University of South Florida

NASA Student Launch
Centennial Challenge MAV Project

Proposal

10 September 2015

Society of Aeronautics and Rocketry

15219 Plantation Oaks Drive
Tampa, FL, 33647

General Information

Educator

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Safety Officer

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Project Organization

The organizational chart below depicts the hierarchy of each leadership position and overall team structure. The majority of the team will be members divided into these subteams lead by the individuals listed below. We expect that overall member activity will change throughout the semester and subteams will be adjusted accordingly.

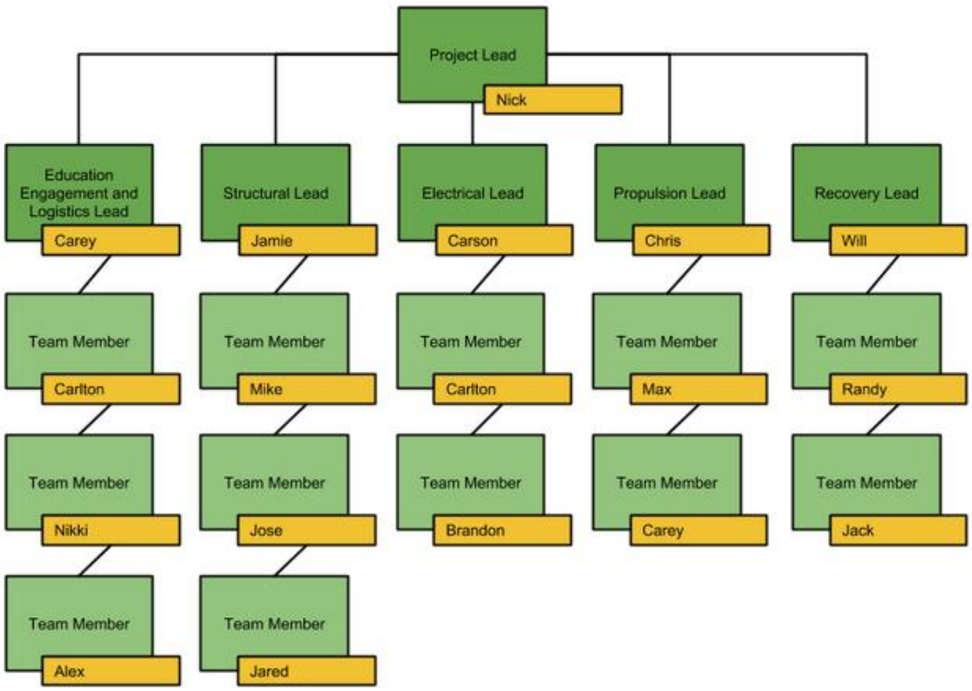

Figure 1. Project Organization Chart

NAR/TRA Sections

The Society of Aeronautics and Rocketry at the University of South Florida Team will utilize the nearby rocketry sections as a source of mentoring, launch assistance, and reviewing. The local Tampa Tripoli Rocketry Association (prefecture #17) will be the high powered launch sites. In addition, the TTRA location has an altitude waiver of 12,000 ft., which exceeds the target altitude.

Facilities and Equipment

Available Facilities

USF Design for X Labs
An engineering lab space dedicated to providing space and tools for engineering organizations and students. This location contains work tables, laser cutters, 3D printers, and small hand tools. Construction and planning will happen at this location.

Equipment:
- Small Hand Tools
- 3D Printers
- Laser Cutters
- Lathe

Hours: 7:00am - 5:00pm Monday - Friday

STEM Suite
A conference room reserved for weekly general body meetings and individual sections of the rocket team.

Equipment:
- White Board

Hours: 5:00pm - 7:00pm

V.A. Clinic
The V.A. Clinic in Tampa includes the office of our mentor Rick Waters. It is a this location that we store the majority of our equipment as well as facilitate build days.

Equipment:
- Lathe/Mill
- Power Tools

Varn Ranch (Tampa)
The Tampa Tripoli Rocket Association launch site. This is where we will primarily be doing our test launches. It has a 12,000 ft ceiling, exceeding what is necessary by a wide margin and wide open fields for easy recovery. Though we have much of the equipment we need to launch there is also equipment on site we can make use of as well.

Equipment:

- Launch Rails
- Dedicated Launch System

Personnel

Dr. Manoug Manougian

Dr. Manougian is Director of the University of South Florida’s STEM Education Center and a distinguished Professor of Mathematics. Dr. Manougian is the organization’s advisor, serving the students as a reference for rocket design, construction, and launching of rocket propulsion systems. He also serves as a role model and scientific inspiration for the entire student body.

Rick Waters

Rick Waters is an experienced member of the hobby rocketry community and the current operations leader of the TTRA. He oversees launches at Varn Ranch on Tripoli launch days and has acted as a mentor in terms of design and manufacturing of our rockets, particularly high powered designs.

Computer Equipment

Communication

Outside of regular meeting times team communication is achieved through email, our website, and texting among the officers. An updated roster on USF’s “Bullsync” will consistently keep the email list up to date and ensure that everyone knows the status of the ongoing project.

Design/Analysis

Our team will utilize the 3D rendering software SolidWorks 2014, which is provided free of charge by the University of South Florida to all students through the application gateway. This software will allow the team to draft feasible mechanical models.

The USF application gateway also provides students with access to MATLAB, a resource that will prove invaluable for data processing, mathematical modelling.

MATLAB will also provide the means for a student-crafted graphical user interface, relying heavily on the Barrowman Equations. Additionally, for precision rocket prediction and simulation we will use a combination of RockSim, a well-known commercial design and simulation program and OpenRocket, a java-based open-source, free-to-use program designed for model rocket analysis. Correlation between these programs will provide a model of best fit.

Web Presence

We can be found online through our Facebook page, which is actively maintained by the organization Webmaster, Nicole Hudson, additionally we may be found at our website, www.usfsoar.com, which was designed by the organization President, Nicholas Conde, and maintained through cooperative development.

Document Development

For document development, as well as data storage, our team intends to use our pre-existing organizational cloud storage, the Society of Aeronautics and Rocketry's Google Drive. This database allows us to instantaneously communicate and work collaboratively on documents and presentations. This free-to-use program gives all users cloud storage and software such as Google Docs, Slides, Forms, even Drawings.

Safety

Safety is paramount in the Society of Aeronautics and Rocketry and the University of South Florida in its entirety. While our Safety Officer actively ensures the well-being of members and property, our entire team is expected to maintain constant vigil. We brief all members of the potential hazards in our project and encourage them to voice any concerns.

Safety Plans

Safety and Hazard Analysis

The following is an assessment of potential risks and modes of failure with the launch vehicle and its associated systems. All possible modes of failure in tasks and equipment have been listed and categorized. The categorization has been based on its probability of occurrence and its associated hazard category.

HAZARD RISK INDEX MATRIX				
Probability of Occurrence	Hazard Category			
	Catastrophic [1]	Critical [2]	Marginal [3]	Negligible [4]
Frequent [A]	1A	2A	3A	4A
Probable [B]	1B	2B	3B	4B
Occasional [C]	1C	2C	3C	4C
Remote [D]	1D	2D	3D	4D
Improbable [E]	1E	2E	3E	4E

Hazard Categories

1. **Catastrophic**: May cause a permanent disabling or fatal injury to personnel or irreparable damage to the surroundings.
2. **Critical**: May cause severe injury or occupational illness and/or damage to facilities, major systems.
3. **Marginal**: May cause minor injury or occupational illness and/or damage to facilities, systems or equipment.
4. **Negligible:** May cause first aid injuries or occupational illness and/or minimal damage to facilities, systems or equipment.

Probability of Occurrence Categories

A. **Frequent**: Likely to occur immediately and will be experienced continuously throughout the life of a part or system.
B. **Probable**: Likely to occur in time and will occur several times in the lifespan of a part or system.
C. **Occasional**: May occur in time and will probably occur during the lifespan of a part of system.
D. **Remote**: Unlikely to occur and the probability of an occurrence in the lifespan of a part or system is low.
E. **Improbable**: An occurrence would be extremely unlikely and it would not be expected to occur during the lifespan of a part or system.

ANALYSIS SOLUTION		
Class Index	Severity/Probability	Suggested Criteria
1	1A, 1B, 1C, 2A, 2B, 3A	Unacceptable
2	1D, 2D, 2C, 3C, 3B	Undesirable (Management Decision Required)
3	1E, 2E, 3E, 3D, 4B, 4A	Acceptable with Review by Management
4	4E, 4D, 4C	Acceptable without Review

Subsystem Analysis

Motor Analysis						
Item #	Component	Function	Hazard Description	Hazard Effects	Hazard Category and Probability	Recommended Control
1	Snap Ring	Fastening Mechanism	Structural Failure	Injury Due to Broken Ring	3D	Control Tools and Safety Equipment
2	Fuel Grain	Fuel Source	Accidental Ignition	Burning Handler	2D	Design to Prevent

Electrical System Analysis						
Item #	Component	Function	Hazard Description	Hazard Effects	Hazard Category and Probability	Recommended Control
1	Power Cable	Transfers Electrical Power	Controller Power Cable Fails	Power Failure/Lack of Control	2C	Provide Warning Devices
2	Battery	Supply Power to Controllers	Leakage of Battery	Loss of Recover/Falling Projectile	2E	Use New Batteries, Ensure Proper Installation
3	E-matches	Ignition	Accidental Ignition	Premature Ignition	3D	Do Not Cross Wire Polarity
4	Wire	Current Flow	Burn Out or Short Circuit	Failure of Instruments/Damage to Handler	4D	Ensure Oversight
5	Gunpowder	Ignition	Accidental Ignition	Explosion	2D	Keep Away From Heat and Sparks

Environmental Analysis						
Item #	Component	Function	Hazard Description	Hazard Effects	Hazard Category and Probability	Recommended Control
1	Strong Winds	N/A	Rocket Stability	Loss of Rocket Control	4A	Provide Warning Devices
2	High Temperature	N/A	Overheating Oxidizer/Electrical Components	High Pressure or Explosion/Electrical Failure	2E	Design to Prevent
3	Rain	N/A	Short Circuit	Loss of Power and Control to Systems	3D	Accept Hazard
4	Corrosion	N/A	Structural Failure	Leaks/Increased Stresses	3E	Provide Warning Devices

Safety Officer Responsibilities and Duties

As mentioned, all members are expected to maintain awareness of the potential dangers. However, we have nominated Chris Willis to be our official Safety Officer. Chris has earned this role through constant dedication to our organization as well as consistent procedural vigilance. When the safety officer is not available we will turn to our Project Leader to oversee the maintenance of safety.

The roles and responsibilities of the safety officer include, but are not limited to:

A. Monitor all team activities with an emphasis on safety, including:

1) Design of launch vehicle and Autonomous Ground Support Equipment (AGSE)
2) Creation of launch vehicle and AGSE
3) Set-up of launch vehicle and AGSE
4) Exhaustive ground testing of launch vehicle and AGSE
5) Sub-scale launch test(s)
6) Full-scale launch test(s)
7) Competition activities and launch
8) Recovery Activities
9) Educational Engagement Activities

B. Coordinate and implement the safety procedures outlined by the organization for the design, creation, set-up, launch, and recovery of the launch vehicle as well as the design, creation, set-up, and use of the AGSE.

C. Finding the relevant Material Safety Data Sheets (MSDS), sharing them with organization, and maintaining the appropriate folder in the organization's Google Drive, Material Safety Data Sheets. The Safety Officer will also ensure proper and safe conditions of materials during storage, transport, and implementation.

D. Analyze and record the team's hazard analysis tests, failure mode analysis, simulations, experimental data, and other relevant information sources for failures and potentially hazardous trends. As well as coordinating the compliance with safety procedures and improvements to reduce risk.

E. Assist in the management and development of the team's hazard analysis, failure mode analysis, safety simulations, safety procedures, and guidelines.

F. Maintaining responsible and appropriate organizational behavior at all stages of design, development, test, travel, and launch.

G. Finally, the safety officer is expected to familiarize herself with all local, state, and federal laws, rules, customs, and regulations which apply to the use and transportation of motors, propellants, and other sources of risk. Based on this familiarity the safety officer is expected to ensure compliance with the aforementioned regulations.

NAR/TAR Personnel

The following launch procedure will be followed during each test launch. This procedure is designed to outline the responsibilities of the NAR/TRA Personnel and the members of the team.

1. A level 2 certified member and an NAR/TRA Personnel will oversee any test launch of the vehicle and flight tests of the vehicle
2. The launch site Range Safety Officer will be responsible for ensuring proper safety measures are taken and for arming the launch system
3. If the vehicle does not launch when the ignition button is pressed then the RSO will remove the key and wait 90 seconds before approaching the rocket to investigate the issue. Only the project lead and safety officer will be allowed to accompany the RSO in investigating the issue
4. The RSO will ensure that no one is within 100 ft of the rocket and the team will be behind the RSO during launch.The RSO will use a 10 second countdown before launch.
5. A certified member will be responsible for ensuring that the rocket is directed no more than 20 degrees from vertical and ensuring that the wind speed is no more than 5 mph. This individual will also ensure proper stand and ground conditions for launch including but not limited to launch rail length, and cleared ground space.This member will ensure that the rocket is not launch at targets, into clouds, near other aircraft, nor take paths above civilians. As well this individual will ensure that all FAA regulations are abided by.
6. Another certified member will ensure that flight tests are conducted at a certified NAR/TRA launch site
7. the safety officer will ensure that the rocket is recovered properly according to Tripoli and NAR guidelines

Safety Briefing

Hazard Recognition

The team Safety Officer will orchestrate all potentially hazardous activities, as well as brief the members who may participate in such activities on proper safety procedures, and ensuring that they are familiar with any personal protective equipment which must be worn during those activities. If a member fails to abide by the safety procedures, he will not be permitted to participate in the potentially hazardous activity. In addition to briefing the members on safety procedures, the team Safety Officer must remain in the immediate vicinity of the hazardous activity as it is occurring, so as to mitigate any potentially dangerous incidents and answer any safety questions which may arise.

Accident Avoidance

It will be the duty of the team Safety Officer to verify, in advance, that procedures planned for testing or construction of materials by team members satisfy safety requirements. In the event that the Safety Officer judges a planned procedure to be unsafe, said procedure will thus be revised or eliminated.

Launch Procedures

At the team meeting most closely preceding the launch, the Safety Officer will be given time to help the members review launch safety and precautionary measures. Topics discussed at this time include but are not limited to: laws and regulations mandated by the Federal Aviation Administration (FAA), the National Fire Protection Association (NFPA), and Florida State Statutes; prohibited launchpad activities and behaviors; maintaining safe distances; and safety procedures pertaining to any potentially hazardous chemicals which will be present during the launch. All team leaders must be in attendance at this briefing, and they are obliged to address the other members with any further safety concerns they are aware of that were not mentioned by the Safety Officer. At this time, launch procedures will be scrutinized, paying special attention to the parts involving caution.

Caution Statements

Any potential safety hazards or concerns that may arise throughout the course of this project will be documented where relevant. To minimize risks the design verification process will include a comprehensive investigation to ensure safety in manufacturing, testing, and launching of our rocket. The Safety Officer and Project Lead will present at all design verification meetings.

Legal Compliance

The Safety Officer and Project Lead have read all relevant laws and regulations that apply to this project in order to ensure compliance with these laws. As well, the team members will also be briefed on these laws as they apply to the project.

Federal Aviation Administration

Relevant aeronautical regulations are found in the Code of Federal Regulations (CFR):

Title 14: Aeronautics and Space, Chapter 1, Subchapter F

Part 101: Moored Balloons, Kites, Amateur Rockets and Unmanned Free Balloons

Subpart C - Amateur Rockets

§101.21 Applicability.

(a) This subpart applies to operating unmanned rockets. However, a person operating an unmanned rocket within a restricted area must comply with §101.25(b)(7)(ii) and with any additional limitations imposed by the using or controlling agency.

(b) A person operating an unmanned rocket other than an amateur rocket as defined in §1.1 of this chapter must comply with 14 CFR Chapter III.

§101.22 Definitions.

The following definitions apply to this subpart:

(a) *Class 1—Model Rocket* means an amateur rocket that:

(1) Uses no more than 125 grams (4.4 ounces) of propellant;

(2) Uses a slow-burning propellant;

(3) Is made of paper, wood, or breakable plastic;

(4) Contains no substantial metal parts; and

(5) Weighs no more than 1,500 grams (53 ounces), including the propellant.

(b) *Class 2—High-Power Rocket* means an amateur rocket other than a model rocket that is propelled by a motor or motors having a combined total impulse of 40,960 Newton-seconds (9,208 pound-seconds) or less.

(c) *Class 3—Advanced High-Power Rocket* means an amateur rocket other than a model rocket or high-power rocket.

§101.23 General operating limitations.

(a) You must operate an amateur rocket in such a manner that it:

(1) Is launched on a suborbital trajectory;

(2) When launched, must not cross into the territory of a foreign country unless an agreement is in place between the United States and the country of concern;

(3) Is unmanned; and

(4) Does not create a hazard to persons, property, or other aircraft.

(b) The FAA may specify additional operating limitations necessary to ensure that air traffic is not adversely affected, and public safety is not jeopardized.

§101.25 Operating limitations for Class 2-High Power Rockets and Class 3-Advanced High Power Rockets.

When operating *Class 2-High Power Rockets* or *Class 3-Advanced High Power* Rockets, you must comply with the General Operating Limitations of §101.23. In addition, you must not operate *Class 2-High Power Rockets* or *Class 3-Advanced High Power* Rockets—

(a) At any altitude where clouds or obscuring phenomena of more than five-tenths coverage prevails;

(b) At any altitude where the horizontal visibility is less than five miles;

(c) Into any cloud;

(d) Between sunset and sunrise without prior authorization from the FAA;

(e) Within 9.26 kilometers (5 nautical miles) of any airport boundary without prior authorization from the FAA;

(f) In controlled airspace without prior authorization from the FAA;

(g) Unless you observe the greater of the following separation distances from any person or property that is not associated with the operations:

(1) Not less than one-quarter the maximum expected altitude;

(2) 457 meters (1,500 ft.);

(h) Unless a person at least eighteen years old is present, is charged with ensuring the safety of the operation, and has final approval authority for initiating high-power rocket flight; and

(i) Unless reasonable precautions are provided to report and control a fire caused by rocket activities.

§101.27 ATC notification for all launches.

No person may operate an unmanned rocket other than a Class 1—Model Rocket unless that person gives the following information to the FAA ATC facility nearest to the place of intended operation no less than 24 hours before and no more than three days before beginning the operation:

(a) The name and address of the operator; except when there are multiple participants at a single event, the name and address of the person so designated as the event launch coordinator, whose duties include coordination of the required launch data estimates and coordinating the launch event;

(b) Date and time the activity will begin;

(c) Radius of the affected area on the ground in nautical miles;

(d) Location of the center of the affected area in latitude and longitude coordinates;

(e) Highest affected altitude;

(f) Duration of the activity;

(g) Any other pertinent information requested by the ATC facility.

§101.29 Information requirements.

(a) *Class 2—High-Power Rockets.* When a Class 2—High-Power Rocket requires a certificate of waiver or authorization, the person planning the operation must provide the information below on each type of rocket to the FAA at least 45 days before the proposed operation. The FAA may request additional information if necessary to ensure the proposed operations can be safely conducted. The information shall include for each type of Class 2 rocket expected to be flown:

(1) Estimated number of rockets,

(2) Type of propulsion (liquid or solid), fuel(s) and oxidizer(s),

(3) Description of the launcher(s) planned to be used, including any airborne platform(s),

(4) Description of recovery system,

(5) Highest altitude, above ground level, expected to be reached,

(6) Launch site latitude, longitude, and elevation, and

(7) Any additional safety procedures that will be followed.

(b) *Class 3—Advanced High-Power Rockets.* When a Class 3—Advanced High-Power Rocket requires a certificate of waiver or authorization the person planning the operation must provide the information below for each type of rocket to the FAA at least 45 days before the proposed operation. The FAA may request additional information if necessary to ensure the proposed operations can be safely conducted. The information shall include for each type of Class 3 rocket expected to be flown:

(1) The information requirements of paragraph (a) of this section,

(2) Maximum possible range,

(3) The dynamic stability characteristics for the entire flight profile,

(4) A description of all major rocket systems, including structural, pneumatic, propellant, propulsion, ignition, electrical, avionics, recovery, wind-weighting, flight control, and tracking,

(5) A description of other support equipment necessary for a safe operation,

(6) The planned flight profile and sequence of events,

(7) All nominal impact areas, including those for any spent motors and other discarded hardware, within three standard deviations of the mean impact point,

(8) Launch commit criteria,

(9) Countdown procedures, and

(10) Mishap procedures.

3.5.2 National Fire Protection Association

The National Fire Protection Association (NFPA) has outlined various regulations pertaining to the “design, construction, limitation of charge and power, reliability of all high power rocket motors, plus design and construction of the rockets propelled by these motors. The code includes qualifications and certification of users as well as requirements for rocket tests, launch sites, and operations; spectator distance separation as well as prohibited activities.”

Significant Points:
4.1.1 The Range Safety Officer (RSO) shall have knowledge of the NFPA 1127, *Code for High Power Rocketry.*
4.1.3 The RSO shall have the authority to intervene and control any safety aspect of a high power rocket launch when, in his or her judgment, a potential or actual danger, accident or unsafe condition exists.
4.4.1 A high power rocket shall be inspected by the RSO to determine whether it meets the provisions of this code.
4.8.2 If the stability of the rocket cannot be determined, or if the rocket is determined to be unstable, it shall not be launched.
4.10.1 A high power rocket shall be launched only if it contains a recovery system that is designed to return all parts of the rocket to the ground intact and at a landing speeding at which the rocket does not present a hazard.
4.17.2 No person shall launch a high power rocket if the surface wind is more than 32 km/h (20 mph).
4.18.1 A high power rocket shall be launched only with the knowledge, permission, and attention of the RSO, and only under conditions where the requirements of this code have been met.

In observance of the NFPA code, our projected motor impulse (4209.7 Ns) places our rocket in Equivalent High Power Motor Type L, requiring a Minimum Diameter of Cleared Area of 100 ft, and a Minimum Personnel Distance of 300 ft.

3.5.3 State Laws

2015 Florida Statutes:

Title XXV: AVIATION

Chapter 331: AVIATION AND AEROSPACE FACILITIES AND COMMERCE

331.303 Definitions.

(1) “Aerospace” means the industry that designs and manufactures aircraft, rockets, missiles, spacecraft, satellites, space vehicles, space stations, space facilities or components thereof, and equipment, systems, facilities, simulators, programs, and related activities, including, but not limited to, the application of aerospace technologies in air-based, land-based, and sea-based platforms for commercial, civil, and defense purposes.

(9) “Landing area” means the geographical area designated by Space Florida within the spaceport territory for or intended for the landing and surface maneuvering of any launch or other space vehicle.

(10) “Launch pad” means any launch pad, runway, airstrip, or similar facility used for launching space vehicles.

(11) “Launch support facilities” means facilities that are located at launch sites or launch ranges that are required to support launch activities, including launch vehicle assembly, launch vehicle operations and control, communications, and flight safety functions, as well as payload operations, control, and processing.

(12) “Payload” means any property or cargo to be transported aboard any vehicle launched by or from the spaceport.

(13) “Person” means any individual, child, community college, college, university, firm, association, joint venture, partnership, estate, trust, business trust, syndicate, fiduciary, corporation, nation, government (federal, state, or local), agency (government or other), subdivision of the state, municipality, county, business entity, or any other group or combination.

(14) “Project” means any activity associated with any development, improvement, property, launch, utility, facility, system, works, road, sidewalk, enterprise, service, or convenience, which may include coordination with federal and state partners or agencies; any rocket, capsule, module, launch facility, assembly facility, operations or control facility, tracking facility, administrative facility, or any other type of aerospace-related transportation vehicle, station, or facility; any type of equipment or instrument to be used or useful in connection with any of the foregoing; any type of intellectual property and intellectual property protection in connection with any of the foregoing including, without limitation, any patent, copyright, trademark, and service mark for, among other things, computer software; any water, wastewater, gas, or electric utility system, plant, or distribution or collection system; any small business incubator initiative, including any startup aerospace company, and any aerospace business proposing to expand or locate its business in this state, research and development company, research and development facility, education and workforce training facility, storage facility, and consulting service; or any tourism initiative, including any space experience attraction, microgravity flight program, aerospace

launch-related activity, and space museum sponsored or promoted by Space Florida.

(15) “Range” means the geographical area designated by Space Florida or other appropriate body as the area for the launching of rockets, missiles, launch vehicles, and other vehicles designed to reach high altitude.

(16) “Recovery” means the recovery of space vehicles and payloads which have been launched from or by a spaceport.

(17) “Spaceport” means any area of land or water, or any manmade object or facility located therein, developed by Space Florida under this act, which area is intended for public use or for the launching, takeoff, and landing of spacecraft and aircraft, and includes any appurtenant areas which are used or intended for public use, for spaceport buildings, or for other spaceport facilities, spaceport projects, or rights-of-way.

(18) “Spaceport territory” means the geographical area designated in s. 331.304 and as amended or changed in accordance with s. 331.329.

(19) “Spaceport user” means any person who uses the facilities or services of any spaceport; and, for the purposes of any exemptions or rights granted under this act, the spaceport user shall be deemed a spaceport user only during the time period in which the person has in effect a contract, memorandum of understanding, or agreement with the spaceport, and such rights and exemptions shall be granted with respect to transactions relating only to spaceport projects.

Title XXXIII: REGULATION OF TRADE, COMMERCE, INVESTMENTS, AND SOLICITATIONS

Chapter 552: MANUFACTURE, DISTRIBUTION, AND USE OF EXPLOSIVES

552.12 Transportation of explosives without license prohibited; exceptions.
No person shall transport any explosive into this state or within the boundaries of this state over the highways, on navigable waters or by air, unless such person is possessed of a license or permit; provided, there is excepted from the effects of this sentence common, contract and private carriers, as mentioned in the next succeeding sentence. Common carriers by air, highway, railroad, or water transporting explosives into this state, or within the boundaries of this state (including ocean-plying vessels loading or unloading explosives in Florida ports), and contract or private carriers by motor vehicle transporting explosives on highways into this state, or within the boundaries of this state, and which contract or private carriers are engaged in such business pursuant to certificate or permit by whatever name issued to them by any federal or state officer, agency, bureau, commission or department, shall be fully subject to the provisions of this chapter; provided, that in

any instance where the Federal Government, acting through the Interstate Commerce Commission or other federal officer, agency, bureau, commission or department, by virtue of federal laws or rules or regulations promulgated pursuant thereto, has preempted the field of regulation in relation to any activity of any such common, contract or private carrier sought to be regulated by this chapter, such activity of such a carrier is excepted from the provisions of this chapter.

552.081 Definitions.

As used in this chapter:

(1) “Explosive materials” means explosives, blasting agents, or detonators.

(2) “Explosives” means any chemical compound, mixture, or device, the primary purpose of which is to function by explosion. The term “explosives” includes, but is not limited to, dynamite, nitroglycerin, trinitrotoluene, other high explosives, black powder, pellet powder, initiating explosives, detonators, safety fuses, squibs, detonating cord, igniter cord, and igniters. “Explosives” does not include cartridges for firearms and does not include fireworks as defined in chapter 791.

(3) “Blasting agent” means any material or mixture, consisting of fuel and oxidizer, intended for blasting and not otherwise defined as an explosive, provided the finished product, ready for use or shipment, cannot be detonated by means of a number 8 test blasting cap when unconfined.

(4) “Detonator” means any device containing a detonating charge that is used for initiating detonation of an explosive and includes, but is not limited to, blasting caps and electric blasting caps of instantaneous and delay types.

(5) “Person” means any natural person, partnership, association, or corporation.

(8) “User” means a dealer or manufacturer-distributor who uses an explosive as an ultimate consumer or a person who, as an ultimate consumer of an explosive, purchases such explosive from a dealer or manufacturer-distributor.

(9) “Blaster” means a person employed by a user who detonates or otherwise effects the explosion of an explosive.

(11) “Highway” means any public highway in this state, including public streets, alleys, and other thoroughfares, by whatever name, in any municipality.

(13) “Two-component explosives” means any two inert components which, when mixed, become capable of detonation by a No. 6 blasting cap, and shall be classified as a Class “A” explosive when so mixed.

(15) “Purchase” and its various forms means acquisition of any explosive by a person with or without consideration.

552.241 Limited exemptions.

The licensing, permitting, and storage requirements of this chapter shall not apply to:

(2) Users who are natural persons and who purchase, possess, or transport:

(a) Smokeless propellant powder in quantities not to exceed 150 pounds, or commercially manufactured sporting grades of black powder not to exceed 25 pounds, provided such powder is for the sole purpose of handloading cartridges for use in pistols or sporting rifles, or handloading shells for use in shotguns, or for a combination of these or other purposes strictly confined to handloading or muzzle-loading firearms for sporting, recreational, or cultural use.

Title XLVI: CRIMES

Chapter 790: WEAPONS AND FIREARMS

790.001 Definitions.

(4) “Destructive device” means any bomb, grenade, mine, rocket, missile, pipebomb, or similar device containing an explosive, incendiary, or poison gas and includes any frangible container filled with an explosive, incendiary, explosive gas, or expanding gas, which is designed or so constructed as to explode by such filler and is capable of causing bodily harm or property damage; any combination of parts either designed or intended for use in converting any device into a destructive device and from which a destructive device may be readily assembled; any device declared a destructive device by the Bureau of Alcohol, Tobacco, and Firearms; any type of weapon which will, is designed to, or may readily be converted to expel a projectile by the action of any explosive and which has a barrel with a bore of one-half inch or more in diameter; and ammunition for such destructive devices, but not including shotgun shells or any other ammunition designed for use in a firearm other than a destructive device. “Destructive device” does not include:

(a) A device which is not designed, redesigned, used, or intended for use as a weapon;

(b) Any device, although originally designed as a weapon, which is redesigned so that it may be used solely as a signaling, line-throwing, safety, or similar device;

(c) Any shotgun other than a short-barreled shotgun; or

(d) Any nonautomatic rifle (other than a short-barreled rifle) generally recognized or particularly suitable for use for the hunting of big game.

(5) “Explosive” means any chemical compound or mixture that has the property of yielding readily to combustion or oxidation upon application of heat, flame, or shock, including but not limited to dynamite, nitroglycerin, trinitrotoluene, or ammonium nitrate when combined with other ingredients to form an explosive mixture, blasting caps, and detonators; but not including:

(a) Shotgun shells, cartridges, or ammunition for firearms;

(b) Fireworks as defined in s. 791.01;

(c) Smokeless propellant powder or small arms ammunition primers, if possessed, purchased, sold, transported, or used in compliance with s. 552.241;
(d) Black powder in quantities not to exceed that authorized by chapter 552, or by any rules adopted thereunder by the Department of Financial Services, when used for, or intended to be used for, the manufacture of target and sporting ammunition or for use in muzzle-loading flint or percussion weapons.

Purchase/Transportation/Storage of Motor

The motor will be purchased and stored by one of our organization mentors who is certified for the purchase of high powered rocket propellant and well versed in storage. The propellant will be stored in a garage at his office off campus, where several other rocket components have been stored carefully. There will be a clear indication that there is propellant in the room, by large lettering on the magazine and yellow/black cautionary tape. There will be a clear indication to keep away in addition to warning about fire in the area. Our mentor shall maintain primary access to the propellant upon storage and shall prep it for transportation. It will be secured carefully within a vehicle, bound down to avoid unnecessary motion and without the risk of any other object resting or falling on top of it.

Written Statement of Compliance

All members of the team agree to abide by all relevant laws and regulations set forth by the FAA, NFPA, and NASA. The team agrees to have the launch site Range Safety Officer perform a safety inspection before each flight and to comply with the determinations from the RSO’s safety inspections. All members recognize that the RSO will determine all final decisions regarding rocket safety and that this individual has the right to deny the launch of any rocket for safety reasons. As well all members recognize that noncompliance with the RSO’s requests will result in the team being unable to launch the rocket.

Technical Design

General Vehicle Details

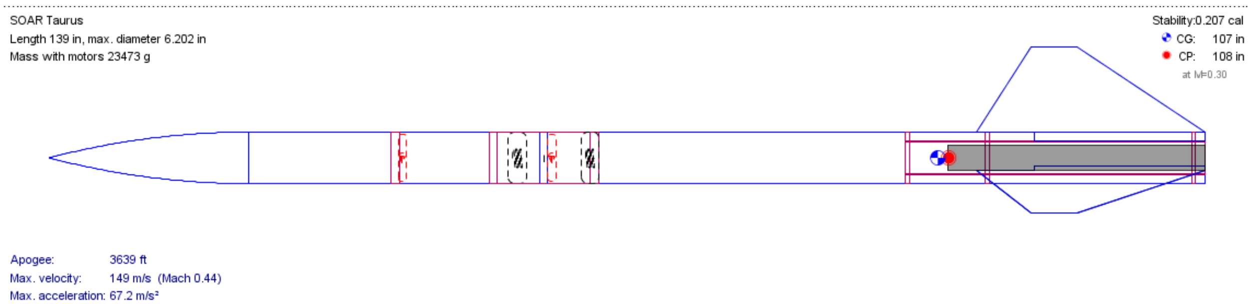

Figure 2. Model of Projected Rocket Designed in OpenRocket

Our rocket design shall consist of the following structural and body components; the nose cone, the payload bay, the altimeter and electronics bay, and the motor bay. The nosecone shall be composed of high grade plastic or fiberglass while the airframe will be composed of phenolic tubing in order to keep our total mass to a minimum. Our proposed design has our rocket at 139 inches in length with a 6 inch diameter. We intend to further develop our design in order to separate our center of gravity and center of pressure in order to further develop stability, by adjusting our fin design.
Our forward payload bay will be an enclosed space between the nosecone and the forward body tube. This "science bay" will be capable of easy removal and adjustment of our payload prior to and after launch. It will be enclosed with two bulkheads made of wood and sealed with epoxy and retaining screws. Should further reinforcement be needed we will include four threaded rods running lengthwise through the bay in order to secure and protect the payload.

Our altimeter bay is a unique design we shall be improving on with this current project. The bay consists of a secure mounting for up to two altimeters and a microcontroller, as well as connections to bulkheads to the forward and aft body tubes. The altimeter bay itself is with the coupling between the body tubes and secured on either side with bulkheads loaded with a carefully determined mass of black powder for separation upon recovery. The bay will be composed of phenolic tubing with a wooden board and brass threaded inserts for support.

The motor bay is in the aft body tube of the rocket. The tube will be composed of a secure motor mount and centering rings, epoxied into place and further secured with brass rods in order to secure the bulk plate upon launch, as a secondary safety precaution. Below the motor we will have a secured motor retaining ring that can be screwed into place firmly and ensure that our motor will not escape through the rear of the rocket.

One challenge that exists in this design are the trade offs between safety precautions and mass management. As we add more structural components we increase our mass and thereby decrease our altitude. One method of mitigating this concern is to take into account all possible modes of error and properly addressing each one to the best of our ability, while finding the most design friendly solution. For example, we have discussed the potential of 3D printing internal components of our altimeter/electronics bay in ABS plastic in order to reduce mass from the normal wooden interior. In addition to that we can mitigate other structural concerns by limiting the use of the brass insert dowels to areas of immediate concern such as with the motor, while finding lighter structural material for the upper bays.

Projected Altitude

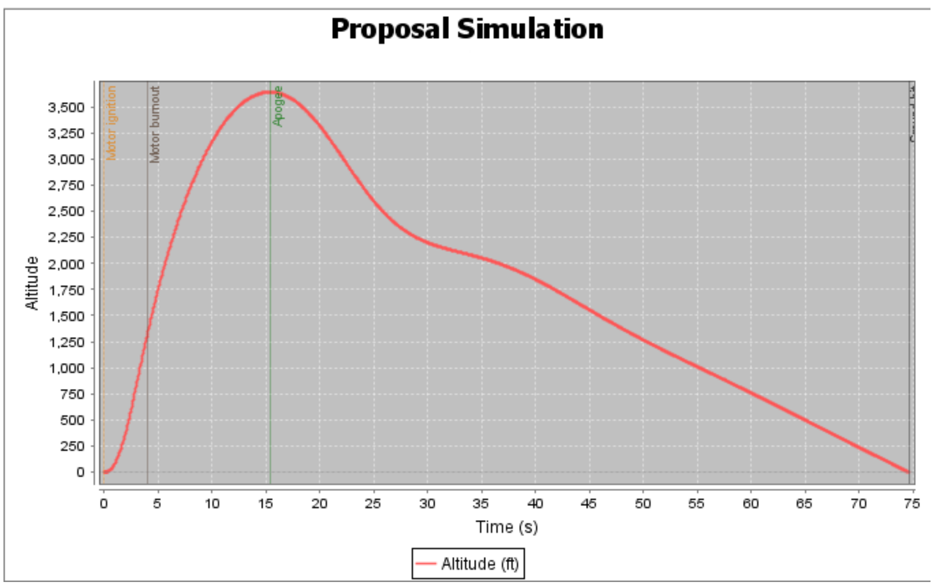

Figure 3. Altitude Curve Generated in OpenRocket

The projected altitude for this design is 3,639 feet. This value was calculated using the program OpenRocket after designing our rocket therein, using parameters to mimic our usual launch site within the TTRA. As this is our preliminary design we kept it simple and aimed for a result below our needed altitude in order to ensure proper stability of our design. As we make adjustments to our payload, structure, and motor we will ensure that our design decisions allow us to reach our desired altitude of 5,280 feet. We will be verifying our calculations via programs such as OpenRocket, RockSim, and by manual calculations.

Projected Parachute System

We will be utilizing a dual deployment system for recovery on this project.

The first deployment, our drogue chute, will be deployed at apogee. We will use two barometric altimeters for redundancy and use black powder charges in order to eject the parachute. The drogue chute is located between the motor mount and our altimeter/electronics bay. A shock cord will keep all components together upon the initial descent.

At 500 feet another black powder charge will eject the nosecone and science bay, releasing the larger main chute and allow our rocket to finish it's landing at a safe velocity for recovery.

We will be using two Sky Angle parachutes for our main and drogue composed of ripstop nylon fabric. They will carefully wrapped and covered with parachute protectors to avoid damage from the black powder charges. Two shock cords will be used, one 18' for the drogue chute and another 24' for the main chute.

Projected Motor

Our projected motor choice is a Gorilla Rocket Motors GR L1065. The motor has a 75 mm diameter, 78.7 cm length, 4209.7 Ns impulse, burn time of 4.0 s, and a maximum thrust of 1931.9 N. Though the motor may be subject to change we found that this choice worked well and kept consistent results throughout our simulations.

Projected AGSE

For the Centennial Challenge MAV Project we will be designing Autonomous Ground Support Equipment (AGSE). Our system will be composed of; the rocket payload bay, a means of loading the payload bay, a system to raise the rocket from horizontal to vertical position, and a system install the igniter.

Sealing Payload Bay

The interior of the upper payload bay shall be modified to contain a cavity for storage and a hinged door. The storage cavity shall be lined with vibration absorbing foam, with a top lining of adhesive in order to firmly hold the payload upon loading. The hinged door shall be manipulated by gear train, adjusted by the AGSE. A key mechanism will allow the AGSE to securely close the payload door in order to prepare the system for launch. The door of the payload hatch will be lined with rubber in order to create a tight seal and prevent any undue vibration of the payload hatch upon launch.

AGSE Loading

The AGSE will employ a robotic arm to load the rocket. The arm will be a six degree of freedom mechanism with both electrical and pneumatic control. The six degrees of freedom should give the mechanism the freedom to pick and place the payload from any direction. The robot's end effector will be an amorphous universal gripper composed of a rubber/latex coating, a fine material such as coffee grounds or sand, and a sealed vacuum system. The system uses a property known as jamming phase transition and was first developed at Cornell. This end effector is cheap and can be used to pick up payloads of a variety of different shapes. The difficulties of employing this end effector will be in creating a sealed pneumatic system, as would be required in the martian atmosphere.

Launch Rail Adjustment

The rocket shall be loaded onto the launch rails via linear actuators. When the system is ready it will use a servo located between the rail and base to adjust the rocket to the desired angle. The platform will be secured by full extension of its three tripod legs by the AGSE.

Igniter Installation

The igniter shall be applied upon an insulated plastic rod, which will be raised through the launch platform by a linear actuator. When launch procedures begin contact will be made between the fuel grain and the igniter rod via the actuator.

Requirements

Launch Vehicle Requirements

1.1. The vehicle shall deliver the payload to an apogee altitude of 5,280 feet above ground level (AGL).
1.2. The vehicle shall carry one commercially available, barometric altimeter for recording the official altitude used in the competition scoring.
1.3. The launch vehicle shall be designed to be recoverable and reusable.
1.4. The launch vehicle shall have a maximum of four (4) independent sections.
1.5. The launch vehicle shall be limited to a single stage.

1.6. The launch vehicle shall be capable of being prepared for flight at the launch site within 2 hours.
1.7. The launch vehicle shall be capable of remaining in launch-ready configuration at the pad for a minimum of 1 hour without losing the functionality of any critical on-board component.
1.8. The launch vehicle shall be capable of being launched by a standard 12 volt direct current firing system.
1.9. The launch vehicle shall use a commercially available solid motor propulsion system using ammonium perchlorate composite propellant (APCP) which is approved and certified by the National Association of Rocketry (NAR), Tripoli Rocketry Association (TRA), and/or the Canadian Association of Rocketry (CAR).
1.10. The total impulse provided by a launch vehicle shall not exceed 5,120 Newton-seconds (L-class).
1.11. Pressure vessels on the vehicle shall be approved by the RSO.
1.12. All teams shall successfully launch and recover a subscale model of their full-scale rocket prior to CDR.
1.13. All teams shall successfully launch and recover their full-scale rocket prior to FRR in its final flight configuration.

Recovery System Requirements

2.1. The launch vehicle shall stage the deployment of its recovery devices, where a drogue parachute is deployed at apogee and a main parachute is deployed at a much lower altitude.
2.2. Teams must perform a successful ground ejection test for both the drogue and main parachutes.
2.3. At landing, each independent section of the launch vehicle shall have a maximum kinetic energy of 75 ft-lbf.
2.4. The recovery system electrical circuits shall be completely independent of any payload electrical circuits.
2.5. The recovery system shall contain redundant, commercially available altimeters.
2.6. Motor ejection is not a permissible form of primary or secondary deployment. An electronic form of deployment must be used for deployment purposes.
2.7. A dedicated arming switch shall arm each altimeter, which is accessible from the

exterior of the rocket airframe when the rocket is in the launch configuration on the launch pad.
2.8. Each altimeter shall have a dedicated power supply.
2.9. Each arming switch shall be capable of being locked in the ON position for launch.
2.10. Removable shear pins shall be used for both the main parachute compartment and the drogue parachute compartment.
2.11. An electronic tracking device shall be installed in the launch vehicle and shall transmit the position of the tethered vehicle or any independent section to a ground receiver.
2.12. The recovery system electronics shall not be adversely affected by any other on-board electronic devices during flight (from launch until landing).

Payload and AGSE Requirements

3.1. The payload shall be designed to be recoverable and reusable. Reusable is defined as being able to be launched again on the same day without repairs or modifications.
3.3.2.1.1 Teams will position their launch vehicle horizontally on the AGSE.
3.3.2.1.2 A master switch will be activated to power on all autonomous procedures and subroutines.
3.3.2.1.3 All AGSEs will be equipped with a pause switch in the event that a judge needs the AGSE to be temporarily halted for any reason.
3.3.2.1.4 Once the judge signals “START”, the AGSE will begin its autonomous functions in the following order: 1) capture and containment of the payload; 2) erection of the launch platform from horizontal to 5.0 degrees off vertical (85.0 degrees), 3) insertion of the motor igniter.
3.3.4.1.1 As one of the goals of this competition is to develop equipment, processes, and technologies that could be implemented in a Martian environment, the AGSE and any related technology cannot employ processes that would not work in such environments.
3.3.5.1 Each launch vehicle must have the space to contain a cylindrical payload approximately 3/4 inch inner diameter and 4.75 inches in length. The payload will be made of ¾ x 3 inch Schedule 40 PVC tubing filled primarily with sand and may include BBs, weighing approximately 4 ounces and capped with domed PVC end caps.

3.3.5.4 The payload shall be placed a minimum of 12 inches away from the AGSE and outer mold line of the launch vehicle in the launch area for insertion, when placed in the horizontal position on the AGSE and will be at the discretion of the team as long as it meets the minimum placement requirements.
3.3.5.5 Gravity-assist shall not be used to place the payload within the rocket. If this method is used no points shall be given for payload insertion.
3.3.5.6 Each team will be given 10 minutes to autonomously capture, place, and seal the payload within their rocket, and erect the rocket to a vertical launch position five degrees off vertical. Insertion of igniter and activation for launch are also included in this time. Going over time will result in the team's disqualification from the MAV Project competition.
3.3.6.1.1 [Each team must have] A master switch to power all parts of the AGSE. The switch must be easily accessible and hardwired to the AGSE.
3.3.6.1.2 [Each team must have] A pause switch to temporarily terminate all actions performed by AGSE. The switch must be easily accessible and hardwired to the AGSE.
3.3.6.1.3 [Each team must have] A safety light that indicates that the AGSE power is turned on. The light must be amber/orange in color. It will flash at a frequency of 1 Hz when the AGSE is powered on, and will be solid in color when the AGSE is paused while power is still supplied.
3.3.6.1.4 [Each team must have] An all systems go light to verify all systems have passed safety verifications and the rocket system is ready to launch.

Major Technical Challenges and Solutions

Mechanical

In terms of manufacturing we will have limited time and resources to work throughout the duration of the project due to student availability and tool availability. in order to mitigate this problem we will be creating a comprehensive build schedule in order to best make sue of members' time, and ensure we are able to make the most effective use of our time with tooling. For tool we are unfamiliar with we will be reaching out to other students or faculty mentors that can train us on the equipment.

Electrical

This project will give us a unique new challenge for handling signal transmission to our rocket. We will be working to ensure we get consistent communication with our onboard systems, reducing latency and maintaining a design for our altimeter/electronics bay that befits proper signal transmission.

AGSE

The AGSE in totality will be a technical challenge. More specifically we will be working heavily on automation, robotics design and programming. In order to fill in the gaps of our collective knowledge in regards to programming we will be working primarily with a base in LabView, Python, and C++ , looking to faculty members for assistance with our programs. Our robotic end effector will be tested rigorously to ensure the payload can be picked up consistently and can be accessed from multiple angles.

Educational Engagement

The need for scientists, mathematicians, and engineers is ever-present throughout the global society of today. Technology is advancing rapidly thanks to the professionals in these fields. The future of these fields is dependent on the students of today. The Educational Engagement division of our team is dedicated to engaging these students whether primary education or secondary education level student. We have set the goal of introducing these students to STEM, specifically in regards to rocketry and aerospace, in an engaging manner that will show the variety and depth of the STEM fields as a whole. We have come to the conclusion that the best way to do this is to begin at the community level.

We will place importance on the Hillsborough County area due to financial and time constraints. Specifically we plan to physically visit local schools delivering interactive presentations as well as planning events for students to attend. In order to widen our reach, we intend to host series of videos and online presentations to teach students about STEM subjects.

Engagement at Local Schools

We have decided that one of the simplest and most effective methods of engaging students is to visit the schools and personally speak to students about STEM. These meetings will be established by contacting local schools and requesting permission to speak in the classroom as well as give demonstrations. This will be organized by the Education Engagement Officer. We plan for one of the major visits to occur as part of the Great American Teach-In, in which university students, professors, and others are encouraged to come give presentations and demonstrations about STEM to local primary education schools.

Engagement at the University of South Florida

Our team will be participating in the Engineering Expo hosted by the University of South Florida. This event is designed for campus organizations to showcase a STEM related project to both the USF community and local schools. In addition to this our team will be hosting a bottle rocket competition for USF students. This will serve as a platform for us to share STEM and rocketry with other students in an education and engaging way.

Online Engagement

In addition to sharing our events online such as the bottle rocket competition and our presentation from the Great American Teach-In, we will host videos and presentations online that look at the different STEM fields. These will allow our team to engage a wider audience outside of the immediate Hillsborough County area. These will be hosted on our organization’s website.

Project Plan

Schedule

Task Name	Start Date	End Date
Proposal	8/7/15	9/11/15
Proposal Awards	10/2/15	10/2/15
Website Established	10/23/15	10/23/15
PDR Phase	10/2/15	11/6/15
Design Options Considered	10/2/15	10/7/15
Design Finalized	10/7/15	10/14/15
CAD Models Created	10/14/15	10/21/15
Budget Established	10/21/15	10/28/15
Design Completion	10/21/15	10/28/15
PDR Writing	10/7/15	10/28/15
PDR Final Draft	10/28/15	11/5/15
Subscale Manufacturing	11/6/15	12/4/15
Parts Ordering	10/21/15	11/6/15
Assembly	11/6/15	11/20/15
Subscale Launch	12/4/15	12/4/15
CDR Phase	11/6/15	1/15/15
CDR First Draft	11/6/15	12/4/15
CDR Q&A	12/4/15	12/4/15
CDR Editing	12/4/15	1/15/15
Full Scale Manufacturing	1/15/15	3/13/15
Parts Ordering	1/1/15	1/15/15
Assembly	1/15/15	2/15/15
FRR Q&A	2/3/15	2/3/15
Test Launch	2/20/15	2/20/15
FRR Writing	2/20/15	3/7/15
FRR Final Draft	3/7/15	3/13/15
Competition	4/13/15	4/16/15
PLAR Phase	4/16/15	4/29/15
PLAR Writing	4/16/15	4/23/15
PLAR Final Draft	4/23/15	4/29/15
Winners Announced	5/11/15	5/11/15

Table 1. Projected Schedule for Project Duration

Budget

Budget Item	Projected Cost
Mechanical Structures	$1,263.49
Recovery Systems	$360.23
ASGE/Electronics	$987.05
Propulsion	$2,867.03
Subscale Rocket	$384.17
Travel	$1,500.00
Total	$7,361.97

Table 2. Projected Budget for Project Duration

Funding Plan

To complete this project our organization shall rely primarily on funding allocated to us through the USF student government, sponsorships, and fundraising. We already have sponsorships from the USF STEM Education Society, funding achieved through the Florida Space Grant Consortium's Hybrid Rocket Motor Competition, and from organization allocations internally.

Community Support

As a university organization we rely on our university for support as well as the greater Tampa community. Throughout the course of the project we shall engage in fundraising efforts in addition to careful budgeting for purchased equipment. We shall be appealing through several proposals to USF donors to STEM education, and making SOAR merchandise available for sale at USFs weekly "Bull Market" event.

We shall also be reaching out to potential corporate sponsors for discounts and donations including, Gorilla Rocket Motors, Public Missiles, and more. We shall also be partnering up with several other organization such as the USF Student Veteran Society, USF ASME, USF Mechatronics, USF X-Labs and USF SAE to pool resources and to gain expertise from students in a wide variety of different disciplines.

We shall continue to seek knowledge and guidance both from members of the TTRA, with whom we have developed a positive relationship, as well as faculty at USF.

Sustainability

This will be the first time an organization at USF will be participating in this competition. SOAR has been a growing organization at USF for three years and as we move forward we are establishing several traditions to be carried on by aspiring engineers and scientists after our current leadership has graduated.

As an established student organization we have developed a lasting relationship with student government based on a history of fiscal responsibility and adherence to procedure. Our budget is consistently awarded annually due to our attention to detail and capacity to explain our need in a way that is approachable to those not familiar with engineering design or jargon.

Every semester we receive several new members, due to word of mouth advertisement and the rapport that we have gained with several members of the USF faculty and other student organization. We remain to be the sole aeronautics organization at USF, using our position to educate and try to facilitate the formation of a legitimate aerospace engineering program at our university through work with faculty and administrators.

As we continue to grow our goal is to create an environment that is enriching and enjoyable for members. As we participate in more competitions and events such as this project we hope to keep our members actively engaged and continually coming back to SOAR. With members who exhibit particular interest or skill we have established mechanisms to groom them for project leadership and more responsibility within our organization.