Minimum Mars Ascent Vehicle - RASC AL

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Abstract

Currently planned missions to Mars are designed with Mars Ascent Vehicles (MAV) exceeding 40,000 kg. This presents extraordinary challenges in terms of entry, descent, landing and launching. NASA is interested in smaller MAV concepts that will reduce the amount and difficulties currently being encountered with MAVs exceeding 40,000 kg of mass. This is the problem our team has tackled. Our MAV concept is not allowed to exceed 20,000 kg wet mass and cannot exceed 5,000 of dry mass. Dry mass being the mass of the entire rocket minus the fuel, and wet mass being the mass of the rocket and the fuel. Our concept must be able to transport two humans from the surface of Mars to low Mars orbit (LMO). Additionally, our concept must be ready to serve a mission date no later than December 31st, 2034, with an annual budget of $2 billion per year from 2025 to 2035.

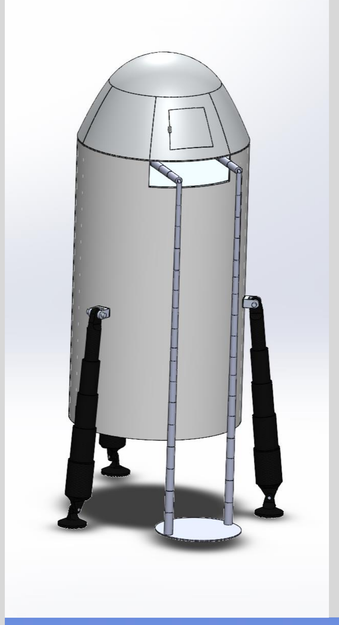
Requirements

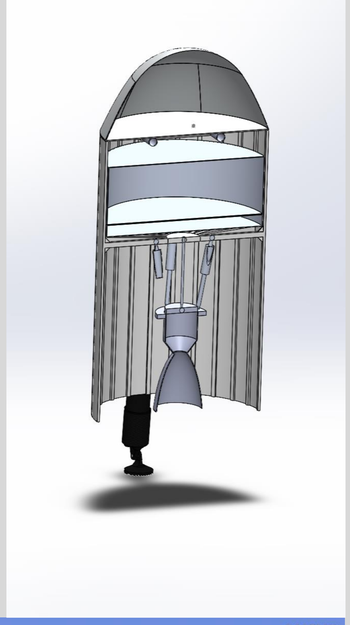
- **Total dry mass cannot exceed 5,000kg, or a wet mass of 20,000kg**
- **Fit a crew of 2**
- **Sustain a Low Mars orbit**
- **Annual budget of $2 billion for 10 years**
- **Developmental timeline**
- **Identify necessary interfaces for the MAV**

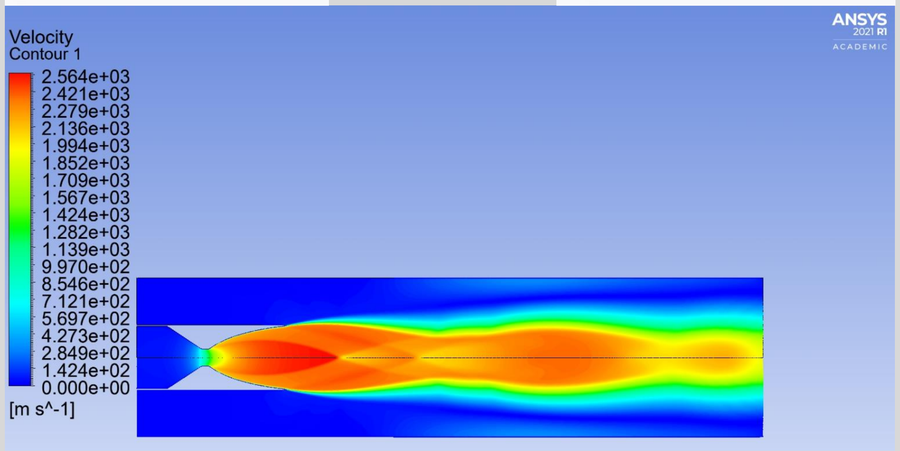
Methods

1. Research and Brainstorm Novel Innovation
2. Find Initial Specific Model Dimensions
3. Create CAD Model
4. Perform CFD and FEA Analysis on CAD Models
5. Verify Simulation Results

Results







Conclusion

- Assuming a LMO of 200km our Δv will need to be 3.47 km/s
- Using a specific impulse of 1091 s for the metallic hydrogen - liquid neon fuel at a 1:2 ratio
- We find that we need 9,000 kg of fuel which is 6,000 kg below our maximum
- This amount of fuel will take about 8 cubic meters of space
- The metallic hydrogen will not be combusting but phase changing
- The liquid neon will keep the metallic hydrogen and thrust chamber cool
- The height of the rocket is 8.08 meters
- The maximum width of the rocket is 4.07 meters
- The central body diameter is 3.00 meters
- Total dry mass of the rocket is 4,350 kg
- Features a lift to allow astronauts and cargo to enter and exit the rocket

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Acknowledgements

This is a large project with many parts to consider, so our team was only able to design at a high level. A larger team would be best for this project in the future, since it would allow for multiple small teams to do lower level design work on subsystems of the rocket.