**To:** Professor Tubergen

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**Design Objectives and Requirements**

**Introduction**

We found this project appealing because there were many aspects of the original design that we felt could be improved and modified. This project is a great learning experience since it allows us learn and analyze multiple systems of a vehicle through the original Calvin-Bolt design and see what improvements can be made systematically.

Knowledge from this experience will be significantly applicable to design and manufacturing as companies are constantly looking to improve on previous designs, as well as know how to fix certain aspects of their product that are not up to standard.

**Objective**

The objective of this project is to improve the Calvin Bolt's **steering, suspension, and (front) braking systems.** We will go in depth on the design of each of these systems and improve what we can. If there is adequate time remaining, the aesthetic appeal of the vehicle will be improved as well as possibly additions of a few bells and whistles such as a better system of charging the batteries.

**Requirements**

**1) Suspension System**  
The suspension on the Calvin Bolt is suspected to be poor and inadequate. It is not believed that it can properly support the weight of the car, the passengers, and anything placed in the trunk space effectively nor efficiently. Also, the suspension system must be designed such that the external forces acting on the car (i.e. rough terrain, breaking, accelerating, turning) are properly absorbed by the suspension. We will do calculations and simulations If the suspension system does not do this adequately, modifications will need to be made.

The suspension design requirements are as follows:

1. Design a four wheel suspension system
2. Suspension can support the car, the tires, full capacity, and any weight in the trunk.
3. Suspension properly dampens any changes in motion on the car. These include stopping, accelerating, turning and rough terrain which includes the Calvin campus road and campus sidewalks.

**2) Steering System**

The steering system is one of the aspects that came up short during last years test drive and needs to be improved. We will look into the options of different breaking systems and which of them would work best and be most suitable for the forces that this vehicle will be under during its operation.

The steering system requirements are as follows:

1. Design a steering system with a gear train that allows for "ease" of turning.
2. The steering system will have a gear box
3. The steering system will remain simple

**3) Front Braking System**

The former team who designed the Calvin Bolt pointed out in their final report that the braking system was not as effective as they expected. One of the possible causes was suspected by lack of a sufficient pressure through the brake lines. For complete air removal, it was suggested to use a vacuum press or adaptive pump, instead of the master cylinder. To avoid repeating the same mistakes from last year, our team will try to better solution with the requirements as shown below:

1. The braking system remains on the front wheels only.
2. We will use improved pumps to pursue the complete air removal in the brake lines.
3. The brake system provides enough hydraulic pressure to be more operational and effective in the speed control including complete stop.

**4) Remaining Aspects**

In order to meet the objectives of this project in a timely manner, the following aspects, aside from the improvements of the systems mentioned above, need to be met:

Functionality: fully functional and able to withstand major road disturbances on the campus. The springs and wheels must be shock-absorbent under operation.

Time Feasibility: the improvements must be designed, constructed, tested and approved before May 7, 2017.

Safety: Safety features should be considered for the passengers such as arm rest and a parking brake. If there is adequate time remaining, possible additional safety features may be turn signals, headlights, and brake lights.

Budget: All improvements will meet the $500 budget approved by the Calvin College Engineering Department. Additional funds can be included upon requests and donations, etc. In terms of integrity, the team should be upright for any budget for the design as much as possible.