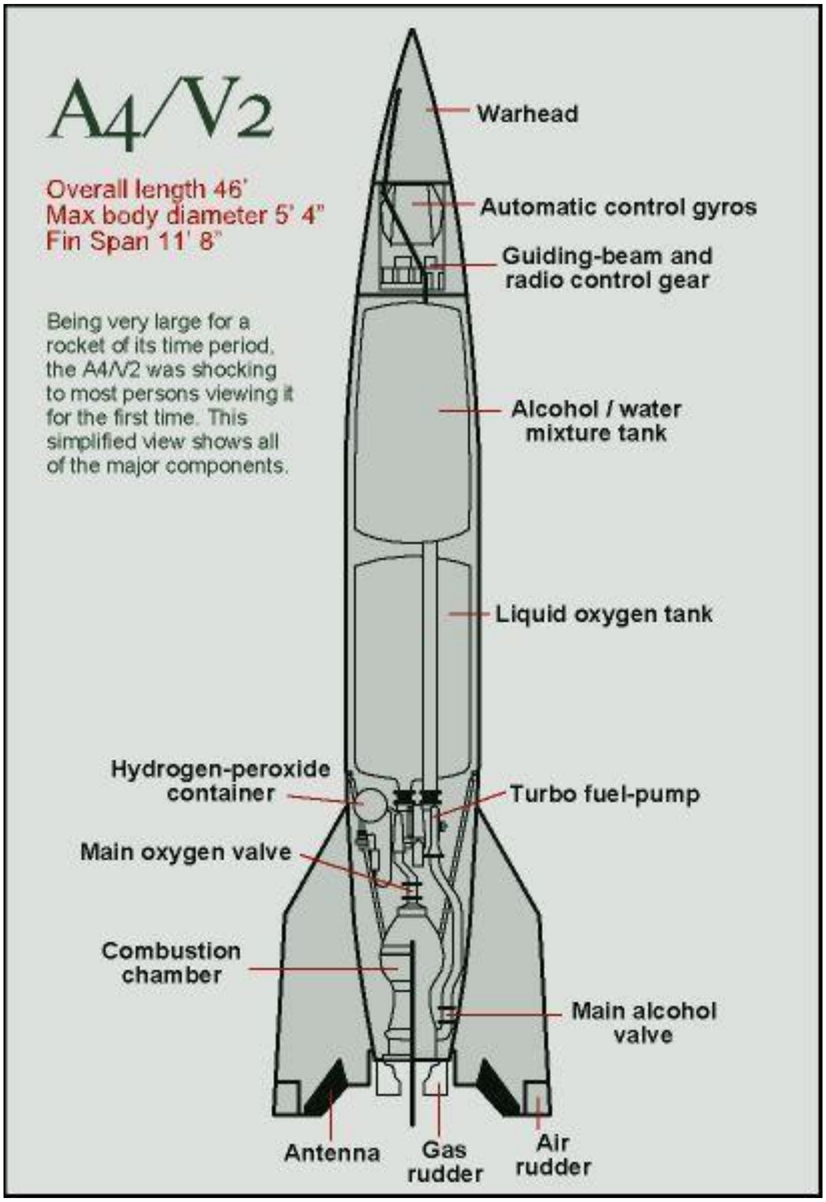
Spring Grove Area School District

Biology Team SLI Rocketry 2015-16 Proposal



Team Darwin

General Information

1. School Information

Name: *Spring Grove Area High School*
Mailing Address: Spring Grove Area High School
1490 Roth's Church Road
Spring Grove, PA 17362
Name of Team:

2. Adult Educators:

- Rosemary Cugliari
  Spring Grove Area High School Principal
  Phone number: (717) 225-4731 ext. 7060
  Email: Cugliarr@sgasd.org

- Brian Hastings
  Physics teacher, Rocket Scientist Club Coach
  Phone number: (717) 225-4731 ext. 7220
  Email: Hastingsb@sgasd.org

- Renee Bosak
  Biology teacher, Rocket Scientist Club Coach
  Phone number: (717) 225-4731 ext. 7242
  Email: EatonR@sgasd.org

3. Safety Officer:

- Brian Hastings
  Level two NAR Representative
  Phone number: (717) 225-4731 ext. 7220
  NAR 96571 SR

4. We are not part of a USLI team, we are a SL team.

5. Key Managers:

- Brian Hastings - Advisor and NAR representatives of students
- Renee Eaton - Advisor and Supervisor of students
- Mr. Sengia - Instructional Technology Specialist
- Josh Staley - Co-Captain and Student Safety Officer
- Adam - Co-Captain (Rocket Design Leader)

6. For Launch Assistance, Mentoring, and Reviewing our team will be working with the local NRA representatives along with MDRA (Maryland-Delaware Rocketry Association) for all questions and launches

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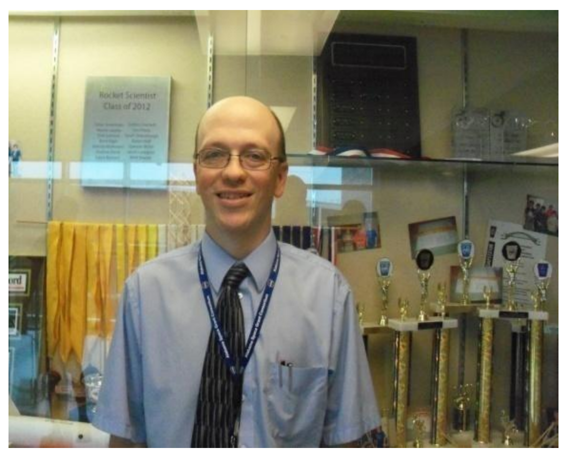
Team Members

Mrs. Bosak: Biology Teacher and Assistant Coach

I have been a Biology teacher at Spring Grove High School since 2009. Since then, I have coached the Marching Band and Junior High Track and Field and have advised the Gay-Straight Alliance, Science Fair participants, the Envirothon team, and the SLI team. In addition, I have been a member of the York Jaycees, a local community service organization, since 2009. I finished my Master's degree in Classroom Technology in 2013. In my spare time, I enjoy spending time with my friends and family, hiking, biking, reading, and training for 5K races and half-marathons. I am a NAR member and have a level 2 certification.

Brian Hastings: Instructor and Head Coach

I have been a teacher at Spring Grove for 19 years, teaching Physics 1, Physics 1 Honors, and AP Physics 1 and 2. I have an Honors B.A. in secondary education Physics, a masters in science education and 60 graduate credits past my Master's Degree. I have taught graduate courses to teachers and for the past 15 years have taught fast -paced high school physics for Johns Hopkins University's Center for talented youth program. As a Rocket Scientists' coach, I have started a Science Olympiad team, a Vex Robotics Team, Physics Olympics Team, and a Team America Rocketry Challenge Team. The Science Olympiad team has advanced to the state level each of the last ten years. We have been participating in TARC for 9 years and have advanced to Nationals each of the past 6 years, placing fourth overall at Nationals in 2012, and eighth at the Nationals in 2013. I am a NAR member and have a level 1 certification. Currently I am building a rocket for level 2 NAR certification.



Adam Cavanaugh 17 Senior: Co-Captain and Rocket Design Leader

Ever since my sophomore year, after my first physics class, I have been more interested in sciences than any other subject. I became a “rocket scientist” last year, my junior year, when I really got involved in our rocketry teams and our science Olympiad team at Spring Grove. My sophomore year intrigued by the rocketry teams at our school but didn’t join. My junior year our TARC team placed 8th in the national competition. I also helped with the Spring Grove SL team, but was not a member. It was a learning experience last year and this year is my chance to apply it all. Outside of school I am an involved youth member at my church and I am a boy scout. I also enjoy golfing and being out in nature. This year I am very much looking forward to being a member of the SL team and the other opportunities that come with this large task.

Josh Staley 18 Senior: Co-Captain and Student Safety Officer

I became interested in science when I joined the Envirothon team in 7th grade. I began taking part in Science Olympiad the following year and have made it to the State competition each year since joining the team. I started learning about rockets in my freshmen year when I took part in Team America Rocket Challenge. I have now had 2.5 years of experience in high powered rocketry and have been an NAR member for 1 year now. I am also a member of the Maryland Rocketry Association and am level 1 certified. I look forward to working with NASA and hope to have a successful year in the SL program.

Carson Buffalow 16 Sophomore: Electronics Bay

When I was in middle school, I was introduced to science Olympiad. I took great interest in this and enjoyed the science field as a whole. Now as a sophomore, I have found SL. I enjoy rockets and working as part of a team so I figured I would enjoy being a part of the Spring Grove team. I like to do graphic design and play lacrosse and am very creative and like to design things so I thought this would be the club for me. I am hoping to use this as an outlet to help me pursue my possible career in engineering and have a lot of fun doing it.

Hannah Sheffer 17 Senior: Budget and Funding Plan

As a student I have always been interested in Math and Science for as long as I can remember. I like being able to solve no matter the difficulty. Being my first year in SLI, I think it will be a new and exciting challenge for me. In addition to SLI I am a member of National Honor Society, a player on Spring Grove's Varsity Field Hockey Team, and President of German National Honor Society. Being a part of SLI will help me to gain more experience in the Math and Science field. I am looking forward to being a member of SLI. After high school I plan to go to college to further my career in Math and Science.

Tre Colbert 15 Sophomore: Chief of Introduction and Table of Contents and Interfaces and Integration

I have always found interest in engineering throughout my time at Spring Grove. It wasn't until the end of last year when I found SL. After speaking with my history teacher about potential engineering fields and colleges to go to she mentioned getting involved in SL to find out if I would have interest in aviation. I see SL as a great opportunity to learn about my own interests and to enhance my knowledge in the engineering field. I also see SL as a great resume builder for college. I have very much enjoyed the short amount of time I have spent in the program and hopefully I will learn a lot this year both from my instructors and returning team members so that I can better support the team in the years to come.

Sarah Staley 15 Freshman: Educational Engagement

I was in the TARC program last year and am excited to be a part of the 2015-2016 SL team. Over the last couple of years I have been to many SL launches for my siblings and I am thrilled to have the chance to be a part of the program this year. I am the vice president of my class and a member of the competition cheerleading squad, orchestra and the German American Partnership Program. I like being around people and working in groups to accomplish our goals. I hope to learn from my teammates and have a great year with the SL team.

Emily Edsall 15 Sophomore

The reason I joined Student Launch was because of my one friend. He talked me into joining with him. This will be my first year in this club as a sophomore. I hope it will be helpful and interesting. Other extracurricular activities that I am a part of our book club, piano, and I'm the treasurer of our school's language club.

Summary of CDR Report

Team Summary

Team Name: Team Darwin

Mailing Address: Spring Grove Area High School

1490 Roth's Church Road

Spring Grove, PA 17362

Mentor: Brian Hastings

Level two NAR Representative

Phone number: (717) 225-4731 ext. 7220

NAR 96571 SR

Launch Vehicle Summary

Size and Mass: 84 in Length 3 oz Mass

Motor: Cesaroni K1200 White Thunder

Recovery: 2 Parachutes

Drogue Chute- 24in Diameter by Fruity Chutes

Released at apogee from back half of rocket

Main Chute-72in Diameter by Fruity Chutes

Released at 700ft from nose cone and slows rocket to 17.6 ft/s

Rail Size ad Length: 10-10 Rail, 8 foot long

Payload Summary

Planaria Altitude Experiment

-The payload will test the effects that a rocket launch has on the growth of a planarian. The planaria have the capability to regrow if they are cut. The experiment will begin with planarian being cut in half. A control group of planarian will be kept separate from the rocket and will. The experimental group of planaria will be inserted into the nose cone. This group will each be placed into small tubes which will be held in place with foam that will have 4 holes drilled into it to keep the test tubes in place. After the flight the planarian in the experimental group will be compared to their control group counterparts in order to see what effects the flight had on them.

Changes from the PDR to the CDR

Interphases and Integration

The length of the body tubes will be changed from 82 inches and made longer to 87.5 inches to accommodate everything needed to fit inside of the rocket. The mass of the rocket will decrease from 336 ounces to an approximate 280 ounces.

Vehicle Criteria

The key switches that were once on the either side of the rocket will now be located on the same side. The back half of the body tube will now be shorter than its original 36 inches, will be down sized to 28 inches. The front body tube, being longer, will grow from 27.75 inches to 37.75 inches. Between the front and back body tubes there will be a two inch spacer. The nose cone, instead of being plastic, will be all fiberglass with an aluminum metal tip, ordered from Animal Motor Works. There will also be an added accelerometer to the electronics bay. Our motor will be changed as well. Eliminating the bulkhead on the end of our motor casing, with possibility of it breaking, we will be using a metal device that sits in front of the casing and holds the I-bolt and the shock cord. Our motor itself will also be changing from a K1440 white thunder to a five grain K1200.

Ejection Charges

The decent rate of our rocket will be slower due to a lighter rocket. The decent will slow from 17.6 feet per second to about 16 to 16.5 feet per second.

Payload Design

Our original one piece of all-thread will be upped to three pieces. Along with the increased all-thread we will be upping our nuts from four to five.

Project Plan and Budget

We have added fundraisers in order to increase our budget these fundraisers include, but are not limited to: the GoFundMe program where people can donate to our cause, the Rutters Rewards program, and a paint night at our school where members of our community are able to paint a scene of the season. Along with the fundraising we have applied for grants to all those willing to look over our application to receive money from local businesses. We have also received all our dates for local launches and will be following a schedule to attend most, if not all, of them. Our GANTT chart will be changing accordingly to our new activities.

Vehicle Criteria

Selection, Design, and Verification of Launch Vehicle

Section 1

Our mission is to efficiently design, build, and launch a rocket able to reach a height of 5,280 feet while improving as a team and helping to build each embers individual skills and talents as well as spread and share our experience with others.

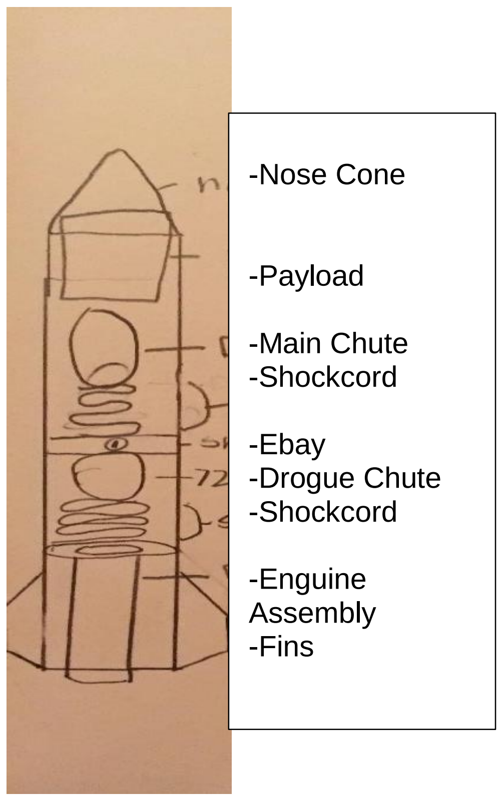
The rocket we plan on launching is designed to reach an altitude of around one mile, but should not exceed this height. The rocket has three independent systems. One system being the redundant recovery system. This system will be able to be set up within two hours of the Federal Aviation Administration flight waivers open, and an additional hour on the launch pad without any of its electrical parts losing their capabilities to operate. The Launch vehicle will be capable of launch from an eight foot one inch rail, or an eight foot 1.5 inch rail. The rocket can withstand a launch from a 12 volt DC firing system, which will be supplied by the Range Services Provider. It will not require any external circuitry or specialized equipment from the ground to initiate the launch, other than what will be provided by the range. The rocket will use an ammonium perchlorate composite propellant that is commercially available and has been approved by the National Association of Rocketry. The motor and rocket combination that we will be using will not exceed an impulse of 2,560 Newtons-seconds. The rocket to be flown in Huntsville will not have a ballast higher than 10% of the rockets mass without the ballast. A full scale of our rocket will be launched prior to the Flight Readiness Review in its final configuration. The full scale rocket will be close to the same design that was made prior to the launch, and will be reviewed by our safety officer. This flight should include our full scientific payload, but if not, mass simulators will be placed approximately at the same location the payload will be placed. Either a full scale motor or a motor that will create the same simulation as the full scale motor will be used to predict the acceleration and velocity of the full scale motor. The vehicle at this launch will also be in its completely-ballasted arrangements as that of what will be flown down in Huntsville. This flight’s success will also be documented by a Level 2 or a Level 3 flight observer and will be recorded in the Flight Readiness Review. The components of the full scale flight will not be modified unless requested to do so by the NASA Range Safety Officer. Lastly, the rocket will not use forward canards, forward firing motors, motors that eject titanium sponges, hybrid motors, or a cluster of motors or multiple stages.

There are several standards that our rocket will need to reach to be considered if our mission is to be successful. To be considered a success the rocket will need to reach an altitude of at least 4,500 feet and no higher than 5,280 feet, since the team recognizes that there will still be uncontrollable sources of error involved with this project. The mission would also be considered a success if it reaches maximum acceleration so that the planarian undergo the largest force possible for a good test. The rocket will have to be able to maintain a straight, stable path and be recoverable within a 2,500 foot radius from its launch position to be successful. The mission will be a great success if the payload collects usable data and the rocket is conducted safely without catastrophic failures.

Major Milestone Schedule

We completed our final design and had it looked over and verified by December 16th of the previous year. We had a successful subscale launch which showed no inherent flaws in the design and provided relevant information. We started ordering parts by the middle of November and finished ordering parts by the first week in January. Since then we have completed construction of the back half of the rocket including the motor assembly, we have one working functional ebay, and are 80 percent complete with the payload and other parts. We intend to launch January 16 which we hope is our first successful full scale launch.

Final Design



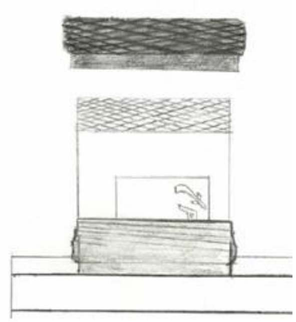
All systems on the rocket are designed that they will work together with each other in a safe and efficient manner as to gather data from the payload and record a safe and stable flight. The total length of the rocket is to be 84 inches in length made from fiberglass tubing with a total diameter of 4.02 inches. The rocket is planned on weighing in at around 317 ounces when complete. With a center of pressure inches from the front of the rocket and a center of gravity 54 inches from the front, the rocket is planned to have a static stability margin of 1.51, making it stable for flight. That is a difference of 6 inches between the center of pressure and the center of gravity, more than one and a half body tube diameters in length.

Systems

Motor and Motor Retention

The motor that is planned on being used is a K-1200 White Lightning Motor made by Cesaroni Technologies Incorporated. The motor has 2,011 Newton Seconds of Impulse that make up the rocket motor and is made from an ammonium perchlorate make-up.
Chart

The propulsion system is comprised of a 2.952" G10 FR4 fiberglass tube acting as a motor mount tube. The motor mount tube is centered within the 3.9" inner diameter of the rocket body tube with two ½ inch thick plywood centering rings. The back end of the centering ring is placed a 1/2 inch in from the base of the rocket body. This allows for more epoxy to secure the motor mount in position. There is half of a threaded motor retainer attached with epoxy to the motor mount tube. The motor retainer is made from aircraft-grade aluminum. One half of the motor retainer is attached to the motor mount, while the other half screws over the top of the motor retainer. The motor retainer will not interfere with the expulsions from the motor, and will secure the motor into the motor mount of the rocket for the duration of the flight.

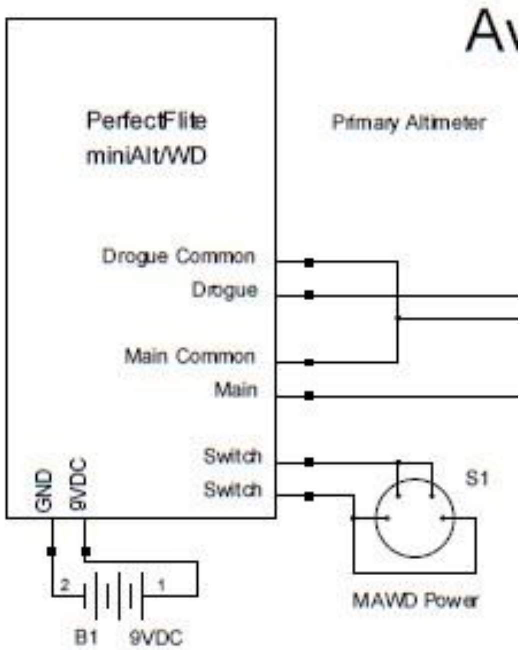


Recovery System

The recovery system is a crucial part of the missions success as it will save the rocket and all of its components from harm. With the recovery system there is a 72 inch main parachute along with a 24 inch main parachute that will allow the rocket to safely reach the ground. Connecting the parachutes to the other parts of the rocket will be tubular nylon shock cord. The shock cord will be hooked around a 1.5 inch quicklink that will then connect to a 1 inch U-Bolt located on all the connection points within the rocket. The main parachute will be attached with shock cord to a bulkhead at the end of the payload. and then connected to one side of the electronics bay. The other side of the electronics bay will have another u-bolt with a connection to the drogue parachute. The drogue parachute will then be attached to the rocket to an eyebolt at the top of the motor casing. These strong connections of quicklinks to U-bolts will allow for solid connection points that will not pull out or break away from the body tube.

Another vital part of the recovery system is the electronics bay which will house two altimeters which will be wired in series along with batteries. Each switch will be wired to have wires going from both the drogue and main parachutes ports to the outside of the bulkhead on the end of the electronics bay through a small hole in the bulkhead. These wires will be attached to a terminal strip so that e-matches put in by our mentor can occur easily and run directly to the ejection well with little to no problem. The power supply from the battery will come from a 9 Volt battery in a battery terminal so that the wires can be sauntered to the terminal strip and ran directly to the altimeter. Both key switches, one for the main altimeter and one for the redundant will run with wires from the switch port to the key switch. These connections will occur for both altimeters and allow for a strong and reliable connection.

On the outside of the electronics bay tube will be four ejection charge wells that allow the black powder to be placed into and then fire when the altimeter is programmed to. The main altimeter will fire a drogue parachute ejection charge at apogee with the redundant firing two seconds later. The main parachute charge will occur at 700 feet and the redundant will occur at 550 feet. Also on the outside of the tube will run the all thread and wing nuts that will securely hold the electronics bay together and also act as supports for the sled that will hold the altimeters and batteries inside the rocket.



Rocket Airframe Subsystem

The rocket airframe design is comprised of a nose cone, 2 pieces of body tubing, and fins. The plastic nose cone is conical in shape, and is smoothed to reduce drag. The body tube is made of G10 FR4 fiberglass tube. The fiberglass will be sanded by the manufacture, Public Missiles Limited, and then will be painted by our team members. The fins will be cut from G10 FR4 fiberglass sheets. Fiber glass provides the extra strength that is needed during the high velocities that the rocket will undergo and will remain intact after impacts with the ground. The fiberglass is also fire retardant and will ensure that the exhaust from the rocket motor does not melt the fins. This fiberglass is also very smooth, causing very little drag.

Analysis for Rocket results

Last month we launched our subscale rocket test in Maryland at a MDRA launch. This launch showed a nice stable trajectory with both parachutes deploying at their preset altitudes of apogee around 1970 ft and 700 ft for the main. From the data gathered while launching we were shown that all internal components of the rocket functioned and all parts worked. This means that the altimeter was built using the correct wiring methods and our amounts of black powder are correct. The rocket that was flown with a stability margin of 2.51, which is higher than the full-scale rocket at 1.51. We can add mass if needed to the full scale. This is accounted for because of modifications to the design and the actual weight of the back half being higher that anticipated. Since we have a hollow cavity in the nosecone we can place mass there thus allowing more weight to be towards the front of the rocket and increasing the stability margin. The rockets predicted altitude on this motor was 2,100 feet.

Testing

Testing Requirement	Achievement Plan
Altimeter Testing	The altimeters and redundant electronics bay setup will be tested on a school Lenovo Laptop using a USB data transfer kit for the Perfectflite Altimeters. This data kit allows us not only to set up the altimeters settings such as the main deployment height, but also test ejection charges with igniters to make sure that the wiring is functioning properly. This testing will ensure that both altimeters will function in reading and also that the ejection charges will deploy and at the correct times. So everything has worked as planned however we can never be sure when or if the electronics will experience problems so we must continue to to test this
Black Powder Testing	At the launch coming up on January 16th, we will be testing our masses of black powder for both sides of the electronics bay by testing on a mock up full scale rocket that will be ground tested on two rocket stands. When the ejection charges go off we are looking for a clear separation of the two tubes and that they fall into the correct pieces without breaking or cracking.
Planaria	We will be conducting a series of ground test on the planaria before we move on to actively placing them in our ebay. These include testing their tolerance to cold and heat as well as to different conditions such as possibly humidity and light vs dark and any other stimuli that may get in the way of a successful experiment. We have not be able to get a hold of the planaria yet due to an administrative error thus we will complete these tests when they arrive.

General Strength Tests	Before we subject our rocket to launch we will be doing a series of strength tests on the various components. This includes testing integrity on the body tubes, payload, and ebay. It will also include testing to see if our fins fillets are solid and if any of the other connection points are lose. So far we have completed the majority of the rocket and it has passed any of the above tests

Final Motor Selection

Our final motor selection for the full-scale rocket will be the K-1200 white lightning motor made by Cesaroni Technologies Incorporated. This motor has an impulse of 2011 Newton*Seconds and has sufficient thrust to be able to get our rocket to apogee on its flight up. It is a 54 mm, 5 grain motor that is 18.5 inches long. This motor is reliable and is easy to access from our supplier: Animal Motor Works. For Back-up, we will have a K-1440 motor from Cesaroni also on hand in case something with the other motor is malfunctioning or we designate that another motor must be used.

Design Meets Designated Requirements

Requirement	Design Feature to Satisfy the Requirement	Verification of Requirement
1.1 The vehicle shall deliver the science or engineering payload to an apogee altitude of 5,280 feet above ground level.	The mass of the vehicle, the air resistance on the vehicle during flight, and the stability of the rocket were designed with the impulse of the selected motor to keep the launch vehicle at one mile above ground level under perfect launch conditions.	This requirement has already been verified on a rocket design program, but it will also be tested and verified during the full scale rocket launch to take place prior to the FRR.

1.2 The vehicle shall carry one commercially available, barometric altimeter for recording the official altitude used in scoring	The rocket will carry at least one barometric altimeter, a PerfectFliteStratoLogger altimeter, inside the electronics bay. The altimeter will give us an accurate reading of our official altitude.	This requirement has already been verified when we designed the electronics bay to house an altimeter for each end of the electronics bay. The 2 altimeters will give an accurate reading of our altitude.

1.3 The launch vehicle shall be designed to be recoverable and reusable.	The rocket has a recovery system designed to deploy a drogue chute at apogee and a larger chute at 600 feet that will provide the rocket with a ground-hit velocity of less than 20 ft/s, which should prevent any damage to the rocket.	The rocket recovery system has been verified to deliver the rocket safely to the ground by a rocket design program. This will also be verified during the tests with the scaled down model rocket. This shall accurately depict how the rocket will recover during a launch.
1.4 The launch vehicle shall have a maximum of four independent sections.	The rocket contains less than four independent sections as designed by a rocket design program. The shock cord shall be tested prior to the launch to determine how strong it is, and how much force it is able to withstand. All sections of the rocket not tethered with a shock cord will be secured by other means (such as epoxy).	The rocket design has been analyzed by a level 2-certified NAR representative, and will be inspected by a level 2-certified NAR representative after the rocket has been constructed in its final configuration to ensure that the rocket does not contain more than four independent sections.
1.5 The launch vehicle shall be limited to a single stage	The rocket contains only a single stage engine as designed in the rocket design program and designed in the teams personal designs.	The design of the rocket has been analyzed b a level 2certified NAR representative and shell be inspected by a level 2-certified NAR representative to be sure that the launch will be limited to a single stage.
1.6 The launch vehicle shall be capable of being	The rocket will be comprised of easy-	The design has been analyzed by a level 2 NAR

prepared for flight at the launch site within 2 hours, from the time the Federal Aviation Administration flight waiver opens.	assembly components, including body tubes that slide onto the electronics bay to hold them together, a recovery system that can be assembled and armed quickly, payload electronics that are preassembled in the nosecone, and a reloadable motor for quick construction.	representative to make sure that the rocket has a sound design that will require little assembly at the launch site. This will be tested during the scale test launch to make sure that all components can be prepared for launch within the 2 hour time restriction.

	The rocket will require little assembly at the time that flight waiver opens.	
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.	The recovery system is designed to contain switches that can arm the recovery system, and nine volt batteries are attached to ensure that the recovery system can operate properly for over one hour.	The recovery system will be tested to see if the electronics can last longer than 1 hour in the on position. If not, a back-up battery will be wired into the recovery system electronics.
1.8 The launch vehicle shall be capable of being launched by a standard 12 volt direct current firing system.	The rocket will use commercially available igniters which will be able to operate on a standard 12 volt DC current.	The igniters will be tested for their reliability when supplied with a 12 volt DC current from a standard firing system.
1.9 The launch vehicle shall require no external circuitry or special ground support equipment to initiate launch (other than what is provided by the range).	The launch vehicle will operate off of standard ignition systems, and will be self-containing all other components needed to initiate launch, including a motor.	The scale model rocket launch and full-scale rocket launch will be conducted using standard ignition and launch ground systems. The rocket design has been reviewed by a Level 2 NAR representative to confirm that the rocket design does not require specialized equipment on the ground or

		circuitry on the outside of the rocket airframe.
1.10 The launch vehicle shall use a commercially available solid motor propulsion system using ammonium perchlorate propellant which is approved and certified by the National Association of Rocketry, Tripoli Rocketry Association, and/or the Canadian Association ofRocketry	The motor being used will be a Cesaroni K1200 White Thunder, which is commercially available. This motor uses an ammonium perchlorate propellant.	The motor we are using has been tested and approved by the Canadian Association of Rocketry and the National Association of Rocketry.
1.11 Pressure vessels on the vehicle shall be approved by the RSO and shall meet the proper criteria.	The design of the rocket meets all of the requirements and criteria regarding to pressures and will be confirmed by the RSO before each launch to ensure that we are correct with the measurements.	The design of the rocket has been analyzed and inspected by a level 2-certified NAR representative to ensure that the specs are met that have been set by NASA to ensure that the rocket has a safe flight that is able to be scored.
1.12 The total impulse provided by a SLI launch vehicle shall not exceed 2,560 Newton-seconds.	The maximum total impulse capable of being produced by the Cesaroni K1200 White Thunder is 2368 newtonseconds	The impulse of the Cesaroni K1200 White Thunder has been tested by the NAR and CAR.
1.13 All teams shall Successfully launch and recover a subscale model of their rocket prior to CDR.	The team will successfully design, launch and recover subscale model of the rocket by the time of submitting the	The launch and recovery of the subscale model of the rocket was verified by our level 2-certified NAR

	CDR.	representative to ensure that it has been a successful design, launch, and recovery and to verify that the rocket function properly according to the design during our launch in December.
1.14 All teams shall successfully launch and recover their full scale rocket prior to FRR in its final flight configuration.	The full scale launch testing prior to launch at Huntsville will be responsible for fulfilling this requirement.	The successful launch and recovery will be verified and documented by an NAR Level 2 or 3 observer on the flight certification form and the FRR Package.
1.15.1 The vehicle shall not utilize forward canards.	N/A	The vehicle design will not include the usage of forward canards.
1.15.2 The vehicle shall not utilize forward firing motors.	N/A	The vehicle design will not include the usage of forward firing motors.
1.15.3 The vehicle shall not utilize motors which expel titanium sponges.	N/A	The vehicle design will not include the usage of motors which expel titanium sponges.
1.15.4 The vehicle shall not utilize hybrid motors.	N/A	The vehicle design will not include the usage of hybrid motors.
1.15.5 The vehicle shall not utilize a cluster of motors, either in a single stage or in multiple stages.	N/A	The vehicle design will not include the usage of a cluster of motors in a single or clusters in multiple stages.

The Team Mentor will be overseeing most of the rocket design and construction to ensure that the rocket is being built properly. At the same time, he will also be verifying the compliance of the rocket with the Statement of Work, along with the Team Advisors, Mr. Hastings and Mrs. Bosak. The rocket design has already been verified. When construction on the rocket begins, most of the other requirements will be verified. The rest of the requirements will be verified before traveling to Huntsville, Alabama. Requirements regarding the use of commercially available products and the materials used by the companies within these products have been verified. Also, the requirements of the vehicle ensuring the compatibility of the rocket with launch equipment supplied in Huntsville have already been verified.

Approach to Workmanship

In order for the team to be successful with the completion of this project, we must collaborate with each other and follow reasonable requests of supervisors/ advisors. Without this collaboration and cooperation, the project will not be completed. Hard working individuals are what the team seeks in order for the project to be completed correctly. Without these qualities within team members, the project will not be completed in an efficient and timely manner, leading to project failure. In order to ensure that good workmanship is being received from each member of the team towards the project, weekly meetings are held, where the team discusses progress on each section of the project which was delegated to them. If a team member is found to not be holding up to their part of the project, the team member will conference with team advisors and be asked to contribute more to the project or be relieved from the team. We all work hard to ensure that every component is made correctly and to the best of our ability. We take our time to ensure that things are correct and do not want anything to ever fall apart on the rocket.

Additional Component Testing

At this point, the team has completed the functional testing of the subscale rocket and therefore the rocket airframe. We have build the majority of our full scale rocket and we plan on testing the bulkheads within a section of the body tubing. This test should confirm that a bulkhead secured in the tube is strong enough to withstand ejection and descent. The proposed method of testing is attaching a bulkhead inside a small section of body tube. From there, a large mass would be placed inside of the body tube on top of bulkhead after the epoxy has finished drying. The body tube, bulkhead, and mass would then be dropped onto a force plate to measure the amount of force that is being stressed on the bulkhead. Larger heights and masses will be used until either the bulkhead breaks free of the inside of the rocket body tube, or the force exceeds an amount determined to be "reasonable," for its intended use inside the rocket.

Testing is being conducted on both the recovery system electronics and payload electronics. Once the recovery system E-Bay is assembled, the team will test it to see if the E-Bay can be correctly powered up with the key switches. This will be tested using a voltmeter to check to see if an electrical charge is sent to ejection charges once the altimeter is programmed to do so at an extremely low test altitude. Finally testing will be done on all parts to ensure that they are strong enough to withstand the pressure of flight.

Status and Plans of Additional Manufacturing and Assembly

So far we have completed an electronics bay that we know works though we have not done the full range of tests on it yet. We have two complete front body tubes and two complete back body tubes with the back body tubes both having all three through the wall fins in place and the motor mount complete. We have one payload that is nearly complete and will be finished on the 15th of January. We are currently having a members relative finish making modifications to the shock cords which will make them complete. We already have a motor casing and the two parachutes. They only need to place the recovery system together, finish the ebay, and put launch lugs and we will have one complete rocket. We intend to build another rocket as a back-up which we will need to cut more shockcord for, build another ebay, and complete the half finished payload we have and then we will have the back-up complete.

Integrity of Design

Fin Shape and Style

The fins have been shaped on RockSim to match the needs of the rocket based on stability and height achieved. The fin style was selected for the same reason. The trapezoid shape of the fins allow them to reduce drag and propel the rocket higher, while forcing the Center of Pressure to the back of the rocket and increasing stability.

Material Usage in Fins, Bulkheads, and Structural Elements

The material being used for the fins is one eighth inch thick G10 FR4 Fiberglass, which was selected for its durability under large amounts of stress. It is also fire retardant, so it will not be affected by the high-intensity of heat that the motor emits. It will be used in a manner that will prevent malfunction of the fin system on the rocket, as the fins will contain tabs, which allow for more points of attachment onto the motor mount tube. The rocket airframe meanwhile, shall perform based on the stability of the rocket and its ability to maintain rigidity, shape, and strength during flight. The rocket tube itself is made to withstand supersonic flights and is formed from fiberglass. Our body tubes should be able to withstand speeds of up to 1000 miles per hour and hitting the ground without a parachute.. Because our rocket will reach the threshold of speed at around 500 miles per hour, the rocket airframe should easily be able to sustain itself and maintain a straight flight on the end of the airframe, the fins should not break at any point and the fillets will not break so long they are done right and the rocket does not malfunction.

The bulkheads/endcaps will be made from 1/8 fiberglass, and will have two holes drilled through it to allow for a U-bolt to be attached through them. The bulkheads will be secured with allthread for the ebay and payload. This connection will be strong enough to keep the shock cord attached to the rocket and not detach away from the rocket.

The body tube is made from fiberglass tubing. The motor mount, with fins attached through the body tube will be secured to the back section of the body tube, with components placed in their correct locations. The front body tube will remain attached to the ebay and contain the main parachute.

Assembly procedures, attachments, and loading paths:

The electronics bay must be assembled in a specific way, in order to limit any interference with other components of it. The key switches on the outside ring of the E- Bay have a long section protruding into the center of the E-Bay. In order to eliminate interference with these key switches, two precautions must be taken. First, the key switches must not be placed 90 degrees from each other. Instead, pairs of key switches will be placed next to each other, with the center of both pairs at 30 degrees to each other. This will allow for the protruding part of the key switches to not interfere with the sled or altimeters which must come down into the E-Bay by sliding it down the two all thread rods.

The motor mount must be assembled in a very specific method. Before fins are attached to the rocket, the top centering ring must be attached at its correct location on the motor mount tube just above where the top of the fin tab will end up. Once this is complete, the motor mount tube and centering ring will be slid up into the bottom of the rocket into its correct position. The centering ring should end up just above the top of the fin slots. After this has been completed, this centering ring will be attached with more epoxy to the inside of the body tube at this location.

For the recovery system, shock cords will be attached to the U-bolts and eyebolts before being sewn in order to form a secure connection to the U-bolts.

In order to ensure correct attachments, epoxy will be applied to all cracks and crevices in component junctions to ensure that those components junctions will not fail. A final inspection of the rocket by our NAR Representative will yield whether or not all junctions are connected correctly with little room for failure.

When loading the rocket, after all parts have been manufactured and attached, there is a procedure that must be followed. The shock cord below the payload will be forced down into the bottom of the rocket, followed by the drogue parachute. The remaining shock cord will be placed on top of it followed by fire protection and wadding. After those components are in the bottom, and the ejection charge wells have been loaded, the recovery system E-Bay will be loaded into the bottom tube. The E-bay will then be secured with pop-rivets to front body tube, In the top half of the rocket fire protection and wadding will be placed first followed by the shockcord then the main chute which will be folded and inserted, and lastly the rest of the shock cord.

Sufficient Motor Mounting and Retention:

In order to ensure that the motor stays in during flight, there must be methods of preventing the motor from going up into the rocket, or coming out of the back end of the rocket. In order to stop the motor from going up into the rocket, a correctly sized motor mount tubing was chosen so that the lip of the motor will not pass a certain point. The motor mount tubing will be secured to centering rings, which will have epoxy on both sides where the motor mount has a junction with the centering rings. The fin tabs also interfere with the free movement of the centering rings and motor mount tube. This prevents the motor mount from moving up or down within the rocket. The aft centering ring is displaced 3/4 inch in from the back end of the rocket in order to allow for more epoxy to be placed in here. This will reinforce that centering ring, decreasing the chances of motor mount failure by even more. To prevent the motor from coming out the other direction, a 54 mm motor retainer will be used. This motor retainer comes in two parts. One part contains male threads and is attached with epoxy to the end of the motor mount tube, with the threads facing away from the rocket. This will allow for the other part of the motor retainer to be screwed down over top of this part, once the motor has been inserted.

Status of Verification

We will be using G-10 fiberglass for the fins of the full scale rocket. We have used 1/8” fiberglass in the past for even larger rockets, and have had no issues whatsoever with this material. G-10 fiberglass can maintain mechanical and physical properties up to 130 degrees Celsius, and it is a non-flame retardant. Eighth inch G-10 fiberglass has a tensile strength of about 40,000 pounds per square inch, a much higher value than we expect to reach during a launch.

Every component of the rocket will be attached to a shock cord. U-bolts and Quick Links will be used to ensure that every component is secured to the shock cord. With this method, none of the shock cord will be attached to the components using epoxy or any other adhesive, but with bolts, ensuring that none of the components will break during the launch and ejection of the payload and main parachute.

We will make sure to attach the launch lugs so that they do not interfere with the fins.We will use two 1010 launch lugs, and both will be attached to the back and front half of the rocket. The back half will be 28 inches long and the front half is 36 inches long so the lugs will be spaced far apart enough that they are not ripped off the rocket during launch.

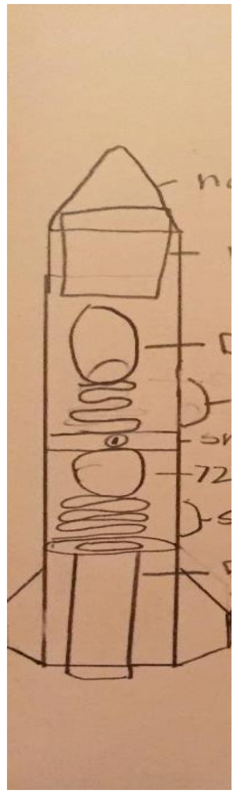
Shear pins will be attached to both the back half and the payload through the body tube, payload and electronics bay. These are used to prevent premature ejection during the launch and the ejection of the payload. We will use about five or six shear pins in both half, enough to hold the components together while allowing for the ejection to be accomplished easily.

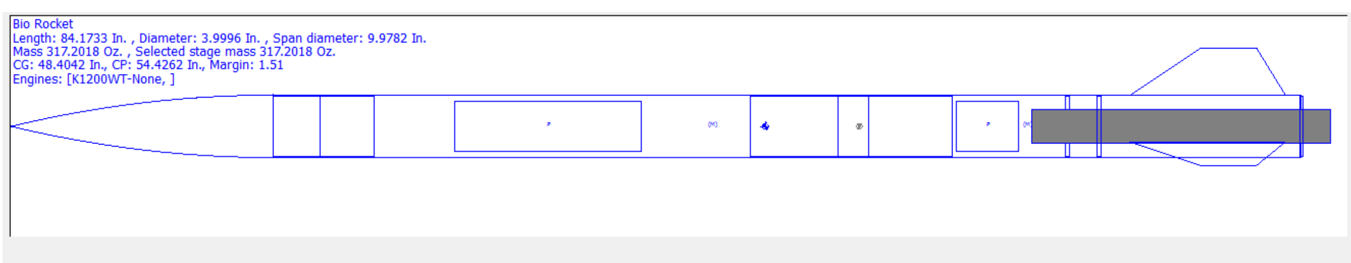
The front half and back half each only contain one parachute, so we expect no problems with the ejection of the either.

The motor mount system will be comprised of a 3.002” diameter body tube, attached to the interior of the body tube with three 1/2” centering rings. The back end of the motor mount tube will extrude about half an inch from the base of the body tube. A threaded motor retainer will be attached to the back centering ring, and the motor retainer will be screwed over the top of the motor. This motor retention system will not interfere with the burning of the motor, and the entire system will ensure that the motor remains centered and stationary throughout the launch process.

Our team has traveled to Maryland to launch the subscale rocket. The flight went well and provided useful data. We are in the process of building the full scale to launch on January 16.

Drawings





Mass Statement

Parts	**Mass (oz.)**
Total System Mass	**280**
Nose Cone	12.0

Bulkhead for Top Half	6.0
Top Body Tube	44.0
Main Parachute	18.0
E-Bay and Components (bulkheads, batteries, altimeters, etc.)	42.0
Bottom Body Tube	32.0
Inside Bulkhead for Payload	6.0
Outside Bulkhead for Payload	6.0
Other materials for payload (all thread, tubes, water, etc.)	32.0
24 inch Drogue Parachute	12.0
Bulkhead for Bottom Half	6.0
Motor Mount Tube	24.0
Lower Centering Ring	4.0
Middle Centering Ring	4.0
Upper Centering Ring	4.0
Fins	28.0
Total Shock Cord and U-Bolts	30.0
Mass With Motor	**317**
Motor Mass	66.76

The total mass is 317gathered using values posted on the manufacturer's website. Based off of our experience with previous rockets, we expect an increase of mass between 10-25% of the total mass of the rocket. This is due to the addition of epoxy and also the difference between the posted mass on the manufacturer's website and the actual mass of the components we receive. We will continuously update our mass statement as we receive parts and build the full-scale rocket. Because we have kept information up to date our current design represents an accurate estimation of the weight with a margin of error of around 5%.

To account for any failures that may occur at launches, we plan to build two full scale rockets to take to any launch, as well as replacement parts that are needed. With two rockets, we can repair rockets on the field, or even swap out a rocket in its entirety, in order to maximize efficiency at launches. During construction and launching all safety protocol will be followed, and our student safety officer constantly ensures that all members are working safely and efficiently.

Safety and Failure Analysis

Risks	Probability of Risk *(1-5)	Impact on Project Progress	Mitigations
The payload may get lodged in nosecone such that it comes down with the rocket and yields no usable data.	2	We will need to redesign, rebuild, or reload the payload. This would delay the progress of construction.	The team shall ensure that the payload is designed so that it will be easily removable so that data can continue to be taken.
The rocket parachute does not deploy and rocket returns unsafely to the ground.	3	We lose a rocket and must build another one, losing work time and time to launch.	The team will carefully insert the parachute and make sure there is enough heat shields to protect our parachutes from any flames.
Injury could occur while using coping saw.	2	A leave of absence of a team member could occur due to minor or severe injury and possibly delay the rocket-building progress.	The team will be very careful and aware of limbs and fingers when using this tool.
Injury could occur during Exacto knife usage.	5	A small injury could occur, possibly delaying the rocketbuilding progress.	The team will carry the knife in cautious matter, cut away from oneself, and be aware fingers when using this tool.

Accidental combustion of rocket materials	3	In addition, possible injury and a delay of rocket-building progress could occur.	The team will keep 25 feet away from electrical outlets and open flames when using combustible rocket materials
Allergic reactions to chemicals involved in rocket production	2	Minor or severe chemical burns of team members and possible delay of rocket progress could occur.	The team will make all students aware of each other's allergies and stay away from possible allergens that could affect the team members
Electrocution during electrical outlet usage	1	Minor or severe injury could occur.	The team will only use electrical outlets when necessary and only if hands are dry and static free. The team will keep fingers away from prongs.
Adhesion to materials or self	4	Minor injury and minor delay of rocket progress could occur.	The team will exercise proper caution when handling adhesive material being sure not to come in contact with the adhesives and using proper methods to rid ones skin of the material if they come in contact
Injury during laser engraver usage	2	Possible combustion of rocket materials could lead to reordering of materials and delay progress.	The team will make sure the laser is on the proper power, speed, and focus settings, and ensure that the exhaust fan is on.

Injury during drill press usage	2	Severe injury and delay of progress could occur.	The team will keep clothing, hair, and body parts away from the drill bit and use safety glasses.
Tripping and falling hazards	3	Minor or severe injury, delay of rocket progress could occur.	The team will make sure any walking paths are clear and keep clutter off of floor.
Abrasions and bruises caused by belt sander	2	Minor injury and delay of progress.	The team will keep hands and clothing away from the sandpaper.
Burning caused by soldering iron usage	2	Minor injury and delay of progress.	The team will use soldering iron in a proper manner and use safety gear.
Premature ignition of rocket motors	2	Possible minor or severe injury, the need to reorder rocket motors, and delay of rocket progress.	Ensure that only the proper level certified personnel handle the rocket motors and installations as well as reloads.
Team estrangement because of lack of cooperation	1	Delay of rocket progress.	The team will talk calmly and will not fight with one another. The team will respect each other and themselves.
Going over-budget	5	Delay of rocket progress due to the need for more time to fundraise	The team will carefully use all materials, order only the parts needed, keep track of materials, and use the budget wisely. The team will be diligent in fundraising endeavors.

Misuse or mishandling of hazardous materials	2	Minor or severe injury, leave of absence for team member affected, and delay of progress	The team will follow all safety code regulations, laws, and instructions very carefully

Unforeseen rocket design complications	4	Delay of rocket design and rocket building progress	The team will design a stable rocket based on the locations of the center of pressure and center of gravity. The team will also have an NAR representative check rocket design.
Unforeseen payload design complications	3	Delay of payload design and production.	The team will design a payload that will be effective for the size nosecone that is used and double-check that the components of the payload are properly secured and insulated
Complications during transportation of participants and materials to SL or practice launch sites	3	Delay of rocket progress due to rocket repairs or cancellation of practice flights because of extensive damage.	The team will make sure that the launch date is known in advanced and that all specifications are planned out well in advance. The team will pack the rocket well and make sure it is secure during transportation.
Accidental partial or complete destruction of building site	2	Damage to work environment, additional expenditures for repairs, possible progress delay.	The team will ensure that safety guidelines from NAR and the MSDS are being followed.

Team communication failure	4	Rocket/payload may be built incorrectly or too many of one part may be made, causing a slight to major delay of progress or loss of material.	Every team member will have access to other members' email addresses and have the ability to talk during the school day.
Shortage of rocket building materials	2	Major delay due to the need to order new material and wait for it to ship.	The team will double-check all materials before ordering and enforce a checklist while parts are being used.
Commitment complications among team members	3	Loss of time or team member if the complication is too great.	The team will make sure all team members make this their first priority and plan accordingly.
Inhalation of dangerous fumes	2	Minor to severe injury, time lost taking student to ER, delay of progress.	The team will wear proper safety gear, exercise proper use of fume hoods if needed, and be aware of surroundings when dangerous fumes are being produced.
Accidental ingestion of rocket materials	1	Minor to severe injury, delay of progress, possible loss of material.	Only experienced students should work with dangerous materials under proper supervision.
Motor ignition delay	3	Launch delay, loss of motor if it does not ignite, minor to severe injury if motor ignites while personnel are approaching rocket.	The team will only use commercially available and Range Safety Officer approved igniters.

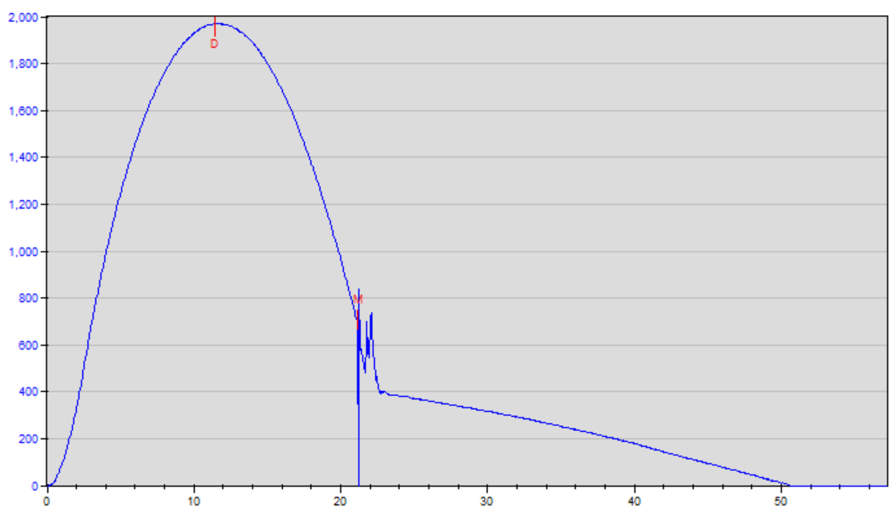
Rocket catches fire on the launch pad	2	Possible loss of rocket, minor to severe injuries if fire is not properly extinguished.	The team will bring a fire extinguisher suitable for the needs of the fire and according to the MSDS of the motors being used.
Cancellation of launch due to poor conditions	4	Delay of testing.	The team will plan multiple days to launch, be flexible in scheduling practice launches, and practice patience.
Motor ignition failure	3	Delay of launch testing and rocket progress.	The team will ensure that commercially available igniters and motors are used and follow the NAR High Power Safety Code, which outlines what to do during motor ignition failure.
Premature Detonation of Black Powder Charges	2	Partial destruction of rocket and/or premature parachute deployment.	All black powder will be handled by professionals and the team will check that the charges are set for the correct time.
Team members becoming sick before or during the trip to Huntsville.	3	Loss of manpower and possible loss of team leaders and/or safety officer	Team members will be well informed and be able to cover multiple rules in the project if needed.
Pieces of the rocket falling off of the rocket during launch	2	Damage to the rocket and danger of injury to the people and processions on the ground.	Check all aspects of the rocket before launch and delay launch if repairs are needed.

Cancellation of Huntsville due to unforeseen causes	1	Ending of the program for this year or the event being held at a later date.	Follow through with the current program and launch separately.

Subscale Flight Results:

Our subscale rocket was launched twice, the first launch was unsuccessful and the second launch was. For our first launch we put a small GPS tracker system inside the body tube of our rocket to help us locate it if blew off course during its descent. However when the ejection charges went off, the tracker was stuck in the rocket and stopped the drogue from being deployed creating a hole in the body tube and only the main parachute was deployed. This caused it to drift from the launch site during its descent. For our second launch we covered the hole with duct tape and when ejection charges went off everything was fine. We also noticed that on our altitude reading for our first launch, there was a major spike in the pressure reading. We discovered that we had forgotten to seal around the whole where the wires from altimeter come out to fire the ejection charges. To fix this, we completely sealed the electronics bay for our second launch to ensure that our altitude and pressure readings were correct. Our rocket still drifted during its descent but it was also windy later in the day when we launched it. As a result of the successful subscale launches we have decided to keep our general design of the rocket the same and change a few components of the design. We also decided not to use the GPS tracker that we used in our subscale launches due to the fact that it is heavier than our usual tracker which makes it easier to break the outside of the rocket body.

Launch 1



Statistics:

Apogee Alt: 1970' AGL

Ground Elev: -252' MSL

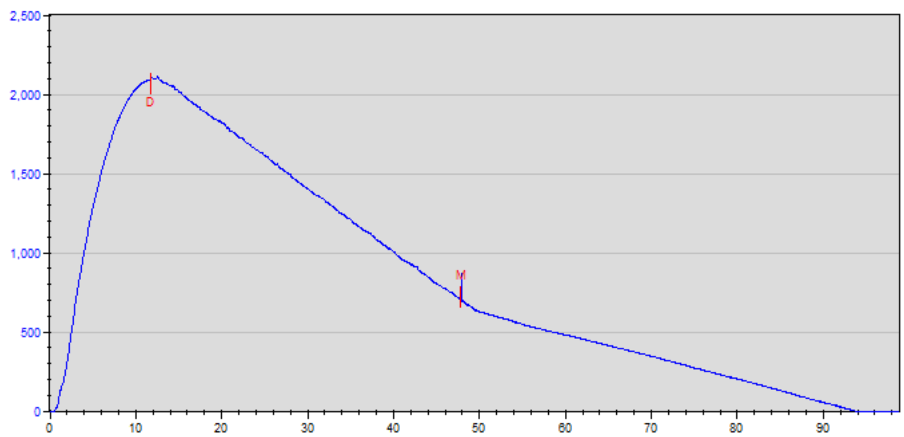
NumSamps: 1144

Main Deploy: 700' AGL

Apogee Delay: 0 SEC

FlightNum: 5

Launch 2



Statistics:

Apogee Alt: 2104' AGL

Ground Elev: -191' MSL

NumSamps: 1976

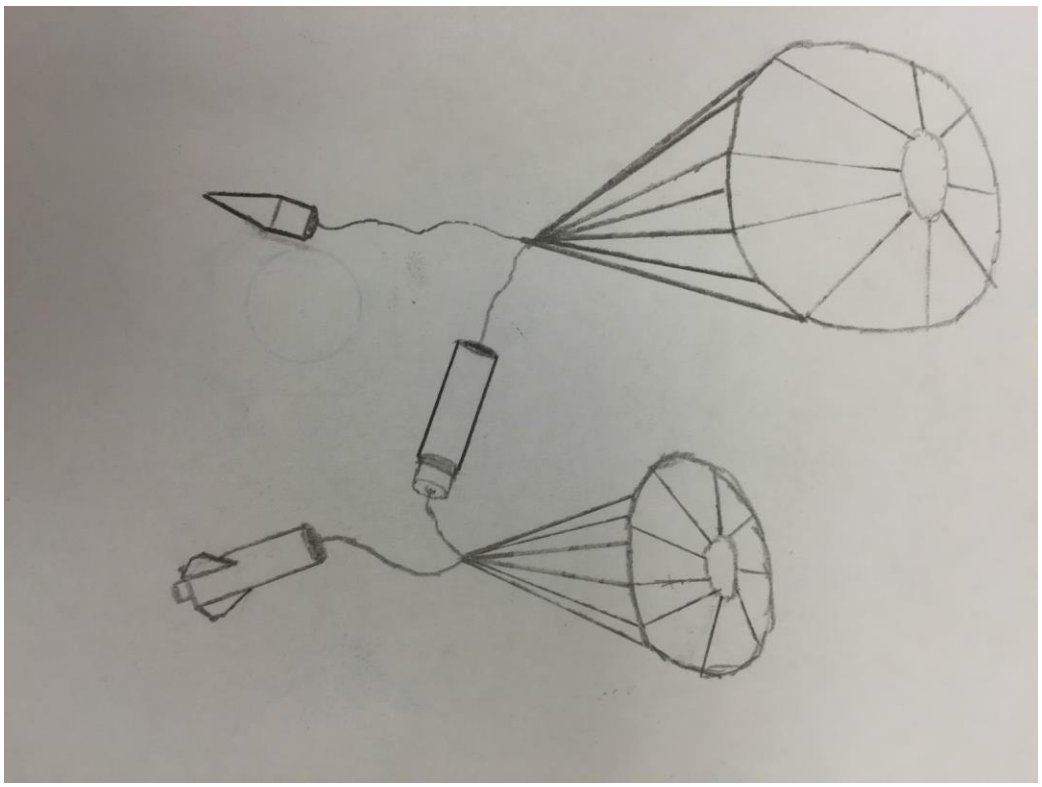
Main Deploy: 700' AGL

Apogee Delay: 0 SEC

FlightNum: 6

Recovery Subsystem

In our rocket recovery system design will have 2 parachutes connected to shock cord. Each shock cord will have one end connected to an end of the electronics bay. Our shock cord in the bottom half of our rocket will have our drogue parachute connected in the middle of the shock cord and the ends will be connected to the bottom of the electronics bay and the bulkhead above our motor. Our shock cord in the front half of our rocket will have the main parachute connected in the middle of the shock cord and the ends will be connected to the top of our electronics bay and to the bulkhead on our nosecone/payload. Our altimeters in the electronic bay will trigger 2 separate ejection charges with one on each end of our electronics bay. One altimeter will be our main altimeter which will fire an ejection charge at apogee to eject our drogue parachute, as well as fire our ejection charge at 600ft to eject our main parachute. The second altimeter is a redundant altimeter that will fire after 3 seconds to ensure that we have separation of our vehicle parts. The first ejection charge fired from the main altimeter will eject the back half of the rocket off away from the electronic bay. The second ejection charge fired from the main altimeter as well and will eject our nose cone out from the rest of our rocket pulling out the main parachute thus deploying our main parachute. The main parachute is projected to slow the rocket's descent to a rate of 16.5 ft/s. The front body tube will be onto the electronics bay with plastic pop rivets to ensure that the front body tube is not ejected away from the electronics bay as well. The nose cone housing the payload will be suspended by the shock cord from one side of parachute, while the electronics bay and body tube piece will be suspended by the shock cord on the other side of the parachute. The electronics bay will then also be suspended by the drogue parachute from the other end, and the back body tube section of the rocket will also be suspended by the other end of the shock cord attached to the drogue parachute. As mentioned previously in the report our main parachute will be a 72 inch Iris Ultra parachute by Fruity Chutes and our drogue parachute will be a 24 inch parachute also made by Fruity Chutes. There will be 2 key switches on the outside of the rocket used to turn the power to the altimeters off and on thus being able to arm them from the outside of elections bay and ultimately outside of the rocket. They will be able to function properly for many hours after being armed because we use a 9 volt battery to power each altimeter. This way we will not



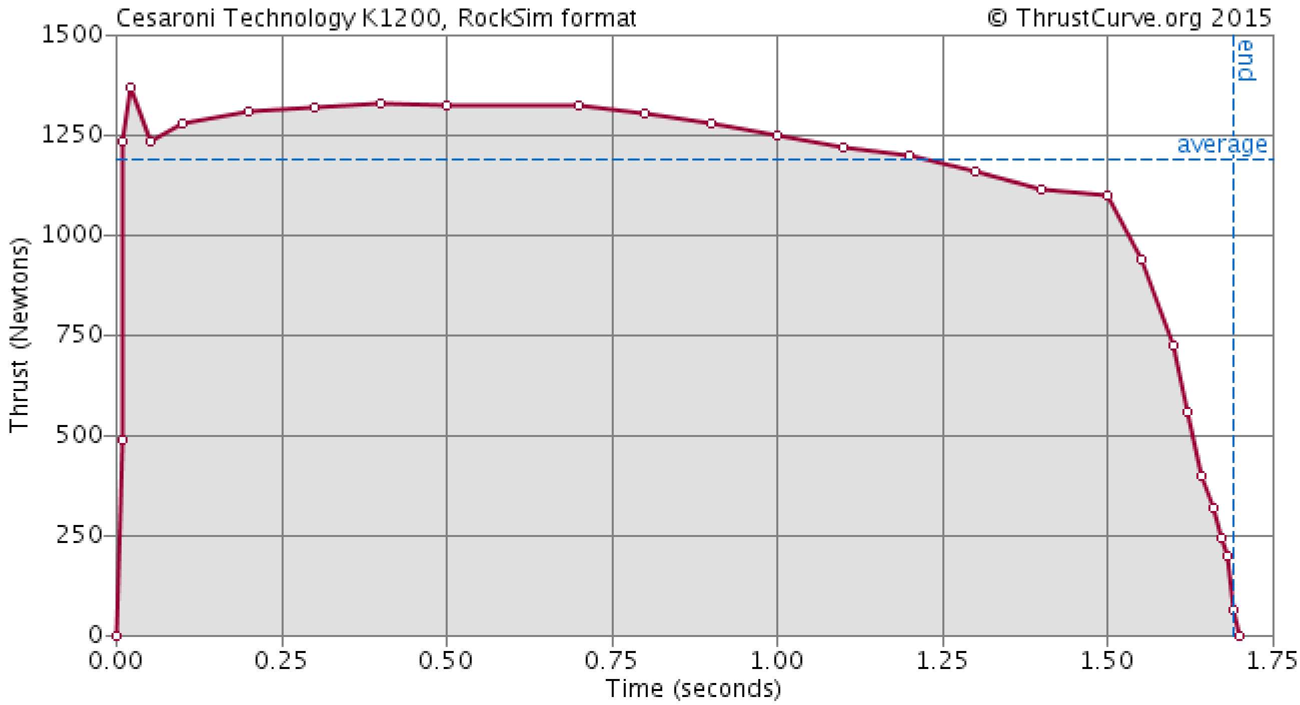
have to worry about any delays while the rocket is armed and on the launch pad waiting to be fired. Inside of our rocket we will have the shock cord for each parachute connected to 2 separate U-bolts at different points in our rocket. For our 72 inch main parachute it will be connected to a piece of shock cord in the front half of the rocket that runs between the electronics bay and nose cone. The end of the shock cord attached to the electronics will be tied onto a U-bolt on the top of our electronics bay. The other end of the shock cord will be connected to the U bolt on the end of our payload and nose cone combo. The main parachute will be attached to this shock cord close to the middle of the shock cords length. For our 24 inch drogue parachute it will be connected to a piece of shock cord in the back half of our rocket that runs between our electronics bay and the end of our motor. One end of the shock cord will be connected to the bottom end of our electronics bay on a U-bolt and the other end will be connected to a metal, machined I-bolt piece at the end of our rocket motor. The image below is the machined piece that is placed in the end of the rocket motor casing above the motor. The piece on the left would be a piece used for a 75mm motor casing and the one on the right will be used for our 54mm motor casing.

Mission Performance Predictions

In order for this project to be successful the following criteria must be met. It must successfully launch and deploy both parachutes. The rocket must be within 10% of our target altitude of 1 mile or 5280 feet. The payload must survive and be able to provide usable data. We must be able to use that data to draw a meaningful conclusion to our experiment. Lastly no onboard systems or parts must break or malfunction during the course of the launch.

85	84	[K1200WT-None]	5318.77	693.23	963.24	17.61	0.06	5318.76
86	85	[K1200WT-None]	5318.77	693.24	962.97	17.61	0.78	5318.76
87	86	[K1200WT-None]	5318.34	693.23	962.97	17.61	3.72	5318.33
88	87	[K1200WT-None]	5318.60	693.23	962.44	17.61	2.23	5318.61

- This is an accurate measure of the thrust over time graph for the Cessaroni K-1200 White Lightning motor made by Cesaroni Technology Incorporated.



- So at 0 miles per hour, the calculated height of the rocket is 5, 406 feet, but multiplying by the percent mass increase and you end up with the rocket reaching 5,101 feet, under the target altitude, but very close to the actual. At 20 miles per hour that will drop to 4,957 ft.
- Motor: Cesaroni K1200 white thunder, 2011Ns of Impulse. This will bring out 317 oz. rocket to an altitude of 5,406 ft and we can expect that the actual weight of the rocket will be heavier and therefore will bring the altitude at or below the mile mark.

Stability Margin

- Stability Margin : 1.51
- Center of Gravity (CG): 42 in from nose cone
- Center of Pressure (CP): 54 in from nose cone

With the 72 inch parachute, the rocket should have a slowed descent of 17. 6 ft/s. With this velocity, the nose cone is calculated to have 10.6 ft-lbf of Kinetic Energy at the moment that the rocket hits the ground. The electronics bay housing the altimeter and tracking device as well as the front bod tube should hit the ground with 49.6ft-lbf of Kinetic Energy. The last section of the rocket (the bottom half) should have 60.92 ft-lbf at the time it hits the ground. The total kinetic energy of the rocket is 120.92 ft-lbf when it hits the ground.

Because all components of the rocket are being tethered to each other, the drift distance for all components is relatively the same. With no wind, the rocket drifts 211 feet from the launch pad. With a 5 mph horizontal wind, the rocket is estimated to drift 492 feet from the launch pad. With a 10 mph horizontal wind, it is calculated that the rocket will drift 873 feet from the launch pad. With a 15 mph wind, the rocket is calculated to drift 1,204 feet from the launch pad. With a 20 mph wind, the rocket should only drift 1,790 feet from the launch pad, ensuring that even under the most extreme launching conditions allowed by the NAR (in reference to wind speed), the rocket will stay within the 2000 foot radius of the launch pad.

Interfaces and Integration

The payload will be located in the nose cone and will eject with the nose cone and main chute at 700ft. It contains tubes that will contain the planarian and these tubes will be placed into foam that will have 2 holes drilled into it for the test tubes. Insulation and other mechanisms may be put into place if needed for the survival of the planarian. It will be connected to the rest of the rocket be a 1 inch u-bolt that will connect to a quicklink which will connect to the shockcord.66

The body tubes of the rocket will be made out of fiberglass. The rocket will be 82in long and 4in in width. The mass will be 402.1oz with a center of gravity at 42.9in from the tip of the nose cone. The center of pressure will be located at 53.5in as well the fins will be made out of fiberglass. These fins will be “through the wall” fins as they will bonded into slits cut into the rocket. These fins will be in a trapezoidal shape with a 10in base and 3.5in top. The Electronics Bay will be located in the middle of the rocket. This will be put into a fiberglass body tubing that will work most like a coupler tube. It will be 3.9in in diameter and 12in long in order for it to fit inside of the rocket. There will then be a 2in piece of fiberglass tubing in the middle of the Electronics Bay that will slide on the outside. This will be epoxied in place to make it secure, because the key switches will be placed through this piece of fiberglass. The Electronics Bay will fit into the back half of the rocket similar to a coupler tube and will be held into the front half of the rocket with plastic pop rivets. This will make sure that the main parachute will eject out of the nose cone and not split at the Electronics Bay from both sides. We do not have any interfaces between the launch vehicle and the ground launch system. The rocket will have small pieces of 10-10 launch lugs epoxied onto 2 places on the body of the rocket. These will then be lined up with and slid onto a 10-10 rail. There is an electronic control pad that will then send out an electric current the will start an igniter that will then launch the rocket.

Launch Concerns and Operation Procedures

Final Assembly and Launch Procedure

To ensure that the rocket was completed properly, the team captains and our safety officer will check over the project. They will be looking to make sure all the parts are secure and where they need to be. They will check for any errors or problems that may endanger our project to be a success. For launch, the motor will be placed in the rocket at the launch site. The rocket will be looked over once again and then will be placed on the launch pad. After this, everyone will clear to a safe distance and the rocket will be launched.

Recovery Preparation

The shock cord will be cut to the proper length, at least one rocket length long or longer, and then attached to each side of the electronics bay and their respective bulkheads. We will place a heat shield on the shock cord to prevent the drogue parachute from melting. Then the parachutes will be connected onto the shock cord and folded so that the fit into the tube. In the electronics bay we will check over the wiring to make sure none are touching so they don't short. We will be using a USB data transfer kit to set the altimeters to send ejection charges at apogee with the drogue chute and at 650 feet with the main chute. The redundant altimeter will be set for ejection of drogue at apogee with a 2 second apogee delay and a main chute deployment at 550 feet.

Motor Preparation

The motor is being built by our Level III NAR representative, Robert DeHate. He will assemble the motor with caution. He will follow all instructions so that the motor is built and will perform properly.

Setup on launcher

The rocket will be set up on the launch pad and we will make sure the launch lugs are smooth moving up the rail. The keys in the electronics bay will be turned and removed to activate the altimeters that will control when ejection charges deploy.

Igniter installation

We will be using the igniter provided with the Cesaroni Motor. It will be inserted into the motor so that it can ignite the motor causing the rocket to lift off.

Post-Flight Inspection

Only the student safety officer and the team mentor may approach the rocket once it has landed. Once it is deemed safe all systems will be looked at for any failures or other problems that may have occured.

Safety and Environmental

Preliminary Checklist for Final Assembly and Launch Procedure

❏ **Ebay**

❏ All batteries have a fully charged

❏ All altimeters are working

❏ Wiring is correct and has no breaks/shorts

❏ All part are secure and fit together

❏ External key switches work

❏ Ebay is airtight when fully assembled

❏ Ejection charges are assembled correctly

❏ Fits inside body tubes without being too tight or too loose

❏ Shear pin holes line up

❑ **Payload**

❑ 8 planaria placed in test tubes with adequate water

❑ 4 test tubes are loaded into our ebay ❑ The end of the payload is securely attached

❑ Recovery System and Shock Cords

❑ Nose cone is properly connected to the first parachute and ebay

❑ Ebay is properly connected to the second parachute and back half of the rocket

❑ Drogue Parachute is folded currently

❑ Main Parachute is folded currently

❑ Heat shielding for the shock cords and parachutes is in place

❑ Motor Assembly

❑ Motor is assembled properly by our NAR safety officer

❑ Motor fits inside motor mount

❑ Motor retainer is in place

❑ Body and Airframe

❑ Necessary number of shear pins and pop rivets inserted correctly

❑ All parts fit together,

❑ There is no issues with the airframe

❑ **Launch Procedures**

❑ Place rocket on launch rail without damaging rocket

❑ Place rail in launch position

❑ Check if altimeters are functioning correctly and remove keys to the keyswitches

❑ Insert ignitor correctly

❑ Attach wires to ignitor

❑ Check continuity before launch

Section 1

Team and Student Safety Officers

Our team safety officer for this project is our NAR representative and mentor Mr. Hastings. Our student safety officer is Josh Staley. For more information look at the bios at the front of the PDR. The responsibilities of these two individuals is that the construction, assembly, and final launch procedures follow safety rules and guidelines and ensure the safety of the project as a whole. Other responsibilities include being responsible for the handling of hazardous materials and retrieval of the rocket post-launch.

Section 2

Rocket Design Failure Modes

Possible failures in the rocket design include all of the following. Failure of the adhesives used to constructing the rocket and failure of centering rings and bulkheads. The airframe is unable to withstand the forces acting on it, failure of connecting points (u-bolts, o-rings, etc…) and possible expansion of fiberglass used making the rocket unusable. To combat adhesion failure we will be using a high-strength slow-curing epoxy that will be able to withstand the forces placed on it and be able resist changes in temperature that can make it more prone to failure. We will be using centering rings and bulkheads that and made to withstand the necessary stressed and have been tested to confirm that. Both are unlikely to happen provided that there are no errors in construction but if it did take place then the outcome would be almost certain integrity failure and danger of flying parts coming down. The airframe is made of fiberglass which has been proven to provide strength and be resistant to failure. Failure of the airframe is unlikely and would result in failure of the rocket and out of control flight trajectory. The connecting pieces that we are using are rated well above the projected stresses to be placed on them and have not failed in any prior test. This is unlikely to occur and would result in the rocket returning in multiple pieces and possible falling debris. Lastly to offset the possible expansion of the fiberglass due to heat we will not be making our motor mount out of fiberglass and have confirmed that the fiberglass that we will be using is resistant to expansion at the projected temperatures of our launch dates. We will also keep the rocket out of direct sun when working and use a light paint. This is unlikely to occur and would result in being unable to fly as the parts would no longer fit together.

Section 3

Payload Integration Failure Modes

The possible payload integration problems that we may experience is the the bulkhead may not fit into the body tube properly and the shock cord may not be able to attach to the payload properly. To mitigate this we will be using a dremel tool to trim the bulkhead down to the current size and we will be using u-bolts and quick links that we know are compatible.

Section 4

Launch Operations Failure Modes

Failures that may arise in the launch operations are the ejection charges not being set off or set off at the wrong attitude, having an ejection charge that is not powerful enough to break apart the rocket to provide a safe decent and eject the parachutes. To help prevent motor failure we will ensure that our

NAR representative properly build or rebuilds the motor as well as using the proper launch mechanisms though we cannot be absolutely certain that this will not occur. To mitigate ejection charges not being set off or off correctly we will redundantly wire the system so that there is a backup if one altimeter, battery or other component fails as well having multiple ejection charges. We will use the proper amount of black powder in our ejection charge so that it will be able to eject both the back half and the nose cone as well as successfully ejecting the parachutes

Section 5

Hazards

Hazards over the course of this project are split up between chemical hazards, construction machines/tools hazards and rocket subsystem hazards.

Chemical hazards

Materials that are hazardous to personal epoxy, epoxy hardener, black powder, spray paint and fiberglass. All such materials are harmful if consumed, inhaled and placed in sensitive areas such as your eyes. They can also act as an irritant while working with them. Included below are material safety data sheets for the before mentioned products.

Materials Safety Data Sheets Z-Poxy Resin http://web.mit.edu/rocketteam/www/usli/MSDS/Z-Poxy%20Resin.pdf Z-Poxy Hardener http://web.mit.edu/rocketteam/www/usli/MSDS/Z-Poxy%20Hardener.pdf Krylon Spray Paint http://www.krylon.com/document/SDS/en/US/724504018179 Goex Black Powder http://www2.epa.gov/sites/production/files/2015-05/documents/9530608.pdf

Construction Machines/Tools Hazards

Injury that may occur due to the incorrect use of the tools provided include but are not limited to hair, clothing, and/or jewelry getting caught in the machines resulting in severe bodily harm to the user. Injuries may include severe bruising, burns, the tearing of skin, flesh and/or vital organs, the spraining, braking and/or shattering of bones, small chance of partial or complete dissection of limbs, and extremely small chance of partial decapitation. Abrasions, bruises and paper cuts may result from using hand tools.

In order to minimize the chance of injury all participants will sit through a series of safety briefings. They will be instructed on the correct use and procedures before operating any tools and will be given demonstrations in their correct use as well as being told examples of their incorrect use. We will identify as many hazards as possible when using each machine and lastly will will always have a senior member and one of our mentors supervise anyone who is using the machines and tools. The proper procedure for machine usage can be found below.

Framar Band Saw

Before operating the bandsaw, remove all jewelry, confine long hair, and remove or roll up long sleeves or any article of clothing that could become caught in the blade or the band saw. Also, obtain an instructor’s permission to use the machine and ensure that safety glasses are covering your eyes. When cutting, make sure adjustment knobs are tight; the upper blade guard should be around one eighth of an inch above the material being cut. Do not force any material through the blade, attempt to cut a radius smaller than the blade will allow, and do not back out of long cuts. Keep fingers on either side of the cut line, never on the line. If necessary, use a push stick or scrap block to guide the material through. Do not allow bystanders to stand at the right of the machine, because if the blade breaks, it may hit them. Never leave the machine until the blade has come to a complete stop. If an injury should occur during the usage of the band saw, stop the machine, step on the brake to stop the blade quickly, inform an instructor of the injury,and then have the rest of the students in the classroom sit outside in the hallway to avoid being in the way of instructors and medical personnel helping the student.

Router

Before operating the router, remove all jewelry, confine long hair, and remove or roll up long sleeves or any article of clothing that could become caught in the router or router bit. Also, obtain an instructor's permission to use the machine and ensure that safety glasses are covering your eyes. Ensure that the power switch is in the off position before plugging in the router. Then, check to make sure that the bit is firmly secured in the chuck and that the piece being worked on is firmly secured and that the intended path of the router is free of obstructions. Hold the router with both hands and apply constant pressure. Never force the router or bit into the work. When changing bits or making adjustments turn off the router and unplug it from its power source. If an injury should occur during usage of the router, turn off the machine, inform an instructor of the injury, and then have the rest of the students in the classroom sit outside in the hallway to avoid being in the way of instructors and medical personnel helping the student.

Delta Radial Arm Saw

Before operating the saw, remove all jewelry, confine long hair, and remove or roll up long sleeves or any article of clothing that could become caught in the blade. Also, obtain an instructor's permission to use the radial arm saw and ensure that safety glasses are covering your eyes. Make all needed adjustments, such as adjusting the blade guard and kickback fingers, while the power is off. Test to see if leaf guards are properly working and that the blade does not extend past the edge of the table. Always firmly hold materials against the fence and pull the blade completely through the material and return blade behind the fence before removing the material and starting another cut. If too much of the table is cut away then the instructor must be notified for the table to be replaced. Wait for the blade to stop before leaving the machine. If injury occurs during usage of the saw, turn off the machine, inform an instructor of the injury, and then have the rest of the students in the classroom sit outside in the hallway to avoid being in the way of instructors and medical personnel helping the student.

Planer-Surface Sander

Before operating the sander, remove all jewelry, confine long hair, and remove or roll up long sleeves or any article of clothing that could become caught in the machine. Also, obtain an instructor's permission to use the sander and ensure that safety glasses are covering your eyes. Turn on the saw dust collection system. Check all material for loose knots, nails, staples, or any other loose, foreign objects. Never force a material through the planer; after insertion the machine will automatically feed it through. The operator should wait on the other side of the machine to receive the material. Select a proper machine depth and speed for the material being used. Never attempt to plane more than an eighth of an inch of material in one pass. Do not look into the machine at surface level or try to clean debris while the machine is turned on. Always stand to the side, because the possibility of kickback always exists. If injury occurs during usage of the sander, turn off the machine, inform an instructor of the injury, and then have the rest of the students in the classroom sit outside in the hallway to avoid being in the way of instructors and medical personnel helping the student.

Dewalt Compound Miter Saw

Before operating the saw, remove all jewelry, confine long hair, and remove or roll up long sleeves or any article of clothing that could become caught in the blade. Also, obtain an instructor’s permission to use the saw and ensure that safety glasses are covering your eyes. Make all changes to the saw and saw blade while the power is off and the plug is disconnected from its power supply. Hold the material firmly against the fence and the table. Allow the motor to reach its full speed before attempting to cut through the material. Make sure that all guards are functioning properly. If injury occurs during usage of the Miter Saw, turn off the machine, inform an instructor of the injury, and then have the rest of the students in the classroom sit outside in the hallway to avoid being in the way of instructors and medical personnel helping the student.

Jointer

Before operating the jointer, remove all jewelry, confine long hair, and remove or roll up long sleeves or any article of clothing that may become caught in the blade. Also, obtain an instructor’s permission to use the jointer and ensure that safety glasses are covering your eyes. Turn on the saw dust collection system. Make all changes or adjustments to the jointer while the power is off. Use a push stick or scrap block if your hands could come within two inches of the blade. Do not attempt to take off more than one eighth of an inch at a time. The minimum length of material that can be cut with the jointer is double the size of the blades. If injury occurs during usage of the jointer, turn off the machine, inform an instructor of the injury, and then have the rest of the students in the classroom sit outside in the hallway to avoid being in the way of instructors and medical personnel helping the student.

Hand Sanders

Before operating the hand sanders, remove all jewelry, confine long hair, and remove or roll up long sleeves or any article of clothing that could become caught in the machine. Also, obtain an instructor’s permission to use the hand sanders and ensure that safety glasses are covering your eyes. Replace the sandpaper while the sander is off and unplugged. Only use sand paper that is in good condition and properly installed. Place the material that you intend on sanding on a flat surface and sand slowly over a large area. Wait for the sander to stop oscillating before placing it on a secure resting surface. Never carry any corded tool by the power cord. If injury occurs during usage of the hand sanders, turn off the machine, inform an instructor of the injury, and then have the rest of the students in the classroom sit outside in the hallway to avoid being in the way of instructors and medical personnel helping the student.

Electric Drills

Before operating the drill, remove all jewelry, confine long hair, and remove or roll up long sleeves or any article of clothing that may become caught in bit. Also, obtain instructor permission and ensure that safety glasses are covering your eyes. Replace the bit while the power is off, install the bit properly and make sure the chuck is tightened and the chuck key is taken out. Never drill without first marking the hole with an awl. Ensure the material is clamp securely and drill with even pressure. Never carry any corded tool by the power cord. If injury occurs during usage turn off machine, inform instructor of injury, then have the rest of the students in the room go into the hallway to avoid being in the way of instructors helping the student.

Powermatic Drill Press

Before operation remove all jewelry, confine long hair, and remove or roll long sleeves or any article of clothing that may become caught in bit. Also, obtain instructor permission and ensure that safety glasses are covering your eyes. Replace the bit while the power is off, install the bit properly and make sure the chuck is tightened and the chuck key is taken out. Firmly secure material with vises or clamps. Adjust the table to avoid drilling into the table and pick the correct bit and properly sharpened. If drill becomes stuck turn of machine and inform instructor. Select proper speed for the material. If injury occurs during usage turn off machine, inform instructor of injury, then have the rest of the students in the room go into the hallway to avoid being in the way of instructors helping the student.

CNC Router

Before operation remove all jewelry, confine long hair, and remove or roll long sleeves or any article of clothing that may become caught in bit. Also, obtain instructor permission and ensure that safety glasses are covering your eyes. Turn on the saw dust collection system. Make all adjustments while machine is off. Material must be firmly secured before the project is run. A person needs to be with the machine during the entire operation. Check the spindle rotation, speed, and depth of cut are all correct before starting the machine. Only clean machine while it is off and make sure all setup tools are cleared from the table. If injury occurs during usage turn off machine, inform instructor of injury, then have the rest of the students in the room go into the hallway to avoid being in the way of instructors helping the student..

Oliver Table Saw

Before operation remove all jewelry, confine long hair, and remove or roll long sleeves or any article of clothing that may become caught in blade. Also, obtain instructor permission and ensure that safety glasses are covering your eyes. Turn on the saw dust collection system. Make all adjustments while machine is off. Gullets of the blade must clear the top of the material. Never use the miter gauge and the fence at the same time, miter gauge for cross cutting and fence for ripping. Use extra caution while using a dado cutting head. Always use a push stick when your hand may come close to the blade and have another person to catch the material that was just cut. Do not leave the table until the blade stops. If injury occurs during usage turn off machine, inform instructor of injury, then have the rest of the students in the room go into the hallway to avoid being in the way of instructors helping the student.

Powermatic Belt Sander

Before operation remove all jewelry, confine long hair, and remove or roll long sleeves or any article of clothing that may become caught in machine. Also, obtain instructor permission and ensure that safety glasses are covering your eyes. Make all adjustments while machine is off. Check that there is adequate tension in the belt and that it is not torn. Keep material on the table at all times. Keep fingers away from sandpaper. If injury occurs during usage turn off machine, inform instructor of injury, then have the rest of the students in the room go into the hallway to avoid being in the way of instructors helping the student.

Powermatic Disc Sander

Before operation remove all jewelry, confine long hair, and remove or roll long sleeves or any article of clothing that may become caught in machine. Also, obtain instructor permission and ensure that safety glasses are covering your eyes. Make all adjustments while machine is off. Check that the disc was properly installed and that it is not torn. Keep material on the table at all times. Keep fingers away from sandpaper. If injury occurs during usage turn off machine, inform instructor of injury, then have the rest of the students in the room go into the hallway to avoid being in the way of instructors helping the student.

Powermatic Drum Sander

Before operation remove all jewelry, confine long hair, and remove or roll long sleeves or any article of clothing that may become caught in machine. Also, obtain instructor permission and ensure that safety glasses are covering your eyes. Make all adjustments while machine is off. Use proper drum for the radius that is being sanded. Keep material on the table at all times. Keep fingers away from sandpaper. If injury occurs during usage turn off machine, inform instructor of injury, then have the rest of the students in the room go into the hallway to avoid being in the way of instructors helping the student.

Craftsman Reciprocating Saw

Before operation remove all jewelry, confine long hair, and remove or roll long sleeves or any article of clothing that may become caught in blade. Also, obtain instructor permission and ensure that safety glasses are covering your eyes. Make all changes with the power off and plug disconnected from the power supply. Firmly secure all material to a workbench or table. Allow the motor to reach its full speed before cutting through the material. Hold saw with both hands while using. If injury occurs during usage turn off machine, inform instructor of injury, then have the rest of the students in the room go into the hallway to avoid being in the way of instructors helping the student.

Craftsman Circular Saw

Before operation remove all jewelry, confine long hair, and remove or roll long sleeves or any article of clothing that may become caught in blade. Also, obtain instructor permission and ensure that safety glasses are covering your eyes. Make all changes with the power off and plug disconnected from the power supply. Firmly secure all material to a workbench or table. Before cutting; check that the cut line is not above the table. At least one person must be holding the material being cut off. Allow the motor to reach its full speed before cutting through the material. Hold saw with both hands while using. If injury occurs during usage turn off machine, inform instructor of injury, then have the rest of the students in the room go into the hallway to avoid being in the way of instructors helping the student. CNC Lathe (EMCO Concept Mill 55, Lab Volt 5400 CNC Mill, a Lab volt

Automation 5500-B0)

Before operation remove all jewelry, confine long hair, and remove or roll long sleeves or any article of clothing that may become caught in bit. Also, obtain instructor permission and ensure that safety glasses are covering your eyes. Make all adjustments while machine is off. Material must be firmly secured before the project is run. A person needs to be with the machine during the entire operation. Check the spindle rotation, speed, and depth of cut are all correct before starting the machine. Only clean machine while it is off .If injury occurs during usage turn off machine, inform instructor of injury, then have the rest of the students in the room go into the hallway to avoid being in the way of instructors helping the student.

Victor metal lathes

Before operation remove all jewelry, confine long hair, and remove or roll long sleeves or any article of clothing that may become caught in work. Also, obtain instructor permission and ensure that safety glasses are covering your eyes. Make all changes with the power off. Center the material so that it will not spin off center. Firmly secure all material to a machine. Use proper speed for the task at hand. Use the correct and sharpened tools. If injury occurs during usage turn off machine, inform instructor of injury, then have the rest of the students in the room go into the hallway to avoid being in the way of instructors helping the student.

Paasche FABSF-6 spray booth

Before use turn on ventilation system and wear proper protection. Use the correct spray for the material and do not inhale. If injury occurs during usage turn off machine, inform instructor of injury, then have the rest of the students in the room go into the hallway to avoid being in the way of instructors helping the student.

Miller Spot Welder

Before operation put on proper clothing, welding mask, gloves, and apron. Obtain instructor permission. Do not look at the welding torch unless wearing a welding mask. Ensure the proper solder is being used and materials are secured. If injury occurs during usage turn off machine, inform instructor of injury, then have the rest of the students in the room go into the hallway to avoid being in the way of instructors helping the student.

Baldor grinder/buffers

Before use put on safety glasses, check the spark shield is intact, and obtain instructor permission. Keep hands away from spinning wheel. Adjust the tool rest to the proper height and always use it. If injury occurs during usage turn off machine, inform instructor of injury, then have the rest of the students in the room go into the hallway to avoid being in the way of instructors helping the student. Tennsmith Sheet metal cutter

Before operation remove all jewelry, confine long hair, and remove or roll long sleeves or any article of clothing that may become caught in work. Also, obtain instructor permission and ensure that safety glasses are covering your eyes. Do not attempt to cut material thicker than the machine is rated for. Make sure the material and blade are free from debris. If injury occurs during usage turn off machine, inform instructor of injury, then have the rest of the students in the room go into the hallway to avoid being in the way of instructors helping the student.

Gravograph LS100 30 watt laser/engraver/cutter

Before operation; ensure that the laser is focused, the vent fan is on, and the right speed and power are selected for the material. Obtain instructor permission before use. Never look directly into the laser. Stay at the laser throughout the entire process. If machine cuts unwanted area or malfunctions turn off and alert instructor immediately. If injury occurs during usage turn off machine, inform instructor of injury, then have the rest of the students in the room go into the hallway to avoid being in the way of instructors helping the student.

Section 6

Environmental Concerns

Our project this year will have minimal impact on the environment and present fex environmental hazards. The use of our motor and the black powder ejection charges will produce small amounts of harmful gases that in small enough concentrations that they are harmless. The major concern is if we lose the rocket and are unable to recover it. In that case the rocket contains several hazardous compounds that could greatly harm any plants and animals that come into contact with it. The rocket also has a payload of planaria which is not natural to our launch location. Lastly the rocket is made of parts that will not easily decompose and will therefore present a long term hazard to plants and wildlife. To minimize this we will be placing a tracker on the rocket that we have used before and have confirmed that it works effectively as well as bringing a long pole in case it gets caught on something. The planaria are in tightly sealed thick plastic test tubes that would have a very difficult to break and will guarantee that known of the planaria escape

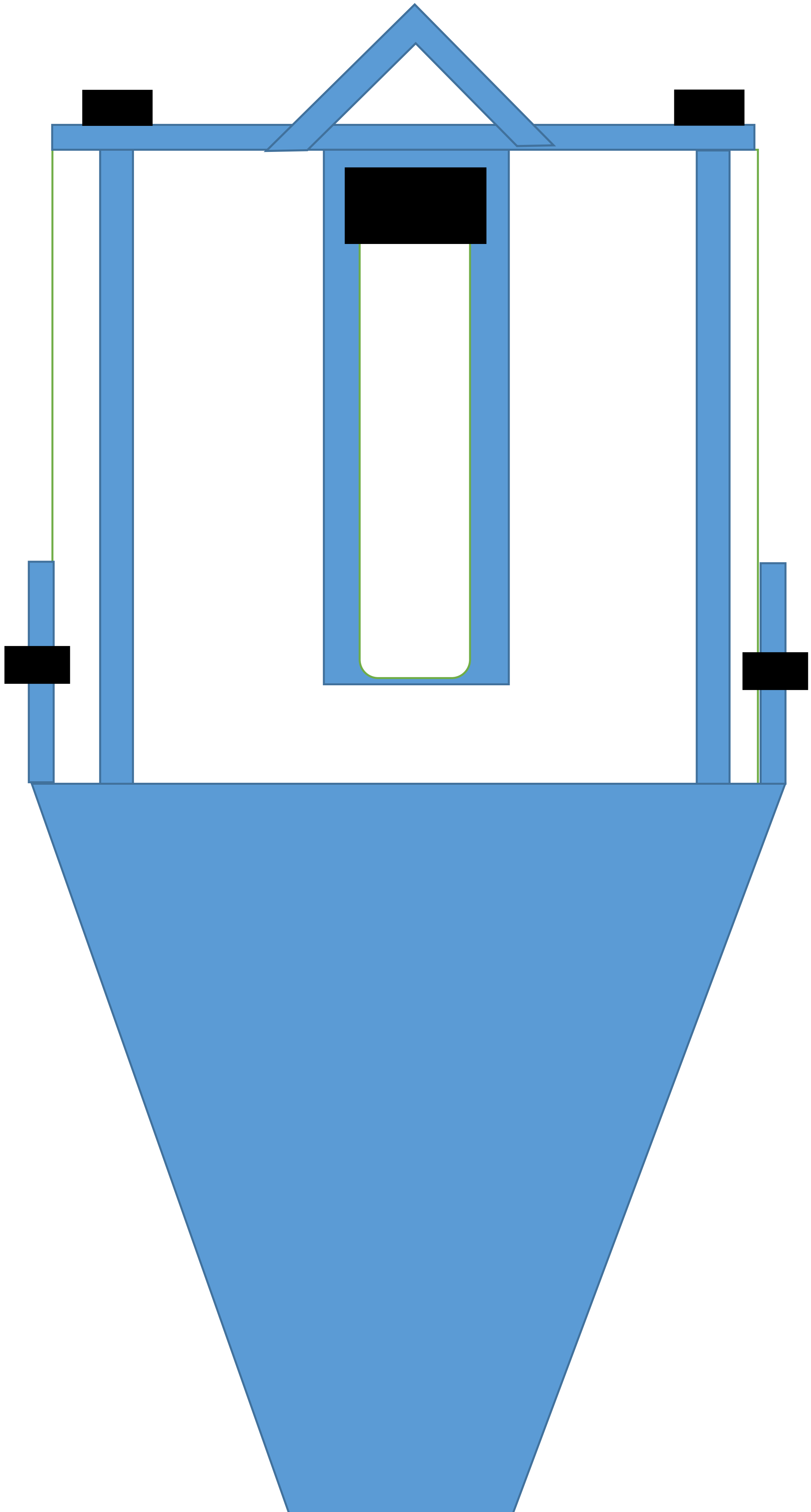
The environment can affect the rocket in several ways. Wind can change the trajectory and attitude of the rocket, rain can hurt electronics, landing in a body of water or wet area can damage electronics, humidity can slow the velocity of the rocket, high temperatures can cause the fiberglass to expand and make launching impossible and decrease battery life, cold can kill off our planaria and ruin our scientific experiment, and direct sun for too long can cause electronics to fail.

Payload

Section 1

Payload Concept, features, and definition

Our payload this year will be a biological payload testing to see how the acceleration of the rocket effect the rate at which a type of aquatic called planaria are able to regrow half there body. Planaria are a type of aquatic flatworm that live in a wide variety of saltwater and freshwater habitats around the world. They are distinctive because of the ability to regrow parts of their body and/or split into two different separate individuals. This is due to the fact that they have a special type of stem cell which allows for their regenerative properties. This has made them the subject of many studies in aging and tissue/organ growth/repair research. It was because of this trait that we decided to make them the basis of our payload this year. So the idea is how does stress effect how the planaria regrow. To answer this we will be cutting the 16 planarian in half and place 8 of them on the rocket in our payload while the other 8 will be in a dummy payload that remains on the ground. Thus they will be under the same conditions. The acceleration of the rocket will act as a stressor for the planaria they are carrying. We can then see how that stress affects the growth process and the tissue repair.



Section 2

So far as we have not yet been able to get the planaria we have not been able to do any of our basic tests yet.

So far our payload has held up structurally and only the actual launch of our full scale will determine if it will stand up to the porces placed on it.

We currently are 90 percent done our first full scale ebay and will complete it January 15th as well as having a second ebay halfway done.

The payload will be attached to the nosecone by 6 pop-rivets and will connect with the rest of the rocket with a u-bolt that is attached to the one end and which connects with a quicklick that is attached to the shockcord.

All planaria will have a very similar genome and will all be subjected to the same conditions except for the excelleration. The only hindrance is if it is too hot or too cold it might skew the data or kill the test subjects.

Section 3

Scientific value

The objective of our payload is to see how the acceleration of the rocket affects the regrowth rate of planaria. We can then use this as an analog to see of how stress affects the growth and development of an organism and evaluate how it affects tissue repair.

Our success criteria is if we can show a definitive difference or no difference in the regrowth process between a planaria that is subjected to the rocket's acceleration and one that has not. The planaria must survive the launch in order for us to obtain valuable data and we must have at least 2 successful launches in order to provide enough data to draw a useful conclusion.

In order to complete the objectives of our payload we will be using cameras that are set up to take 2 pictures a day and will allow us to see the progression of the regrowth process. We will be using these to record both the control and the experimental group. This will give us an accurate way to compare the differences between the two groups. The experimental group will be placed in our payload onboard the rocket, recovered and then observed using the cameras. The control group will stay on the ground and then observed using the cameras and act as our baseline. Both the experimental and the control group will be placed in one of our payloads and kept in the same environment. The only difference is the experimental payload will be the placed on the rocket and the control will not. The independent variable is the acceleration the planaria is subjected to and the dependent is the length of regrowth time and visual observations of that process. Our control variables include cutting both groups at the same time, subjecting them to the same conditions, giving both groups the same amount of nutrients and water with the same qualities, and using the same species and type of planaria. In this experiment if we are able to obtain relevant data in order to satisfy our objectives so long as the planaria do not die and the rocket is not lost. In order to make experimental error small enough to gain a reasonable conclusion we need to complete at least 2 launches and preferably 3. This will give us at least 8 members in the control group and 8 members in the experimental group.

Section 4

Design

Our payload for this year will be located in the nose cone of our rocket. It will consist of an internal bulkhead with all thread running through it and connecting it to a second bulkhead at the back of the nose cone. We will have a piece of coupler between the two bulkheads which will be secured in place by 6 pop-rivets running between the coupler and the nosecone. We will then fill the area between the two bulkheads with a type of insulation. Our current choice is to use expanding foam but we can experiment with different types if this does not work. We will cut 2 cavities in the insulation that will firmly hold our test tubes that contain the planaria. We will have a second payload that is an exact copy of the one placed on the rocket that is for our control. We are using soda-bottle preforms as our test tubes.

Verification requirement	Status
Planaria survive Rocket Launch	Pending
At least 2 successful launches	Pending
Gain useful data from at least 16 planaria in two groups	Pending

We need the planaria to survive, the test tubes to remain intact and the all threads to remain intact in order to have a successful launch Our payload will be connected to the rocket via a u-bolt and quicklick that is then connected to the shock cord. We are able to reuse this payload as many times as needed do not have any complex instruments that we must account for.

Project Plan

Timeline

- August 7, 2015: Request for Proposal (RFP) goes out to all terms
- September 11, 2015: Electronic copy of completed proposal due to project office by 5pm
- October 2, 2015: Awarded proposals announced
- October 7, 2015: Kickoff and PDR Q&A
- October 23, 2015: Team web presence established

  November 6, 2015: Preliminary Design Review (PDR) reports, presentation slides, and flysheet posted on the team website
- November 9-20, 2015: PDR video teleconferences
- November 10, 2015: Team Darwin's teleconference
- November 14, 2015: Yankee Candle fundraiser due
- November 18, 2015: Nuts About Granola fundraiser due
- November 20, 2015: Paint Night registration due
- November 21-22: Proposed November Subscale Launch
- November 30, 2015: Paint Night at Spring Grove High School for fundraising
- December 4, 2015: CDR Q&A
- December 23, 2015: Bonus Book fundraising ends
- January 5, 2016: CDR writing session and construction of Full Scale Rocket
- January 6, 2016: CDR writing session and construction of Full Scale Rocket
- January 13, 2016: CDR writing session and construction of Full Scale Rocket
- January 14, 2016: CDR finalizing and construction of Full Scale Rocket
- January 15, 2016: Critical design review (CDR) reports, presentation slides, and flysheet posted on the team website
- January 15, 2016: Packing in preparation for launch
- January 16-17, 2016: Launch of the Full Scale Rocket
- January 19-29, 2016: CDR video teleconferences

- January 31, 2016: Rocket Real Estate finalized (sponsors)
- February 3, 2016: FRR Q&A
- February 20-21, 2016: Launch of Full Scale Rocket
- February 28, 2016: Final donations sent in from GoFundMe or Paypal
- March 12-13, 2016: Launch of Full Scale Rocket
- March 14, 2016: Flight Readiness Review (FRR) reports, presentation slides, and flysheet posted to team website.
- March 24, 2016: Paint Night at Spring Grove High School for fundraising
- March 17-30, 2016: FRR video teleconferences
- April 8-10, 2016: Emergency Date to launch the Full Scale Rocket
- April 13, 2016: Teams travel to Huntsville, AL; Launch Readiness Reviews (LRR)
- April 14, 2016: LRR's and safety briefing
- April 15, 2016: Rocket Fair and Tours of MSFC
- April 16, 2016: Banquet; launch day
- April 17, 2016: Backup launch day
- April 29, 2016: Post-Launch Assessment Review (PLAR) posted on the team website
- May 11, 2016: Winning team announced

Team Schedule

There are two different types of gatherings: meetings and sessions. Discussions will be lead by the Team Captain and Co-Captain. All members will discuss and comment on the tasks at hand. Sessions will be work time for the members of the team. This work includes typing and editing the proposals, building the rocket, discussing any changes, and planning fundraising for the program. An advisor will be at the sessions to supervise and assist the team. There may also be short briefings, general meetings, bonding sessions, work sessions, and construction sessions.

Meetings

An informal and short meeting will be held before a work session. Jobs and tasks will be given including the time they must be completed and turned in to the advisor.

Formal meetings will be conducted according to a strict agenda, discussing all the tasks that need to be completed and the due dates of such tasks. Updates and changes to ongoing projects will be discussed and compared. Questions, comments, or concerns can be brought about by the members or advisors of the team. The purpose of the formal meetings is to ensure tasks are getting accomplished and make everyone aware of what needs to be done.

Briefings will be short, clear, and concise. They will be used to efficiently inform all of the members of the team. These short meetings will go over what has been completed and the progress on other ongoing tasks. Any changes or modifications to the schedule, budget, fundraising program, and proposals will be announced. These changes or modifications will be the majority of discussion at the briefings.

Sessions

Sessions will be to talk about any problems that have slowed down or stopped the progress of a certain aspect of the project. Personal problems of the members that inhibits their ability to work or work well may be discussed. These problems may not involve the project at all but affects a member's ability to work or attend meetings. The other members can assist to finish the pieces of the project or tasks a member is having difficulty with. These meeting may help to relieve stress surrounding the program or surrounding personal issues. This time will allow team members to grow, to understand one another, and to help each other. Sessions will help the team work more cooperatively and efficiently. Without the sessions, the project may seem more stressful and massive for the team as a whole.

Bonding sessions will also be held to help the team grow together. These particular sessions will improve the bonds between the team members and the advisors. Watching science based movies, genres as specific as aerospace, or any other activities may be held to help relationships within the team grow. A friendly and open environment is necessary to have a pleasurable experience throughout the course of the program. A healthy atmosphere is crucial to a successful and exciting end result.

Work sessions will be strictly for working on the reports and proposals due throughout the course of the year. This will allow time for any questions or clarifications from the members and advisors. The progress on all tasks will be checked and the due dates on those tasks will be restated. Any projects that have been completed will be accounted for. Also, the time allotted for work sessions allows for the two teams to discuss any concerns, to compare progress, and to assist each other in any way.

Construction sessions will be sessions used for the building of the rocket or any parts of it such as the payload. Specific parts will be assigned to pairs of team members to ensure the rocket is built efficiently and correctly. The grouping of team members will hopefully prevents any mistakes or accidents from occurring during construction. If anything does happen, the other member is there to help. The construction sessions will be supervised by at least one adult advisor in case any assistance is needed. All team members must abide by all of the safety rules, including the operation of tools or any other task, for the safety of the entire team.

Meeting Times, Session Times, and Proposed Schedule

General meetings will be held when the majority of the team is able to meet. They will typically be prior to work sessions or before/after school hours. Formal meetings will be held every Wednesday around 2:50pm. Directly following the formal meetings, a work or construction session will be held. More work or construction sessions may be held depending on how much work has been accomplished and how much still needs to be completed. Construction sessions will begin once that point in the project has been reached. As previously said in the section on Sessions, a partner must be present to ensure safety while working on a certain task. Briefings will be held before school or an email may be a substitute to inform and update all members of the team. Group sessions and team bonding will be planned on whatever day works the best for the team. Team bonding also includes any excursions the team takes together.

Budget

Item:	*Cost (In Dollars):*
Travel to Huntsville	6000.00
Food for All Trips:	2354.00
Practice Trips to Maryland	840.00
Lodging in Huntsville	3600.00
Nose Cone	19.95
Body Tubes	450.00
Fast-Hardener	44.99
Resin	85.00
Shock Cords	47.80
Large Parachute	188.00
Small Parachute	113.00
Centering Rings	60.00
Bulkheads	70.50
Motor Casing	149.95

Couplers	100.00
Motor Mount Tube	9.95
Engine Retainers	72.76
U-Bolts	15.84
Quick-Links	14.88
Altimeters	120.00
Batteries for E-BAY	25.46
Wires	30.78
All-Threads	6.40
Key-Switches	106.68
Subscale Rocket	500.00
Fly Nuts	15.00
Battery Holder	6.60
G10 Fiberglass (Fins)	55.00
West Systems Epoxy	70.00
Soda Bottle Preforms	18.95
Ward's Science Planaria	120.00
Expanding Insulating Foam (Payload)	18.99

Animal Motorworks Accelerometer	85.00
Cesaroni K1200 (Motors)	950.00
Misc. Parts	100.00
Total	***$16463.48***

Funding Plan

Since Spring Grove's NASA Student Launch Initiative is not a school funded project, other ways of funding must be sought out. To raise the money to fully and successfully complete this project our team intends to carry out several fundraisers, seek out donations, and look for possible sponsors/grants. All of our alternatives for funding will be completed and approved during the course of the year. Every small amount we can earn adds up to make a substantial difference at the end of the year. A paint night to help raise money has occurred and another is currently being scheduled. We raised $900 from our first paint night. Recently, we have received a $1000 grant from First Energy and are currently awaiting a $7500 grant from TE Connectivity. A picture of our SLI team receiving the grant from Kathy S. at First Energy is located below. Fundraisers that are currently going on include a Yankee Candle sale (information is located at www.yankeecandle.com), the sale of Bonus Books (information is located at www.bonusbook.com), and the sale for Nuts About Granola (located at fundraising@nutsaboutgranola.com). We have raised $340 from the Yankee Candle sale and $750 from the Bonus Book sale. A cotton candy stand has been and will be set up at local sporting events to help raise money and awareness for the program. By selling cotton candy, we have made $1300. We have also earned money through the Rutter's Rewards card; a total of $500 has been earned. Donations are always accepted. We have been able to raise $415 in donations on our GoFundMe account. A donation jar will be seen at all of the events our team takes part in. New ideas are always being welcomed and brainstormed.

Team Picture with Kathy S. from First Energy.

Community Support

To help gain support, our team will be contacting local television stations such as FOX 43 of the FOX Corporation and WGAL 8 in the Susquehanna Valley. Contacting such stations has been done in the past in addition to also contacting radio stations from our area including 107.7 and 105.7.. Also, we are planning to contact local newspapers. All of these examples will help to spread the word about the Spring Grove Rockets and our program. A brief bit of information summarizing our project will be sent to all of the organizations contacted asking if they are willing to help spread awareness of our club. An SLI website will also be constantly updated to help notify the public of the project and any updates. Presentations will be made to our intermediate and middle schools about our project and what we do. We hope this will help to make the kids more aware of and more excited about the possibilities that SLI provides. Signs and posters will also be made. These posters will then be hung around the schools and local businesses to help encourage the program and raise donations for the projects.

Sustainability Plan

We intend to keep our SLI club together now and into the future. This will be accomplished through a combination of many activities and elements. We intend to maintain all of our current relationships with local businesses and sponsors by sending them regular reports, maintain an active dialogue with them, and using their feedback to improve upon our program. Our current relationships are with several certified NAR members, Advanced Application Design and the Engineering Society of York. To keep a steady stream of new members coming into the rocketry club, we will primarily recruit new members from our TARC teams who have had past experience in rocketry. However, anyone who wants to join and is willing to put in the work will be welcome. We will be using a combination of announcements, posters, and our website to get the word to potential club members. We intend to engage the students of Spring Grove Area School District in our club and our mission through a series of assemblies and workshops. Lastly we intend to keep a steady stream of funding coming in through fundraisers, donations, and sponsors/grants. All of these aspects will help to ensure that our club is maintained well into the future. We also plan to:

a) Avoid safety hazards by assuring that every team member and team supervisor that will be handling tools or products reads all of the operation manuals and instructions about the tool before proceeding with any such devices. Reading all of the proper information and also following the enclosed safety plan will help to avoid any errors as we will be using many different tools will be used throughout the duration of completing the project.

b) Address each member of the team to make sure that he/she is comfortable using a tool or product during the construction of the rocket.

c) Raise enough funds for our project we will be holding public outreach programs for funding and support we will be contacting local businesses for grants.

d) Stay on budget. We will keep track of all funds being used and track whether the prices of materials are within the projected cost by researching for the best pricing of the materials. If the price of materials, trips for rocket launches, or any other expenses begins approaching or eventually exceeds our budget, we will raise more funds from additional fundraisers, grants, and sponsorships by using our progress on the project.

e) Work with people, local businesses, and corporate sponsors in and around the Spring Grove area. We plan on spreading awareness of our rocketry programs at Spring Grove to every adult and student in the area. To accomplish this we would like to create hands-on learning experiences for kids in our community to explore and learn more about the rocketry field.

f) Hold public outreach and funding programs at school and local events to help with awareness of our project to get the attention of adults of our community.

g) Provide fun hands on experience for our students so more students will be interested in joining TARC and potentially even SL in the future. We hope to have small groups work together and build small scale rockets. Each group will have an SL member directing the group to help teach the students to build the small rocket. If feasible, we may launch the said rockets (if they are deemed safe to fly).

h) Spread public awareness by contacting television stations, such as FOX and our local news channels, to see if they are interested in making a short segment on the SL program of Spring Grove High School. We also plan to contact local radio stations such as 107.7 and 105.7 to see if they are interested in speaking on behalf of our program here at Spring Grove Area High School.

Educational Engagement

Involving and educating our community about what we do in SLI is very important to the continuation of this program and STEM programs offered in the high school as well. Without the approval of our community we would never get the chance to take part in a once in a lifetime opportunity to fly our SLI rocket down in Huntsville Alabama. As a group we diligently work to prove that the SLI team is a program that affects our members positively for years. In turn we have received respect and support from our community and we wish to keep this positive relationship going on for the future SLI teams.

This year we plan to hold similar events as the members of the 2014 SLI team did last year to educate the younger students of Spring Grove. By focusing on the younger grade levels we have the opportunity to spark the imagination of these kids and hopefully inspire them to join one of the programs offered in the high school. We will achieve this by holding presentations in the middle, intermediate, and elementary schools to inform the students of what we do in SLI, why they should care, and how they can join when they come to the high school. These presentations help keep our STEM programs going by motivating the younger Spring Grove students to join and continue this positive program.

NASA would like us to focus on students in grades 5 through 9 specifically. In addition to the presentations, we would like to hold a rocket building workshop for these age groups. Our workshop will give the students a chance to experience rocketry first hand, by allowing them to assemble their very own in a safe and educational environment. Rocket designs will be created by members of the 2015 SLI team to ensure the students safety and the ability of the rocket to fly with little to no complications. These students will be working in groups of 3 to 4 along with a mentor from the SLI team to assist the students in the building of their rockets. Before the workshop, the students will attend a brief seminar where they will learn the basics of rocket designing and how the rockets they are building (previously designed by a member of the SLI team) were constructed. By doing this rocket building workshop we will help widen the students' knowledge of the rocketry process, and enhance their experience with the SLI team positively.

As mentioned above, SLI team members will be assisting in the workshop by showing the students how to properly use tools and inform them about safety precautions throughout the building process. Following the workshop, students will be able to launch their rockets. This will hopefully inspire them to continue with their interest in STEM programs. After the rocket launch, students will be encouraged to ask questions and give comments about the SLI and rocketry programs. They will also be able to see a more in depth look at what the SLI team does.

Students will be able to enroll in this workshop, by filling out a signup sheet after our presentations held at their schools, and will bring home a consent form for their guardian or parent to sign.

There will also be a meeting prior to the workshop for these students and parents to get more information about the project.

Gant chart

Conclusion

We now have moved beyond the beginning and continued to advance our project design and overall plan. Our current focus is to improve our documentation and begin work on the subscale rocket. We will continue to move forward with our current plan and will look forward to the presentation.

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