St Monica Rocketry Club

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Preliminary Design Review

2018 NASA Student Launch

November 3, 2017

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Acronym Dictionary

AGL = Above Ground Level

APCP = Ammonium Perchlorate Composite Propellant

CDR = Critical Design Review

CG = Center of Gravity

CP = Center of Pressure

EIT = Electronics and Information Technology

FAA = Federal Aviation Administration

FN = Foreign National

FPS = Feet Per Second

FRR = Flight Readiness Review

HEO = Human Exploration and Operations

LCO = Launch Control Officer

LRR = Launch Readiness Review

MSDS = Material Safety Data Sheet

MSFC = Marshall Space Flight Center

NAR = National Association of Rocketry

PDR = Preliminary Design Review

PLAR = Post Launch Assessment Review

PPE = Personal Protective Equipment

RFP = Request for Proposal

RSO = Range Safety Officer

SLI = Student Launch Initiative

SME = Subject Matter Expert

SOW = Statement of Work

STEM = Science, Technology, Engineering, and Mathematics

TRA = Tripoli Rocketry Association

I. Summary of PDR

A. Team Summary

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B. Launch Vehicle Summary

1. Size and Mass:

The rocket will have an outer diameter of 4.0 inches and has a projected mass of 19.8lbs. The total length of the rocket will be 90.25 inches from the tip of the nose cone to the end of the tailcone. The rocket's center of gravity with a fully loaded motor is located 50.44 inches from the tip of the nose cone. The center of pressure is located 63.43 inches from the tip of the nose cone. The combination of the center of pressure and gravity produce a stability margin of approximately 3.25.

2. Motor Choice

Based on these simulations and considerations, it was determined that a Cesaroni K1200 will best satisfy the requirements; however, there several motor choices available.

3. Recovery System

The recovery system utilizes a dual deployment system. At apogee, the rocket will separate into two pieces, tethered together by a shock cord and a 2 foot Rocketman ballistic parachute will deployed. At approximately 600 feet, another separation event will occur, which will deploy the main parachute, a 10' Fruity Chutes Iris Compact parachute. This parachute will slow the decent enough so that the live shrimp payload is not harmed.

C. Payload Title

Survival to Mars

It takes seven years to get to Mars and a difficulty is feeding the astronauts fresh food during their journey. The Payload Experiment seeks to answer if shrimp would be able to survive the G-Forces encountered during rocket launch. The shrimp we are using are primarily used to feed other fish and creatures. This knowledge could then be applied to larger shrimp that people eat, astronauts could filter out the brine shrimp and eat them for protein or they can be used to feed other food sources being raised on-board during the journey to Mars.

II. Changes made since Proposal

A. Changes Made to Vehicle Criteria.

Our design originally was going to be made of fiberglass, because of the strength. Fiberglass turns out to be too heavy for us to make the desired altitude of 5,280 feet because of the increased weight requirements of our payload. Our new design consists of a body tube made out of BlueTube which is lighter and slightly weaker. Our new design has the fins made out of aircraft plywood with a layer of carbon fiber which reduces weight and increases strength.

The nosecone was changed to a plastic nose cone which is less expensive, lighter and slightly less durable.

The design originally called for a main a parachute that was heavy and space inefficient. Our new chute is a Fruity Chutes Iris Compact which is lighter, more compact and more effective. The only down side is their cost, which is almost 4 times as expensive as our original Rocketman parachute. We can afford this due to the savings on the body tube, nose cone and fins.

B. Changes Made to Payload Criteria

Through testing, we determined that we definitely need a cooling system for our delicate shrimp payload. The prototype cooling system added an additional 2 pounds to the mass of the rocket.

C. Changes Made to Project Plan

The name was altered to be uniform with the registered name which is St Monica Rocketry Club. The budget was altered due to the changing of materials in the design. We saved on the body tube, nosecone and fins. This savings was offset by the expense of the parachutes.

Our funding changed in that we could not do the photo shoot because of complications. NY Space Grant quoted a low funding figure, and instead they granted our team the maximum allowed Grant of $2,000. Prime in Ridgefield is sponsoring us for $2,000.

III. Vehicle Criteria

A. Launch Vehicle

1. Mission

We will make a reusable launch vehicle that will achieve an altitude of 5,280ft, deploy a drogue chute at apogee, and a main chute at a lower altitude (600ft). We will have two flight computers on-board the rocket, one of which will have a GPS tracking system, recording flight status. The launch vehicle will use a motor with sufficient thrust to leave the launch rail at a safe exit speed.

The success of the launch vehicle will be evaluated by the following: Having a safe flight, deploying both chutes at the required altitudes. After the rocket has safely landed, we will conduct a visual analysis to determine if the vehicle has sustained any damages during the flight.

2. Airframe Materials Alternative

Below are the materials for consideration, details on their cost, and their ranking compared to the other materials (1 being the least favorable, 6 being the most favorable).

Material	$/ft.	oz./ft.	Company	$ Ranking	Oz. Ranking	Strength Ranking	Machinability Ranking	Total Ranking
Cardboard (11021)	4.06	3.71	Apogee	6	4	1	6	17
Bluetube (10505)	9.74	6.39	Apogee	4	4	4	5	17
Fiberglass (10607)	26.25	11.86	Apogee	2	1	5	1	9
Carbon Fiber (CFAF-3.9-UL-60)	47.99	4.90	Public Missiles	1	6	6	2	15
Phenolic (PT-3.9)	6.99	5.10	Public Missiles	4	4	2	3	14
Quantum (QT-3.9)	8.65	6.00	Public Missiles	4	4	3	4	15

Table 1-Air Frame Materials

When constructing a machine that goes over one mile into the air, you must take caution when choosing the material of the tube. Not only will this material have to sustain much heat, it will carry a fragile payload.

Cardboard tubing is low-priced, lightweight, and easy to work with, but is easily damaged by impact and water. The details listed above describe the 4” cardboard tubing manufactured by LOC Precision.

BlueTube is low-priced, strong, and easy to work with. It is a similar material to phenolic and is similarly heavy, but is not as brittle—meaning that it does not crack under stress. The details listed above describe the 4" BlueTube manufactured by Always Ready Rocketry.

Fiberglass tubing is strong and waterproof, but expensive, difficult to work with, and the heaviest of the options. The details listed above describe the 4" fiberglass tubing manufactured by ProLine Composites.

Carbon fiber tubing also is strong, waterproof, and lightweight, but expensive and difficult to work with. The details listed above describe the 4" carbon fiber tubing distributed by Public Missiles LTD.

Phenolic tubing is low-priced, lightweight, and fairly strong, but it is brittle, and could crack under hard impact or stress. The details listed above describe the 4" phenolic tubing distributed by Public Missiles LTD.

Quantum tubing is a material similar to PVC. It is low-priced, similar in weight to BlueTube and phenolic, and easy to work with, but is not the strongest of the options. The details listed above describe the 4" quantum tubing distributed by Public Missiles LTD.

The team initially chose to have a fiberglass airframe based on its durability and strength. However, a lighter material is needed because the payload design will be heavier than initially expected. When taking the entire rocket into consideration, three pounds will be saved by using BlueTube instead of fiberglass. Although carbon fiber is lighter than BlueTube, it is the most expensive of all the materials. If the weight of the payload increases further, the team may need to use a carbon fiber airframe; however, right now the costs do not justify it and there are many other K-class motors that will support the extra weight in order to achieve the 5,280 feet target altitude. Based on the chart above, the team decided to use BlueTube, which had a final ranking of 17, for the airframe of the rocket.

Material	Weight	$ Ranking out of 5	Strength	Ease of Construction
Carbon Fiber	Light	5	Extremely Strong	Easy
Balsa Wood	Light	2	Weak	Easy
Fiberglass	Heavy	3	Strong	Medium
Aircraft Plywood	Light	3	Strong	Easy
Basswood	Light	4	Strong	Easy
Carbon Fiber End Grain Balsa Core	Very Light	3	Very Strong	Hard
Fiberglass End Grain Balsa Core	Light	2	Strong	Hard
Carbon Fiber Balsa Core	Very Light	3	Very Strong	Hard
Fiberglass Balsa Core	Light	2	Strong	Hard
3D Print	Light-Medium	2	Medium	Medium

Table 2 - Fin Material and Shape Alternatives

3. **Fin Material and Shape Alternatives**

These are the fin materials which we evaluated:

- Carbon Fiber is light and very strong but is expensive.
- Balsa Wood is strong as a core material but weak by itself.
- Fiberglass which is not too expensive is still strong but the heaviest material. The weight may be prohibitive because of our payload requirements.
- Aircraft Plywood is light, is a medium expense, and is strong. some differences between plywood and aircraft plywood is aircraft plywood is made with better glues and has to be able to withstand sitting in boiling water for 3 hours.
- Basswood is also light, is stronger than Aircraft Plywood, but is more expensive. It is, more prone to breaking though.
- Carbon Fiber End Grain Balsa Core is very strong and extremely light but expensive.
- Fiberglass End Grain Balsa Core is strong and light but a medium expense.

- Carbon Fiber Balsa Core is extremely light, medium expense, and very strong.
- Fiberglass Balsa Core is a medium weight, low expense, and strong.
- 3D printing could be from light to medium weight, low to medium cost and medium strength.

When using core materials if the material is the same thickness as the original, the strength will be the same but much lighter. But, when using core material, it takes much longer to manufacture. We decided to use aircraft plywood because it is relatively inexpensive and easy to manufacture.

We also evaluated several different fin shapes, some of which were:

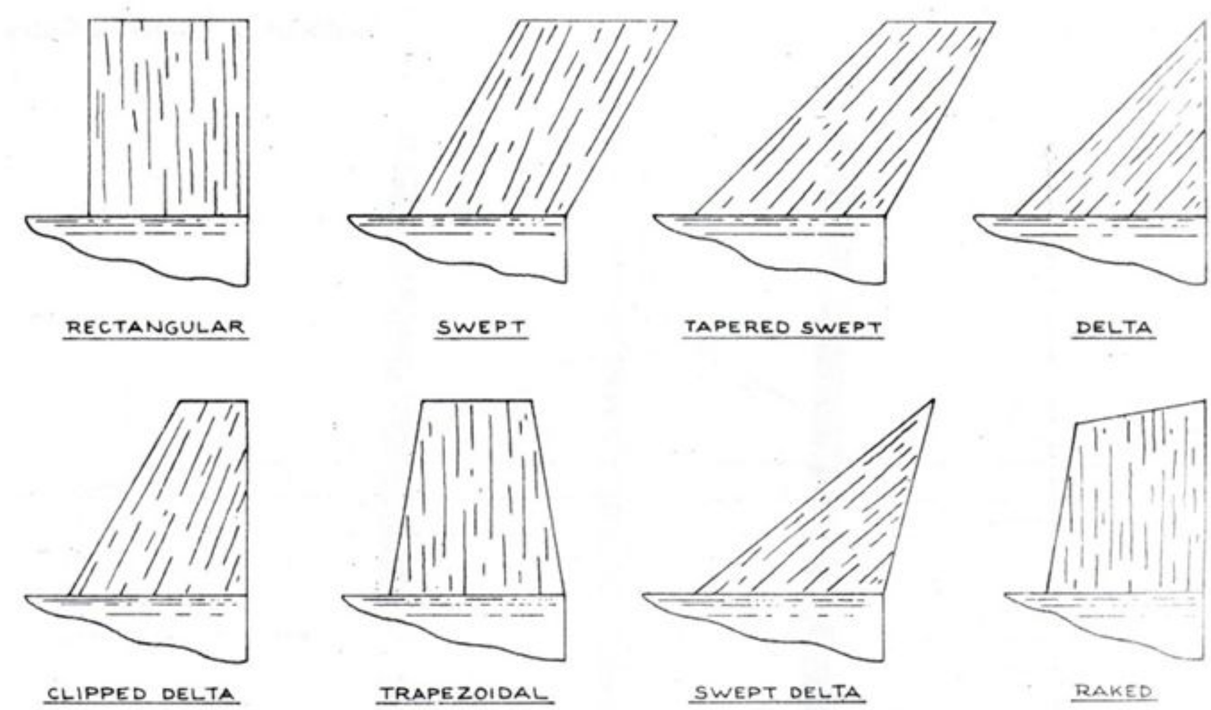


Figure 1-Fins Source: Handbook of Model Rocketry, 7th Edition Model Rocketry

- The Shape with the least drag is the elliptical (not shown). Although elliptical fins create less drag than the others, they are difficult make.
- The delta has a triangular shape so a bent tip is more likely when landing.
- Swept delta is like the delta but leaning back more, creating less drag than the regular delta. Still, the tip is prone to breaking.
- Rectangular fins are easy to make but are less aerodynamic.
- Swept fins, which angle either backwards or forwards, cause less drag then rectangular fins.

- Tapered Swept fins are thinner than Swept fins; thus, they are more aerodynamic.

Our leading design is the trapezoidal fin as we didn't see a significant difference between fin shapes, other than the elliptical which would have created more issues with making than any of the other designs.

4. **Other Components**

Nose Cones:

With BlueTube as our airframe material, selecting fiberglass for the nose cone would add weigh unnecessarily and potentially cause stability issues with this weight being at the end of the rocket. Carbon fiber is too expensive and will take too long to make. Balsa is also impractical as it would have to be manufactured and is not highly durable. Reviewing our options, we determined that using plastic for the nose cone was the best alternative because plastic is light weight and it is sufficiently durable since the rocket is not going to be flying fast for a long enough period of time to cause it to melt or catch on fire.

The rocket nose cone that we selected is the parabolic plastic nose cone from LOC Precision. We picked this nose cone because it was the most aerodynamic of the three that we assessed (the other two being a 5:1 Von Karman from Giant Leap Rocketry and an 8" nose cone from MadCow Rocketry). It is 12 inches in length, long enough to fit the flight computer if we determine that is necessary.

5. Leading Design

The diagram below reflects our current design.

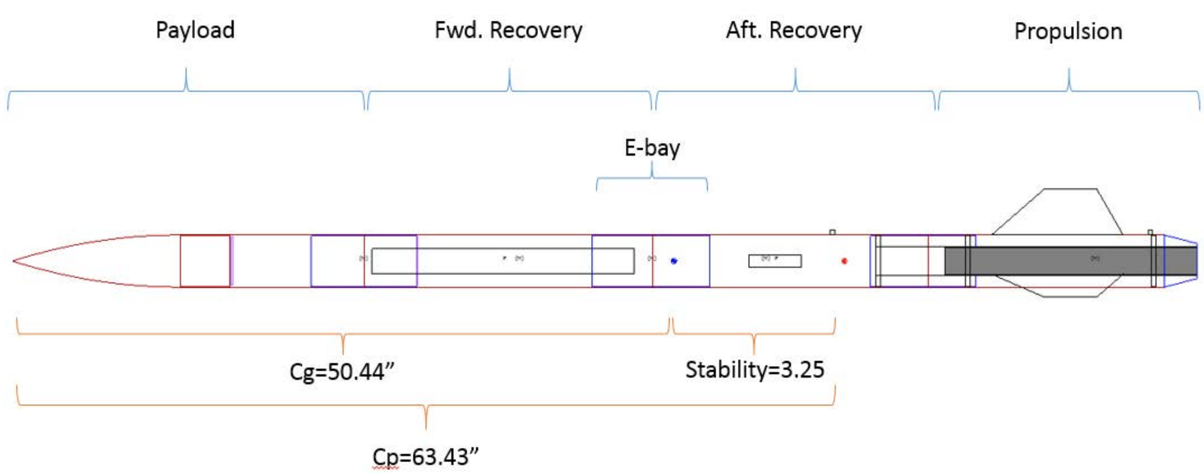


Figure 2 - Leading Design

We initially based the design of our rocket upon the Wildman Extreme 4" diameter rocket kit from Wildman Hobbies. However, we decided to switch from fiberglass to BlueTube to accommodate the mass of the payload. There are 8" couplers placed between all body tubes.

Payload: The foremost section will consist of a 12.75" plastic nosecone and a 14" body tube. The body tube will contain a scientific payload.

Forward Recovery: The second section consists of a 22" body tube, which will contain the main parachute: The Fruity Chutes 10' Iris Ultra Compact.

Aft Recovery: The aft recover is a 17" long body tube, which will contain the drogue parachute: the Rocketman 2' Ballistic Parachute.

Propulsion: The propulsion section contains a 22" body tube and a 2.5" tailcone. The tailcone is manufactured by Aeropack from machined aluminum, this tailcone also serves as the motor retainer for our 22" 54 mm. motor tube.

All four of these sections will come down in two parts; the payload and fwd. recovery will be screwed together as will the aft recovery and propulsion. The coupler that will be joining these two parts together will act as the electronics bay, containing all of the electronics for the rocket. These three pieces will all be joined together by 3/8" tubular Kevlar.

The components and masses for each section are reflected in this table:

FULL SCALE ROCKET AND PAYLOAD COMPONENT LISTING					
				Mass (grams)	
Totals				**7,968.13**	
Lookup Description	**Unit Mass**	**Unit**	**Quantity**	**Total Mass**	**Comment**
BOOSTER					
3.9" BlueTube Airframe	15.10	g / in	22	332.29	Booster, Exterior Body Tube
Tailcone 390 to 54mm	115.00	g	1	115.00	
2.1" BlueTube Airframe	8.54	g / in	22	187.92	54mm motor mount
Centering Ring 3.9" to 2.1"	25.89	g	3	77.68	centering rings for motor mount
1/4-20 stainless threaded rod	4.58	g/in	48	220.00	2 threaded rod stiffeners to go through centering rings
1/4-20 eye nut	17.58	g	2	35.15	eye nuts to attach booster to aft recovery
1/4-20 Hex Nut	3.22	g	2	6.45	
1/4" Split Lock Washer	1.00	g	4	4.00	
1/4" Washer	1.40	g	4	5.60	
1515 rail button- pair (large)	15.00	g	1	15.00	
1/4" Aircraft Plywood	1.57	g	150	235.94	Fins
Paint & Glue				200.00	
				1,435.03	
LOWER RECOVERY					
3.9" BlueTube Airframe	15.10	g / in	17	256.77	
Rocketman drogue balistick 2 feet	166.80		1	166.80	
3.9" BlueTube Coupler	15.00	g / in	8	120.00	Coupler between booster and aft recovery
18x18 nomax	39.80		1	39.80	
Harness: 3/16" tubular kevlar - 25 ft long, 3 loop	138.10		1	138.10	
3/16" Quik Link	21.40	g	4	85.60	2 attach to booster, 2 attach to e-bay
Paint & Glue				100.00	
				907.07	
ELECTRONICS BAY					
Stratologger CF Altimeter	10.21	g	1	10.21	
TRS Altimeter/Tracker	40.00	g	1	40.00	
Wiring	14.46	g	2	28.92	
Screw Switch	3.69	g	2	7.37	
Charge Holder (3.0g) - pair	26.60	g	2	53.20	
1/4-20 stainless threaded rod	4.58	g/in	22	100.83	2 pieces that extend through ebay
1/4-20 eye nut	17.58	g	4	70.31	2 on each end of ebay
1/4-20 Hex Nut - aluminum	1.00	g	8	8.00	for interior of ebay to secure sled
1/4" Split Lock Washer	1.00	g	4	4.00	
1/4" Washer	1.40	g	4	5.60	
1/8" G10 Fiberglass Sheet	3.90	g / in^2	28	109.27	8 x 3.5 ebay sled

Lookup Description	Unit Mass	Unit	Quantity	Total Mass	Comment
Turnigy 500mah 2s	58.00	g	3	174.00	2 required for Eggtimer and 1 for Stratologger
3.9" Airframe Bulkhead	38.46	g	2	76.92	
3.9" Coupler Bulkhead	36.15	g	2	72.29	
3.9" BlueTube Coupler	15.00	g / in	9	135.00	
Paint & Glue				100.00	
				995.92	
FORWARD RECOVERY					
3.9" BlueTube Airframe	15.10	g / in	22	332.29	
FruityChute Iris Ultra compact 120	627.00	0	1	627.00	
4" Deployment bag - 9" long	100.00	0	1	100.00	
Harness: 1/2" Flat kevlar - 25 ft long, 2 loop	188.00	0	2	376.00	
3/16" Quik Link	21.40	g	4	85.60	2 to attach to ebay and 2 to payload
Paint & Glue				100.00	
				1,620.89	
PAYLOAD					
3.9" BlueTube Airframe	15.10	g / in	14	211.46	
3.9" Nose Cone - 12.75"	200.00	g	1	200.00	LOC precision
3.9" BlueTube Coupler	15.00	g / in	8	120.00	Fwd recovery to Payload
3.9" Airframe Bulkhead	38.46	g	1	38.46	
3.9" Coupler Bulkhead	36.15	g	1	36.15	
1/4-20 eye nut	17.58	g	2	35.15	
Payload Adruino Parts	2,268.00	0	1	2,268.00	This is just a placeholder
Paint & Glue				100.00	
				3,009.22	

Table 3 - Full Scale Rocket and Payload Component Listing

6. **Motor Alternatives-** We evaluated the following motors

Simulation conditions/criteria	
Rocket mass- pre motor	7,950
Rail length in.	144
Temperature (F.)	75
Humidity (%)	75
Wind (mph)	5
Cloud coverage (%)	50
Airframe finish	polished

Motor	Total thrust (N.)	Burn time (sec)	Max. Alt. (ft)	Rail exit velocity (ft/sec)	Max velocity (ft/sec)
Cesaroni K-490-green	1,978	4.1	5,000	62	552
Cesaroni K-650-pink	1,997	3.1	5,291	76	590
Cesaroni K-1200	2,014	1.7	5,592	100	656
Cesaroni K-780	2,108	2.7	5,915	82	651
Aerotech K-828	2,120	2.5	5,789	87	646
Aerotech K-1275	2,225	1.8	5,885	106	670
Aerotech K-702	2,261	3.5	6,426	85	660
Aerotech K-1050	2,426	2.1	7,458	97	767

Table 4 - Motor Alternatives

We eliminated the following motors; the Cesaroni K-490-green because it did not reach the target altitude of 5,280 feet; and the Aerotech K-702 and K-1050 because they exceeded the target by too large of a margin.

The chart below reflects the thrust curves for the remaining motors.

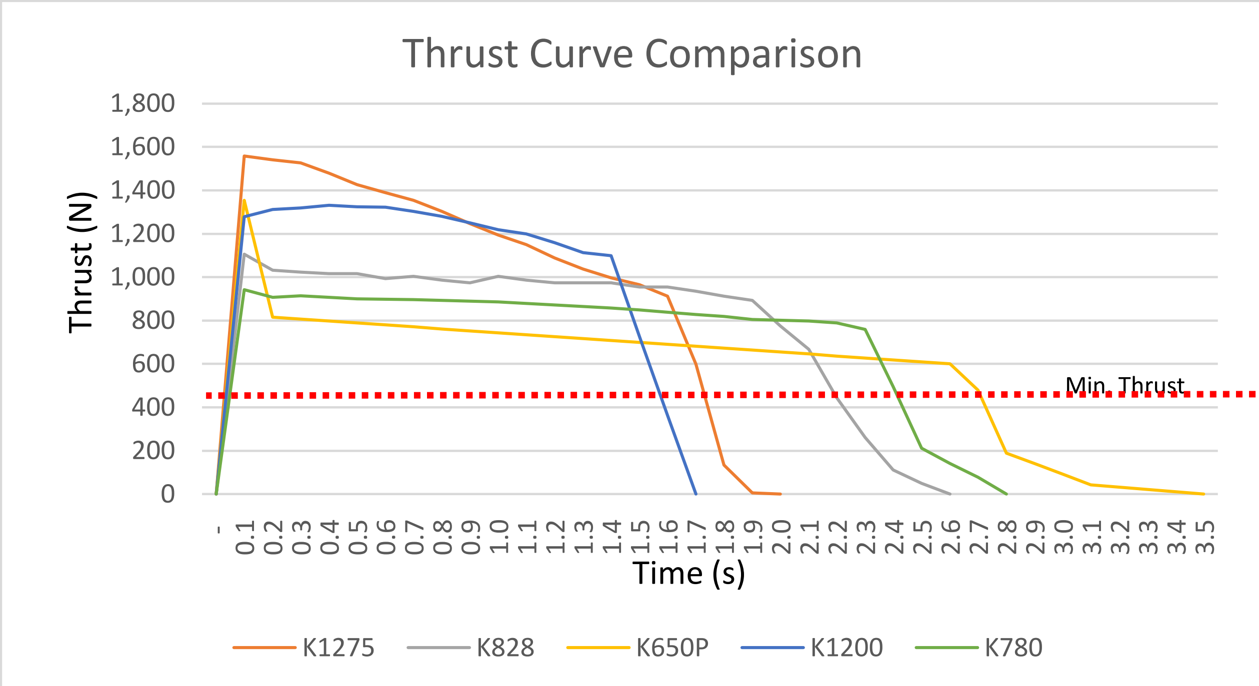


Figure 3 - Thrust Curve Comparison

We also modified several parameters of the simulation to see how each of these motors performed. We increased the mass by 600 g, we reduced the temperature from 75 degrees to 55 degrees, we reduced the cloud cover from 50% to 0%, we changed the finish from polished to gloss and matt, and we simulated different wind speeds. The results of the simulation are shown below.

Motor	10 kg. rocket mass	55 F. Temp.	0% cloud coverage	Matt finish	Gloss finish	0 mph wind	10 mph wind	15 mph wind	20 mph wind
Cesaroni K-650-pink	4,842 ft.	5,254 ft.	5,291 ft.	5108 ft.	5,232 ft.	5,304 ft.	5,250 ft.	5,181 ft.	5,084 ft.
Caeseroni K-1200	5,146 ft.	5,549 ft.	5,592 ft.	5,369 ft.	5,510 ft.	5,598 ft.	5,573 ft.	5,541 ft.	5,494 ft.
Cesaroni K-780	5,439 ft.	5,869 ft.	5,415 ft.	5,676 ft.	5,827 ft.	5,927 ft.	5,878 ft.	5,815 ft.	5,727 ft.
Aerotech K-828	5,337 ft.	5,746 ft.	5,789 ft.	5,653 ft.	5,707 ft.	5,799 ft.	5,759 ft.	5,709 ft.	5,637 ft.
Aerotech K-1275	5,434 ft.	5,829 ft.	5,885 ft.	5,641 ft.	5,793 ft.	5,890 ft.	5,868 ft.	5,838 ft.	5,796 ft.

Table 5 - Motor Simulations

After considering all of the factors we have several different viable motor choices, with our leading candidate being the Cesaroni K-1200.

B. Recovery System

1. Electronics Alternatives

We have viewed many of the options for commercially available altimeters. From the vast amount of options, we have decided to narrow down the options to having at least two pyro control outputs, the ability to record up to 10,000 feet, and flight memory. With these expectations narrowing down the choices, there are much less to choose from. Some manufacturers are: Eggtimer, Adept, Altus Metrum, and PerfectFlite. Some of the options we have eliminated because of unreasonable price with vast amounts of storage that we just do not need. Some were taken out because they are not allowed to be used in the SLI. Such as some altimeter that did not contain pyro output controls or flight memory.

Altimeters	Manufacturer	Flight Memory	Pyro Outputs	max. alt.	price
Quark (DIY)	Eggtimer	1	2	30,000 ft.	$ 20.00
ADEPT22	Adept	1	2	25,000 ft.	$ 45.00
ALTS25	Adept	1	2	25,000 ft.	$ 99.00
RRC2+	MissileWorks	1	2	40,000 ft.	$ 45.00
Eggtimer (DIY)	Eggtimer	32	2	30,000 ft.	$ 35.00
EasyMini	Altus Metrum	1	2	100,000 ft	$ 80.00
StratoLoggerCF	PerfectFlite	16	2	100,000 ft	$ 55.00
AIM USB	Entacore	1	2	40,000 ft.	$ 99.00
Eggtimer TRS (DIY)	Eggtimer	32	2	30,000 ft.	$ 90.00
RRCe Xtreme	MissileWorks	15	3	100,000 ft	$ 80.00

Table 6 - Electronics Alternatives

The chart above shows some examples of the options for our launch vehicle that met our requirements. Seeing as we already have the StratoLoggerCF by PerfectFlite and have found it to be extremely reliable, we have chosen to use this type of altimeter. Since we have some experience with this altimeter, it will also make it easier for us to use. We have decided to use the StratoLoggerCF as our primary altimeter and the EggTimer TRS as our back-up. The EggTimer TRS is the most inexpensive of the altimeters that have GPS capabilities, thus eliminating the need to have a separate tracker. However, the downside to this is that it has to be assembled. When the EggTimer TRS arrives, it is just a bag of parts, so we must build this ourselves. The downside to making an altimeter yourself is that there is a high chance that the altimeter could be faulty. Because of this, we must extensively test the EggTimer TRS once it is built to ensure that there are no faults and we can rely on it.

The following chart shows that the two flight computers are completely independent of each other.

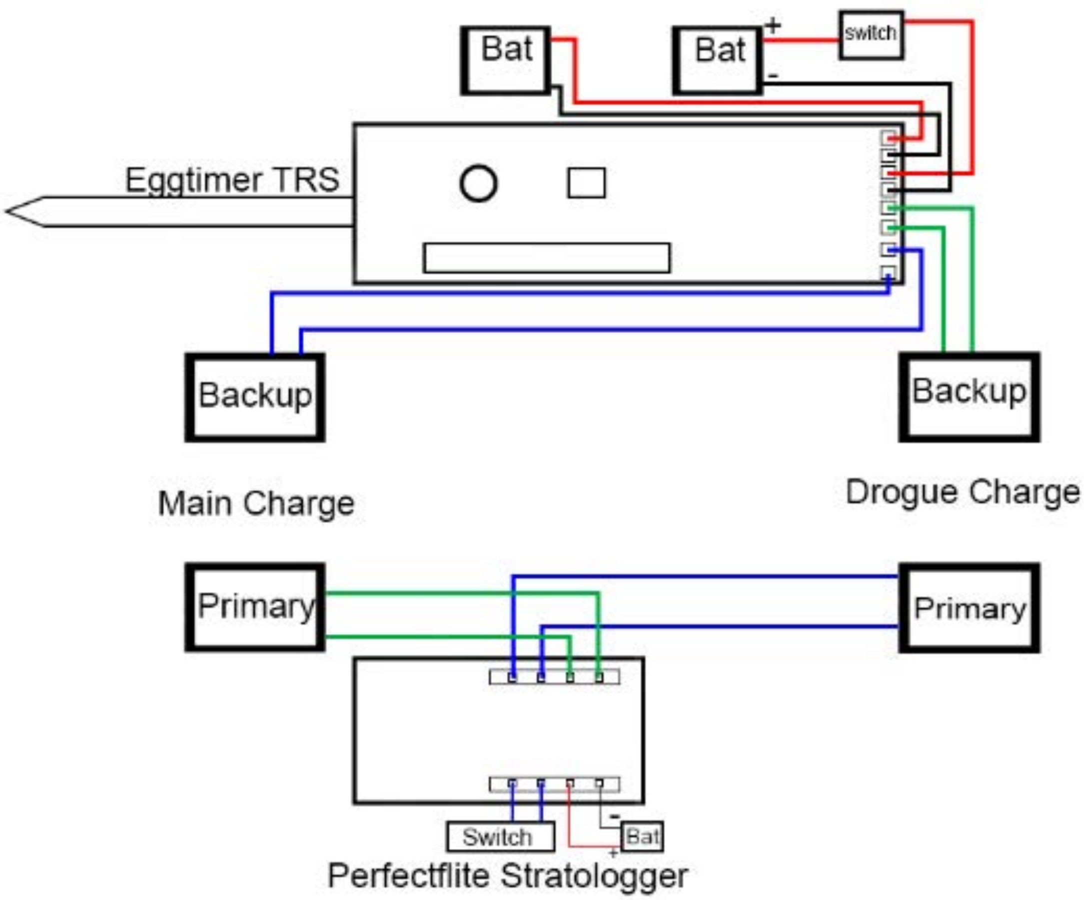


Figure 4 – Redundant Flight Computer Diagram

2. **Parachutes Alternatives**

   We have reviewed many different alternatives for our parachute. Our go-to Rocketman parachutes, we have found, weigh too much to be used as our main parachute but have a great amount of durability for being used as a drogue. Seeing as these parachute weigh too much for our launch vehicle, we have viewed other commercially available parachutes. Some other companies we have found are: Fruity Chutes, and Sky Angle. Sky Angle parachutes are very similar to the previously mentioned Rocketman chutes.

Sky Angle is similar in weight, drag, and shape to the Rocketman. But we need something with a higher amount of drag and of light weight. So, we found Fruity Chutes. Fruity Chutes are a great deal more expensive than the Rocketman chutes, but they are much lighter, and have significantly more drag. In the chart below, you can see the difference of weight, price and drag of the different parachutes.

Parachutes	Cd	Mass g.	Price
Fruity Chutes	2.2	309	$ 275
RocketMan/Sky Angle Chutes	1.7	283	$ 91.95

Table 7 - Parachute Alternatives

The above chutes are based upon a 60" diameter. Because of our live shrimp payload, we need the rocket to come in more slowly than would otherwise be required. Therefore, our leading alternative for the main chute is the Fruity Chute Compact Iris. We will still use the Rocketman ballistic drogue chute.

Figure 5 – Iris Ultra Compact Parachutes – Fruity Chutes

(https://fruitychutes.com/buyachute/iris-ultra-chutes-30-to-192-c-18/)

Figure 6 – RocketMan Ballistic Mach II Drogue

(http://the-rocketman.com/chutes.html)

3. **Other Components**

Recovery harnesses are used to connect the parachutes and other parts of the launch vehicle so it can safely land. For our recovery harnesses, we have found three different types of materials we will be able to use: nylon, Kevlar, and spectra. We had never even heard of spectra harnesses before we started looking for different alternatives. Nylon harnesses save some weight but are not fire resistant. They also have the lowest scored strength test of the three. Kevlar is extremely strong and is fire resistant unlike the nylon and spectra harnesses. Spectra lines are extremely light but are not fire resistant.

	Weight limit	Price
Kevlar	2200 lb.	$ 3.30
Nylon	1000 lb.	$ 2.90
Spectra	1400 lb.	$ 11.50

Table 8 - Harness Alternatives

We compared the alternatives in the chart above according to strength and price per yard. We have decided to use Kevlar as it is the most durable and fire resistant. Even though we have chosen Kevlar as our harness material, the parachute we will be using contains spectra shroud lines to save weight. This will not be an issue, however, as we will be using a deployment bag that will protect the parachute from the ejection charges and also help aid in deployment of the parachute.

C. Mission Performance Predictions –

1. **Flight Simulations –** See Section III.A.5 above
2. **Stability Margins–** See Section III.A.4 above
3. **Kinetic Energy at Landing**

chute	Entire rocket	Minus booster	Minus booster and E-bay
Drogue	1005.61 lbf	576.4 lbf	414.44 lbf
Main	40.28 lbf	23.16 lbf	16.55 lbf

4. **Drift Calculations**

	0 mph	5 mph	10 mph	15 mph	20 mph
Ascent	0	132 ft.	264 ft.	396 ft.	528 ft.
Under Drogue (4680 ft.)	0	545 ft.	1090 ft.	1635 ft.	2180 ft.
Under Main (600 ft.)	0	405 ft.	810 ft.	1215 ft.	1620 ft.
Total	0	1,082 ft.	2164 ft.	3264 ft.	4328 ft.

IV. Safety

A. Personnel Hazard Analysis

Scale	Severity of Failure	Likelihood of Occurrence
1	Minimal or no impact	remote
2	Some	unlikely
3	Moderate	likely
4	major impact	highly likely
5	Unacceptable	near certainty

Figure 7 - Hazard Scale

Source	Hazard	Cause	Result	Severity	Likelihood	Mitigation
Drill	Puncture wounds. Particles in eyes. Contusions. Lacerations.	Failure to clamp work properly. Failure to keep hands, body out of drill path.	- Damage to person - Damage to rocket - Damage to tool	3	2	Keep drill pointed away from hands, body. Use protective eyewear, close-toed shoes, remove all jewelry and do not wear loose-fitting clothing. Always assume the tool is powered. Do not use dull bits. Concentrate on task while utilizing tool - do not become distracted. NEVER do more work than the tool is capable of. Be patient and let the tool do the work.
Solder	Burns. Dust or flux in eyes	Incorrect equipment use; contact with heated work or solder.	-Severe burns -Eye irritation	3	2	Use protective eyewear, close-toed shoes, remove all jewelry and do not wear loose-fitting clothing . Always assume the tool is powered. Concentrate on task while utilizing tool - do not become distracted.
Grease	Harmful if swallowed or inhaled	- Not washing hands after use - Improper ventilation	-Irritated eyes, throat and nose.	2	2	-Do not induce vomiting if swallowed. Seek medical advice as a precaution. For inhalation, move affected person to fresh air.
Rotary hand tool	Particles in eyes Contusions Lacerations	Incorrect use of equipment--putting hand or body in past of cutter.	- Damage to person - Damage to rocket - Damage to tool	3	2	Use protective eyewear, close-toed shoes, remove all jewelry and do not wear loose-fitting clothing. Always assume the tool is powered. Do not use dull bits. Concentrate on task while utilizing tool - do not become distracted. NEVER do more work than the tool is capable of. Be patient and let the tool do the work.
Drill press	Particles in eyes Contusions Lacerations	Incorrect use of equipment	- Damage to person - Damage to rocket - Damage to tool	3	2	Utilize protective eyewear, close-toed shoes, remove all jewelry and do not wear loose-fitting clothing . Always assume the tool is powered. Concentrate on task while utilizing tool - do not become distracted. NEVER do more work than the tool is capable of. Be patient and let the tool do the work.
Lighters	Flammable commpresed gas	Incorrect use of equipment	-Start an unintentinal fires	2	2	Keep in cool, dry, ventelated storage and closed containers. Keep away from heat, sparks and open flames
Sandpaper	May cause eye irritation, skin irritation, inhalation of harmful substances.	Incorrect use of equipment	-May cause damage to person	2	2	Utilize protective eyewear and respirator designed for dust inhalation.
Table saw	Serious lacerations to fingers, hands, limbs.	Incorrect use of equipment--esp failure to secure work or putting hands, body or equipment in path of saw blade.	- Damage to person - Damage to rocket	5	1	Use protective eyewear, close-toed shoes, remove all jewelry and do not wear loose-fitting clothing. Always assume the tool is powered. Concentrate on task while utilizing tool - do not become distracted. NEVER do more work than the tool is capable of. Be patient and let the tool do the work.

Source	Hazard	Cause	Result	Severity	Likelihood	Mitigation
Compound slide miter saw	Laceration, esp of hands, fingers, limbs.	Incorrect use of equipment	- Damage to person - Damage to rocket	5	1	Use protective eyewear, close-toed shoes, remove all jewelry and do not wear loose-fitting clothing . Always assume the tool is powered. Concentrate on task while utilizing tool - do not become distracted. NEVER do more work than the tool is capable of. Be patient and let the tool do the work.
Variable speed jigsaw	Laceration, esp of hands, fingers, limbs.	Incorrect use of equipment	- Damage to person - Damage to rocket	5	1	Use protective eyewear, close-toed shoes, remove all jewelry and do not wear loose-fitting clothing. Always assume the tool is powered. Concentrate on task while utilizing tool - do not become distracted. NEVER do more work than the tool is capable of. Be patient and let the tool do the work.
Epoxy resin	Eye or skin irritation.	Failure to avoid glue or hand contact with eyes. Not washing hands with proper solvent after use	-Irritated eyes and throat	2	2	Use gloves to contact glued surfaces and wear vapor-protective mask.
Fast hardening glue	Eye or skin irritation. Irritation of breathing passages.	-Insufficient ventilation. Failure to wear gloves when handling glued surfaces. Not washing hands with proper solvent after use.	- Damage to person	2	2	Use protective eyewear, skin protection, and respiratory mask.
Slow hardening glue	Eye or skin irritation. Irritation of breathing passages.	- Not washing hands after use -Improper protection	- Damage to person	2	2	Use protective eyewear, skin protection, and respiratory mask.
Battery	Eye irritation from battery chemicals, inhalation, ingestion and toxic reaction, skin irritation.	Failure to wear gloves during use. Failure to wash hands with proper soap, solvent after use	- Damage to person - Damage to rocket	3	2	Use protective eyewear, skin protection, and respiratory mask.
Epoxglas	Eye irritation, skin irritation, respiratory irritation.	Incorrect use of equipment	- Damage to person - Damage to rocket	2	3	Use protective eyewear, skin protection, and respiratory mask.
Dry lubricant	Eye or skin irritation. Irritation of breathing passages.	-Improper protection	- Damage to person - Damage to rocket	3	2	Keep in cool, dry, ventelated storage and closed containers. Keep away from heat, sparks and open flames

Source	Hazard	Cause	Result	Severity	Likelihood	Mitigation
Spray paint.	Eye or skin irritation. Irritation of breathing passages.	-Improper protection	- Damage to person- Damage to rocket	2	2	Use protective eyewear, skin protection, and respiratory mask.
Super glue	Eye or skin irritation. Irritation of breathing passages.	-Improper protection	- Damage to person	2	2	Use protective eyewear, skin protection, and respiratory mask.
Woodworking tool	Lacerations or bruises.	Incorrect use of equipment	- Damage to person- Damage to rocket	4	2	Use protective eyewear, close-toed shoes, remove all jewelry and do not wear loose-fitting clothing. Always assume the tool is powered. Concentrate on task while utilizing tool - do not become distracted. NEVER do more work than the tool is capable of. Be patient and let the tool do the work.

Table 9 - Personal Safety Hazards

B. Failure Modes and Effects Analysis

Potential Failure	Cause	Consequence	Severity	Likelihood	Mitigation
External Structural Failure	Fins break or fail	unstable flight/ vehicle failure	4	2	Construct with through the wall fins
External Structural Failure	rail buttons break	unstable flight/ vehicle failure	3	3	screwed in to prevent break off, also test for looseness before flight
External Structural Failure	body tube fails	unstable flight/ vehicle failure	5	1	inspect body tubes for flaws prior to flight
External Structural Failure	Body tubes come apart during flight	unstable flight/ vehicle failure	5	1	all body tubes will be mechanically fastened together
Motor Failure	Motor improperly assembled	Rocket Failure	1	2	Check motor to the fullest possible degree before launch
Motor Failure	Ignitor improperly installed	Unstable flight possible rocket failure	5	2	Test before launch
Internal Structural Failure	centering rings not aligned correctly	unstable flight	3	1	Build carefully and measure multiple times
Internal Structural Failure	Motor retention fails	motor falls out	5	3	Test before launch.

Potential Failure	Cause	Consequence	Severity	Likelihood	Mitigation
shock cord failure	excessive loading	rocket components come in ballistically	5	2	Design fitting for proper load (eyebolts & quick links)
shock cord failure	de-taches from eye bolts	rocket components come in ballistically	5	2	Check eyebolts, quicklings and recovery harness for proper fit prior to flight
shock cord failure	Cut by other objects in rocket	rocket components come in ballistically	5	1	Inspect parachute compartments for sharp edges prior to intalling parachutes
shock cord failure	burned by ejection charges	rocket components come in ballistically	5	2	Shock cord made from fireproof kevelar
Altimeter Failure	Ejection charges do not go off	parachutes don't deploy/rocket comes in ballsitic	5	2	Observe the motor before loading to see if the ejection charge is on
Ejection Charge failure	igniter failure	parachutes don't deploy/rocket comes in ballsitic	5	3	test deployment system before launch
Parachute Failure	Parachutes packed too tightly	parachutes fail to deploy, or tangle upon deployment	5	3	Ground test parachutes; Inspect parachute packing during final assembly
Parachute Failure	parachutes detach from shock cord	rocket comes in ballistic	5	3	Check if parachutes are properly secured
Parachute Failure	parachute burns from ejection charges	parachute opens partially, or not at all	5	3	Protect parachutes and flamable shroud lines with flameproof shroud lines with flameproof material
Payload Environment Fails	Water environment leaks	contaminates the rest of the rocket, including motor/electronic s	4	2	Test environment before launch.

C. Project Risks

Project Risks

What	Likelihood	Impact	Mitigation
Fundraising	Medium	Medium	Begin fundraising early
Out of stock components	Medium	Medium	Order early as early as possible
Time understanding requirements	High	High	Schedule tasks early with detail and communicate!
Arduino programming	Medium	High	Need to start ASAP
Cooling system not being completed	Medium	High	Accelerate schedule-test early
Shrimp do not survive trip to Huntsville	Medium	High	Look for alternate sources of shrimp in Huntsville

Figure 8 - Project Risks

V. Payload Criteria

A. Scientific Experiment

It takes seven years for astronauts to reach Mars, and maintaining a self-sustaining food supply is a difficult problem. An ecosphere could possibly be the solution to that problem. Our scientific goal is to prove that it is possible to launch shrimp one-mile-high, and recover them without the shrimp dying. We will not be using an ecosphere because even though the gravitational pull would have kept the shrimp safely glued to the bottom, when coming down the organic matter, gravel and other objects that are inside the original ecosphere would potentially harm the shrimp, which would defeat the purpose of this experiment. So instead, we will be using a vessel that will hold only the shrimp and water.

The experiment will measure the gravitational forces on the shrimp to determine if they even can survive such gravitational force of the rocket being launched a mile high. The tank we will use will hold approximately 3-4 shrimp. We will have a control group we will be keeping on the ground. The conditions of the test group and the control group will have to be kept exactly the same. For example, the shrimp in the control and test group would need the same vessel, the same amount of water, the same amount of food, be kept at the same temperature and the same type of lighting. The vessel will have to be airtight in the rocket. We will design the vessel to have a maximum of 8 hours of oxygen supply once we seal the container. We will seal both containers at the same time and transport them both to the launch pad, but only the test group will go up in the rocket. During the flight, we will measure the gravitational forces using an accelerometer. After we launch the test group, we will compare the two groups to see the differences in each group. The point of this experiment is to see if the gravitational forces have any effect on the shrimp.

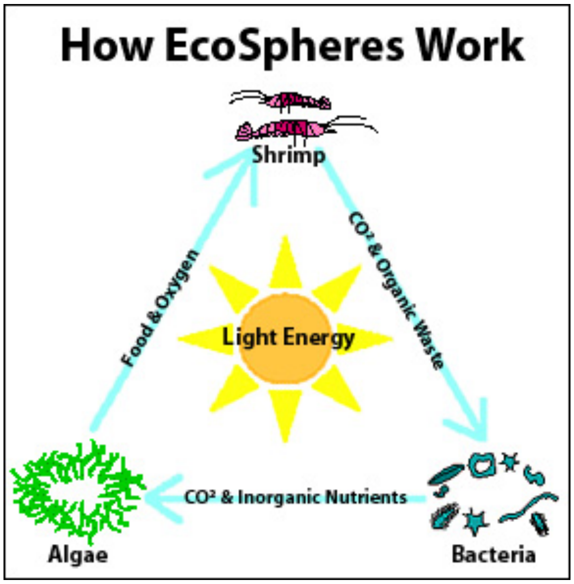


Figure 4 How EcoSpheres Work

(Photo courtesy of Abundant Earth at http://www.abundantearth.com/store/media/howecosphereswork.jpg)

We will be sending other devices in our payload bay besides the shrimp in its vessel. These devices include an Arduino device that will control the temperature in the vessel and a thermo-electric cooler that will keep the shrimp at a constant temperature. We are exploring different ways to vent the heat produced by the thermo-electric cooler.

B. Why Shrimp

In our experiment, we will be using Brine Shrimp. We were going to use Brine Shrimp because they are protein filled, multiply easily and are hardier then most other kinds of shrimp. They are very temperature sensitive and most sources say to keep them at room temperature which we will say is between 70 to 85 degrees Fahrenheit. They need a very high level of salt in their water with 80% saline. A female lays her eggs and these can be hatched within minutes if the conditions are right. If there is not enough oxygen or salt, the eggs will remain dormant for up to 50 years before they hatch.

This is a chart we made to compare the differences between other varieties of shrimp.

Variety	Pros	Cons	Why we did or did not select variety
Brine shrimp	Eggs are easily obtainable and easy to take care of.	Must be kept at high saline (or salt) levels. Very temperature sensitive.	We did not select this variety because the salt levels are harder to manage then the Sea monkeys.
Fairy shrimp	Eggs are very hardy and can survive very dry climates.	They have no carapace, which is the hard shell that protects them. This make them more delicate and fragile.	They are very fragile and during the launch and flight, they could be easily killed.
Sea monkeys	Very robust, survive easily.	Lacks carapace. Very temperature sensitive.	We selected these shrimps because they are easy to obtain and easier to observe then the other shrimp, and reproduce quickly.

Table 10 - Shrimp Alternatives

We decided to use a variety of brine shrimp marketed as Sea Monkeys. Sea Monkeys were developed by Harold von Braunhut in 1957 to be an easy maintainable pet that did not need to live in salt water, and therefore easy to take care of. They have actually been sent into orbit twice. Once in 1972 and then again in 1989. On Oct 29, 1989, 400 million Sea Monkey eggs were taken into orbit for nine days in the spacecraft Discovery. Once back safely on Earth, the eggs hatched and there was no mutilations or deficiencies found in the shrimp. This showed that the gravitational forces did not have a visible effect on the shrimp eggs.

We decided on the Sea Monkey variety because it seems as though they are the easiest to upkeep and maintain, primarily as a result of not having to maintain a salt water habitat as with the other alternatives. They are strong and durable and there would not be as much of a risk of them being killed then if we used another variety of brine shrimp. They also reproduce quickly so we should only have to buy one batch of shrimp.

Figure 9 – Sea Monkey

(http://ecx.images-amazon.com/images/I/51OzP7yyTuL._SY300_.jpg)

C. Cooling System

The payload team conducted an experiment to see whether it was necessary for a water cooler to cool our sea monkey payload. An empty apple juice bottle, which is serving as our shrimp habitat, was filled with water. The bottle was put in a heat box whose temperature was 108 degrees. The starting temperature of the bottle was 72.8 degrees. In 30 minutes, the bottle of water increased in temperature to 92.2 degrees. The total water temperature change over 30 minutes was 19.4 degrees. With the surviving temperature for brine shrimp being 70-85 degrees this experiment demonstrated that it is highly likely our shrimp will not survive four hours on the launch pad without a cooling system.

The payload team performed a separate experiment, also using the heat box, to determine the difference in temperatures between a plain body tube and an insulated body tube. We conducted this experiment to see if adding insulation to the shrimp environment would be effective at keeping the shrimp environment cool in hot temperatures. If so, then we wouldn't need to construct a cooling system to keep our payload (brine shrimp) cool enough on our launch pad in the hot Alabama sun. We took one body tube and sanded the top and bottom of it until both sides fit well. Then we made a hole in the top of the body tube in which to fit a thermometer. With the other body tube, we did the same thing, but covered it with insulation as well, ensuring that all edges were sealed well. After assembling each body tube, we put both in a heat box with a temperature of 120 degrees. We picked the temperature of 120 because inside our closed rocket under the direct sunlight we believe it could get that hot.

For the first ten minutes the plain body tube was increasing in temperature significantly more than the insulated one. The heat box had decreased in temperature to 108 degrees, probably from us opening up the lid and letting air escape. Within 10 minutes, the plain body tube went from a temperature of 74 degrees to a temperature of 109.5 degrees and the insulated body tube went from a temperature of 77.8 degrees to a temperature of 96.7 degrees.

Although the insulation makes a difference in temperature, keeping the tube marginally cooler; It didn’t keep it cool enough to ensure the survival of our payload (brine shrimp). Therefore, we definitely need some sort of cooling system to keep our shrimp cool.

Figure 10 - Heat Test

Our cooling system operates mainly by our Peltier Cooler. This Peltier Cooler is lodged between two components as shown in the figure below. The Peltier cooler has a hot side, and a cold side. The cold side connects to a metal water block which will lead it to the rubber tubing. This tubing will be filled with water and this water will be circulated with a pump. The tubing connects to a copper coil and this coil surrounds the container for the shrimp. This coil will be cooled by the water and the water will be cooled by the Peltier Cooler. The heat sink will ensure that the heat from the hot side of the Peltier Cooler will not heat the shrimp. There is a fan connected to the heat sink which blows away any excess heat.

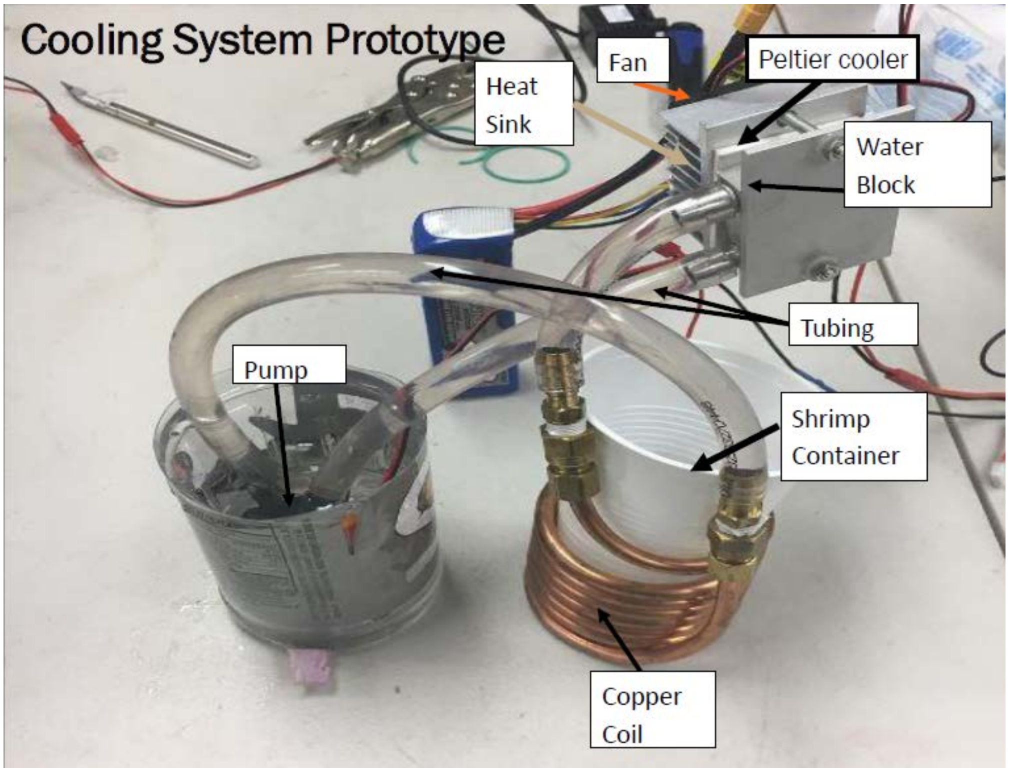


Figure 11 - The Cooling System

D. Payload System Design

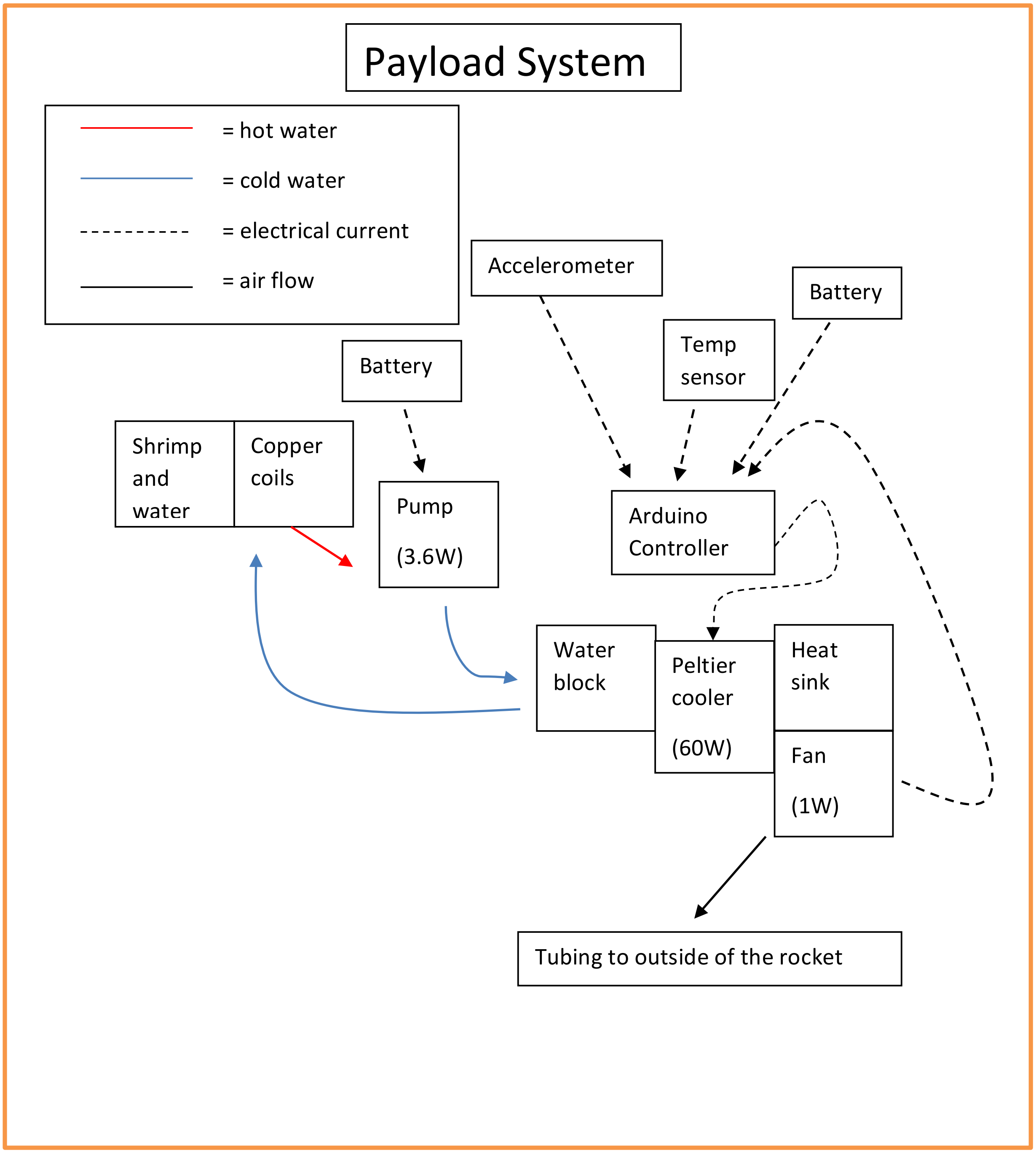


Figure 12: Payload System Diagram

VI. Project Plan

A. Requirements Verification

1. Handbook Criteria

General Requirements		
Requirement	**Verification**	**How Satisfied**
1.1. Students on the team will do 100% of the project, including design, construction, written reports, presentations, and flight preparation with the exception of assembling the motors and handling black powder or any variant of ejection charges, or preparing and installing electric matches (to be done by the team's mentor).	Observation	The team will take notes of their progress and steps to success, showing that they did all of the work.
1.2. The team will provide and maintain a project plan to include, but not limited to the following items: project milestones, budget and community support, checklists, personnel assigned, educational engagement events, and risks and mitigations.	Analysis	The project plan consists of the events necessary for the project's success. Milestones, budget, community support, checklists, personnel assigned, educational engagement, and risks and mitigations will all be provided.
1.3. Foreign National (FN) team members must be identified by the Preliminary Design Review (PDR) and may or may not have access to certain activities during launch week due to security restrictions. In addition, FN's may be separated from their team during these activities.	Observation	Our team does not have any FN team members

General Requirements		
Requirement	**Verification**	**How Satisfied**
1.4. The team must identify all team members attending launch week activities by the Critical Design Review (CDR). Team members will include: 1.4.1. Students actively engaged in the project throughout the entire year. 1.4.2. One mentor (see requirement 1.14). 1.4.3. No more than two adult educators.		All members attending launch week, will be identified by CDR. Their individual roles throughout the year will be recorded No more than two adult educators will attend launch week activities
1.5. The team will engage a minimum of 200 participants in educational, hands-on science, technology, engineering, and mathematics (STEM) activities, as defined in the Educational Engagement Activity Report, by FRR. An educational engagement activity report will be completed and submitted within two weeks after completion of an event. A sample of the educational engagement activity report can be found on page 30 of the handbook. To satisfy this requirement, all events must occur between project acceptance and the FRR due date.	Analysis	Educational Engagement will include: informing children about our project and Nasa Student Launch, showing our successes and up until that point, and having a large demo rocket for them to see individual parts and understand the rocket more fully.
1.6. The team will develop and host a Web site for project documentation.	Observation	The team's website is www.stmonicarocketryclub.com, all of our documents will be uploaded to this site.
1.7. Teams will post, and make available for download, the required deliverables to the team Web site by the due dates specified in the project timeline.	Observation, Analysis	All documents, private or public, will be available for download on the website by the due dates specified in the project timeline.

General Requirements		
Requirement	**Verification**	**How Satisfied**
1.8. All deliverables must be in PDF format.		All documents will be converted into PDF format.
1.9. In every report, teams will provide a table of contents including major sections and their respective sub-sections.	Observation, Analysis	Reports will have a table of contents, including major sections and their respective sub-sections.
1.10. In every report, the team will include the page number at the bottom of the page.	Observation	The page number that we will include on the bottom of the page will correlate with our table of contents.
1.11. The team will provide any computer equipment necessary to perform a video teleconference with the review panel. This includes, but is not limited to, a computer system, video camera, speaker telephone, and a broadband Internet connection. Cellular phones can be used for speakerphone capability only as a last resort.	Observation	The team has two locations for video teleconferences, one main and one backup. Both consist of a computer system, video camera, speaker phone and a solid internet connection.
1.12. All teams will be required to use the launch pads provided by Student Launch's launch service provider. No custom pads will be permitted on the launch field. Launch services will have 8 ft. 1010 rails, and 8 and 12 ft. 1515 rails available for use.	Test	Our design was made to accommodate for launch services provided.

General Requirements		
Requirement	**Verification**	**How Satisfied**
1.13. Teams must implement the Architectural and Transportation Barriers Compliance Board Electronic and Information Technology (EIT) Accessibility Standards (36 CFR Part 1194) Subpart B-Technical Standards (http://www.section508.gov): §1194.21 Software applications and operating systems. §1194.22 Web-based intranet and Internet information and applications.	Analysis	Teams will implement the EIT accessibility standards.

General Requirements		
Requirement	**Verification**	**How Satisfied**
1.14. Each team must identify a "mentor." A mentor is defined as an adult who is included as a team member, who will be supporting the team (or multiple teams) throughout the project year, and may or may not be affiliated with the school, institution, or organization. The mentor must maintain a current certification, and be in good standing, through the National Association of Rocketry (NAR) or Tripoli Rocketry Association (TRA) for the motor impulse of the launch vehicle and must have flown and successfully recovered (using electronic, staged recovery) a minimum of 2 flights in this or a higher impulse class, prior to PDR. The mentor is designated as the individual owner of the rocket for liability purposes and must travel with the team to launch week. One travel stipend will be provided per mentor regardless of the number of teams he or she supports. The stipend will only be provided if the team passes FRR and the team and mentor attends launch week in April.	Observation	Our mentor maintains a current certification, through NAR or TRA. He is certified to fly, and has flown the motor of which our design has. He has had a minimum of 2 flights in this or a higher impulse class, prior to PDR. Our mentor is designated as the individual owner of the rocket, for liability purposes and this rocket will travel with us to launch week.

Table 11 - General Requirements

Design Requirements		
Requirement	**Verification**	**How Satisfied**
2.1. The vehicle will deliver the payload to an apogee altitude of 5,280 feet above ground level (AGL).	TEST/DEMOMSTRATION	To test this requirement the team will launch the vehicle prior to the FRR and make any modifications necessary to bring the vehicle to 5,280 ft.
2.6. The launch vehicle will be designed to be recoverable and reusable. Reusable is defined as being able to launch again on the same day without repairs or modifications.	INSPECTION	The materials of the vehicle must be thoroughly inspected to ensure quality before use.
2.7. The launch vehicle will have a maximum of four (4) independent sections. An independent section is defined as a section that is either tethered to the main vehicle or is recovered separately from the main vehicle using its own parachute.	INSPECTION	The team will ensure that the design has 4 or less sections.
2.8. The launch vehicle will be limited to a single stage.	INSPECTION	The team will ensure that the design has only one stage.
2.9. The launch vehicle will be capable of being prepared for flight at the launch site within 3 hours of the time the Federal Aviation Administration flight waiver opens.	DEMONSTRATION	The team will demonstrate at every launch that the rocket is capable of being prepared within 3 hours of the flight waiver being opened.
2.10. The launch vehicle will 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 components.	TEST/DEMONSTRATION	The team will demonstrate at every launch that the rocket is able to remain in launch-ready configuration for a minimum of 1 hour without losing functionality.
2.11. The launch vehicle will be capable of being launched by a standard 12-volt direct current firing system. The firing system will be provided by the NASA-designated Range Services Provider.	TEST	The team will test the rocket on a 12-volt direct current firing system.
2.12. The launch vehicle will require no external circuitry or special ground support equipment to initiate	DEMONSTRATION	The team will demonstrate that all launch equipment is internal or provided by Range Services.

Design Requirements		
Requirement	**Verification**	**How Satisfied**
launch (other than what is provided by Range Services).		
2.13. The launch vehicle will 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).	INSPECTION/DEMONSTRATION	The team will ensure that the K-class motor has been approved by NAR, TRA, or CAR, and will demonstrate that the motor has the ability to propel the rocket.
2.13.1. Final motor choices must be made by the Critical Design Review (CDR).	DEMONSTRATION	The team will show that their final motor has been selected prior to the Critical Design Review.
2.13.2. Any motor changes after CDR must be approved by the NASA Range Safety Officer (RSO), and will only be approved if the change is for the sole purpose of increasing the safety margin.	DEMONSTRATION	The team will show that the motor has not been changed after CDR unless it is necessary to increase safety.
2.16. The launch vehicle will have a minimum static stability margin of 2.0 at the point of rail exit. Rail exit is defined at the point where the forward rail button loses contact with the rail.	TEST	The team will simulate and test the rocket to ensure it has a minimum static stability margin of 2.0 at the point of rail exit.
2.17. The launch vehicle will accelerate to a minimum velocity of 52 fps at rail exit.	TEST	The team will simulate and test the rocket to ensure it will accelerate to a minimum velocity of 52 fps at rail exit.
2.18. All teams will successfully launch and recover a subscale model of their rocket prior to CDR. Subscales are not required to be high power rockets.	TEST/DEMONSTRATION	The team will demonstrate the ability of their subscale rocket at a launch prior to CDR.
2.18.1. The subscale model should resemble and perform as similarly as possible to the full-scale model,	TEST/DEMONSRATION	The team will build a subscale rocket, test its ability at a launch, and demonstrate its similarity to the full-scale rocket.

Design Requirements		
Requirement	**Verification**	**How Satisfied**
however, the full-scale will not be used as the subscale model.		
2.18.2. The subscale model will carry an altimeter capable of reporting the model's apogee altitude.	INSPECTION	The team will ensure the altimeter of choice is capable of reporting the model's apogee altitude.
2.19. All teams will successfully launch and recover their full-scale rocket prior to FRR in its final flight configuration. The rocket flown at FRR must be the same rocket to be flown on launch day. The purpose of the full-scale demonstration flight is to demonstrate the launch vehicle's stability, structural integrity, recovery systems, and the team's ability to prepare the launch vehicle for flight. A successful flight is defined as a launch in which all hardware is functioning properly (i.e. drogue chute at apogee, main chute at a lower altitude, functioning tracking devices, etc.). The following criteria must be met during the full-scale demonstration flight:	TEST/DEMONSTRATION	The team will test their full-scale rocket in a launch prior to FRR and demonstrate a successful launch with the same rocket that will be used on the final launch day.
2.19.1. The vehicle and recovery system will have functioned as designed.	DEMONSTRATION	The team will demonstrate at a launch that the recovery system functions as designed.
2.19.2. The payload does not have to be flown during the full-scale test flight. The following requirements still apply:		The payload may or may not be flown with in the full-scale test flight, depending on its completion.
2.19.2.1. If the payload is not flown, mass simulators will be used to simulate the payload mass.	TEST/DEMONSTRATION	The team will test the weight of the payload with either the payload itself or an object of similar mass, and demonstrate that the rocket is functional with this payload.
2.19.2.1.1. The mass simulators will be located in the same	INSPECTION	The team will ensure that in case of the payload not being

Design Requirements		
Requirement	**Verification**	**How Satisfied**
approximate location on the rocket as the missing payload mass.		completed in time, the mass simulators will be located in the same approximate location as the missing payload mass.
2.19.4. The full-scale motor does not have to be flown during the full-scale test flight. However, it is recommended that the full-scale motor be used to demonstrate full flight readiness and altitude verification. If the full-scale motor is not flown during the full-scale flight, it is desired that the motor simulates, as closely as possible, the predicted maximum velocity and maximum acceleration of the launch day flight.	TEST/DEMONSTRATION	The team will test a subscale motor in the rocket during the test flight, and demonstrate that the subscale motor will simulate the full-scale motor performance as closely as possible.
2.19.5. The vehicle must be flown in its fully ballasted configuration during the full-scale test flight. Fully ballasted refers to the same amount of ballast that will be flown during the launch day flight. Additional ballast may not be added without a re-flight of the full-scale launch vehicle.	INSPECTION	The team will ensure that the amount of ballast used at the full-scale test flight is equal to the amount used at the final launch.
2.19.6. After successfully completing the full-scale demonstration flight, the launch vehicle or any of its components will not be modified without the concurrence of the NASA Range Safety Officer (RSO).	DEMONSTRATION	The team will demonstrate that no vehicle components have been altered after the full-scale test flight.
2.19.7. Full scale flights must be completed by the start of FRRs (March 6, 2018). If the Student Launch office determines that a re-flight is necessary, then an extension to March 28, 2018 will be granted. This extension is only	DEMONSTRATION	The team will show that any test flights will have taken place prior to March 6, 2018.

Design Requirements		
Requirement	**Verification**	**How Satisfied**
valid for re-flights; not first-time flights.		
2.20. Any structural protuberance on the rocket will be located aft of the burnout center of gravity.	INSPECTION	The team will ensure that there will be no structural protuberances on the rocket except for the fins and rail buttons, which are located aft of the burnout CG.
2.21. Vehicle Prohibitions	INSPECTION	The team will ensure that none of the following prohibited items are used in the rocket or for the launch of the rocket.
2.21.1. The launch vehicle will not utilize forward canards.	INSPECTION	The vehicle will not utilize forward canards.
2.21.2. The launch vehicle will not utilize forward firing motors.	INSPECTION	The vehicle will not utilize forward firing motors.
2.21.3. The launch vehicle will not utilize motors that expel titanium sponges (Sparky, Skid mark, Metal Storm, etc.)	INSPECTION	The vehicle will not utilize motors that expel titanium sponges.
2.21.4. The launch vehicle will not utilize hybrid motors.	INSPECTION	The vehicle will not utilize hybrid motors.
2.21.5. The launch vehicle will not utilize a cluster of motors.	INSPECTION	The vehicle will not utilize a cluster of motors.
2.21.6. The launch vehicle will not utilize friction fitting for motors.	INSPECTION	The vehicle will not utilize friction fitting in its motor tube.
2.21.7. The launch vehicle will not exceed Mach 1 at any point during flight.	INSPECTION	The vehicle will not exceed Mach 1 at any point during flight.
2.21.8. Vehicle ballast will not exceed 10% of the total weight of the rocket.	INSPECTION	The vehicle ballast will not exceed 10% of the net vehicle weight.

Table 12 - Design Requirements

Recovery Requirements		
Requirement	**Verification**	**How Satisfied**
3.1. The launch vehicle will stage the deployment of its recovery devices, where a drogue parachute is deployed at apogee and a main parachute is deployed at a lower altitude. Tumble or streamer recovery from apogee to main parachute deployment is also permissible, provided that kinetic energy during drogue-stage descent is reasonable, as deemed by the RSO.	Demonstration/analysis	The launch vehicle will demonstrate a successful deployment of both the drogue and main parachutes. Analysis through calculations will prove that the kinetic energy during drogue-stage descent is reasonable.
3.2. Each team must perform a successful ground ejection test for both the drogue and main parachutes. This must be done prior to the initial subscale and full-scale launches.	Demonstration.	The team will demonstrate a successful ground ejection test prior to the initial launch.
3.3. At landing, each independent sections of the launch vehicle will have a maximum kinetic energy of 75 ft.-lbf.	Analysis.	Analysis through calculations will prove that upon landing, the launch vehicle will have a maximum kinetic energy of 75 ft.-lbf
3.4. The recovery system electrical circuits will be completely independent of any payload electrical circuits.	Inspection.	Inspection will prove that the recovery system electrical circuits are completely independent of any payload electrical circuits.
3.5. All recovery electronics will be powered by commercially available batteries.	Inspection.	Inspection will prove that all recovery electronics are powered by commercially available batteries.
3.6. The recovery system will contain redundant, commercially available altimeters. The term “altimeters” includes both simple altimeters and more sophisticated flight computers.	Inspection.	Inspection will prove that the recovery system contains redundant commercially available altimeters.
3.7. Motor ejection is not a permissible form of primary or secondary deployment.	Inspection.	Inspection will prove that the launch vehicle does not use motor ejection.
3.8. Removable shear pins will be used for both the main parachute compartment and the drogue parachute compartment.	Inspection.	Inspection will prove that removable sheer pins will be used.

Recovery Requirements		
Requirement	**Verification**	**How Satisfied**
3.9. Recovery area will be limited to a 2500 ft. radius from the launch pads.	Analysis.	Analysis through calculations will prove that the recovery area is within a 2500 ft. radius.
3.10. An electronic tracking device will be installed in the launch vehicle and will transmit the position of the tethered vehicle or any independent section to a ground receiver.	Inspection.	Inspection will prove that an electronic tracking device will be located in the launch vehicle and will transmit the position of the tethered vehicle or any independent section to a ground receiver.
3.10.1. Any rocket section, or payload component which lands untethered to the launch vehicle will also carry an active electronic tracking device.	Inspection.	Inspection will prove that any rocket section or payload component will carry its own separate tracking device.
3.10.2. The electronic tracking device will be fully functional during the official flight on launch day.	Test/Inspection.	Tests and inspection will prove that the electronic tracking device will be fully functional during the official launch day.
3.11. The recovery system electronics will not be adversely affected by any other on-board electronic devices during flight (from launch until landing).	Inspection.	Inspection will prove that the recovery system electronics will not be adversely affected by any other on-board electronic devices during flight.
3.11.1. The recovery system altimeters will be physically located in a separate compartment within the vehicle from any other radio frequency transmitting device and/or magnetic wave producing device.	Inspection.	Inspection will prove that the recovery system altimeters will be physically located in a separate compartment within the vehicle from any other radio frequency transmitting device and/or magnetic wave producing device.
3.11.2. The recovery system electronics will be shielded from all onboard transmitting devices, to avoid inadvertent excitation of the recovery system electronics.	Inspection.	Inspection will prove that the recovery system electronics will be shielded from all onboard transmitting devices.

Recovery Requirements		
Requirement	**Verification**	**How Satisfied**
3.11.3. The recovery system electronics will be shielded from all onboard devices which may generate magnetic waves (such as generators, solenoid valves, and Tesla coils) to avoid inadvertent excitation of the recovery system.	Inspection.	Inspection will prove that the recovery system electronics will be shielded from all other onboard devices which may generate magnetic waves.
3.11.4. The recovery system electronics will be shielded from any other onboard devices which may adversely affect the proper operation of the recovery system electronics.	Inspection.	Inspection will prove that the recovery system electronics will be shielded from any other onboard devices which may adversely affect the proper operation of the recovery system electronics.

Table 13 - Recovery Requirements

Experiment Requirements		
Requirement	**Verification**	**How Satisfied**
4.1. The launch vehicle will carry a science or engineering payload. The payload may be of the team's discretion, but must be approved by NASA. NASA reserves the authority to require a team to modify or change a payload, as deemed necessary by the Review Panel, even after a proposal has been awarded.	We will analyze the requirements and make sure that our payload meets them.	We will only fly a NASA approved payload.
4.2. Data from the science or engineering payload will be collected, analyzed, and reported by the team following the scientific method.	We will inspect if this work was done.	We will be collecting data, graphs and charts during our experiment, and will analyze them as we go along.
4.3. Unmanned aerial vehicle (UAV) payloads of any type will be tethered to the vehicle with a remotely controlled release mechanism until the RSO has	We will inspect our payload for a UAV.	We do not have a UAV.

given the authority to release the UAV.		
4.4. Any payload element that is jettisoned during the recovery phase, or after the launch vehicle lands, will receive real-time RSO permission prior to initiating the jettison event.	We will test for a payload item that could be jettisoned and inspect if an item did jettison.	We do not have any payload element that will be jettisoned.
4.5. The payload must 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.	We will test if our design is reusable.	Our design is reusable.
The cooling system is affective and works properly.	We will test if the cooling system will work.	We will use an air heated box which we will put our cooling system in. We will then verify if the cooling system can cool the shrimp.
The Arduino is programmed correctly and is functional.	We will test the Arduino.	We will test if the components attached to the Arduino react when they are put under the circumstances that they are supposed to react to.
If the payload gets below the temperature of 75 degrees.	We will test and then correct this problem.	We will leave the cooler off more to solve this problem.
If the payload exceeds the temperature 85 degrees.	We will test and then correct this problem.	We will insure that the cooler stays on longer to cure this problem.
That the battery lasts long enough.	We will test if the battery lasts long enough.	We will plug the battery in and test if it lasts for the time we require.
That the shrimp holder does not leak.	We will test if the shrimp holder leaks.	We will set the payload down and check if view if it leaks.
The impact that the shrimp can withstand.	We will test on the impact that the shrimp can withstand without dying.	We will drop our payload from different heights and see the highest height which they can withstand.

Table 14 - Payload Requirements

Safety Requirements		
Requirement	**Verification**	**How Satisfied**
5.1. Each team will use a launch and safety checklist. The final checklists will be included in the FRR report and used during the Launch Readiness Review (LRR) and any launch day operations.	Analysis	The team will use a launch and safety checklist, and it will be included in the FRR report and used during the LRR and any launch day operations.
5.2. Each team must identify a student safety officer who will be responsible for all items in section 5.3.	Analysis, Observation	The team will identify a student safety officer who will be responsible for all item in section 5.3.

Safety Requirements		
Requirement	**Verification**	**How Satisfied**
5.3. The role and responsibilities of each safety officer will include, but not limited to: 5.3.1. Monitor team activities with an emphasis on Safety during: 5.3.1.1. Design of vehicle and payload 5.3.1.2. Construction of vehicle and payload 5.3.1.3. Assembly of vehicle and payload 5.3.1.4. Ground testing of vehicle and payload 5.3.1.5. Sub-scale launch test(s) 5.3.1.6. Full-scale launch test(s) 5.3.1.7. Launch day 5.3.1.8. Recovery activities 5.3.1.9. Educational Engagement Activities 5.3.2. Implement procedures developed by the team for construction, assembly, launch, and recovery activities 5.3.3. Manage and maintain current revisions of the team's hazard analyses, failure modes analyses, procedures, and MSDS/chemical inventory data 5.3.4. Assist in the writing and development of the team's hazard analyses, failure modes analyses, and procedures.	Analysis, Observation, Test	The role and responsibilities of each safety officer will include, but not limited to: Monitor team activities with an emphasis on Safety during: Design of vehicle and payload Assembly of vehicle and payload Ground testing of vehicle and payload Sub-scale launch test(s) Full-scale launch test(s) -Launch day -Recovery activities Education Engagement Activities Implement procedures developed by the team for construction, assembly, launch, and recovery activities Manage and maintain current revisions of the team's hazard analyses, failure modes analyses, procedures, and MSDS/chemical inventory data Assist in the writing and development of the team's hazard analysis, failure modes analysis

Safety Requirements		
Requirement	**Verification**	**How Satisfied**
5.4. During test flights, teams will abide by the rules and guidance of the local rocketry club's RSO. The allowance of certain vehicle configurations and/or payloads at the NASA Student Launch Initiative does not give explicit or implicit authority for teams to fly those certain vehicle configurations and/or payloads at other club launches. Teams should communicate their intentions to the local club's President or Prefect and RSO before attending any NAR or TRA launch.	Analysis, Observation	Teams will abide by the rules and guidance of the local rocketry club's RSO. The allowance of certain vehicle configurations and/or payloads at the NASA Student Launch Initiative does not give explicit or implicit authority for teams to fly those certain vehicle configurations and/or payloads at other club launches. Teams should communicate their intentions to the local club's President or Prefect and RSO before attending any NAR or TRA launch.
5.5. Teams will abide by all rules set forth by the FAA.	Analysis, Observation	Teams will abide by all rules set forth by the FAA.

Table 15 - Safety Requirements

2. **Team Specific Criteria**

Requirement	Verification	How Satisfied
The cooling system is effective and works properly.	We will test if the cooling system will work.	We will use a heated box which we will put our cooling system in. We will then verify if the cooling system can cool the shrimp vessel to the required temperature.
The Arduino is programmed correctly and is functional.	We will test the Arduino.	We will test if the components attached to the Arduino react when they are put under the circumstances that they are supposed to react to.
That the battery lasts long enough.	Analysis and test	We will calculate the required battery capacity and

		test to ensure it lasts that duration.
That the shrimp holder does not leak.	Test	We will perform various tests on the shrimp vessel to ensure that it does not leak, including drop tests.
The impact that the shrimp can withstand.	Analysis and Test	We will drop our payload from different heights and see the highest height which they can withstand.
Verify that the Eggtimer TRS and LCD receiver work	Demonstration/testing	We will test the Eggtimer TRS in our sub-scale model and again in the full scale to ensure it works as designed.

B. Budgeting and Timeline

1. Budget

Summary

EXPENSE BUDGET SUMMARY		
Budget Item	**Amount**	**Comment**
Full Scale Rocket and Payload	$ 1,476	Includes payload and electronics expenses
Subscale Rocket	$ 100	Do not need electronics or recovery
Motors	$ 570	3x K class @ $150 ea. And 3x H class @ $40 ea.
Huntsville Travel/Lodging	$ 5,923	
Educational Engagement	$ 200	
Fundraising	$ 200	
Website	$ 100	
Shipping and Handling	$ 110	
Other	$ 250	
	$ 8,929	

Table 16 - Budget Summary

Huntsville Trip

EXPENSE BUDGET SUMMARY				
Budget Item	**Price**	**Quantity**	**Total**	**Comment**
Hotel/Lodging	$ 133.58	24	$ 3,205.92	six nights
Vehicle	0	2	$ -	Borrowing cars from parents
Gas	3	308	$ 923.08	1000mi. @ 13 mpg.
Food	23	78	$ 1,794.00	breakfast free, lunch $8, dinner $15
			$ 5,923.00	

Table 17 - Budget Huntsville Trip

Full Scale Rocket and Payload Expense

FULL SCALE ROCKET AND PAYLOAD EXPENSE BUDGET - BlueTube substitute						
				Mass (grams)	Cost	
Totals				**7,968.13**	**$ 1,476.02**	
Lookup Description	**Lookup_Unit**	**Lookup$**	**Quantity**	**Calculated Weight**	**Calculated Price**	**Comment**
BOOSTER						
3.9" BlueTube Airframe	g / in	$ 0.81	22	332.29	$ 17.85	Booster, Exterior Body Tube
Tailcone 390 to 54mm	g	$ 54.00	1	115.00	$ 54.00	
2.1" BlueTube Airframe	g / in	$ 0.50	22	187.92	$ 10.98	54mm motor mount
Centering Ring 3.9" to 2.1"	g	$ 7.20	3	77.68	$ 21.60	centering rings for motor mount
1/4-20 stainless threaded rod	g/in	$ 0.12	48	220.00	$ 5.70	2 threaded rod stiffeners to go through centering rings
1/4-20 eye nut	g	$ 4.62	2	35.15	$ 9.24	eye nuts to attach booster to aft recovery
1/4-20 Hex Nut	g	$ 0.24	2	6.45	$ 0.47	
1/4" Split Lock Washer	g	$ 0.25	4	4.00	$ 0.99	
1/4" Washer	g	$ 0.50	4	5.60	$ 1.99	
1515 rail button- pair (large)	g	$ 2.50	1	15.00	$ 2.50	
1/4" Aircraft Plywood	g	$ 0.02	150	235.94	$ 3.13	Fins
Paint & Glue				200.00	$ 20.00	
				1,435.03	**$ 148.44**	
LOWER RECOVERY						
3.9" BlueTube Airframe	g / in	$ 0.81	17	256.77	$ 13.79	
Rocketman drogue balistick 2 feet		$ 70.00	1	166.80	$ 70.00	
3.9" BlueTube Coupler	g / in	$ 0.83	8	120.00	$ 6.66	Coupler between booster and aft recovery
18x18 nomax		$ 10.00	1	39.80	$ 10.00	
Harness: 3/16" tubular kevlar - 25 ft long, 3 loop		$ 25.00	1	138.10	$ 25.00	
3/16" Quik Link	g	$ 1.95	4	85.60	$ 7.80	2 attach to booster, 2 attach to e-bay
Paint & Glue				100.00	$ 5.00	
				907.07	**$ 138.25**	
ELECTRONICS BAY						
Stratologger CF Altimeter	g	$ 57.50	1	10.21	$ 57.50	
TRS Altimeter/Tracker	g	$ 75.00	1	40.00	$ 75.00	
Wiring	g	$ 4.00	2	28.92	$ 8.00	
Screw Switch	g	$ 3.00	2	7.37	$ 6.00	
Charge Holder (3.0g) - pair	g	$ 10.00	2	53.20	$ 20.00	
1/4-20 stainless threaded rod	g/in	$ 0.12	22	100.83	$ 2.61	2 pieces that extend through ebay
1/4-20 eye nut	g	$ 4.62	4	70.31	$ 18.48	2 on each end of ebay
1/4-20 Hex Nut - aluminum	g	$ 0.07	8	8.00	$ 0.58	for interior of ebay to secure sled
1/4" Split Lock Washer	g	$ 0.25	4	4.00	$ 0.99	
1/4" Washer	g	$ 0.50	4	5.60	$ 1.99	
1/8" G10 Fiberglass Sheet	g / in^2	$ 0.12	28	109.27	$ 3.33	8 x 3.5 ebay sled
Turnigy 500mah 2s	g	$ 6.00	3	174.00	$ 18.00	2 required for Eggtimer and 1 for Stratologger
3.9" Airframe Bulkhead	g	$ 5.40	2	76.92	$ 10.80	
3.9" Coupler Bulkhead	g	$ 5.40	2	72.29	$ 10.80	
3.9" BlueTube Coupler	g / in	$ 0.83	9	135.00	$ 7.49	
Paint & Glue				100.00	$ 5.00	
				995.92	**$ 246.56**	

Lookup Description	Lookup_Unit	Lookup$	Quantity	Calculated Weight	Calculated Price	Comment
FORWARD RECOVERY						
3.9" BlueTube Airframe	g / in	$ 0.81	22	332.29	$ 17.85	
FruityChute Iris Ultra compact 120	0	$ 504.00	1	627.00	$ 504.00	
4" Deployment bag - 9" long	0	$ 42.00	1	100.00	$ 42.00	
Harness: 1/2" Flat kevlar - 25 ft long, 2 loop	0	$ 25.00	2	376.00	$ 50.00	
3/16" Quik Link	g	$ 1.95	4	85.60	$ 7.80	2 to attach to ebay and 2 to payload
Paint & Glue				100.00	$ 5.00	
				1,620.89	**$ 626.65**	
PAYLOAD						
3.9" BlueTube Airframe	g / in	$ 0.81	14	211.46	$ 11.36	
3.9" Nose Cone - 12.75"	g	$ 23.05	1	200.00	$ 23.05	LOC precision
3.9" BlueTube Coupler	g / in	$ 0.83	8	120.00	$ 6.66	Fwd recovery to Payload
3.9" Airframe Bulkhead	g	$ 5.40	1	38.46	$ 5.40	
3.9" Coupler Bulkhead	g	$ 5.40	1	36.15	$ 5.40	
1/4-20 eye nut	g	$ 4.62	2	35.15	$ 9.24	
Payload Adruino Parts	0	$ 250.00	1	2,268.00	$ 250.00	This is just a placeholder
Paint & Glue				100.00	$ 5.00	
				3,009.22	**$ 316.11**	

Table 18 - Budget Full Scale Rocket and Payload

Shipping and Handling:	
Vendor	$
Always Ready Rocketry (BlueTube, rings, nosecone) -	30
Perfectflite (altimeters) -	6
Eggtimer (altimeters) -	6
Railbuttons.com (railbuttons) -	3
Fruity Chutes (parachutes)-	10
McMaster (various hardware) -	8
Hobbyking (batteries) -	8
Ebay – Peltier/waterpump -	3
MissileWorks – ScrewSwitch -	6
Unicorn Stainless – Hardware -	30
Total	**110**

Table 19 Budget Shipping and Handling Costs

Fundraising

The Saint Monica Rocketry Club (Rocket Club) has a variety of ideas to raise money for this program. The projected income and expenses are reflected in the budget within this document.

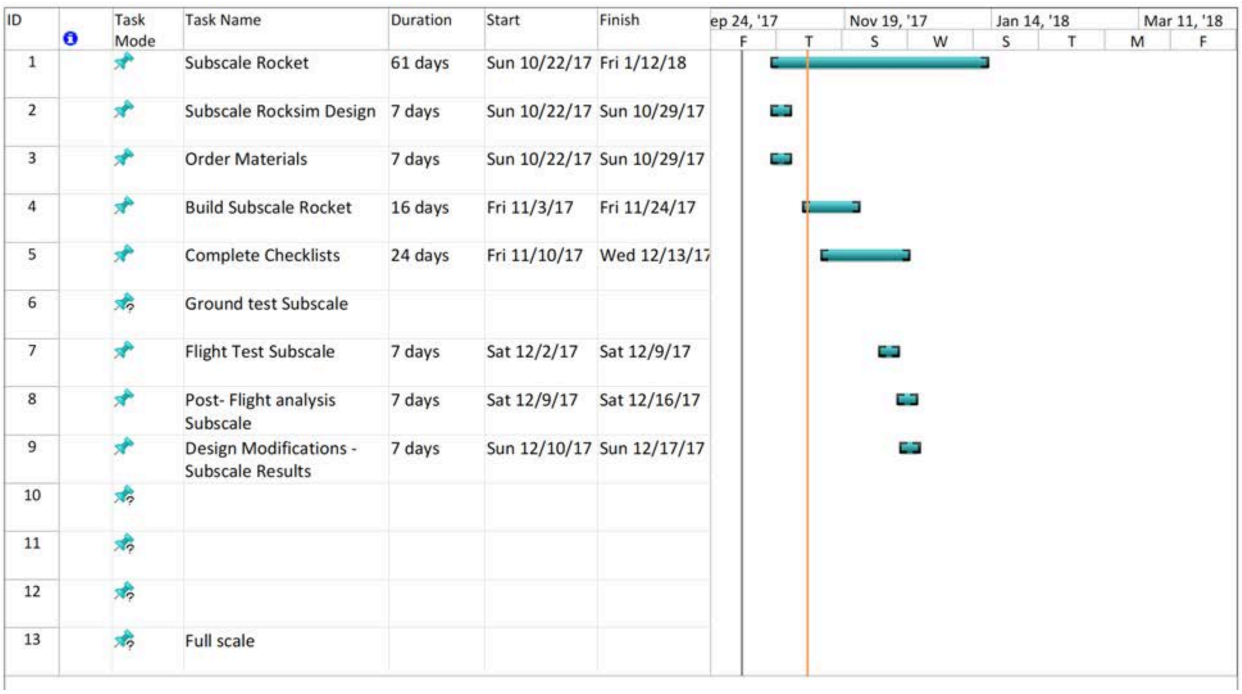
1. We will offer raffle off a $100 American Express Gift Card. The tickets will be able to purchase for $10 each. We will go to our neighbors, tell them about our Rocket Club and ask them to buy tickets. The expense is $100 for the cost of the American Express Gift Card. We will sell a minimum of 75 tickets. The net income will be $650.
2. Prime Taco a new restaurant in Ridgefield, CT has offered the Rocket Club their Soft Opening. A Soft Opening is when a new restaurant tries out their menu and staff on a limited number of customers. Prime Taco will donate 10% of their sales to the Rocket Club. Additionally, Prime Burger, their other restaurant in Ridgefield will offer an additional day of sales from their restaurant of 10% sales. Anything less than $2,000 will be given by the owners. Therefore, we are guaranteed $2,000.
3. The Rocket Club has a Go Fund Me page at https://www.gofundme.com/stmonicarocketry. All team members, friends and family will post this Go Fund Me page on all their social media and regularly ask for money for this. We anticipate an income of $1,000; however, Go Fund Me takes a 25% commission, so our net will be $750.
4. We will ask 5 benefactors to give the Rocket Club $500 each. There's no expense with this, so our income would be $2,500.
5. Ridgefield, CT businesses will be asked to contribute money to the Rocket Club by asking door-to-door. We will ask for Gift Cards and raffle them off, and we will ask for cash. This income is projected to be $1,000.
6. NY and CT Space Grant require grant applications. The NY Space Grant has been completed, and we have received the maximum grant allowed of $2,000. CT application is due on Dec 1. We anticipate $1,000 from CT Space Grant.

This funding plan is taking into account no expenditures from our 11 team members' families. Any deficit will be split evenly between all team members.

Description	Income	Expense	Net
$100 American Express card	$750.00	$100.00	$650.00
Soft Opening for Prime Taco	$2,000.00	$0.00	$2,000.00
Go Fund Me	$1,000.00	$250.00	$750.00
Hit up 5 benefactors ($500 each)	$2,500.00	0	$2,500.00
Ridgefield Sponsorship	$1,000.00	0	$1,000.00
NY and CT space grant	$3,000.00	0	$3,000.00
Total			$9,900.00

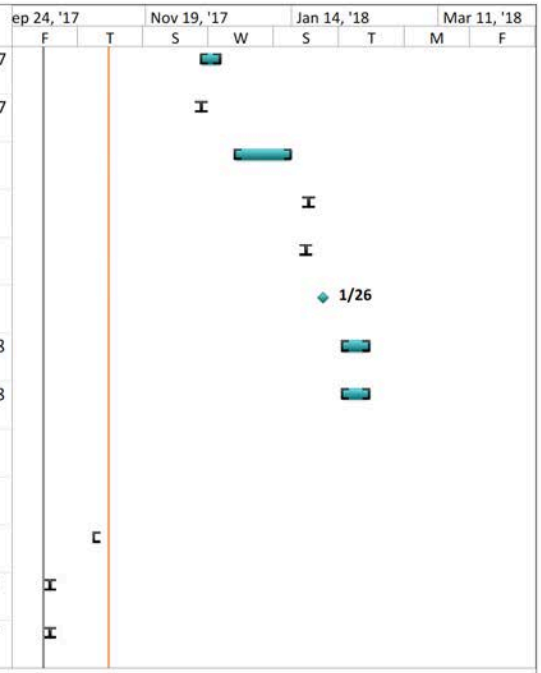
Table 20 - Fundraising

2. **Timeline –**

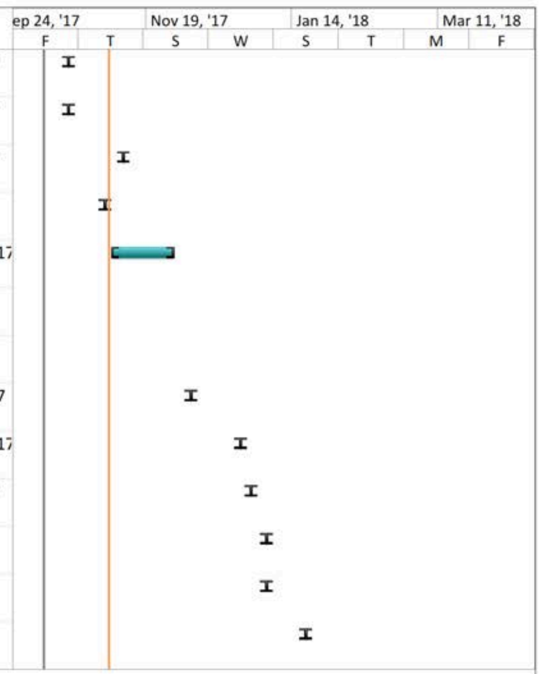


ID	Task Mode	Task Name	Duration	Start	Finish
1		Subscale Rocket	61 days	Sun 10/22/17	Fri 1/12/18
2		Subscale Rocksim Design	7 days	Sun 10/22/17	Sun 10/29/17
3		Order Materials	7 days	Sun 10/22/17	Sun 10/29/17
4		Build Subscale Rocket	16 days	Fri 11/3/17	Fri 11/24/17
5		Complete Checklists	24 days	Fri 11/10/17	Wed 12/13/17
6		Ground test Subscale			
7		Flight Test Subscale	7 days	Sat 12/2/17	Sat 12/9/17
8		Post- Flight analysis Subscale	7 days	Sat 12/9/17	Sat 12/16/17
9		Design Modifications - Subscale Results	7 days	Sun 12/10/17	Sun 12/17/17
10					
11					
12					
13		Full scale			

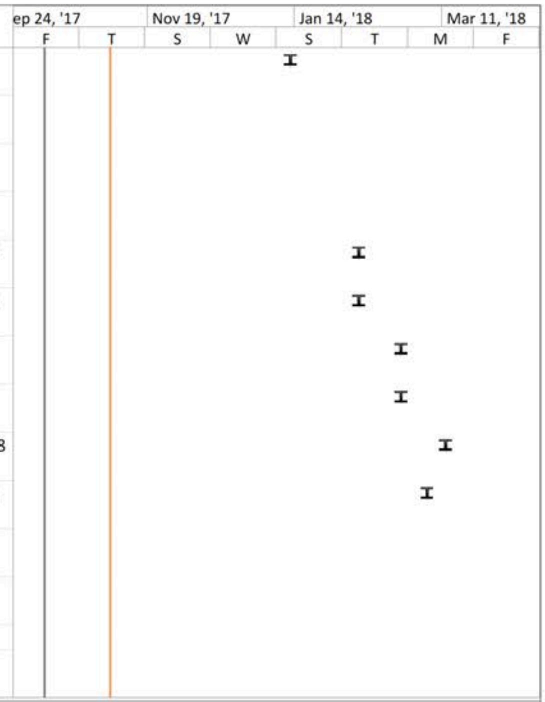
ID		Task Mode	Task Name	Duration	Start	Finish
14			fullscale Rocksim Design	7 days	Sun 12/10/17	Sun 12/17/17
15			Order Materials	1 day	Sun 12/10/17	Sun 12/10/17
16			Build fullscale Rocket	17 days	Sat 12/23/17	Sat 1/13/18
17			Complete Checklists	1 day	Sat 1/20/18	Sat 1/20/18
18			Ground test Subscale	1 day	Fri 1/19/18	Fri 1/19/18
19			Flight Test fullscale	0 days	Fri 1/26/18	Fri 1/26/18
20			Post- Flight analysis fullscale	7 days	Fri 2/2/18	Mon 2/12/18
21			Design Modifications - fullscale Results	7 days	Fri 2/2/18	Mon 2/12/18
22						
23			PDR			
24			Web Site URL sent to project office		Mon 10/30/17	
25			report draft 1	1 day	Fri 10/13/17	Fri 10/13/17
26			slides draft 1	1 day	Fri 10/13/17	Fri 10/13/17



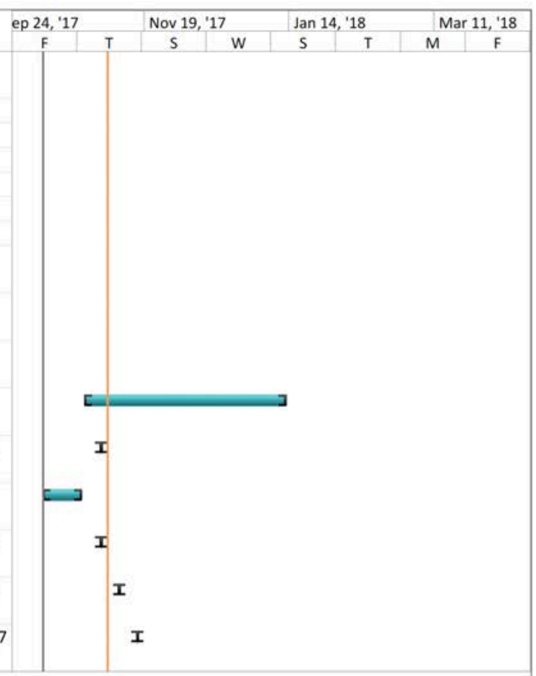
ID		Task Mode	Task Name	Duration	Start	Finish
27			report draft 2	1 day	Fri 10/20/17	Fri 10/20/17
28			slides draft 2	1 day	Fri 10/20/17	Fri 10/20/17
29			presentation dry run	1 day	Fri 11/10/17	Fri 11/10/17
30			reports, presentation and flysheet to web	1 day	Fri 11/3/17	Fri 11/3/17
31			video teleconference	18 days	Mon 11/6/17	Wed 11/29/17
32						
33			CDR			
34			Q&A	1 day	Wed 12/6/17	Wed 12/6/17
35			report draft 1	1 day	Mon 12/25/17	Mon 12/25/17
36			slides draft 1	1 day	Fri 12/29/17	Fri 12/29/17
37			report draft 2	1 day	Thu 1/4/18	Thu 1/4/18
38			slides draft 2	1 day	Thu 1/4/18	Thu 1/4/18
39			presentation dry run	1 day	Fri 1/19/18	Fri 1/19/18



ID	Task Mode	Task Name	Duration	Start	Finish
40		reports, presentation and flysheet to web	1 day	Fri 1/12/18	Fri 1/12/18
41		video teleconference		TBD	
42					
43		FRR			
44		report draft 1	1 day	Wed 2/7/18	Wed 2/7/18
45		slides draft 1	1 day	Wed 2/7/18	Wed 2/7/18
46		report draft 2	1 day	Fri 2/23/18	Fri 2/23/18
47		slides draft 2	1 day	Fri 2/23/18	Fri 2/23/18
48		presentation dry run	1 day	Mon 3/12/18	Mon 3/12/18
49		reports, presentation and flysheet to web	1 day	Mon 3/5/18	Mon 3/5/18
50		video teleconference		TBD	
51					
52					
53					



ID	Task Mode	Task Name	Duration	Start	Finish
54					
55					
56					
57					
58					
59					
60					
61					
62					
63		Payload			
64		Finalize design for payload	56 days	Fri 10/27/17	Fri 1/12/18
65		Determine payload success criteria	1 day	Thu 11/2/17	Thu 11/2/17
66		Determine design alternatives	11 days	Wed 10/11/17	Wed 10/25/17
67		Conclude on leading design	1 day	Thu 11/2/17	Thu 11/2/17
68		order parts for payload prototype	1 day	Thu 11/9/17	Thu 11/9/17
69		Build payload prototype	1 day	Thu 11/16/17	Thu 11/16/17



ID	Task Mode	Task Name	Duration	Start	Finish
70		Test payload prototype for temperature	20 days	Thu 11/23/17	Wed 12/20/17
71		Determine maximum impact speed of payload	6 days	Fri 12/8/17	Fri 12/15/17
72		Determine arduino components and functionality	1 day	Fri 11/10/17	Fri 11/10/17
73		Program arduino to control temperature	16 days	Fri 11/17/17	Fri 12/8/17
74		Integrate arduino with hardware	6 days	Fri 12/8/17	Fri 12/15/17
75		Determine and Adjust Design final adjustments	1 day	Fri 12/22/17	Fri 12/22/17
76		Build payload	6 days	Fri 12/22/17	Fri 12/29/17
77		Document payload funcionality, design and alternatives	1 day	Fri 1/5/18	Fri 1/5/18
78		build habitat	1 day	Sat 12/22/18	Sat 12/22/18
79		buy shrimp	1 day	Fri 11/3/17	Fri 11/3/17
80					
81					

ID	Task Mode	Task Name	Duration	Start	Finish
82					
83		Educational Outreach			
84		St Marys school in Ridgefield CT	8 days	Wed 11/1/17	Fri 11/10/17
85					
86		Community Outreach			
87		Ridgefield CT fall walk			
88					
89		Fundraising			
90		PRIME			
91		NY Space grant			
92		CT Space grant			
93		Homeschool group donations			

Table 21 – Timeline

C. Educational Engagement

This year for the educational outreach program, we expect to have a total of 300 people at
our programs. Our program will have the following elements:

1. Rockets will be on hand so children can pack and unpack the rocket.
2. We will discuss basic model rocketry.
3. We will have hands on STEM projects for the children to participate.

We have had a few inquiries about schools that can host the Rocket Club. Our choices are:

1. Saint Mary school in Ridgefield, CT. There are 142 students K-8 for this school. We do not have a specific date, but it has been approved.
2. Regina Caeli in Wilton, CT. They are a K-12 school and have 80 students.
3. Padre Poi in Ridgefield, CT. They are K-12 and have 40 students.
4. Mt Kiso Elementary School in Mt Kiso, NY. They are K-5 school and has 500 students. The administration is interested, but has not given us a date.

D. Community Outreach

Our team has been together for several years, from participating in T.A.R.C. for five years now
to currently participating in the 2018 NASA Student Launch.

On October 26, 2017, the team set up a booth at the Halloween Walk in Ridgefield, CT where more than 4,000 children ages pre-school to high school participate in the walk. The booth was constantly active, and the children enjoyed the hands-on science experiments. Over 500 flyers were handed out explaining the science experiments that also had our web site and Go Fund me page listed.

Additionally, the local high school, Ridgefield High School has inquired about TARC, and we have agreed if they are interested to help set up a program at their location.

We have a web site, Facebook page, Instagram, Twitter and Go Fund Me pages that all tell about the NASA Student Launch Initiative.

VII. Appendix

A. Table of Figures

B. Table of Tables