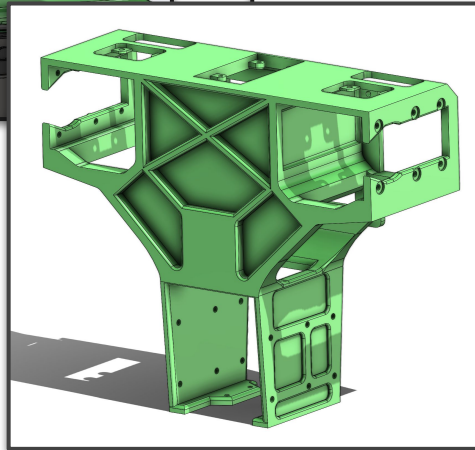
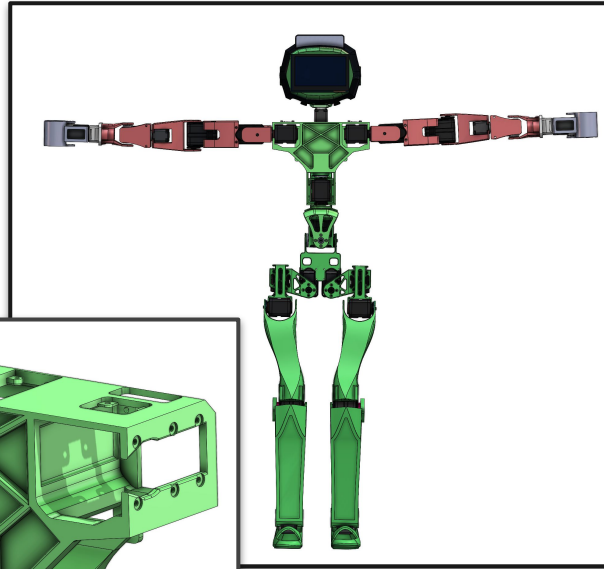
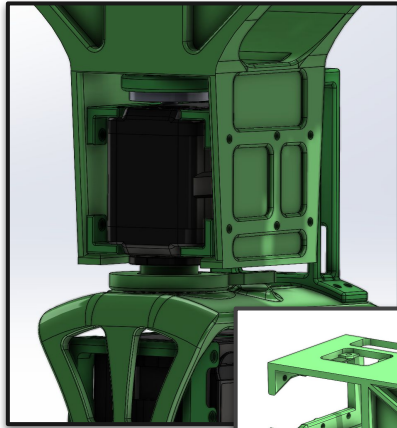


# Goals

Performed with Ansys Finite Element Analysis:

1. How does the old chest design's structural performance compare with the new design?
2. Is there a significant risk of the new chassis deformation or failure under the applied loads?

# Model of Robot





# Prescribed Loads

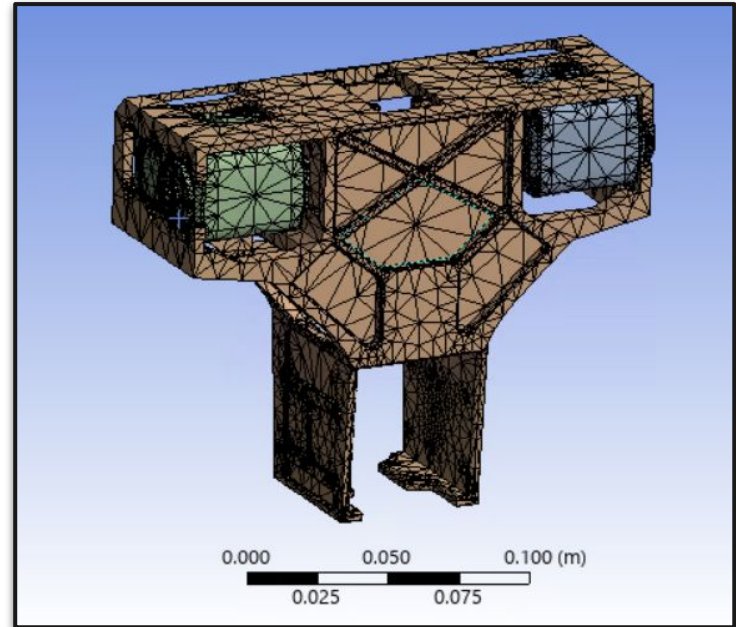
Source of Force	Force Value (N)
Arms x2	10
Head	5.1
Reaction Force	25.1

The loads we used in the simulation were based on the weight of the arms and head bearing down on the chest, as well as the reaction forces of both coming up from the hips

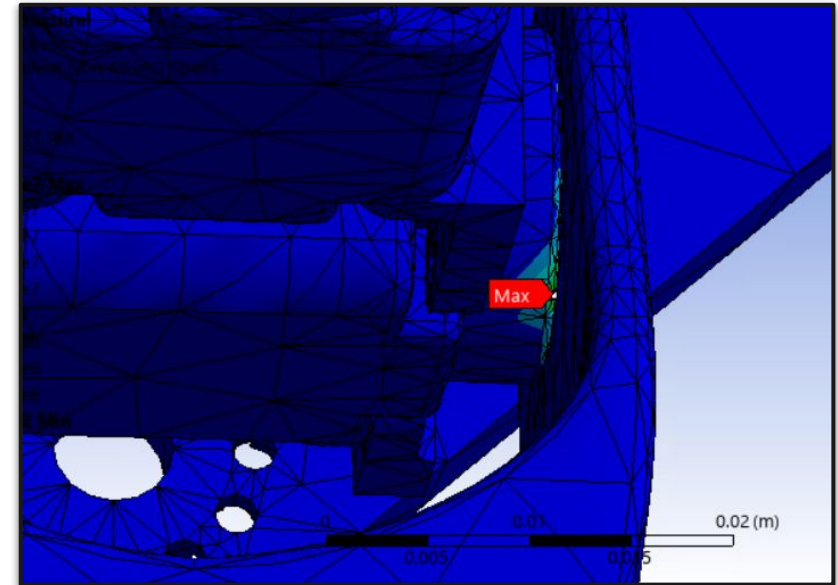
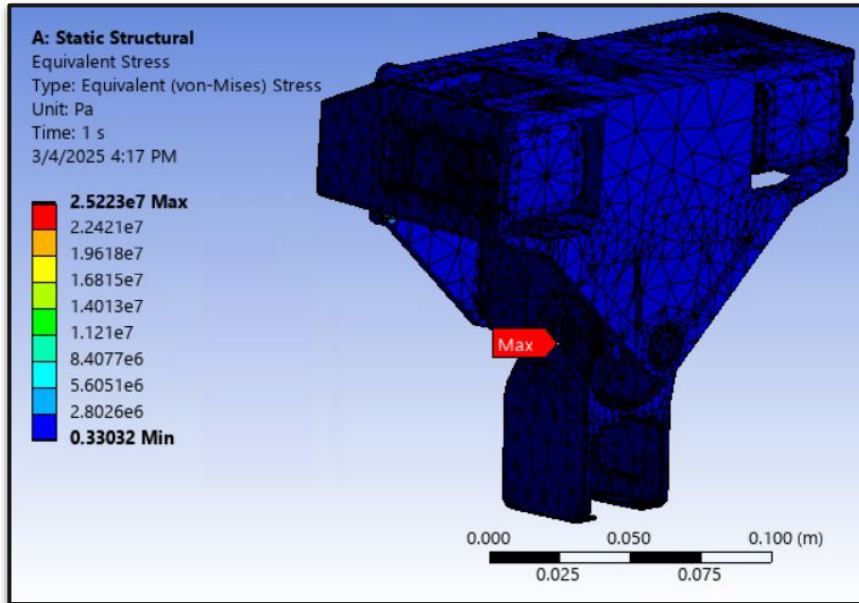
# Boundary Conditions + Assumptions

The boundaries were allocated to where the motors are meant to connect with different sections of the part, as well as where the forces of the connected arms and hips will be acting according to the model of the robot shown

We assume that the motors will not go through any deformation in general, as the robot itself is made of 3D printed resin and the motors are made of steel/aluminum

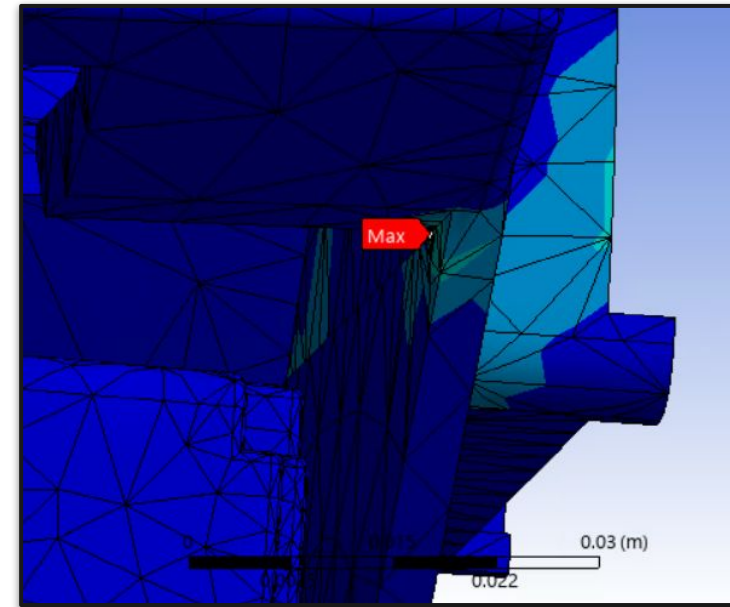
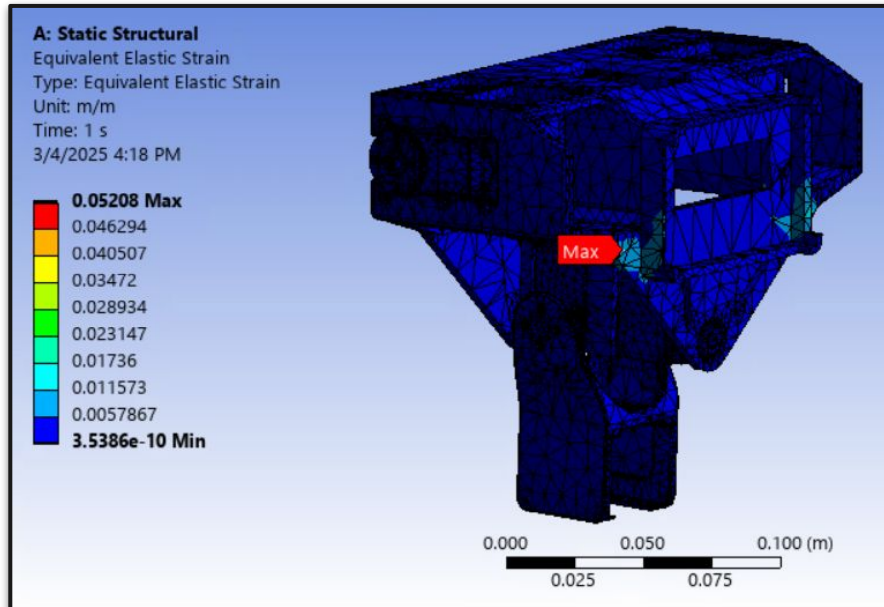


# Stress Results - Old Chassis

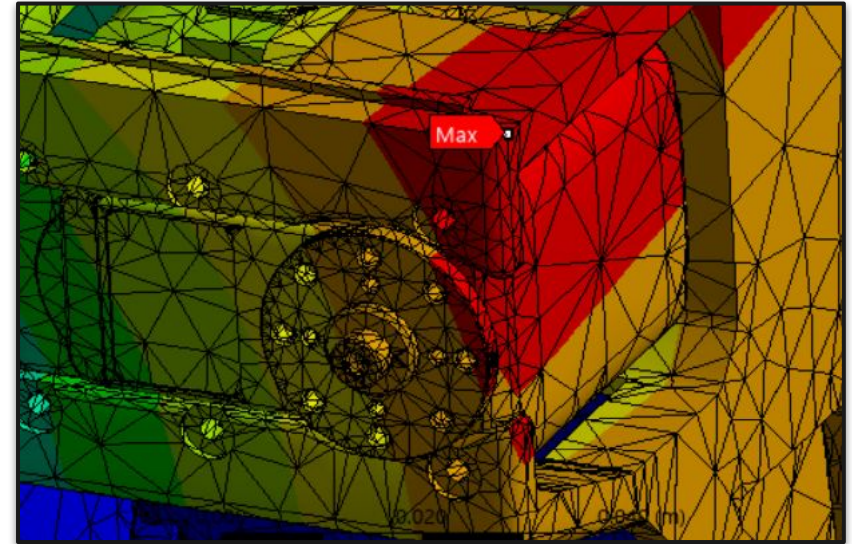
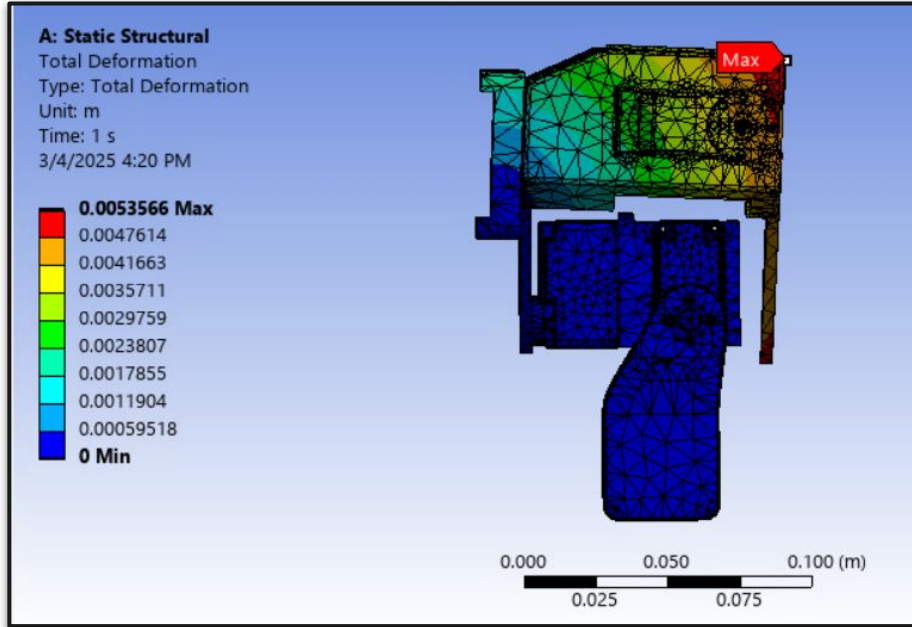




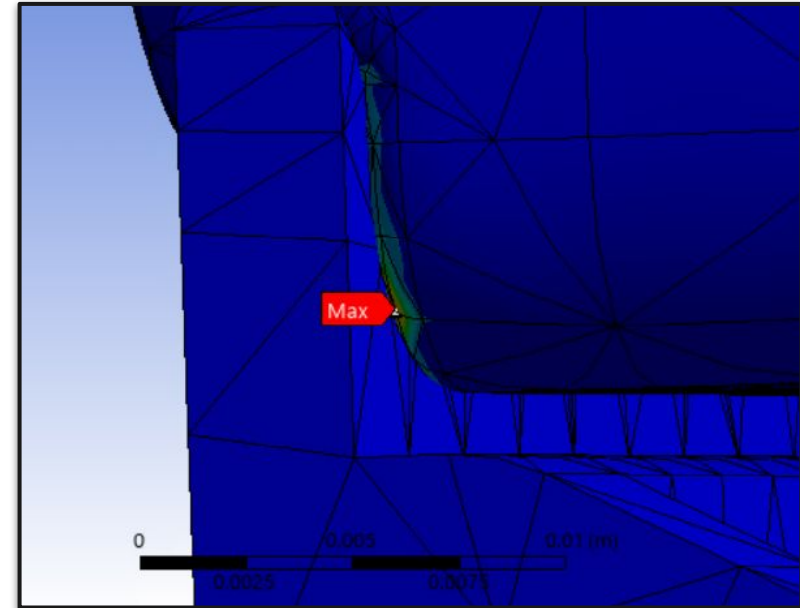
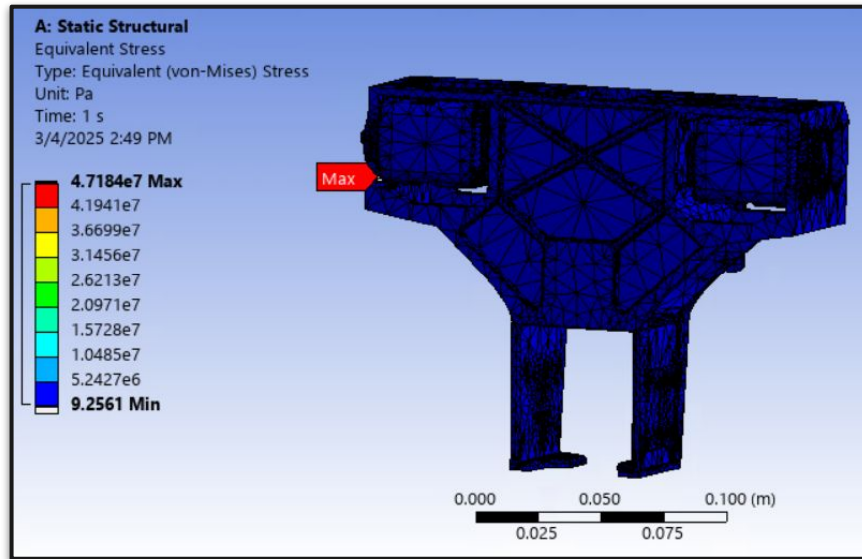
# Strain Results - Old Chassis



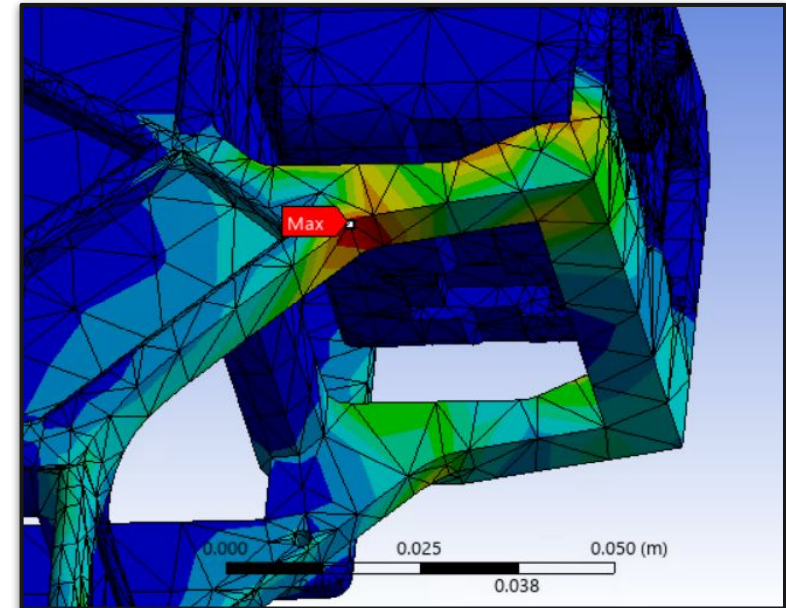
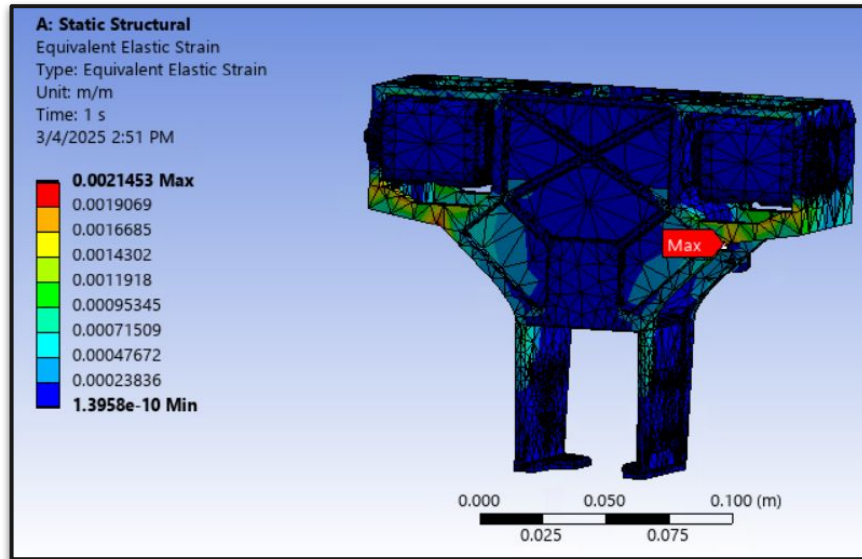
# Deformation Results - Old Chassis



# Stress Results - New Chassis

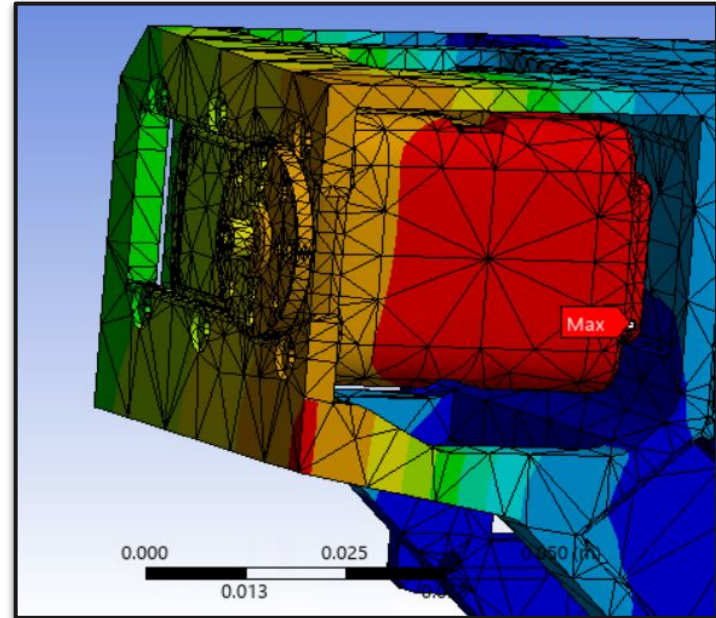
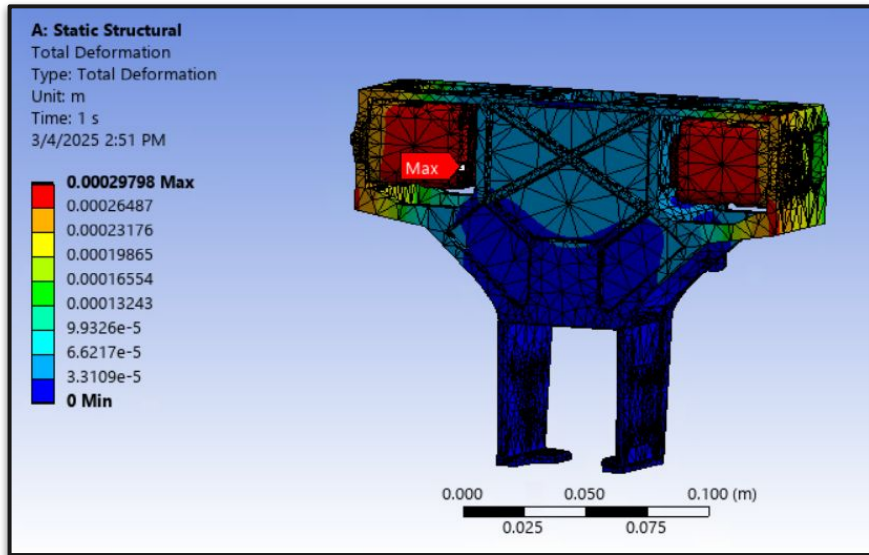


# Strain Results - New Chassis





# Deformation Results - New Chassis





# Numerical Results

	Max Stress (MPa)	Max Strain (m/m)	Max Deformation (m)
Old Design	25.223	.05208	.0053566
New Design	47.18	.0021453	.00029798



# Conclusions

- The new design has improved the structural integrity of the chest, and thus the robot as a whole
- Given our experience with the other load bearing parts of the robot, the forces shown at their respective pressure points on the mesh should be negligible when the robot is fully assembled

A green robot with a red laser beam pointing at a large, glowing blue and red creature in space. The robot is on the right, and the creature is on the left. The background is a dark space with blue and red nebulae and stars.

**Questions?**

**Thank you**