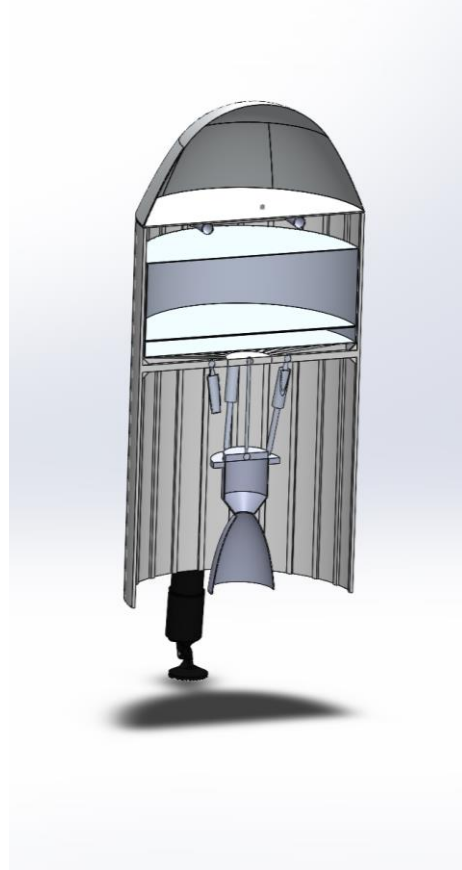
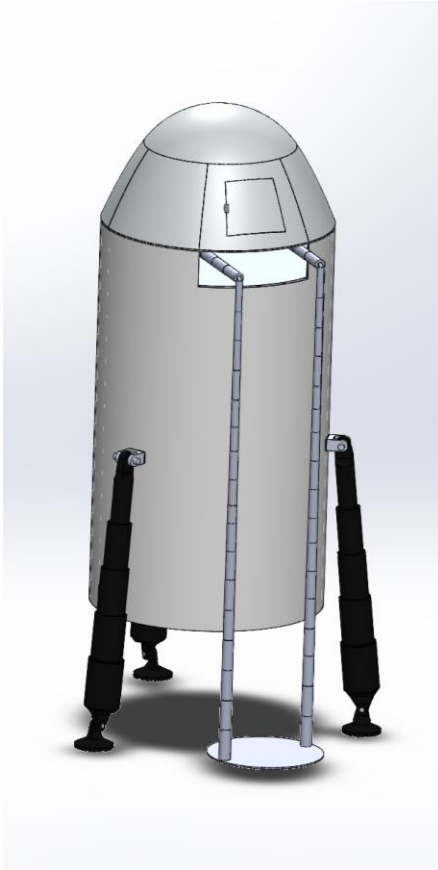


FINAL PRODUCT BREAKDOWN

TEAM: 20F08 RASC MAV

Due Date: 4-23-2021

Completed system here:

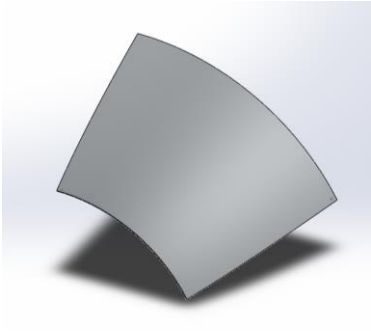
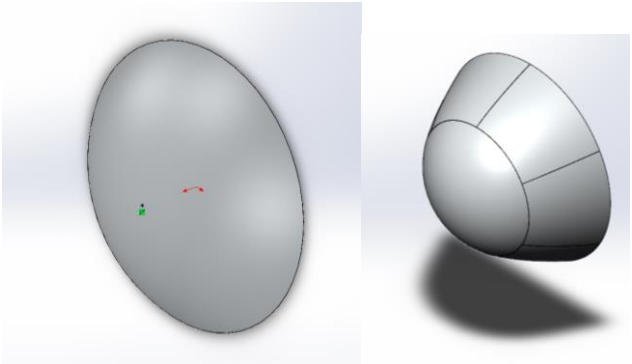


The following are the Action Items each person completed between Hardware Review 2 and the completion of the final product:

Team Member: Zachary Small


Action Item	Date Completed	Result/Proof of Completion
Created Transient Simulation of Rocket Nozzle Ignition	4/10/21	https://www.youtube.com/watch?v=JTjCUIY-vL0
Created Elevator	4/17/21	This elevator connects to the underside of the nose cone and protrudes out of the vehicle to bring up and down both cargo and astronauts.
Found Specific Fuel/Acceleration/Volume Parameters in MATLAB	4/15/21	https://drive.google.com/file/d/1bjM-rWMD4Acup-9wW_tNhFITP73bxc61/view?usp=sharing

Team Member: Katrina Kittelsrud


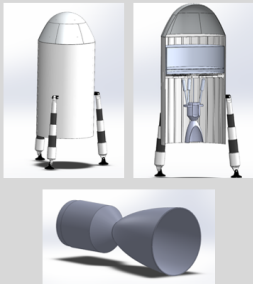
Action Item	Date Completed	Result/Proof of Completion
Create a new nose cone as panels.	4/3/21	
Used weldments in place of rivets.	4/7/21	

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Team Member: Lexie Marquez

Action Item	Date Completed	Result/Proof of Completion
Design way to landing gear will be attached to MAV	4/3/21	

Team Member: Jacob Mettler

Action Item	Date Completed	Result/Proof of Completion
Completed final poster	4-201-2021	 <p>NAU NORTHERN ARIZONA UNIVERSITY Mechanical Engineering</p> <p>Minimum Mars Ascent Vehicle - RASC AL</p> <p>Katrina Kittlesrud, Peng Zhao, Lexie Marquez, Jacob Mettler, Zachary Small Mechanical Engineering Department, Northern Arizona University, Flagstaff, AZ 86011</p> <p>Abstract Currently planned missions to Mars are designed with Mars Ascent Vehicles (MAVs) 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, 2024, with an annual budget of \$2 billion per year from 2022 to 2025.</p> <p>Requirements</p> <ul style="list-style-type: none"> Total dry mass cannot exceed 5,000kg, or a wet mass of 20,000kg Fit a crew of 2 Low Mars orbit Annual budget of \$2 billion for 10 years Developmental timeline Identify necessary interfaces for the MAV <p>Methods</p> <ol style="list-style-type: none"> 1. Research and Brainstorm Novel Innovation 2. Find Initial Specific Model Dimensions 3. Create CAD Model in Solidworks 4. Perform CFD and FEA Analysis on CAD Models 5. Verify Simulation Results <p>Results</p>  <p>Conclusion</p> <ul style="list-style-type: none"> Assuming a LMO of 200km our Δv will be 3.47 km/s Using the previous rocket equation and a specific impulse of 1091 s for the metallic hydrogen and a specific impulse of 320 for our liquid neon 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 cool <p>References</p> <ol style="list-style-type: none"> [1] J. F. Silver, "Metallic hydrogen: The most powerful rocket fuel yet to exist," <i>Journal of Physics: Conference Series</i>, 2010. [Online]. Available: https://science.lp.org/entities/10.1088/1742-6596/215/1/012164.pdf. [Accessed: 07-Mar-2021] [2] All Standards NASA Technical Standards System (NTSS) standards.nasa.gov. [Online]. Available: https://standards.nasa.gov/en/standards [3] J. F. Silver, "Metallic Hydrogen: A Game-Changing Rocket Fuel," <i>NASA</i>. [Online]. Available: https://www.nasa.gov/sites/default/files/69621main_Silver_FinalReport.pdf. [Accessed: 03-11-2021] [4] Lockere, F., Cocchi, F. & Dumas, P. Synchrotron infrared spectroscopic evidence of the pressure transition to metal hydrogen. <i>Nature</i> 571, 631–638 (2020). https://doi.org/10.1038/s41586-020-2527-3 [5] "Next Rocket Equation," <i>NASA</i>. [Online]. Available: https://www.nasa.gov/press/20200415main/next.html. [Accessed: 05-Mar-2021] [6] J. J. Lissauer and I. G. Passer, <i>Fundamental planetary sciences: physics, chemistry and habitability</i>. Cambridge [1999?], Cambridge University Press, 2019. <p>Acknowledgements</p> <p>This is a large project with many parts to consider. A larger team would be best for this project in the future.</p>

Team Member: Peng Zhao

Action Item	Date Completed	Result/Proof of Completion																																																																																																																																																																																																																																									
Updated the budget analysis	4/8/21	<table border="1"> <thead> <tr> <th colspan="9">RASC-AL Minimum Mars Ascent Vehicle</th> </tr> <tr> <th rowspan="2">#</th> <th rowspan="2">Content</th> <th rowspan="2">Quantity</th> <th rowspan="2">Weight (kg)</th> <th colspan="2">Material</th> <th rowspan="2">Labor costs (per day)</th> <th rowspan="2">Time Consuming (day)</th> <th rowspan="2">Total</th> </tr> <tr> <th>Type</th> <th>Unit Price</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>Ribbed Body</td> <td>1</td> <td>2268.83</td> <td>6061 Aluminium Alloy</td> <td>\$13.27</td> <td>\$219</td> <td>20</td> <td>\$34,487.37</td> </tr> <tr> <td rowspan="2">2</td> <td rowspan="2">Engine Gimbal</td> <td>Engine to Gimbal Ring</td> <td>1</td> <td>66.75</td> <td>6061 Aluminium Alloy</td> <td>\$13.27</td> <td>\$219</td> <td>10</td> <td>\$3,075.77</td> </tr> <tr> <td>Nozzle</td> <td>1</td> <td>509.58</td> <td>Copper</td> <td>\$8.79</td> <td>\$219</td> <td>10</td> <td>\$6,669.21</td> </tr> <tr> <td>3</td> 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