

**UNIVERSITY OF MINNESOTA
SOLAR VEHICLE PROJECT**



**MECHANICAL SYSTEMS STRUCTURAL
REPORT**

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Project Advisor

Jeff Hammer

Mechanical Team Members

Brakes Team

Bryan Horvat
Rebecca Michels
Jin Yan

Chassis Team

Konrad Brown
Jessica Gilbertson
Sarah Gilbertson
Alex LaMoore

Front Suspension Team

Derek Brochu
Taylor Hill
Dan Nigon
Jon Olson

Rear Suspension Team

Jason Davis
Will Jaffray
Daniel Valencia

Steering Team

Jesse Behnke
Michael Lind
Nick Lee

6 – Rear Suspension

6.4 – Rear Suspension Design Changes

In order to make the design of the parking brake simpler, we increased the diameter of the bracing arm tube from 1.25 [in.] OD to 1.75 [in.] OD. In order to compensate for the increased outer diameter, the wall thickness was reduced from .065 [in.] to .049 [in.], which will have negligible effect on the stress that will be applied to the bracing arm. The angle of the bracing arm was also changed in order to make sure that the wheel does not touch the bracing arm. Calculations follow:

- I make the assumption that the force will be equal in both the original design and the revised design.
- I will be calculating the percent change in the amount of stress that the bracing arm is capable of handling.

$$\sigma = \frac{P}{A} \quad \sigma_o = \frac{P}{A_o} = \text{original stress} \quad \sigma_f = \frac{P}{A_f} = \text{stress of new design}$$

$$A_o = \frac{\pi}{4}(d_o^2 - (d_o - t_o)^2) = \frac{\pi}{4}(d_o^2 - (d_o^2 - 2d_o t_o + t_o^2)) = \frac{\pi}{4}(2d_o t_o - t_o^2)$$

The area of the new tube is equivalent, therefore:

$$A_f = \frac{\pi}{4}(2d_f t_f - t_f^2)$$

$$\%change = \frac{\sigma_f - \sigma_o}{\sigma_o} = \frac{\frac{P}{A_f} - \frac{P}{A_o}}{\frac{P}{A_o}} = \frac{PA_o - PA_f}{A_f A_o} \left(\frac{A_o}{P}\right) = \frac{A_o - A_f}{A_f} = \frac{A_o}{A_f} - 1$$

$$\frac{A_o}{A_f} - 1 = \frac{\frac{\pi}{4}(2d_o t_o - t_o^2)}{\frac{\pi}{4}(2d_f t_f - t_f^2)} - 1 = \frac{d_o t_o - t_o^2}{d_f t_f - t_f^2} - 1$$

all numbers are inches:

$$\frac{(1.25)(0.065) - (0.065)^2}{(1.75)(0.049) - (0.049)^2} - 1 = -.0758737$$

Therefore there has been a decrease in the ability of the bracing arm to withstand loads by only 7.587%

7 – Steering

7.4 – Steering Design Changes

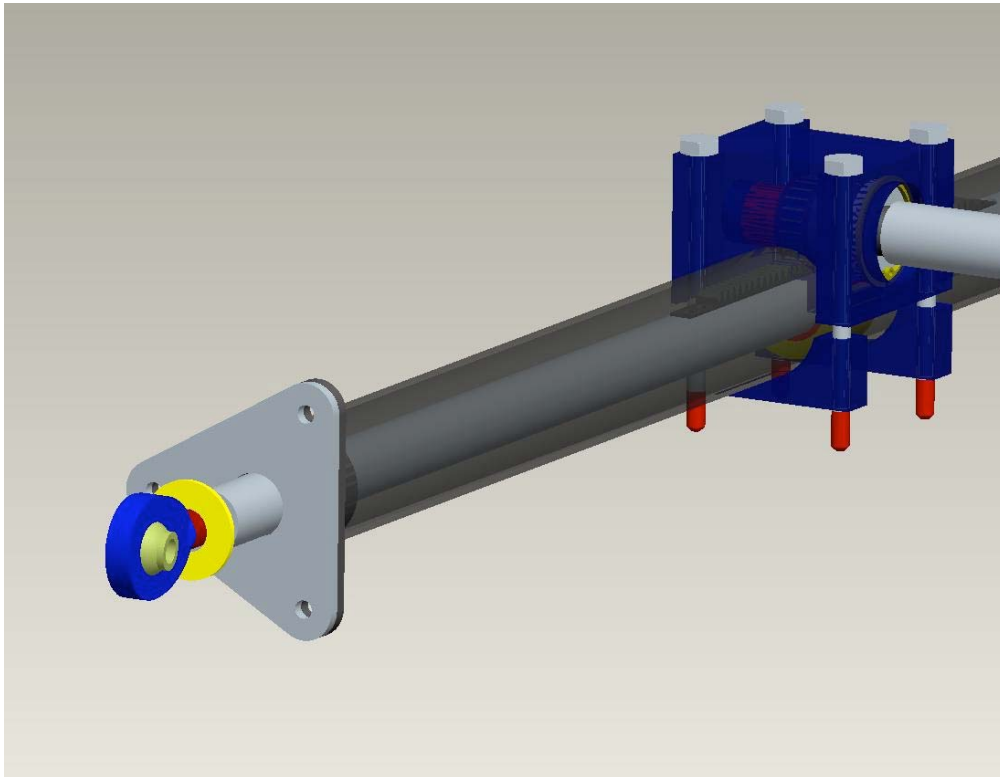


Figure 7.1: Gear Box with custom rack, rack cover, and chassis attachment brackets. Steering limit washer shown in yellow.

The design of the gearbox has been changed to be more easily machined and assembled. The method of steering the vehicle has not been changed. The gear box is now bolted in place with retaining brackets outside and underneath the rack cover. Its orientation is maintained by mating to a slot that has been cut out of the rack cover. Once bolted, castle nuts and cotter pins are used to retain the fasteners. The bushings used to guide the shaft outside the chassis have been changed to PEEK plastic instead of Rulon J. PEEK plastic has good fatigue and temperature resistance, as well as good impact and tensile characteristics. The last change concerns the mating of the rack to the aluminum shaft. The rack will now extend beyond the diameter of the shaft, so the strength of this shaft will be increased because less machining is required.