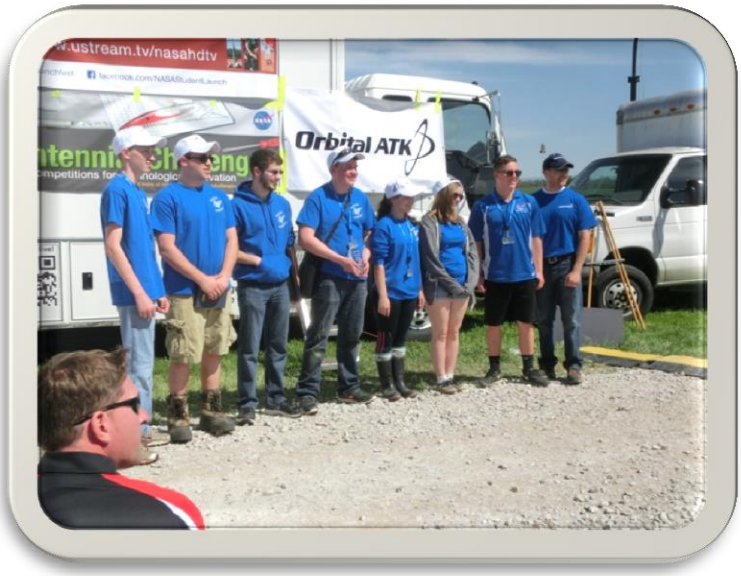
Spring Grove Area High School

SL Rocketry Team PLAR 2015



Project TreeTop

The Rocket Men of Spring Grove

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: The Rocket Men (TRM)

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

3. Safety Officer:

- Robert Dehate
  NAR Representative
  Phone number (cell):978-766-9271
  NAR L3CC 75198
  TRA TAP 9956

4. Key Managers:

- Brian Hastings- Advisor and Supervisor of students
- Renee Eaton- Advisor and Supervisor of students
- Mr. Sengia- Instructional Technology Specialist
- Kyle Abrahims- Team Co-Captain (Electronics Bay Leader)
- Wyatt Nace- Team Co-Captain (Payload Leader)

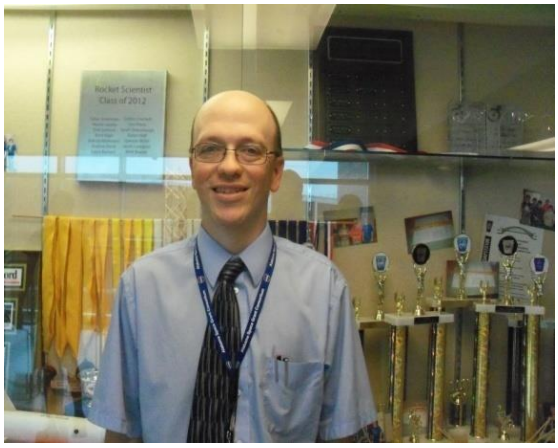
5. For Launch Assistance, mentoring, and reviewing our team will be working with the local NRA representatives along with MDRA (Maryland-Delaware Rocketry Association) for all questions and launches.

Team Members

Name: Brian Hastings

Position: Physics 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 Masters 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.



Name: Renee Eaton

Position: 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, and the Envirothon 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 1 certification. Currently I am building a rocket for level 2 NAR certification.

Name: Wyatt
Age: 17
Grade: 12
Position: Team Co-Captain and Payload Leader

In fourth grade, I participated in my first competition, Math 24, and became the champion for my school. I advanced through the county competition to the state competition, where I received a bronze medal. I became a “rocket scientist” at Spring Grove in eighth grade, when I joined Science Olympiad. I have been in Science Olympiad ever since, and we have advanced to the State competition every year since. My sophomore year was my first for both TARC and the SLP. In my first year with NASA I learned so much and being able to work with the top people in the field, I was able to prepare for becoming an Aerospace Engineer. These experiences taught me how to work with a team, working on a tight schedule, and leadership, among other things, and am ready for another year to work with NASA.

Name: Kyle
Age: 17
Grade: 12
Position: Team Co-Captain and Electronics Bay Leader

As a student I am involved in many activities throughout the school. I am a part of the Science Olympiad team that has made it to States' the past 5 years in a row including a 12th place finish in 2013. I am a part of TARC and am currently working with my team as a captain, and last year at my first nationals' was able to place a respectable 39th. This year I get to work with Wyatt and become a Co-Captain from our past experience with the SL Program in 2012 and good finishes in TARC. The Student Launch Program is a great experience for all of us and I plan to use the experience in my future clinical labs and use it to further my education in science. In the future I plan to get a bachelors' degree in Chemistry or Mechanical Engineering from either The University of Pittsburgh or Bucknell University.

Name: Josh (Budget and Funding plan)

Age: 16

Grade: 11

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 am also a member of the book club, German American Partnership Program, and I have played violin since 3rd grade. This year, I am looking forward to being a SL team member.

Name: Jake (Student Safety Officer)

Age: 18

Grade: 12

Position: Head Safety Officer and E-Bay Worker

I became a "Rocket Scientist" in 4th Grade by joining Envirothon. I have been doing Envirothon ever since then and was the captain of the team last year. Also last year I became a member of our Science Olympiad team, TARC team, and High powered rocketry team. In Science Olympiad we won the regional competition and advanced to the state competition. My TARC team qualified for Nationals and competed against 100 teams around the nation. Our high powered rocketry team launched a 38lb, 6in diameter rocket to an apogee of 5955 feet. All of these rocketry experiences have helped me develop my teamwork skills as well as learn many key concepts of engineering.

Name(s): Sarah H. and Sarah E. (Educational Engagement)
Age: 17
Grade: 12

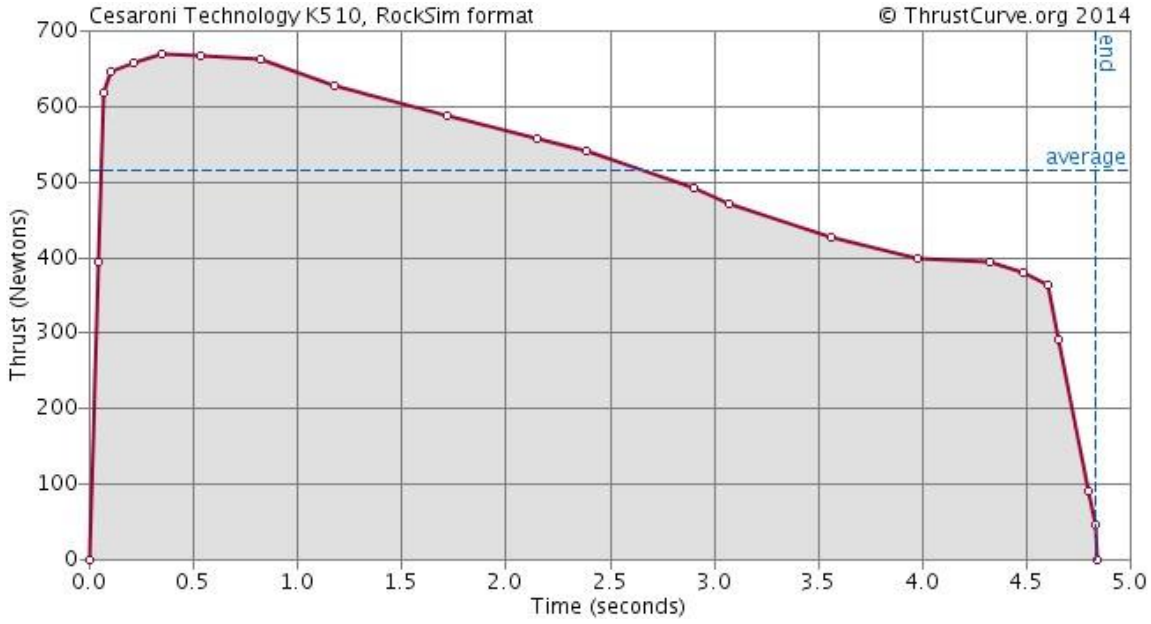
(Right): This is my first year participating in both Student Launch (SL) and Team America Rocketry Challenge (TARC). I am involved in other school activities including National Honor Society, the German-American Partnership Program, Spring Grove Choral Ensembles, Expressions, and Globetrekkors. My out-of-school activities include Midstate Ballet, Greater York Dance, and National Honor Society for Dace Arts. I dance pre-professionally over 20 hours a week. I got involved with the rocketry program because I loved physics class and I wanted to explore the engineering field before deciding on a college major. Math was always my favorite subject in school because it is black and white. The answer is either right or wrong; it is simple and precise. I think my involvement in SL and TARC will allow me to utilize my math skills, apply them to my life, and have fun in the process.

(Left): As a student of Spring Grove Area High School, I have been involved in many extracurricular activities such as Student Launch Program, Team America Rocketry Challenge, Choir, Drama Club, International Thespian Society, National Honor Society, Administrative Technology Teaching, Symphonic Band, as well as dance outside of school. I had recently joined the SL program this year after joining TARC the previous year and making it to nationals with my team. In TARC, I am the team captain of an all girl team and I am the only girl involved in this year's Administrative technology Teaching. After school I plan on attending college majoring in Biology and following a pre-medical route.

Name: Gavin (Safety and Payload)
Age: 16
Grade: 11

Throughout my school career I was always interested in the sciences. It wasn't until 10th grade when my Physics teacher introduced the rocket programs at our school. I started my 10th grade year and I was quick to join again this year and take it to the next step by joining the SL team. My first year in TARC, Team America Rocketry Challenge, we made it to nationals and finished highest out of all the teams from our school. That year got me interested in all the science related clubs and activities and hope to expand my horizons even more this year.Other than SL and TARC, I'm on the soccer team which takes up a lot of my time in the fall season. I'm really looking forward to the opportunity to be on the Spring Grove SL team.

Motor Used: K-510 Classic Motor



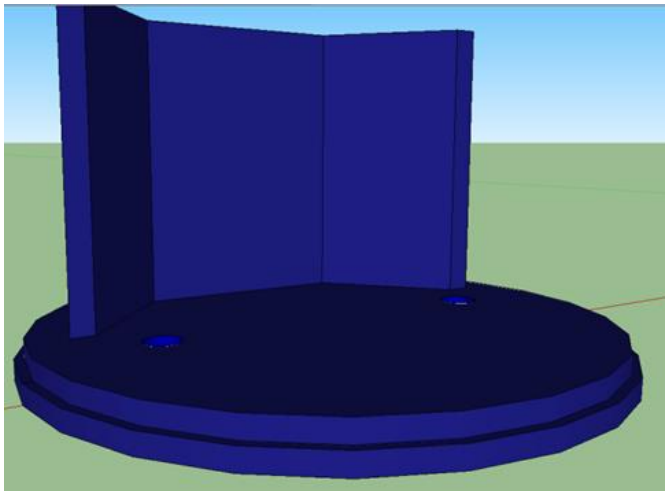
Payload Summary:

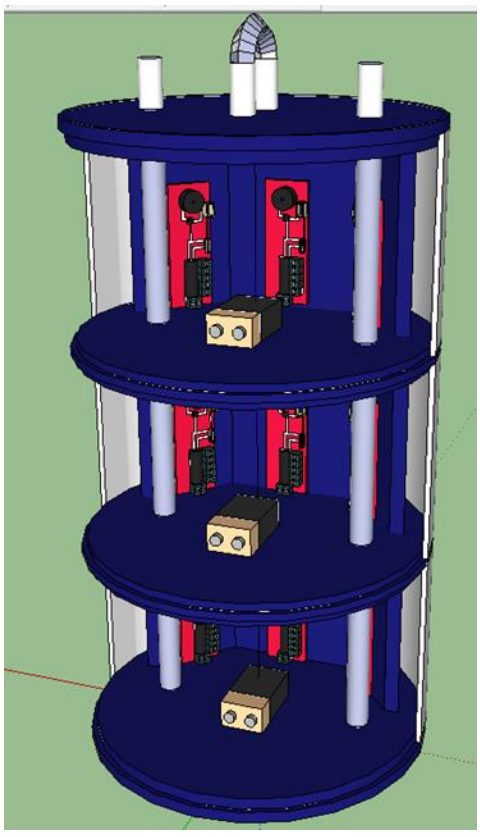
AGSE/Payload Title: Not needed because of being a middle/high school team

Autonomous Procedures Summary: Not needed because of being a middle/high school team

Payload Summary:

The payload determined the effect of the size of a single port hole on the measurements taken by a Stratologger CF altimeter. Each altimeter was completely sealed in its section except for the single hole, which allowed it to take data during the entire





flight. Each section housed three altimeters, and the entire payload was comprised of three sections. Each of the three altimeters in each section took measurements from the exact same hole, allowing for analysis of consistency among the altimeters. These three sections allowed for testing of various hole sizes, so a smaller and larger hole could be used. The Stratologger user's manual offered an equation for ideal single port hole size, and this size was used as a control for the experiment. This equation yielded a hole diameter of approximately 3/32", and a slightly smaller and larger hole was selected for the other two sections. The smaller hole was 5/64" and the larger hole was 7/64".

This experiment determined the precision of the altimeters, because each section's altimeters operated under completely identical circumstances. With the data, we were able to judge the typical variance of the altimeters.

Each of the three altimeters in each section were wired in parallel to a single nine volt battery, which was held within a battery terminal that was mounted to the 3D printed pieces. After a launch, each altimeter could be plugged into a computer and all data could be collected, including height, temperature, and voltage.

The payload was designed to remain stationary throughout the flight through the use of carriage bolts. Two carriage bolts were placed through the entire body tube, and they both threaded inside of the U-bolts on either end of the payload. This prevented the payload from shifting up or down during the rocket's flight. Also, a small screw was placed through the exterior body tube into one of the 3D printed pieces, preventing the payload from rotating in any way. These two components prevented the payload from moving in any way during the flight.

Vehicle Dimensions

- *Length* - 114.5 inches
  - Top Half- 36 inches
  - Bottom Half- 60 inches
- *Mass*- 23.22 pounds in Huntsville
- *Diameter*- 4 inch fiberglass phenolic
- *Fins*-Specifically designed for the rocket and made to allow for proper placement of the *center of pressure.*
- *Major Parts*-
  - Payload
  - Electronics Bay

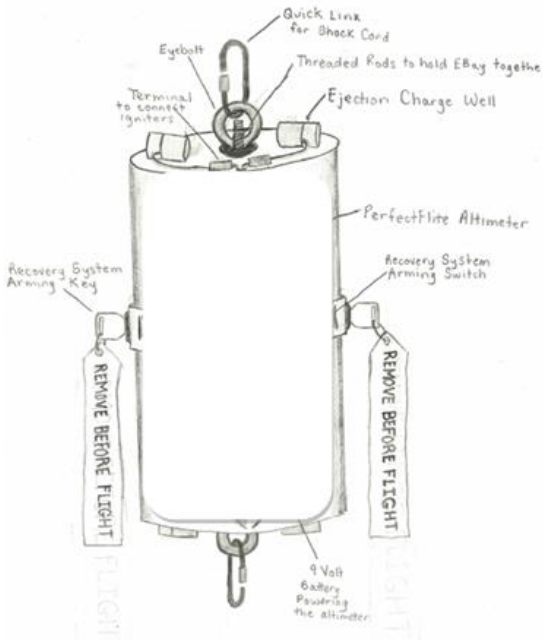
Altitude Reached

In Huntsville, Alabama our rocket achieved an altitude of 5,291 feet. This was only 11 feet off of our desired altitude of 5,280 feet and earned us the title of high school altitude champions!

Vehicle Summary

At the back body tube we used a 3-D printed fin bracket. This 3-D fin can was printed by one of our sponsors, TE Connectivity. It was printed using fused deposition modeling with ABS plastic and fitted on the back body tube in one piece. We mounted a 75mm motor mount in the back body tube with 3 center rings that had wood strips glued vertically between the rings. We could screw the 3-D printed fin bracket into these strips. The fin bracket is structurally sound and did not comprise any other part of the rocket. Above the motor mount, we placed a ½ inch bulkhead with a U-bolt on it. The U-Bolt had shock cord going from it to the back of our scientific payload. The scientific payload had two U-bolts on both sides with shock cord attached and had ½ inch bolts holding the payload in place during flight. Above the payload, was our 24 inch drogue parachute attached to shock cord from the payload. The shock cord that holds the drogue parachute went to the electronics bay which had a U-bolt on both sides. The electronics bay coupled the back body tube to the front body tube and housed the ejection charges with the altimeters. Above the electronics bay in the front body tube was shock cord attached to a U-bolt which had a 15 inch pilot parachute and a 72 inch iris ultra-main parachute. The shock cord from the main parachute went to a bulkhead at the top of the front body tube that had a U-bolt.

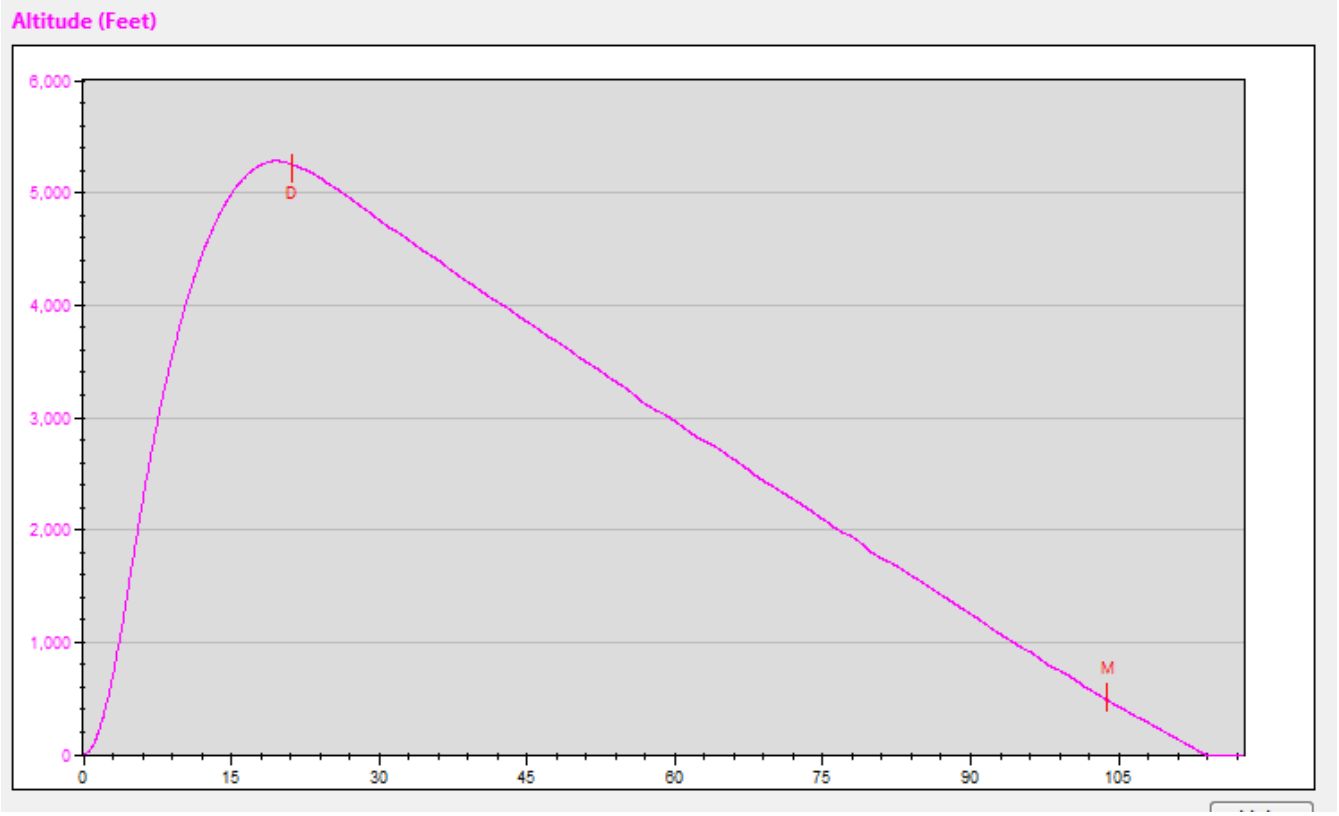
The rocket overall with all of these components was 114.5 inches in length and was comprised of a 4 inch body tube made from fiberglass phenolic tubing. The tubing withstood the flight very well and did not show any signs of damage. The nosecone was made up of plastic and was fitted to the rocket with pop rivets so that it did not fall off. Overall the vehicle worked really well and was structurally intact from the flight.



Data Analysis

In Huntsville the rocket took a very straight and stable flight off of the pad and took data with the two redundant altimeters that were in the electronics bay. The first altimeter read a height of *5,291* feet while the second altimeter had a power loss during flights due to a battery coming loose from impact, but still recorded a height at apogee of *5,292 feet*.

The rocket then ejected the drogue parachute at apogee and drifted down to 600 feet without the main parachute ejecting. At 600 feet the ejection charge went off for the main parachute but the full parachute did not come out due to some blockage in the tube and too long of a front shock cord. This was okay as we had a backup pilot chute of 24 inches which allowed the rocket to slow down to a safe enough velocity as to take on little to no damage at landing except for the battery terminal coming loose in the electronics bay.



Payload Summary / Scientific Value

Our payload was able to collect data during the flight in Huntsville even with the clock running against the batteries in our payload. All nine of the altimeters we able to collect data and with that we were able to get average height readings for each section. The readings in the 7/64" section were all within a foot of each other. The first altimeter read a height of 5289 feet; the second altimeter read 5287 feet, and the third read 5290 feet. The average height for this section was 5288.7 only 8.7 feet off from our target apogee of one mile. The second section of

our payload gave us very similar data using 3/32" holes. The first altimeter in this section read 5279 feet, the second read 5281 feet, and the third read 5279 feet. The average height in this section 5279.7 feet, only .3 feet away from our target apogee. The third section of our payload, again, gave us very similar data. The 5/64" holes didn't make a noticeable difference compared to the other two sections. The first altimeter in this section gave us a height reading of 5286 feet, the second altimeter gave us a height of 5291 feet, and the third altimeter gave us a height of 5287 feet. The average height in the third section of the payload was 5288 feet, 8 feet away from our target apogee. The payload data was rather inconclusive on whether or not port hole size affects readings but with more tests the data may start to point on one direction or the other. We plan to use the payload later this year in another launch that will reach a higher apogee to see is that changes anything. We also might drastically increase the size of one or more of the holes to see how that changes things. *The data should eventually be able to help us when dealing with what size port hole to use.* As of now we plan to publish our data in a popular rocket magazine so hopefully someone else will be able to use the data from our experiment.

Visual Data

On the day of the launch in Huntsville, we had mostly clear skies with a light wind that got slightly stronger as the day went on. During our launch the engine worked correctly and our rocket had a straight trajectory with only minor instability during launch. Our drogue parachute correctly deployed and opened without any problems or complications. The main parachute however did not deploy and was stuck in the front half of the rocket. We had a small pilot chute that was supposed to provide additional force to dislodge the main in the instance that it would get caught. However this did not happen and the main never deployed. The rocket landed safely without the main and our data was recovered. The launch was a success

Lessons Learned

During the course of this project and the final stage in Huntsville we had a variety of challenges and problems that we had to solve and overcome. These included limited battery life for onboard electronics, issues with building materials and necessary design changes. These have provided us with experience and knowledge of how we can be better prepared for next year. The first is that we can never expect that everything will go right and that we must be prepared if something goes wrong. During the testing of our subscale we had many different malfunctions that hindered the completion of that part of the program. This included bad motors and parts of our design that do not work as they were intended. To mitigate this, we learned to always have more than one functioning rocket for each launch and to always bring any tools or materials that we could possibly need. The next thing is that we can never expect that the conditions at our launch site to be ideal and that we could never anticipate what we could or could not get done. We have had multiple instances where we were not able to launch or a launch date had been postponed because the weather made it unsafe to launch. We dealt with this by launching at

every available opportunity until we got the results that we needed. Lastly we should never assume that a design is final as we had to continue to make adjustments throughout.

Overall Experience

Overall the experience was helpful and constructive to all of the students that took part in it. We all learned a lot and gained invaluable skills from being on the project. The paperwork was not overly difficult to complete though it did take a lot of time and effort. Unfortunately the program did not get up and running until later than it usually would so we did not have as much time to complete all of the parts as we normally would. This placed a little more stress and responsibility on every member but did not overly impact our ability to complete our paperwork on time. The teleconferences and evaluations of our documents was mostly streamlined and without any major problems or complications. All video conferences had some minor problems due to inexperience with the programs and devices involved on our part but this did not impact the content, quality, or timeframe of said conferences. All feedback was useful and constructive on our project. During the building of our subscale and full scale we had only construction issues that were derived from translating our design on paper to the actual rocket. This included strength and integrity of materials and construction processes. At times this meant an increased amount of time and effort was exerted for different parts of construction. This did not affect our ability to meet deadlines and specifications. Our launches were prone to bad weather and less than ideal conditions. This led to many problems when launching both our subscale and full scale such as inability to launch when specified, hazards like our rockets landing in nearby trees due to the wind, and having to launch under less than ideal conditions due to not being able to launch at a different date in order to meet deadlines. All trips were planned out well enough and all necessities and special cases were taken into account. In Huntsville we had excellent accommodations and assistance was readily available. All tours and activities were well planned and organized. All were constructive and interesting to be a part of. All debriefing and safety checks went smoothly for the most part with only minor problems with miscommunication and timeframes. All transportation was comfortable and more than satisfactory. On launch day we had adequate room and on-site resources. Our team had enough time to prep and launch our rocket. The only concern here was that out rocket was out on the pad for a long time before launching. This is a concern because all of the onboard systems run on batteries and if they are out there too long then the recovery system will have no power to deploy our main parachute. It was great to not only have a successful flight but to win the altitude award this year as well. Overall the program was very constructive and interesting.

Educational Engagement Overview

In order to spread awareness of all science programs at Spring Grove, we held presentations for both 7^{th} and 8^{th} graders at our middle school to inform them of our project, the basics of a rocket, and how to get involved in them when they reach the high school. We introduced to them about creating a TARC team at the middle school, which was of popular

interest when they were allowed to ask us questions at the end of the presentation. This presentation reached over 500 students at the middle school.

To obtain feedback, we gave small surveys to all the students who were involved in our presentations. These surveys asked how well the presentation was given, how interested the student is in joining a rocketry club, what the mission of the Student Launch Program is, and additional information. These are some of the interesting results we received. 74% of the student had absolutely no prior knowledge of rocketry and 90% of the students said they learned something. By the end 63% were even able to identify where the motor casing was on the rocket, which is very impressive for a presentation that was only around 25 minutes long. Students also received permission slips to attend a unique rocketry workshop at the high school. The experience was very positive and we had 18 students who signed up to participate in the rocketry workshop in result of the presentation.

We just recently held a rocketry workshop for students that heard the presentation and were interested in learning more about rocketry. ---- students attended and the outcome was very positive. This idea was created when we received kits of small rocket parts donated by our sponsor, AquaPhoenix, where upon, we wanted to hold a workshop for children to build these kits and get involved in rocketry. The rocket kits include body tubes, nose cones, 2 oz. bottles of super glue, bulk heads, motor centering rings, wings, air resistance tubes, sandpaper, motors, ruler, shock cord, twine, solar igniters, bags, and scissors. Every team member of the Student Launch program led a small group and guided the children through the basics of rocket-building. The groups then launched their small rockets, further spreading rocketry awareness and teaching the fundamentals of rocketry. Photos of the event can be found on our website and some here. Students who attended the workshop were then given the following survey at the conclusion of the event. Feedback will be useful for planning purposes and contacting interested students about TARC. After the event, participants were able to view TARC launches from current high school teams and some were even qualifying score attempts.

After the workshops, we took a survey from the 18 students who attended and found out that:

- All 18 enjoyed the workshop
- 15 of 18 learned something new
- 18 of 18 understood the basics of building rockets by the time they left
- 12 of 18 are interested in joining TARC next year

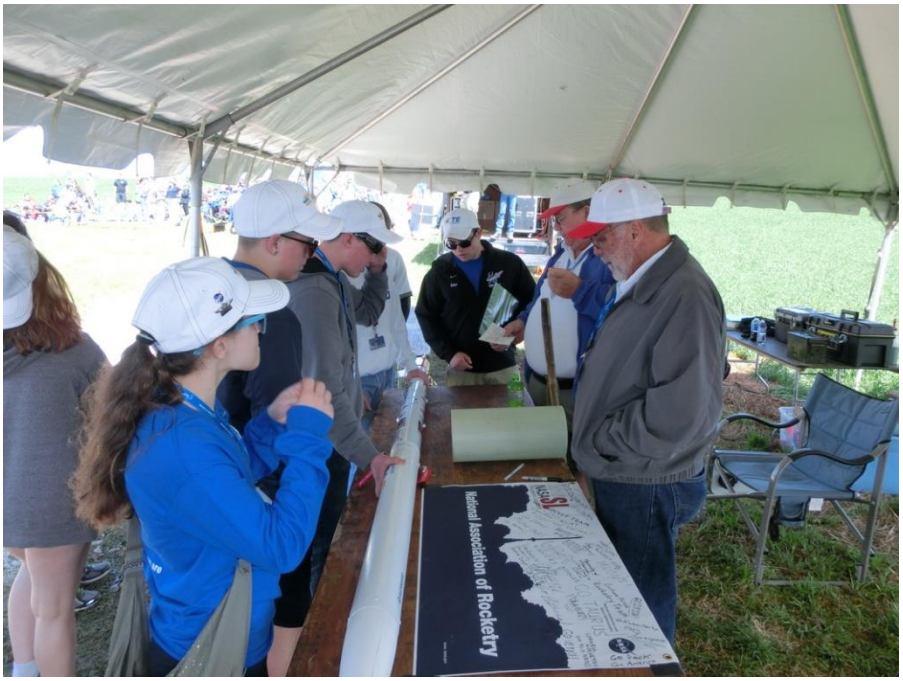
Funding Total

We obtained all funding necessary to reach Huntsville, Alabama in April. Through many grant applications and generous donations we reached our goal. Near the conclusion of our project, we have found funding from TE Connectivity (4800), The Spring Grove Educational Fund (5000), Aquaphoenix Scientific (2000), The Engineering Society of York (1000), Advanced Application and Design (500), McClaren Plastics (500), Penn Waste (250), and numerous other small sponsors and donators that have helped us achieve the ultimate goal and be able to reach Huntsville, Alabama

A Nuts About Granola sale took place, collecting $150 for the Student Launch project. Each bag of granola sold raised $2.00 for the club. We also sold Bonus Books from a local company around the area with a profit of $12.50 per book. That sale netted over 1000 dollars in profit for the club and helped chip away at the goal of 18,000 dollars total.

We also rented a cotton candy maker from Harvey's Rental and sold cotton candy at our school's events, including football games, wrestling matches, and any other event where concessions can be sold. Each event netted approximately $350 per event.

Picture Summary



The End!! Thank You for this amazing opportunity
-Spring Grove NASA SL Team