Student Launch Initiative- Mars Ascent Vehicle 2016

University of Iowa AIAA Student Section
Hawkeye One Rocket

The University of Iowa
3131 Seamans Center for the Engineering Arts and Sciences
Iowa City, Iowa, 52242

September 8th, 2015

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Member Information

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Members

Austin- Team leader
The
Victoria- Safety officer
Ryan- Budget/funding
Frank- Educational Outreach and Public Relations
Andrew- Rocket Simulation

Team Mentor/Contact

Kevin Trojanowski, NAR/TRA Level 3
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Facilities Description

Design

Design will be conducted in the Seamans Center computer labs and study spaces, which are open to all engineering students 24 hours of the day. Within the Seamans Center are multiple computer labs that students have 24-hour access to. These computers have various software programs that will be used by the team during the construction process. Creo Parametric 2.0 will be used to model the rocket and its components. ANSYS Fluent will be used for computational fluid dynamics analysis during the design refinement process. In addition to these university computers, the team members will use personal laptops. OpenRocket will be used on these personal computers during the design process to analyze the rocket design and determine the motor to be used.

Construction

The University of Iowa Engineering student org shop located on campus will be used for construction of all physical models and full scale vehicles. All members are required to pass safety quizzes and sign waivers to work in the shop. The safety requirements are further detailed in the safety section on page 8. This shop contains various hand tools and power tools that are owned by both the Univesity and the team. The team has a separate room in this shop space for storage of materials, including a flammable cabinet.

Pro

Timeline

<u>September 2015</u>

11 Electronic copy of completed proposal due to project office by 5 p.m. CDT to

<u>October 2015</u>

23 Team web presence established
25 Preliminary Design finalized
28 Company Sponsorship Proposals submitted

<u>November 2015</u>

6 Preliminary Design Review (PDR) reports, presentation slides, and flysheet posted on the team Website by 8:00 a.m. Central Time.
7 Begin Subscale vehicle construction
20 PDR video teleconference
27 Complete Subscale construction
29 Subscale vehicle launch

<u>December 2015:</u>

4 CDR Q&A

<u>January 2016:</u>

15 Critical Design Review (CDR) reports, presentation slides, and flysheet posted on the team Website by 8:00 a.m. Central Time.
29 CDR video teleconferences
30 Begin Full scale vehicle construction
30 First Educational Outreach Presentation

<u>February 2016:</u>

3 FRR Q&A

March 2016:

11 Finish Full scale build

14 Flight Readiness Review (FRR) reports, presentation slides, and flysheet posted to team Website by 8:00 a.m. Central Time.

16 Final Educational Outreach Presentation

17-30 FRR video teleconferences

April 2016:

13 Teams travel to Huntsville, AL

13 Launch Readiness Reviews (LRR)

14 LRR's and safety briefing

15 Rocket Fair and Tours of MSFC

16 Launch Day

17 Backup launch day

29 Post-Launch Assessment Review (PLAR) posted on the team Website by 8:00 a.m. Central Time.

Budget

Rocket	fins	$100
	body (blue tube)	$150
	nosecone	$25
	motor (class I) x3	$400
	altimeter	$100
	parachute	$50
	recovery devices	$250
	shear pins	$15
	motor casing	$75
	electronic components	$200
	other parts	$400
	Tracking system	$300
	Scale model	$150
	cameras and sensors	$400
Vehicle	Steel tube	$400
	electronics	$300
	motor	$200
	cables	$100
	gears	$100
	steel plating	$150
	cameras & sensors	$200

	power supply	$75
	rubber track	$100
Tower Stand	conveyor belt	$500
	gears	$75
	electronics	$125
	chains	$100
	metal sheets	$250
	motor	$250
	steel bars	$200
	cables	$150
	other	$200
Tools	glue/epoxy & stains	$75
	screws, bolts, washers	$75
	Machine shop labor	$200
TOTAL		$6,040

Travel (assuming 8 people)	2 cars (680 miles of gas) $3/gal	$500
	lodging(2 rooms 5 nights) ($150/night)	$1,500
TOTAL		$2,000

Community/ Sustainability

The community will be engaged in this project in multiple ways. Fundraising will be sought from the University of Iowa. The University of Iowa Student Government provides financial support for student groups, and this support will be sought. The Department of Mechanical and Industrial Engineering has provided financial support in the past, along with Engineering Professional Development. Corporate sponsorship will be sought from area engineering companies, with compensation being provided in the form of company logos being on team materials including shirts and banners.

Additional community support and sustainability will come from the educational engagement aspect. By engaging the community in this way, future university students will learn about rocketry principles and see what opportunities exist in the STEM fields. Engagement of current high school students will allow students to see the opportunities within our club, ensuring that participation in this challenge will continue into the future.

Safety Plan

No work shall be done on the construction of the rocket unless at least 2 general members and the safety officer are present. The safety officer will make final determinations on who may or may not use power tools, and will ensure that proper supervision is given during use of power tools. The safety officer will also be responsible for ensuring that all members are wearing proper personal protective equipment while in the workspace. The University also requires safety quizzes to be taken through Environmental Health and Safety once per semester in order to access the shop. These quizzes provide general safety knowledge about power tools, fire hazards and mitigation, and personal protective equipment. In addition to these quizzes, the safety officer will provide safety information specific to the shop used during the construction process. Minimum personal protective equipment will be safety glasses, with other protective equipment such as gloves and earplugs being used as needed for certain tools and materials. Prior to the first construction session, the safety officer will ensure that all members have been informed of the health hazards associated with shop work, taken the required University safety quizzes and have signed the proper paperwork. An additional form written by the safety officer will be signed by all members. This form will detail rules specific to the construction process beyond general rules established by the university, and will ensure that all members abide by the rules throughout the construction process.

Materials:

Risks:

- Epoxies: could cause irritation to eyes, skin, and respiratory system
- Flammable materials: combustion hazard
- Liquids: spill hazards

Mitigation:

- All epoxies will be handled with gloves, safety glasses, and respirators in a well-ventilated area
- All flammable materials will be handled away from sources of heat or flame
- All flammable materials will be stored in the flammable cabinet when not in use
- Long pants and closed-toe shoes will be required while in the lab

Facilities

Risks:

- Unclean work areas
- Falling hazards
- Poor lighting
- Broken power tools

Mitigation:

- All work areas will be cleaned, and materials/tools will be put away at the end of each build session
- Items will be stored in a way that prevents falling hazards
- Tools and materials will be stored in their proper places, with drawers and cabinets being labeled
- Work areas will be well-lit and task lighting will be used as needed

- Power tools will be inspected to ensure that they are in working order, and if damaged, will not be used until repaired by a professional

Risks to Successful Completion

Risk	Mitigation Strategy
Poor Rocket Design; unstable or missing details	NAR guidelines for safe rocket design will be read by all participating members and will be used as a reference. The team mentor will be included in the design process to ensure that all necessary components are being included in the design.
Injury During Construction: due to hand/power tools, falling objects, etc.	All members will take the required safety quizzes from EHS prior to being allowed in the shop. A tour of the shop space will be given on the first construction day so that all members are familiar with the shop and the tools. PPE will be used as required, and all tools will be maintained to ensure safety.
Poor Construction Quality	Poor construction quality could cause the rocket to break up upon launch. To prevent this, quality control will be of the utmost importance. More experienced members will lead the construction process, and will be supervised when needed. Proper tools and materials will be used during all stages of construction.

The NAR/TRA mentor will either perform the preparation of the motor on launch day, or will assist qualified team members in this process. The angle of the launch rail will be cleared through the mentor to ensure that it is a safe angle for launch based on the weather conditions that day. Prior to launch, the safety officer and mentor will coordinate on launch day procedures, with the mentor having final say on who performs specific launch-related tasks.

Prior to construction of the rocket, all participating members will be trained in the use of power tools. Explanation of hazards in the work area, including flammable and hazardous materials, will be given in a mandatory meeting to be conducted by the team leader and safety officer. Personal protective equipment will be worn by all members working on the construction process, and will be provided within the shop space. Supervision will be provided when working with hazardous materials to ensure the safety of all members. All members will be encouraged to stop and ask questions when they aren't sure on how to use a certain tool, and to ask for assistance as needed.

The pre-launch briefing will be planned by the safety officer and team mentor. This is to ensure that all important details are mentioned during pre-launch briefings. Pre-launch briefings will be conducted by the team safety officer and team mentor and will go over all important details of the assembly and launch process. These briefings will be mandatory for all members attending the launch, even if they will only be spectating. Only a few members will take the rocket to the launch pad, and they will be accompanied by an NAR/TRA member.

All written plans for the rocket will include pertinent safety information regarding the specific materials. Each member will be responsible for reading the given safety information before handling any hazardous materials. Prior to the first construction session, all participating members will be given a sheet detailing safety procedures and rules within the workspace. Members will be asked to sign these sheets as proof that they have read and understand the safety guidelines for the construction space. These sheets will be written by the safety officer, with input given by the team leader. All submitted materials required for the competition will contain the pertinent safety information as prepared by the safety officer. The work space will include safety information, including the sheets as prepared by the safety officer. MSDS will also be provided for all applicable items.

Prior to the construction process, laws and regulations regarding flammable materials and fire prevention will be read. This is to ensure that safety is kept in mind throughout the construction process. Prior to launch, all regulations concerning airspace, fire prevention, and motor handling will be read through by all participating members, even if they will not be handling the motor. The NAR/TRA mentor will be consulted during this time to ensure that all members and the mentor are in agreement with launch procedures.

Any and all motors needed will be purchased through the NAR/TRA mentor, and will be kept by the mentor until needed for launch. The NAR/TRA mentor will assist the team in preparing the motor for launch to ensure safe use of the motor. Any other energetic devices that will be used in the rocket will be cleared through the mentor before being added to the rocket itself to ensure proper assembly and safe use. Storage and transport of the energetic devices will be coordinated with the mentor as needed.

All members will be given a written statement detailing safety regulations. This will include basic safety during the construction process, as well as details of safety before and during the launch. All members will be informed of the required safety procedures on launch day during the pre-launch briefing, and will be expected to listen to the RSO throughout the launch process and respect the RSO's final decision on the launch. The safety officer will coordinate directly with the RSO during the inspection to answer any questions and ensure that the rocket will be able to be safely launched.

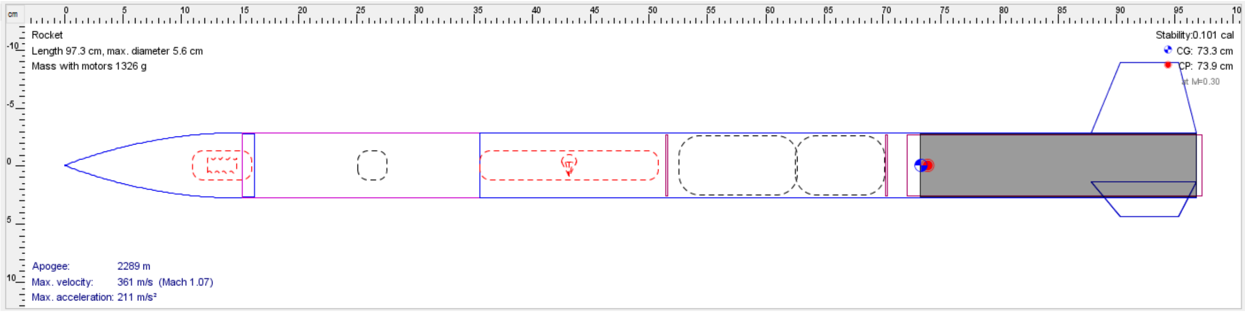
Technical Design

The launch vehicle will be approximately 95cm in length, 5.6cm diameter weighing 2.6lbs using an I class motor. The airframe will be BlueTube for strength and low weight, with a 6 in. ogive PVC nose cone and 1/8th inch thick carbon fiber fins. The carbon fiber for the fins is currently owned by the team, providing a cost savings. The shape of the fins will be modeled using Creo Parametric 2.0. The fins will be cut using a waterjet in the machine shop located within the Seamans Center.

The vehicle will be constructed using fixed screws, shear pins and epoxy to fix the nose cone, centering rings, motor mount, and other structures inside the airframe. The fins will also be attached using epoxy, and will go through the wall of the rocket to provide stability and support to the fins. Epoxy will be used to add fillets along the edges of the fins for stability and aerodynamics.

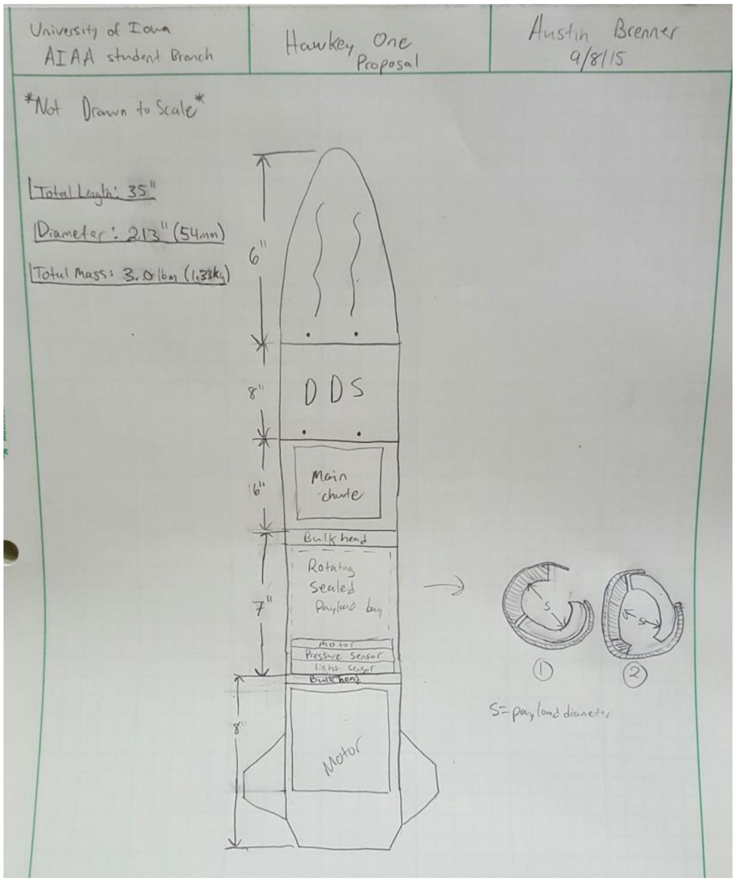
The projected altitude with a Cesaroni I445 motor is 5100 ft. This was calculated using Openrocket V15, an open source rocket modeling software. The simulated rocket can be seen in Figure 2 with mass objects to approximate the electronics, payload, and altimeters that will be inside of the vehicle. Further simulations will be done as the design is refined, with studies being conducted to ensure that the correct motor is selected prior to launch.

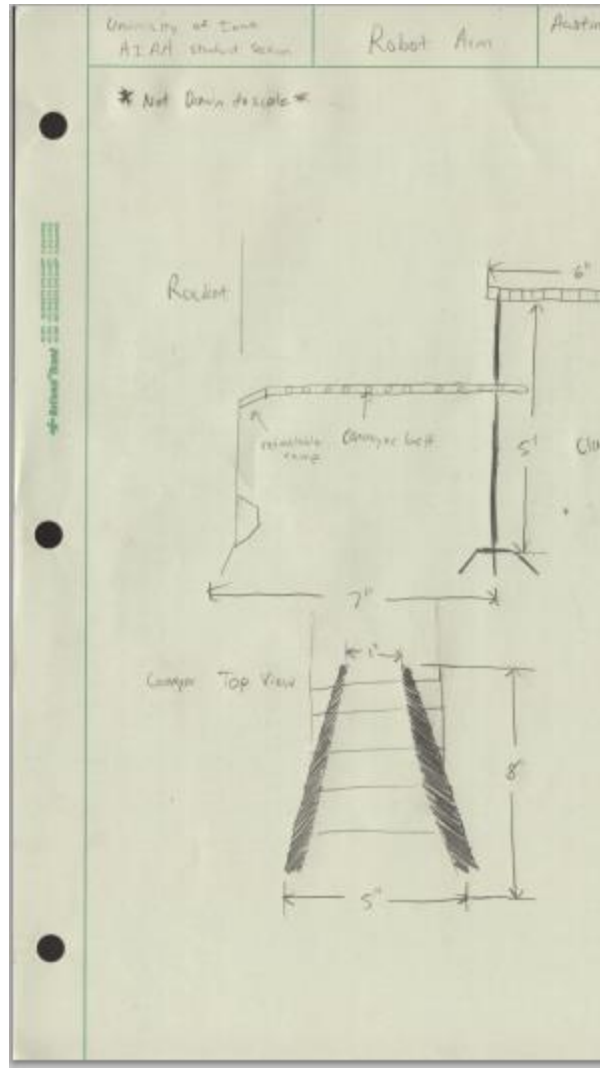
A dual deployment system, commercially available from apogeerockets.com, will be used. It will deploy a nylon streamer 50cm in length at apogee, as well as a 36in Angel parachute at 100m rated for 4.5lbs at 20ft/s. This should be more than strong enough for a safe descent.



The payload, in accordance with the Mars Ascent Vehicle competition, will be a simulated mars sample. It will be a 4.75in long ¾ in diameter PVC cylinder weighing approximately 4 ounces.

The AGES system will be attached to a launch stand approximately 5 feet long by 3 feet wide. the launch stand will stand the rocket up right as the AGES locates and picks up the PVC sample, then place the sample inside the launch vehicle via elevator and conveyor system and insert the motor igniters before upright launch. The launch vehicle will seal the sample by rotating a door and safely carry it to an altitude of 5280ft, deploy parachutes and return to the ground with minimal vibration or impact damage to itself or the payload.





AGES Conceptual Design

The major technical challenges of this project will be the AGES system both for loading and sealing the sample autonomously. It will be accomplished using light sensors, proximity switches, air pneumatics and coding that will work without any human interaction as well as redundant sensors to verify payload containment. The other challenge will be getting an altitude of exactly 5280 ft for the launch vehicle. This will be achieved through careful aerodynamic analysis and appropriate motor selection.

Educational Engagement

The team will be working with educational outreach coordinators at the University of Iowa to set up basic rocketry presentations to elementary and high school student classrooms locally in the Iowa City school district. This will allow the team to achieve the 200 participant minimum requirement for educational engagement.

Prior to presentations, members that will be conducting the educational engagement will receive the proper background screening needed to work with students under the age of 18.

The presentations will cover basic rocketry principles, mission description, practice problems, and hands on activities such as bottle stomp rockets depending on the average age of the classroom. Prior to presenting, the team will meticulously pick out all of the most important concepts that will be the most beneficial for students. Once this is done, ways to explain these concepts in an age-appropriate style will be brainstormed. This includes thinking of different ways to explain the same thing, so that if some students are unable to understand, the team can explain it in a different way that is more conducive to their learning style. This also includes reviewing different teaching styles with the presenters so that they can adapt how they are describing concepts if the students are unable to grasp them at first. The goal in this outreach is to teach the students about the science behind rocketry, and describe some the more basic, but still very important concepts in a way that they can all understand. The team also hopes to spark an interest in aeronautics. Practice problems and hands-on activities will be used to gauge understanding and to provide additional educational opportunities. Hands-on activities such as bottle stomp-rockets will be a fun activity that will help to better engage the students and spark an interest in aeronautics.