Critical Design Review

Rensselaer Rocket Society (RRS)

Project Andromeda

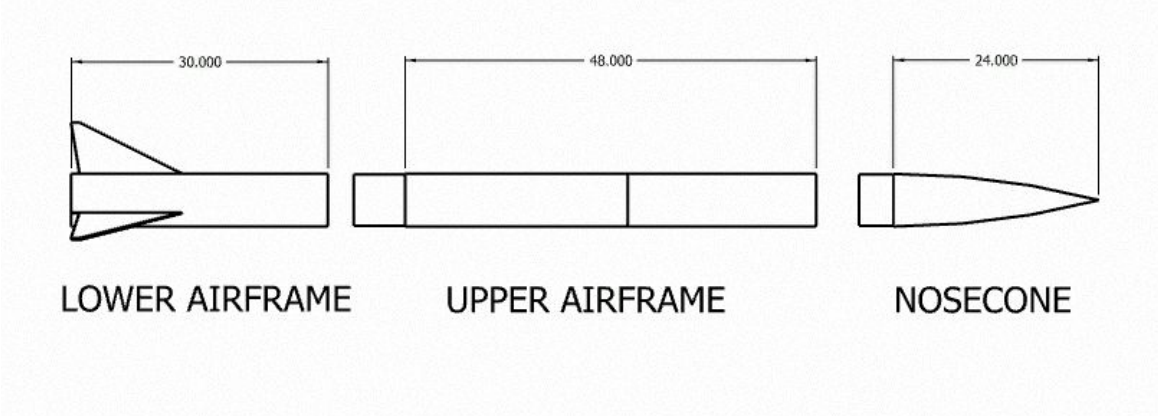
System Level Design

Tasks: 3.3 Roll Induction and Counter Roll

Three Major Subsystems:

- Vehicle - Lead by Sean Beacham
- Payload - Lead by Joe Hatch
- Recovery - Lead by Rebecca Caswell

Final Launch Vehicle Dimensions

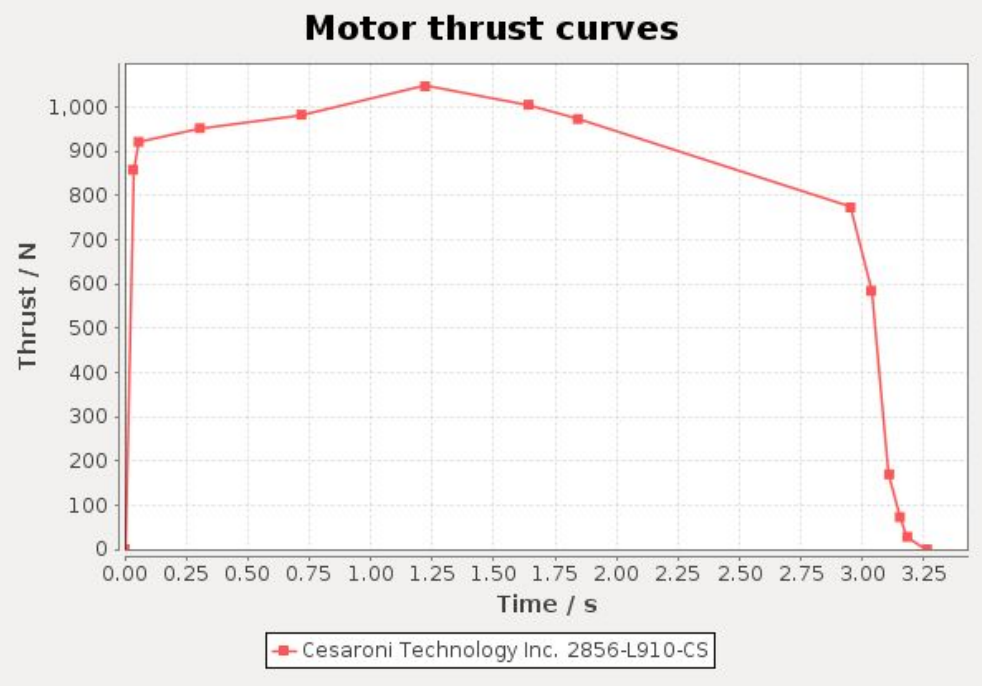


- Length - 102 Inches
- Inner diameter - 6.007 Inches
- Outer Diameter - 6.155 Inches

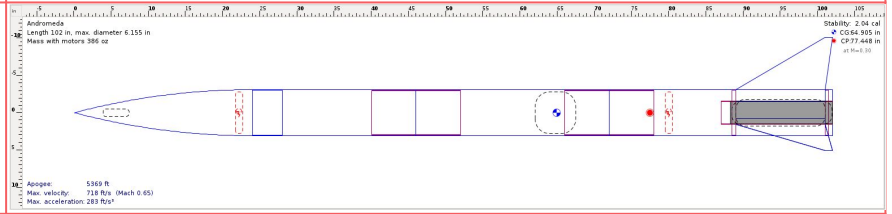
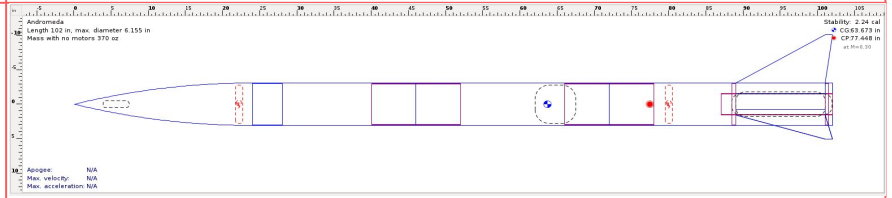
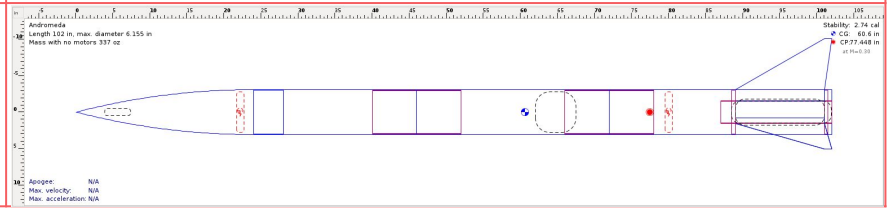
- Airframe Tubing Mass - 60 oz
- Fin Mass (total) - 22.7 oz
- Nose Cone Mass - 28.2 oz
- Subtotal Mass - 408.16 oz

Motor Selection and Justification

- Cesaroni L910 (75 mm)
  - Total Impulse: 2869 Ns (12% L)
  - Avg Thrust: 906 N
  - Peak Thrust: 1048 N
  - Burn Time: 3.16 s
  - Launch Mass: 92.3 oz
  - Empty Mass: 44.1 oz
  - Length: 13.8 in
- Reasonable burn time and even profile
- Relatively short length and low mass
- Simulated apogee remained satisfactory as design matured



Launch Vehicle Stability

Point of Interest	Center of Gravity (inches from top)	Stability (Cal)	Figure
Launch Ready	**64.9**	**2.04**	
Rail Exit	**63.7**	**2.24**	
Pre-payload Deployment Coast	**60.5**	**2.74**	

Vehicle Verification Status

- Target apogee
- Four or fewer sections
- Single stage
- Electronic dual deploy
- Shear pins will hold
- Kinetic energy at landing
- Chute deployment at apogee
- Static stability margin

Thrust-to-weight Ratio and Rail Exit Velocity

- Average TWR: **8.10**
- Maximum TWR: **9.37**
- Rail Exit Velocity: **79.2 ft/s**
- Rail Size: **144 in (1515)**

Vehicle Subsystems

Recovery System

- Main parachute: SkyAngle Classic II 60
- Drogue parachute: Ballistic Mach II 2 ft
- Attachment hardware
  - 1.5” stainless steel eyebolts - rate for 500 lbs
  - ½ ‘’ birch plywood bulkhead
  - Tubular nylon shock cords - 250’ long
- Descent Rates
  - After drogue: 91 ft/s
  - After main: 23 ft/s

Vehicle Subsystems

Recovery System: Electrical Components

- Altimeters
  - Featherweight Raven 3
  - PerfectFlite Stratologger
- GPS tracking
  - Xbee wireless transmitter - 2.4 GHz frequency
- Black powder ejection charges mounted in blast cups on fore and aft bulkheads
  - Drogue deployment @ apogee
  - Main deployment @ 700 ft
  - 1.7 g for both charges

Kinetic Energy & Drift Calculations

V_{final} = 23.9 ft/s

Independent Section	Kinetic Energy
Nose Cone = 52.2 oz	28.96 ft · lbf
Upper Airframe = 126.72 oz	70.31 ft · lbf
Lower Airframe = 121.5 oz	67.41 ft · lbf

Wind Speed (mph)	Drift Distance (feet)
0	0
5	579
10	1157
15	1736
20	2314

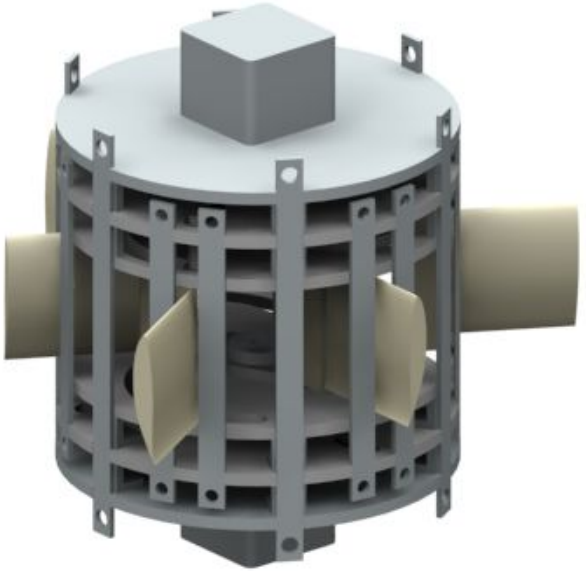
Subscale Flight

Nominal subscale flight

- Simulated altitude of 1220 ft AGL
- Max altitude of 1290 ft AGL
- 5 mph wind speed, 16°F temperature
- Successful dual-deployment
    - Body separation at apogee
    - Main parachute deployment at 550 ft AGL

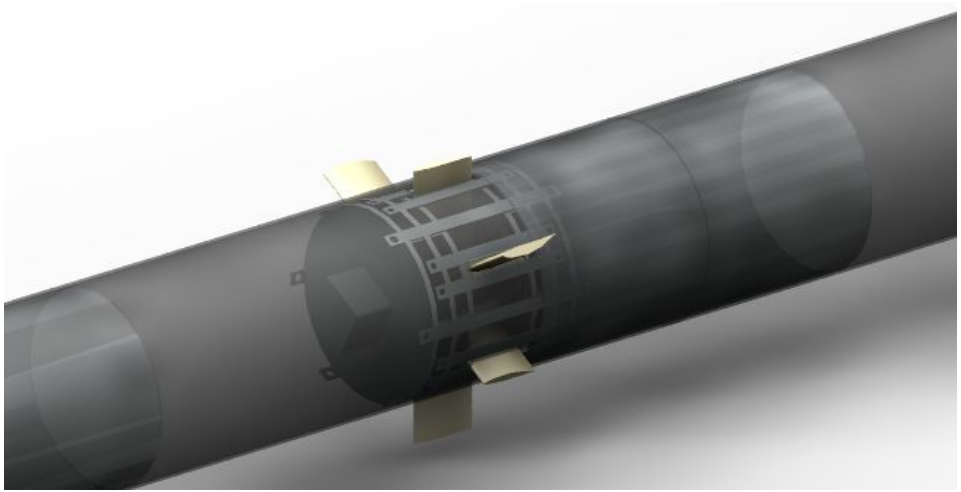
Payload Design Overview

- Two sets of three blades to roll rocket
- Each half is composed of the following:
  - 3 extruded airfoil blades
  - A cam plate and a straight plate
  - Stepper motor with support plate
  - Threaded rods to secure blades in slots
  - Rollers to reduce drag in slots
- Initial CFD results indicate capability of at least 25 rotations/second with fully extended blades
- 12 screw locations for integration purposes (6 top, 6 bottom)
- Guides to constrain blades



Payload Integration

- System secured by 12 screws
- Slots for blades are to be rectangular with filleted corners
- Stress concentrations due to slot creation
  - Require fiberglass reinforcement
- Payload electronics activated with Hall effect switches



Safety Overview

- General overhaul and improvement to incorporate project specific risks and mitigation strategies
- Added risks the project poses to the environment
- RF testing demonstrates that transmitters should not interfere with recovery electronics
    - Regardless, requirement 2.12.2 will be followed, and all recovery electronics shall be shielded

Budget Summary

Vehicle Design Team Expenses	$1,218.96
Recovery Team Expenses	$398.95
Payload Team Expenses	$798.16
Travel Costs	$3,150.00
Income	$9,825.00
Total Expenditures	$5,566.07
Total Budget	$4,258.93