

Motivation, Goal, Impact

This low-cost design will be able to navigate farm terrain and collect soil from various sites for later composition testing.

Motivation

Current automated soil sampling solutions require a truck or ATV mount. Our design will maneuver itself into place, and deliver packaged samples anywhere.

Major Goals

- Develop a cheap soil extraction system
- Reduce farm worker labor
- Integrate with existing terrain navigation systems

Impact

Streamline soil sampling process and reduce cost for farmers.

Requirements

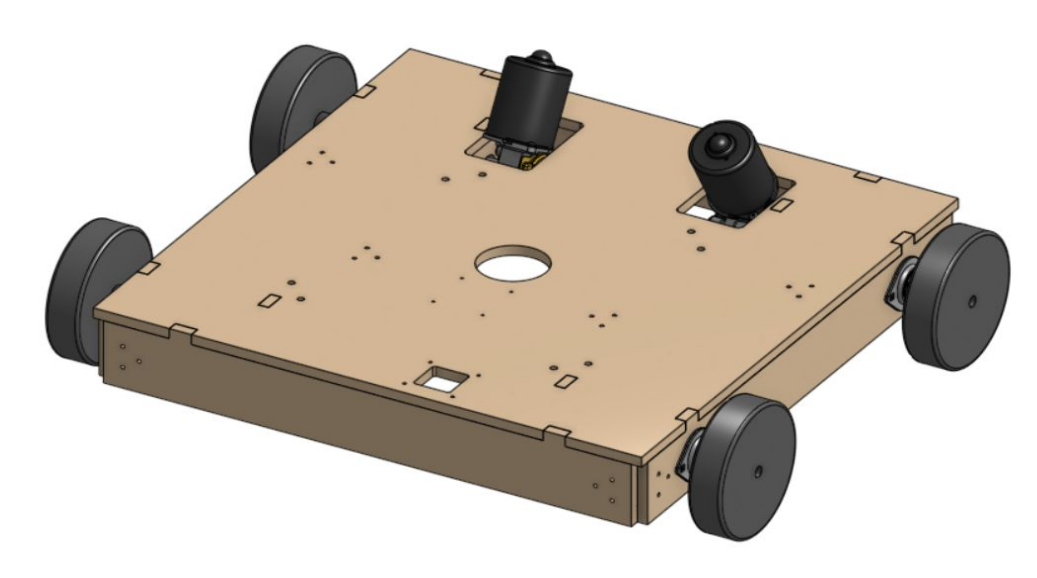
- Maximum budget \$500
- Autonomously navigate outdoor terrain
- Extract sample 6-8" deep
- Samples must be ≥1/4 cup
- 3-5 samples per acre
- Store and mark individual samples with time, date, and location
- Sample collection time is under 3 minutes

Final Design

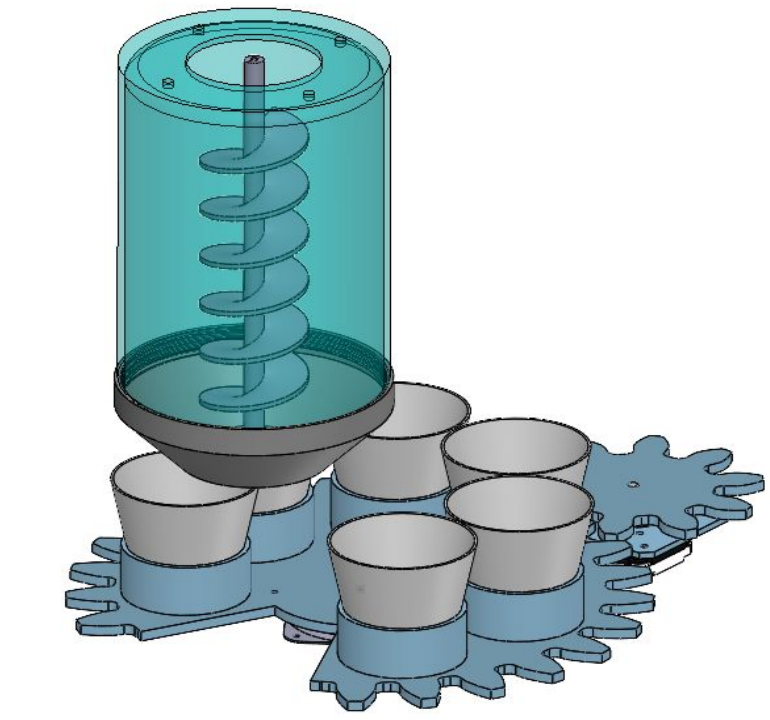
Soil Sampling



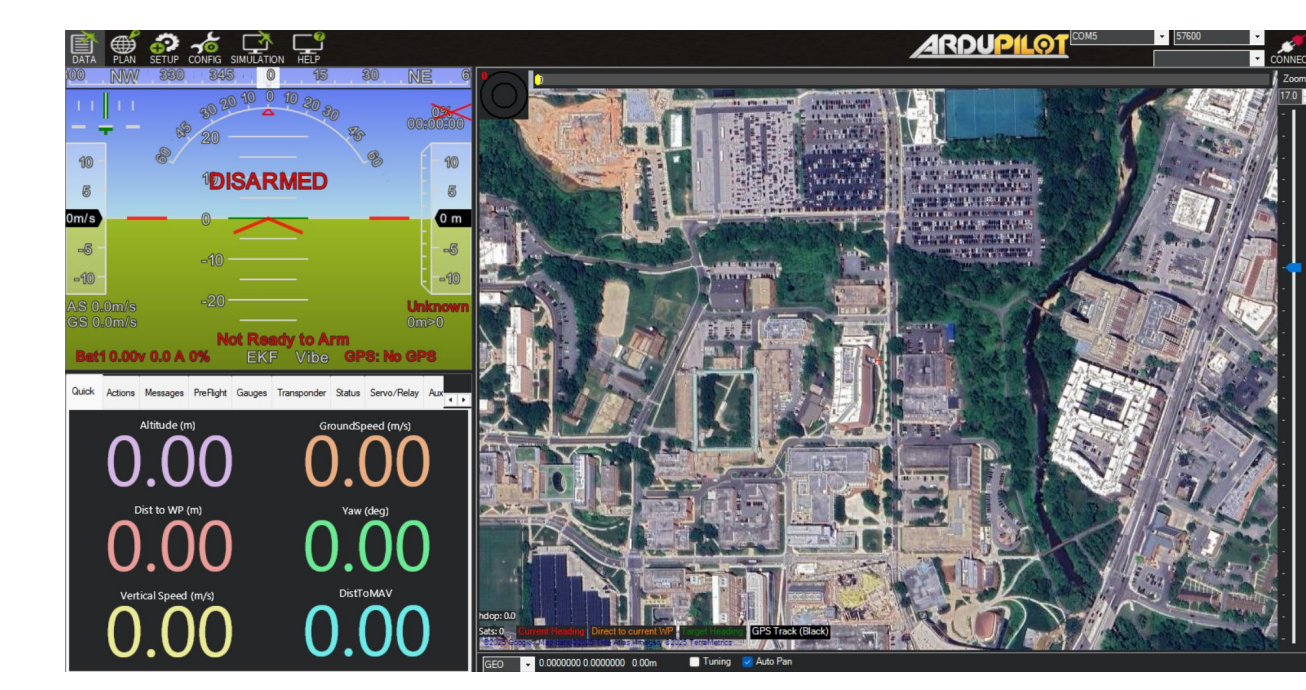
Chassis



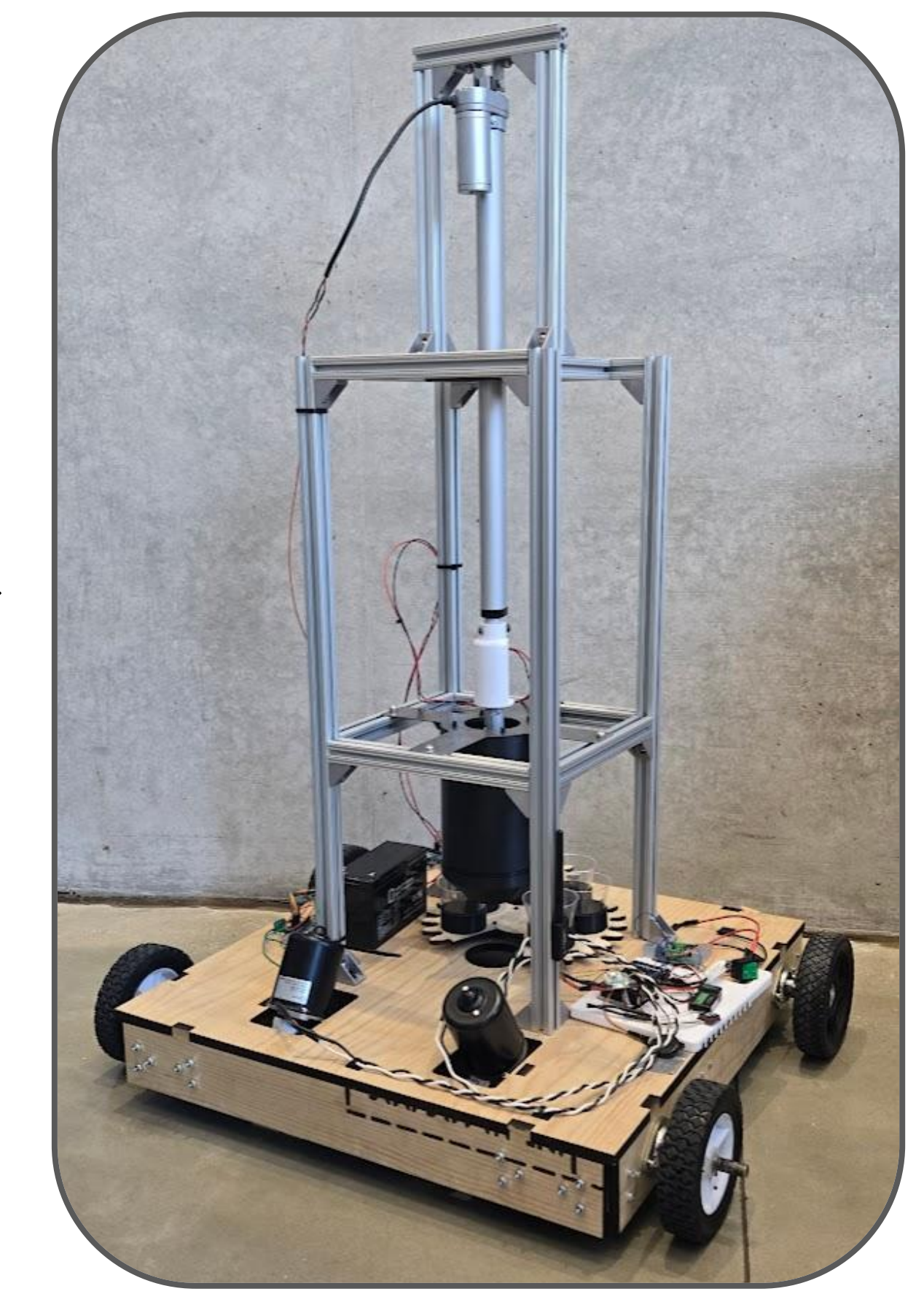
Packaging



Mission Planner - Autonomous



Assembly



Design Calculations & Decisions

Chassis Motor Calculation

$$\text{Rolling Resistance} = RR = \text{weight} \times \mu_f \text{ [lbf]}$$

$$\text{Grade Resistance} = GR = \text{weight} \times \sin(\text{max incline}) \text{ [lbf]}$$

$$\text{Acceleration Force} = \frac{\text{weight} \times v_{\text{max}}}{g \times t_{\text{acceleration}}} \text{ [lbf]}$$

$$\tau = \frac{RR + GR + \text{Acceleration Force} \times R_{\text{wheel}} \times RF}{\text{Number of Motors}} \text{ [in} \cdot \text{lbf]}$$

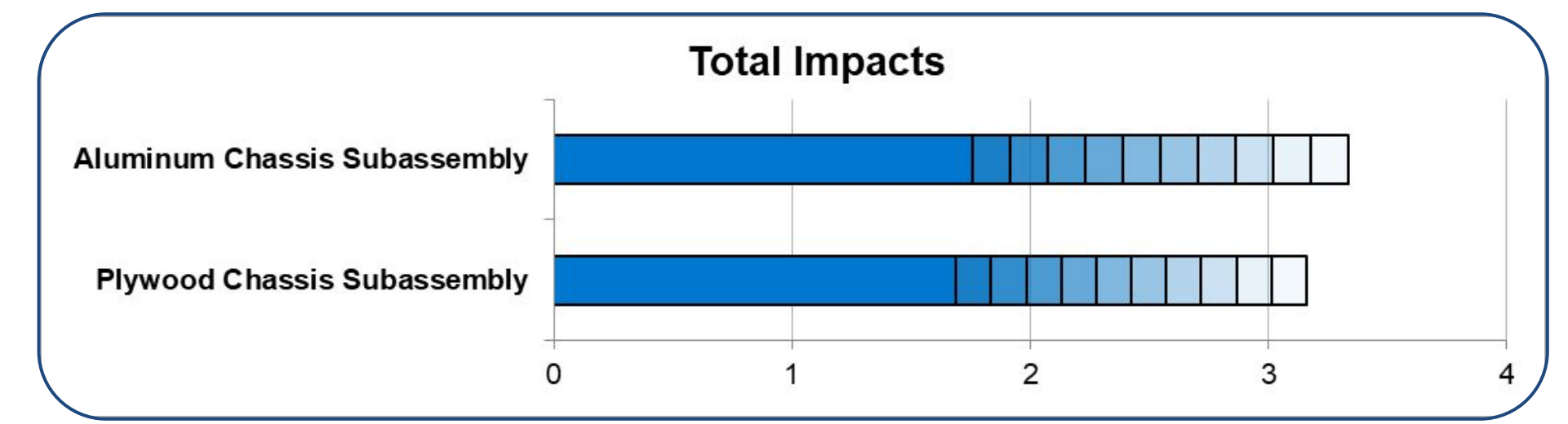
$$\text{acceleration} = a = \frac{v_{\text{max}}}{t_{\text{acceleration}}} \text{ [in/s}^2\text{]}$$

$$\tau = \frac{a + \text{weight} \times \sin(\text{max incline}) \times R_{\text{wheel}}}{\text{Number of Motors}} \text{ [in} \cdot \text{lbf]}$$

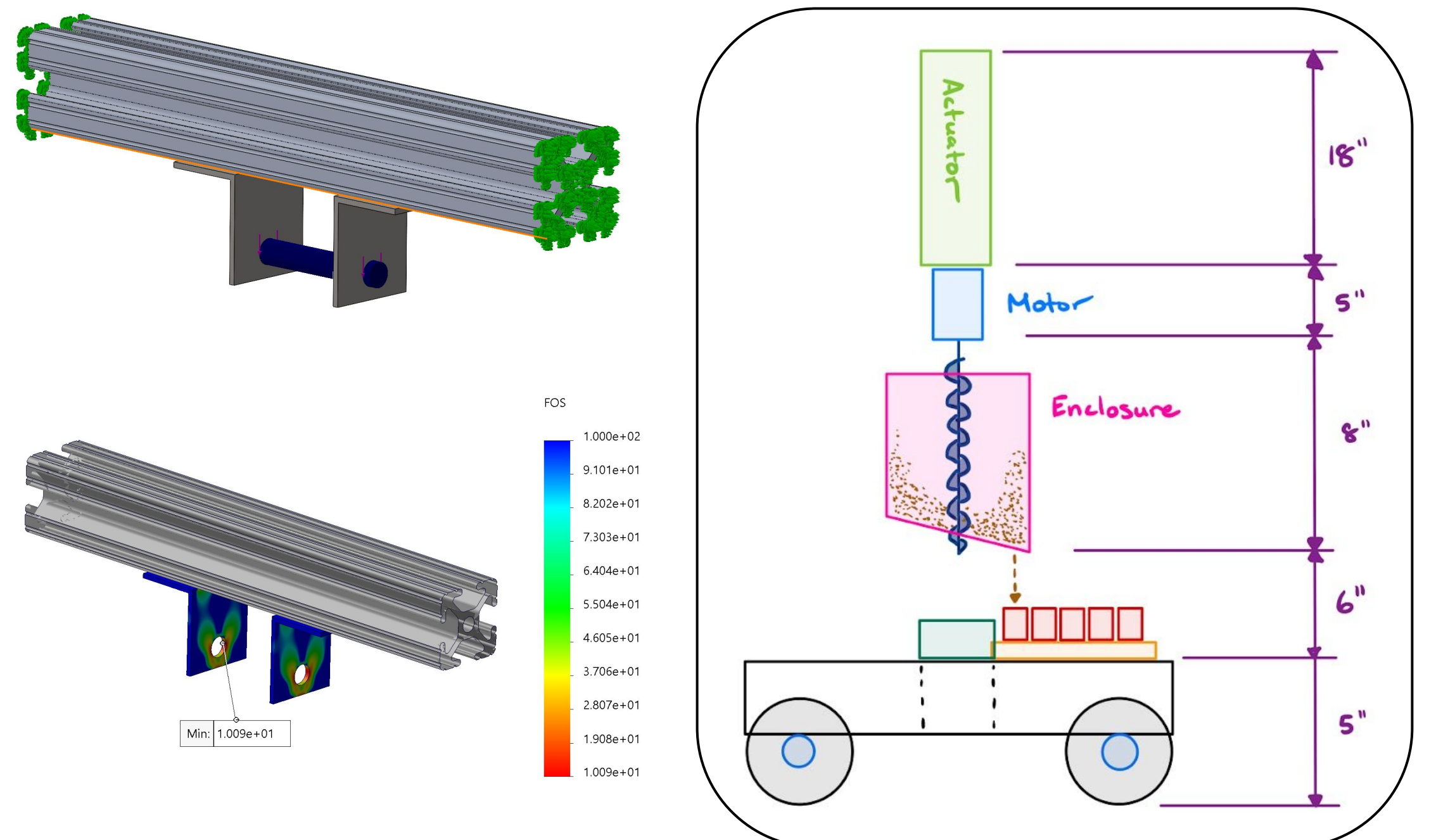
Pessimistic Torque = 4.375766e+01 in-lb
Optimistic Torque = 2.453668e+01 in-lb

Results calculated using MATLAB

Life Cycle Assessment: Aluminum vs. Plywood

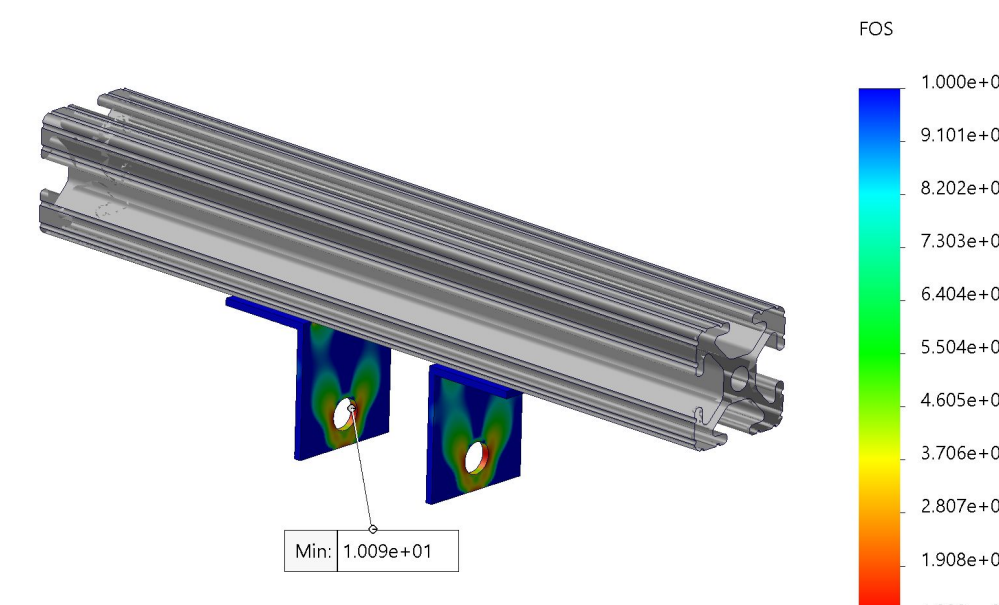


Soil Collection Height Analysis



Linear Actuator Mounting Tab FEA

- Analysis of auger retraction force on Mounting Tabs
- Component Weight: ~7.25 lbs
- Auger Retraction Force: ~30 lbs
- **Minimum FOS: 10**



Prototype & Test Results

Prototype Concepts



Soil Collection Test Results

