University of South Florida
Society of Aeronautics and Rocketry

Critical Design Review

NASA Student Launch Initiative // MAV Challenge

Agenda

Project Overview
- Vehicle Overview
- AGSE Overview

Vehicle Criteria
- Subsystems
- Motor Selection
- Simulations
- Testing and Verification Plans

Subscale Overview
- Vehicle Overview
- Mission Performance

AGSE Overview
- Subsystems
- Testing and Verification Plans

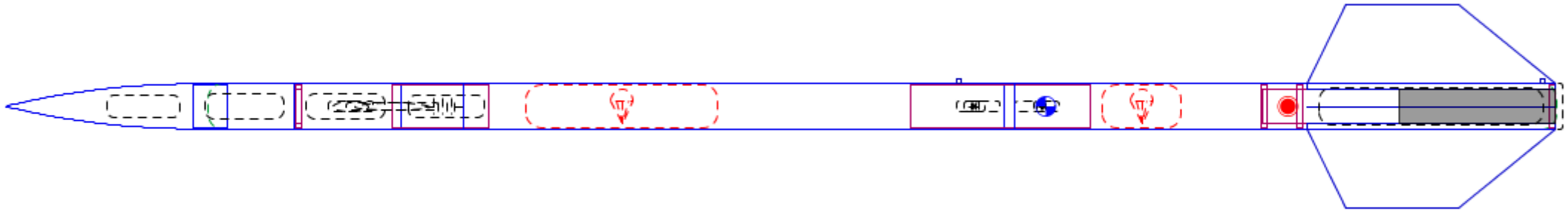
Project Plan
- Safety
- Budget
- Educational Engagement
- Next Steps

PROJECT OVERVIEW

Vehicle Overview

Minotaur MkII
Length 138 in, max. diameter 4 in
Mass with motors 22.8 lb

Stability: 5.38 cal
CG92.512 in
CP: 114 in
at M=0.30



Apogee: 5279 ft
Max. velocity: 746 ft/s (Mach 0.67)
Max. acceleration: 298 ft/s²

Vehicle Overview

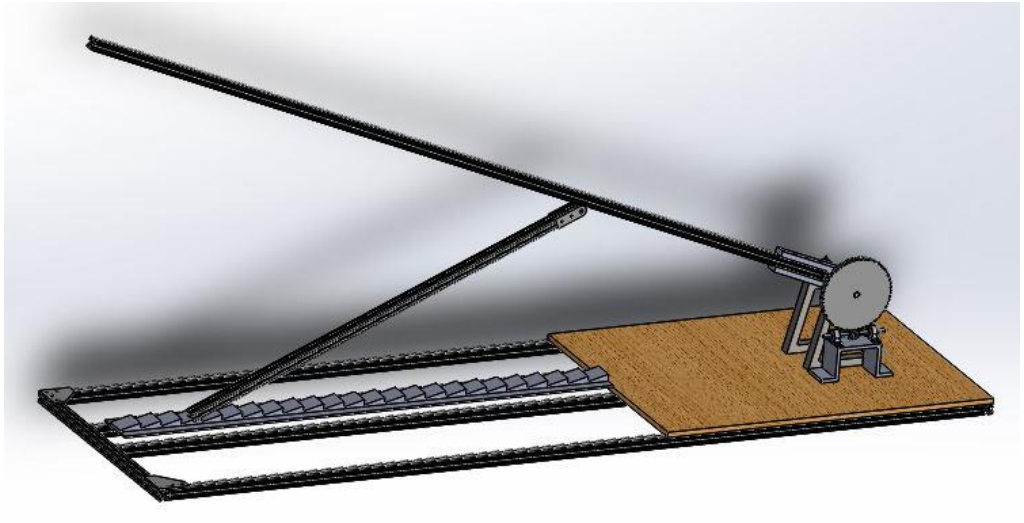
Dimensions

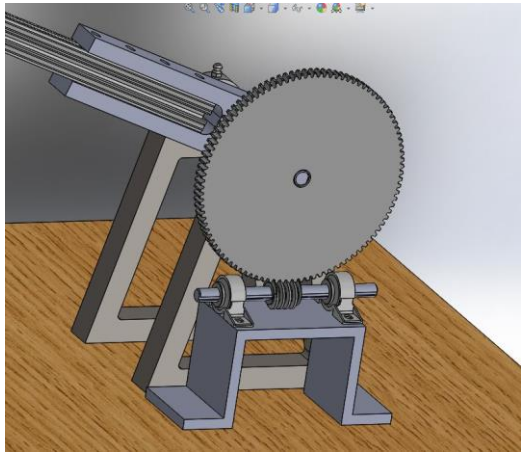
- Length: 138 inches
- Diameter: 4 inches
- Weight (Loaded/Dry): 23.2 lbs/17.1 lbs

Materials

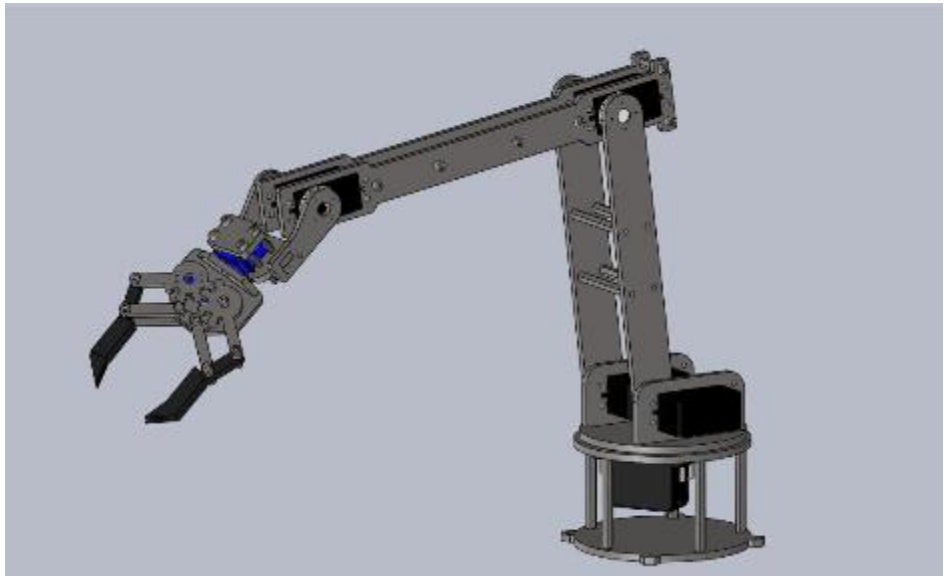
- G12 Fiberglass Airframe
- G10 Fiberglass Fins
- Phenolic Couplers
- Baltic Birch Bulkheads and Centering Rings
- Plastic Nosecone

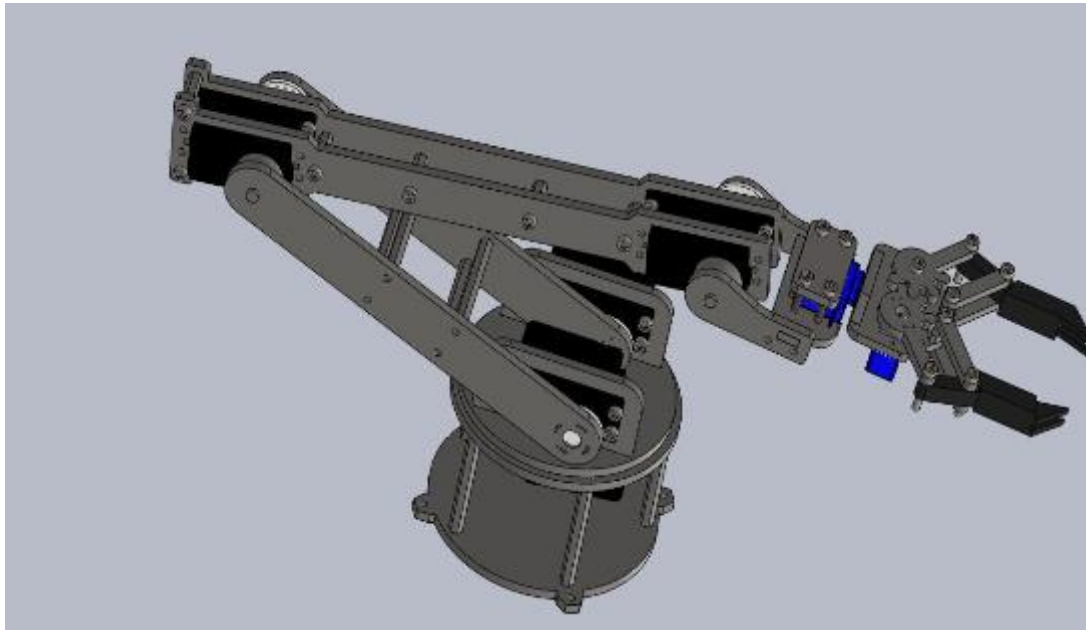
AGSE Overview



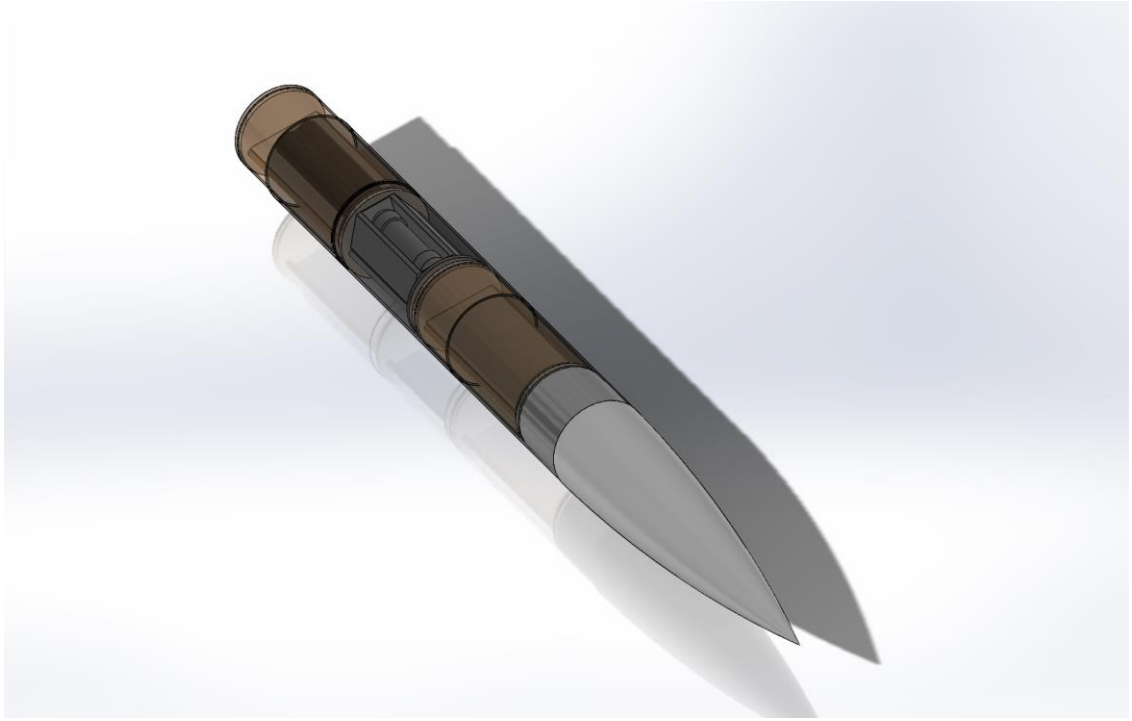


AGSE Overview





AGSE Overview



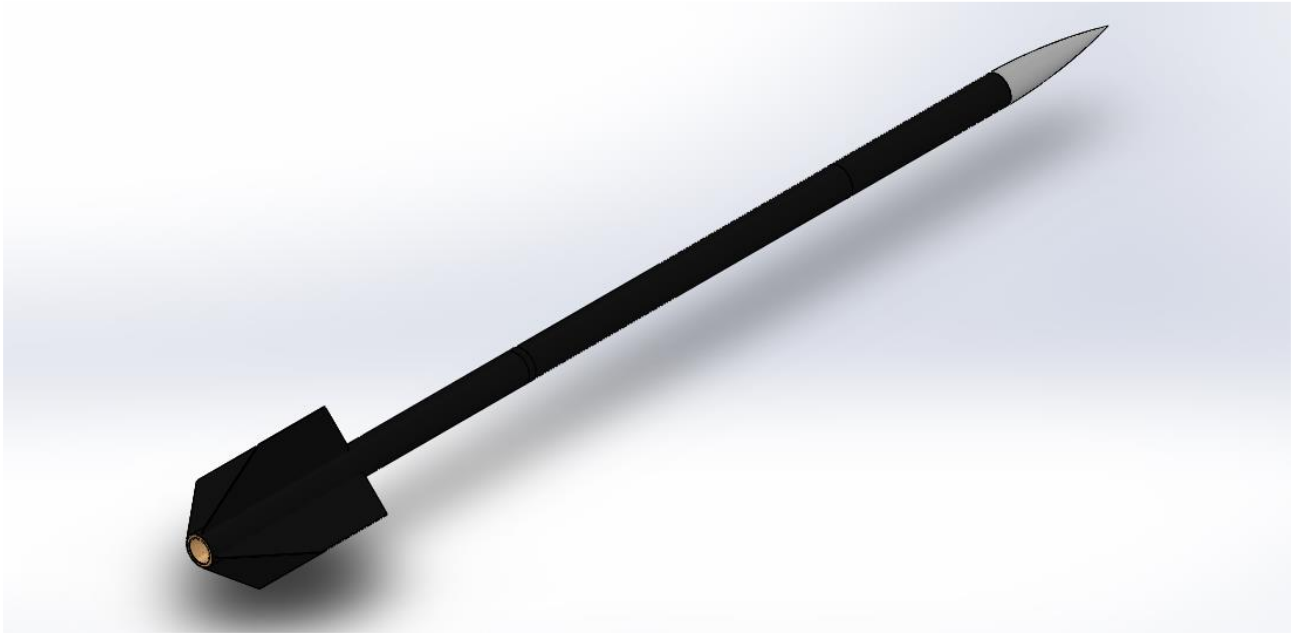
VEHICLE OVERVIEW

Subsystems (Airframe)

G12 Fiberglass

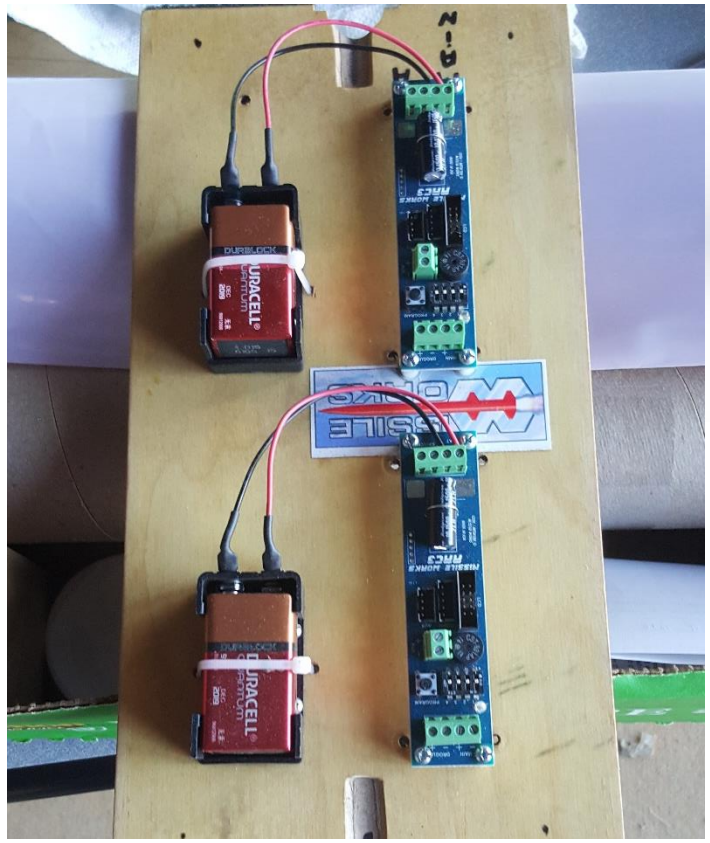
Sections

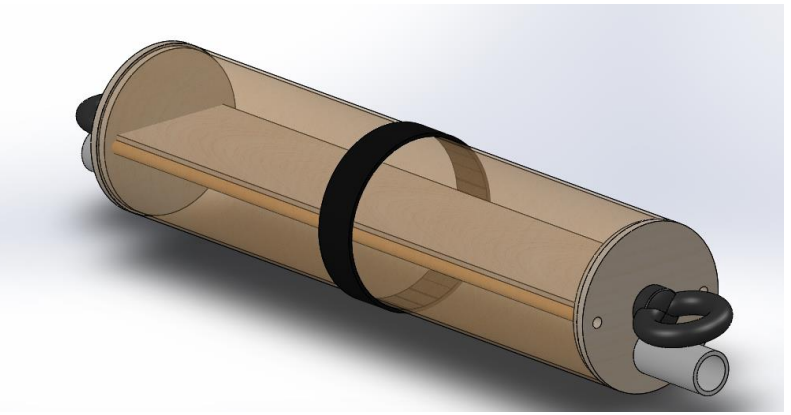
- Payload Bay: 24 inches
- Fore Airframe: 48 inches
- Aft Airframe: 48 inches



Subsystems (Altimeter Bay)

- 16” Phenolic Coupler
- Baltic Birch Bulkheads
- RRC3 Altimeters
- Black Powder Charges
- Dual Deployment





Subsystems (Recovery)

- Dual Deployment with Drogue at Apogee and Main at 500 feet with black powder charge separation
- Sky Angle Cert 3 Parachutes
- **Main**
  - Large 57 sq. ft, Descent Velocity 15.93 ft/s
  - **Drogue**
  - Drogue 6.3 sq. ft, Descent Velocity 63.04 ft/s

Subsystems (Recovery)

Parachute	Load Capacity	Surface Area	Drag Coefficient	Suspension Line	Net Weight	Packed Length
Cert-3 Large	16.2 – 35 lbs	57 ft^2	1.26	80 in	34.0 oz	17 in
Cert-3 Drogue	1.0 – 2.2 lbs	6.3 ft^2	1.16	24 in	6.0 oz	<7 in

Subsystems (Recovery)

Wind Speed (mph)	Lateral Drift (ft)
5	650
10	1300
15	2000
20	2525

Subsystems (Recovery)

- Kinetic Energy at Impact in ft-lbm

Section		Kinetic Energy (lbm-ft)
Nosecone/ Payload		12.184
Fore Airframe		14.032
Aft Airframe		28.612

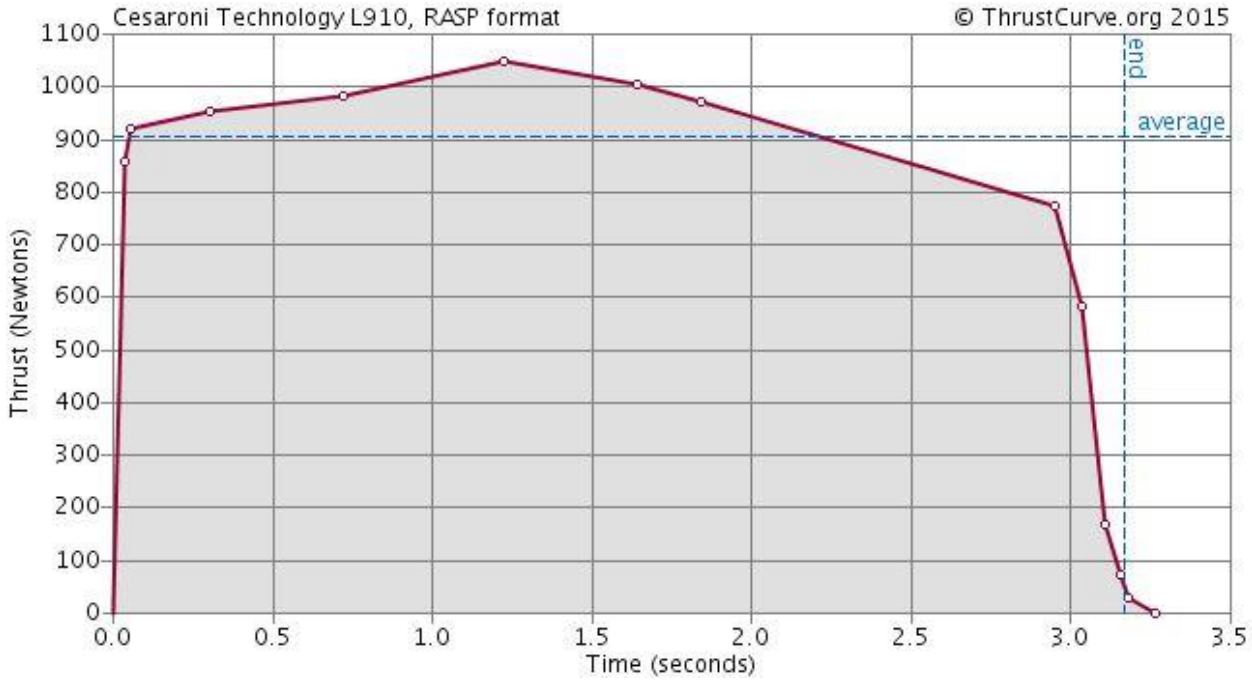
Mass Statement

Section	Mass (lbs)
Nosecone	1.925
Payload/Electronics	2.59
Fore Airframe	4.445
Fin Can	8.145
Motor	6.1

Motor Selection

Motor Selected	CS L910s
Maximum Thrust	1086.1 N
Average Thrust	907.10 N
Thrust-to-weight ratio (Total)	8.93
Motor Diameter	75 mm

Rail Exit Velocity: 82.3 ft/s



Simulations (Stability)

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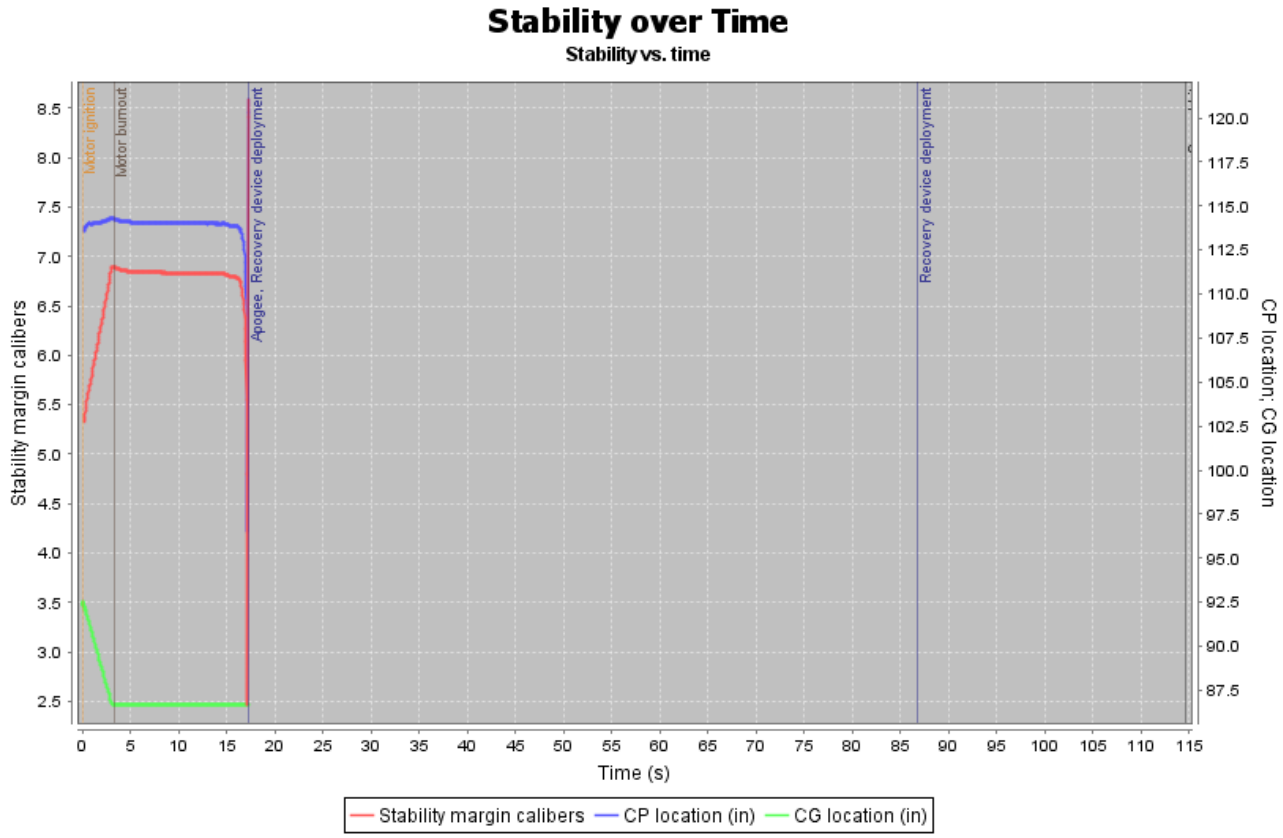
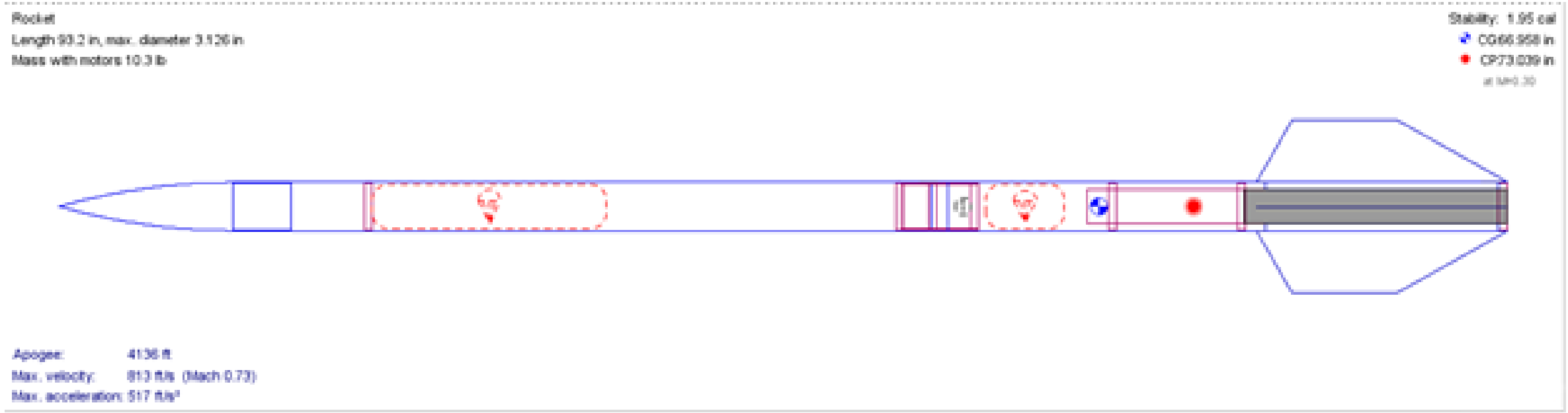


Testing and Verification

Requirement	Design and Verification
All teams shall successfully launch and recover their full-scale rocket prior to FRR in its final flight configuration.	• Design a 3:4 scale rocket • Run OpenRocket Simulation • Perform Mission Analysis Post-Flight
Prepare Launch Vehicle within 2 Hours	• Practice Vehicle Preparation with Checklists • Inspect for potential delays
The vehicle shall deliver the payload to an apogee altitude of 5,280 feet above ground level (AGL).	• Design for altitude • Motor Selection • OpenRocket Simulation • Test Flight
The launch vehicle shall be designed to be recoverable and reusable.	• Design for reusability • Inspect Recovery Systems
Recovery system successfully cause separation and the ejection of both the drogue and main chutes.	• Design for recovery • Test black powder charges prior to launch • Ensure proper parachute packing. • Inspect for verification

SUBSCALE OVERVIEW

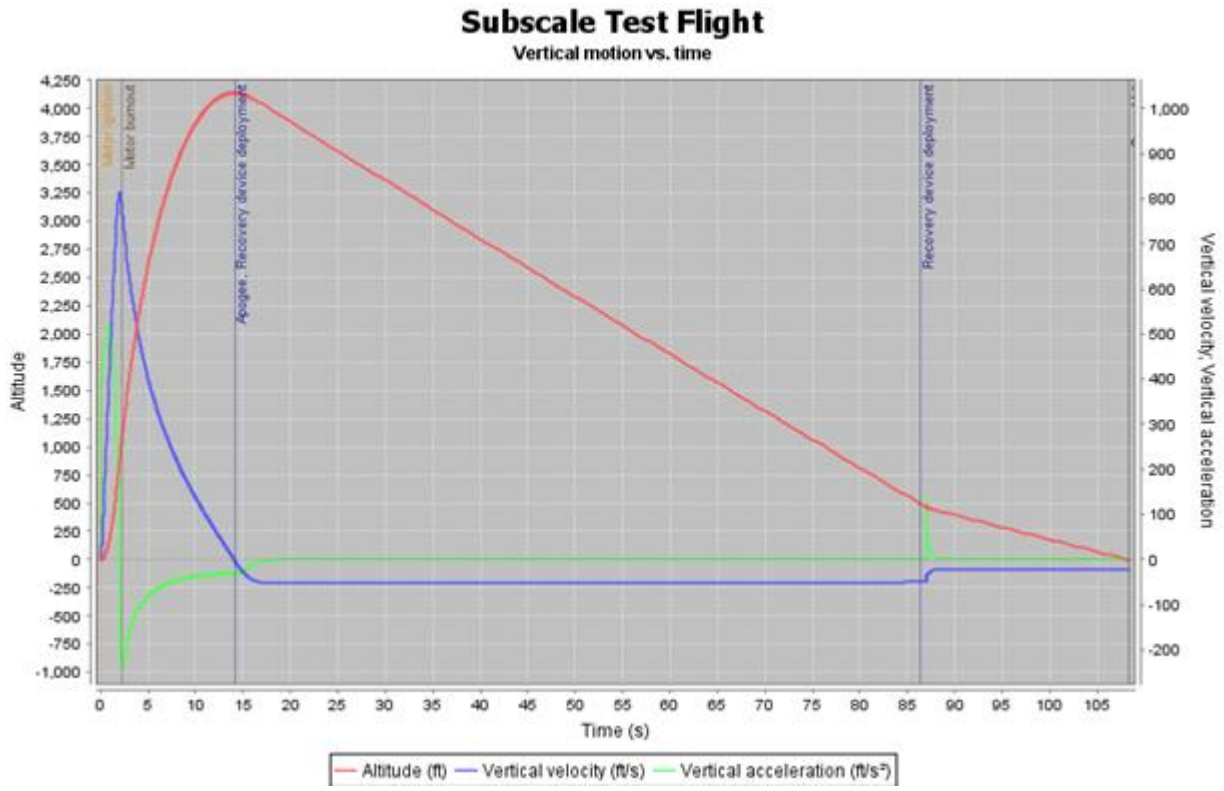
Subscale Overview



Subscale Overview

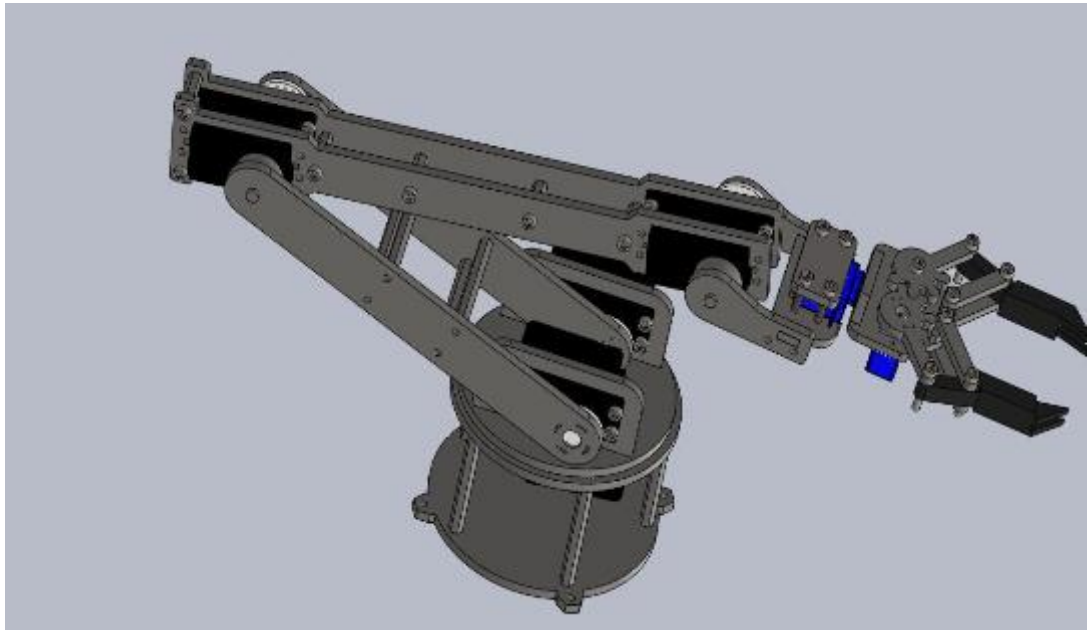
Length (in)	**93.2**
Mass (Loaded/Empty) (lbs)	**10.3/7.14**
Projected Altitude (ft)	**4136**
Projected Max Velocity (ft/s)	**813**
Stability (cal)	**1.95**

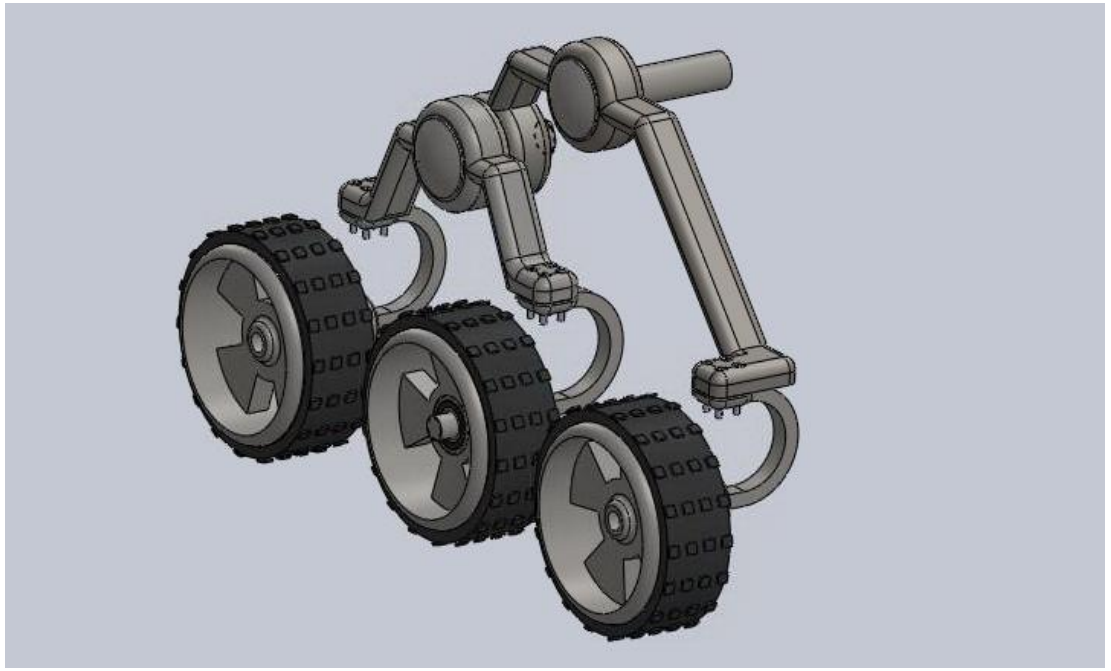
Subscale Overview



AGSE OVERVIEW

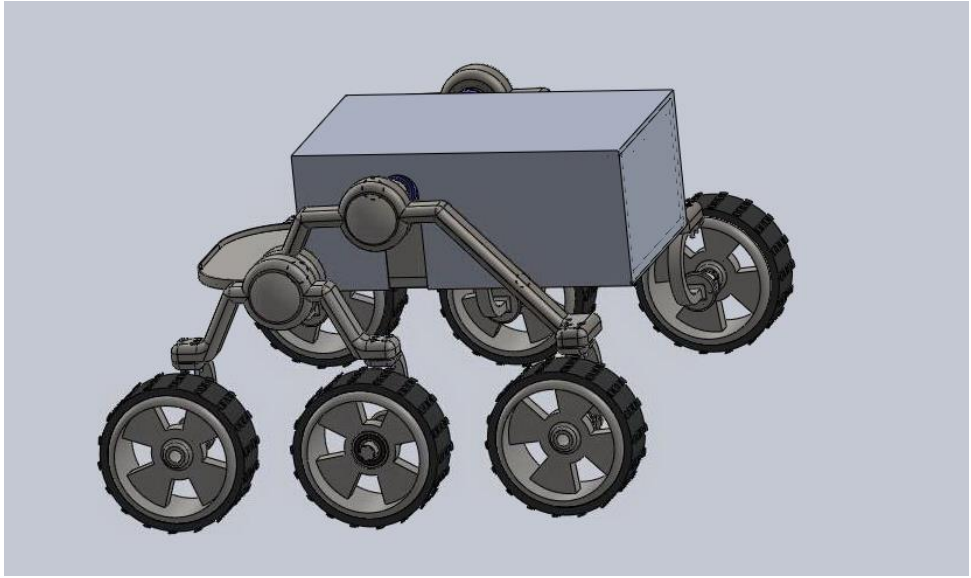
Subsystems (Capture)





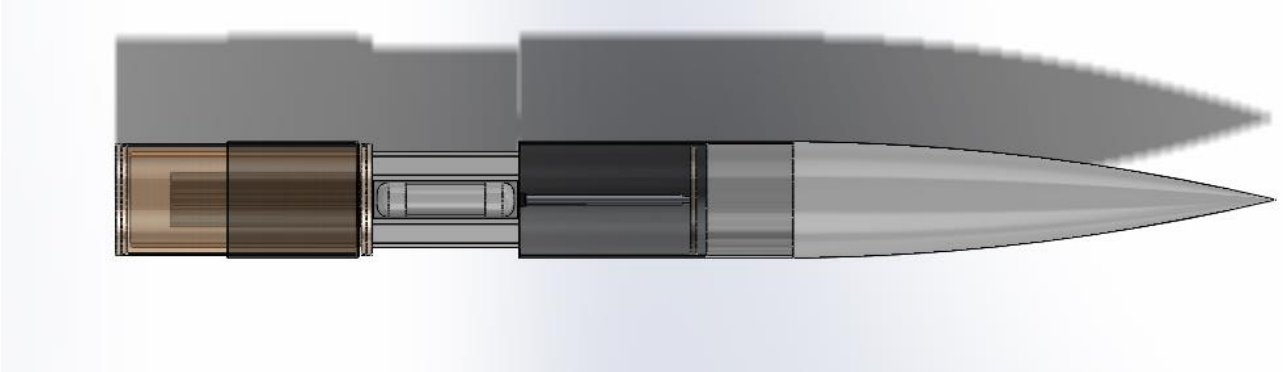
Subsystems (Capture)

- Payload Approach through Rover
- OpenCV Machine Vision Detection and Verification
- Rover Approach with Arm
- Mechanical Arm and Gripper Interaction
- Rocket Approach and Positioning



Subsystems (Containment)

- Linear Actuator Movement
- 3-D Printed Payload Sled
- Can easily be integrated into launch vehicle design



Testing and Verification

Requirement	Design and Verification
Autonomously Capture Payload	• Mechanical Arm and Rover Approach • Machine Vision Payload Detection • Test for Verification
Contain Payload Within Rocket	• Payload Bay Containment System • Sealable Door • Simulation and Test for Verification
Raise Rocket to 5 Degrees from Vertical	• Worm and Gear System • Calculations for Design • Test for Verification
Insert Igniter	• Linear Actuator on Rocket Blast Plate • Design and Test for Verification

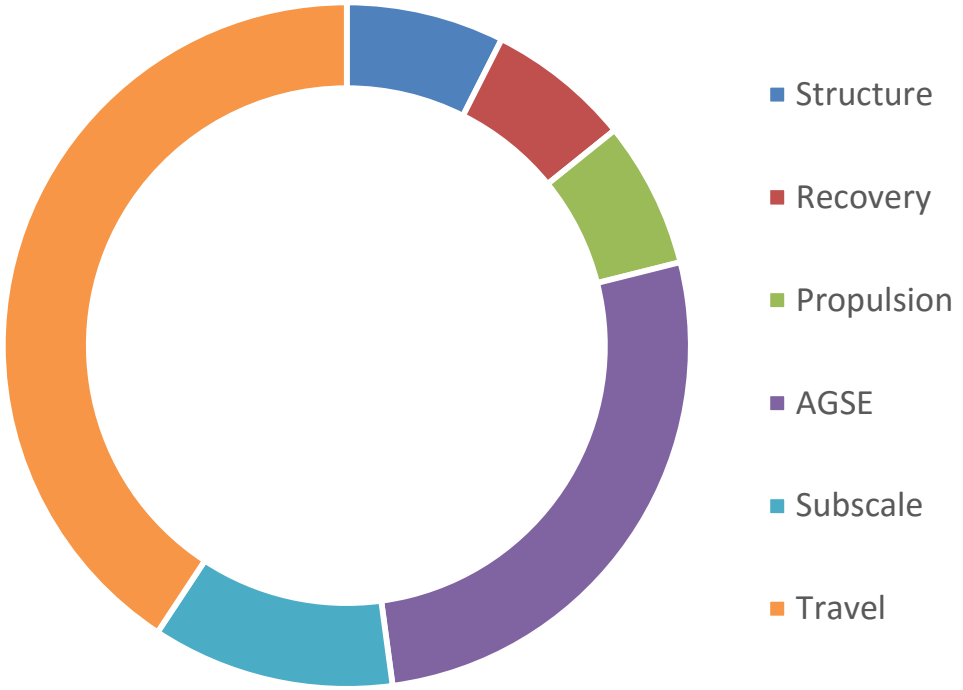
PROJECT PLAN

Safety

- Before each launch the checklist and safety standards as set internally and by the Tripoli Rocket Association shall be rehearsed and understood by all attending members.
- Team Mentor Rick Waters will oversee all preparatory activity and directly handle black powder charges.
- A Failure Modes and Hazards Analysis Document has been completed and shall be updated throughout the course of the project.

Budget

BUDGET	Amount
Structure	$766.64
Recovery	$697.28
Propulsion	$710.85
AGSE	$2,761.80
Subscale	$1,175.58
Travel	$4,200.00
TOTAL	**$10,312.15**



Educational Engagement

- Engagement at local schools with passive and active events
- Involvement in USFs Engineering EXPO outreach event to numerous local students

Next Steps

- Fabricate Final Design
- Develop AGSE Prototype
- Test Full Scale 2/20
- Initiate Educational Engagements

QUESTIONS?