

FIRST® Tech Challenge Team #11587 Engineering Notebook

Starry Knights

Imago Dei Academy
Alamogordo, NM

ABSTRACT

The Starry Knights were organized in 2016 at Imago Dei Academy in Alamogordo, New Mexico. Imago Dei Academy is a classical Christian school with a strong academic focus on classical liberal arts. In 2016, the School Board decided to increase the school's emphasis on STEM activities to develop more well-rounded graduates. FTC Team #11587 was formed as part of the school's increased STEM focus. Team #11587 has grown significantly since its beginning and now includes not only IDA students, but also team members from local public and home schools. Major team milestones include:

- Team Formation: September 12, 2016
- Robot Build Complete: October 31, 2016
- Robot Testing Complete: December 12, 2016
- Alamogordo FTC Competition 2nd Place: December 17, 2016
- Robot Re-design Complete: January 27, 2017

We invite judges to review our Team Overview and Biographies on pages 4-21 to get to know us better. Judges may also find the following portions of this Notebook particularly interesting:

- Programming/Control Section (p.29-32)
- Engineering Notebook Document Processing Section (p. 22)
- Scissor Lift Design Section (p. 23-27)

27 January 2017

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1. Team Overview

Welcome to the Engineering Notebook for FIRST® Tech Challenge Team #11587! This book documents the development process for our team's robot for the 2016-2017 competition season.



FTC Team #11587

Team Vision

To glorify God through the practice of Gracious Professionalism® and deliberate excellence both in the competition arena and in daily life.

Team Mission

Build and develop engineering skills for tomorrow through innovative thinking, a diligent work ethic, exceptional design, and Gracious Professionalism® in execution.

The *Starry Knights* organized in September 2016 at Imago Dei Academy in Alamogordo, New Mexico under the guidance of Head Coach Deneen Black. Imago Dei Academy is a private classical Christian school with an academic focus that traditionally has been strong in liberal arts education. In 2016 the school board decided to increase the school's focus on STEM activities to develop more well-rounded graduates. The *Knights* organized and quickly expanded our membership to include not only IDA students, but also students from local public and homeschools.

When the team initially formed, none of our members had any experience in robotics or computer programming. For the first two months, our learning curve was very steep! In late October 2016 we reached the point of having a basic functioning robot, leaving us approximately six weeks before our first competition to develop OpModes and Driver code. We settled on a strategy of simple, basic maneuvers during the Autonomous period, and focused on Driver skill in accomplishing Beacon claims during the Driver period of a match. This approach resulted in a 2nd place finish at the Alamogordo FTC Competition in mid-December. We could not have succeeded at the Alamogordo competition without the help of the FTC R²D² Team from Alamogordo, who graciously supplied us with tool boxes, shared work space, and plenty of encouragement as we prepared for our first competition.



Thank you R²D² Team!

We were able to "pay it forward" by taking the opportunity to support and mentor two FIRST® Lego League teams at our school during the fall season.

Our 2nd place finish at Alamogordo secured us a spot at the Arizona/New Mexico Championship being held at Flagstaff in February 2017. We quickly realized we needed to step up our game significantly to be competitive at that match. We reorganized, went back to the drawing board, and identified three target tasks for our robot to allow us to remain competitive at the inter-state match. Under the guidance of our

new Head Coach, Kurt Kochendarfer, we tore our robot all the way down to the basic drivetrain and started a rebuild to meet our target goals. During this time our team also branched out to accomplish an increased focus on community outreach, fundraising/support, and Team spirit! Along the journey we've had lots of opportunities to learn, to teach, and to grow in our understanding of and appreciation for science, technology, engineering, and mathematics. FIRST® Tech Challenge has allowed us to meet and exceed our School Board's expectations for STEM development. The credit for all of this goes, first and foremost, to God.

1.1. Team Biographies

Our Team consists of members from a wide variety of backgrounds and interest areas. The biographies listed below will allow you to get to know us better!

1.1.1. Build Team

1.1.1.1. Emmet Burks - Build Team Lead



Emmet Burks

Emmet is a junior at Imago Dei Academy. He joined FTC for entertainment, and has found his time on the Build Team a good experience which has broadened his horizons. Emmet plans to pursue a college degree in criminal justice and a follow-on career in law enforcement. He also enjoys hunting, shooting, and martial arts.

1.1.1.2. Brandon McLaughlin



Brandon McLaughlin

Brandon McLaughlin is a 9th grader at Imago Dei Academy. He joined FTC for a chance at good scholarship opportunities in the future, and to fill his after school time with something interesting. He is interested in writing and getting a broad range of experience in different fields. His favorite subject in school is History. His hobbies are writing, bike riding, and playing video games. He hopes to be an author of fiction or non-fiction, or to be a journalist. Brandon is a creative young man with a fun personality.

1.1.1.3. Joshua Bryant



Joshua Bryant

Joshua Bryant is an 11th grader at Imago Dei Academy. He joined the FTC team because he did FLL and wanted to move to the next level. He really enjoyed participating in FLL. He was a valued participant on the building sub-team and had many good ideas. Josh would like to be a Lego Master Builder who builds life-sized Lego models. He does not plan to attend college but maybe will change his mind. Josh was the mastermind behind the team's Autonomous mode driving strategy this year. His other interests include reading, watching TV and playing video games.

1.1.1.4. Gabe Steckler

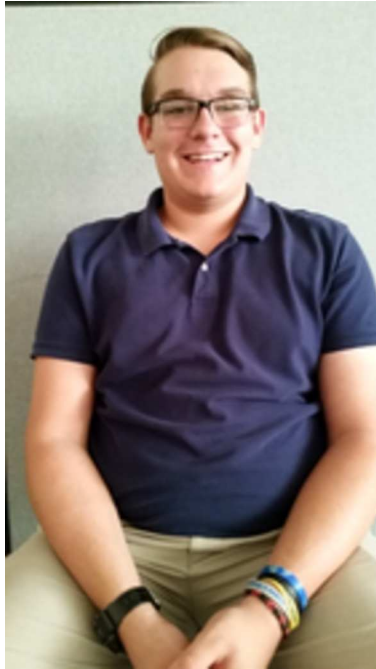


Gabe Steckler

Gabe Steckler is in the 8th grade. He joined FIRST® Tech Challenge to learn and have fun. He chose to be on the Build Team because he did not think he would be good at programming. He thinks he may be interested in studying Engineering because he is fulfilled when he creates or builds something. Gabe describes himself as tall and a bit weird. He is interested in history and particularly in WWII tanks. He likes to read and play with Legos. Gabe would like to be a fire fighter in the future.

1.1.2. Programming Team

1.1.2.1. Dax Bash - Programming Team Lead



Dax Bash

Dax is a senior at Imago Dei Academy. He joined the Starry Knights to become part of the Programming Team and develop some Java programming experience. He has really enjoyed programming the robot and applying the programming skills he has learned. His school interests are primarily history and writing, but he also enjoys working with computers. His hobbies include computer games, camping, and cycling. After graduation, Dax is considering careers in law enforcement, information technology, or possibly becoming a history teacher. Dax is currently an Eagle Scout Candidate.

1.1.3. Community Outreach Team

1.1.3.1. Araya Blaylock - Community Outreach Team Lead



Araya Blaylock

Araya is a junior at Imago Dei Academy. She joined FTC because she thought it would be a great way to learn about the practical application of electronics in structures. She also wanted to have the experience of working in a team environment. In addition to serving as the Social Media Manager on the Community Outreach Team, Araya was instrumental in helping the Build Team organize parts and materials. Araya is skilled in public speaking and drama. She plans to study veterinary medicine after high school at North Carolina State University.

1.1.3.2. Adrian Martinez



Adrian Martinez

Adrian Martinez is in 9th grade at Imago Dei Academy. His Mom encouraged him to join FIRST® Tech Challenge. He chose to be on the robot building team to create the ideas that are in his head. Adrian would like to be a Cartographer because it involves technology, math, and science. H believes we need to know what the world we live in is like, so that we can take care of our planet. Caring for the earth is a thing we must do, because it can help make everything easier for future generations.

1.1.4. Fundraising Team

1.1.4.1. Dale James - Fundraising Team Lead



Dale James

Dale James is an 8th grader at Imago Dei Academy. He joined this team to be a part of something challenging. He has learned a lot and was a member of the team who organized and documented the meetings and accomplishments. He has lots of diversity in his interests and is a great team player and encourager. Dale's outgoing personality and professionalism paved the way for sponsor support this year. You can always count on Dale for genuine smile!

1.1.5. Project Management Team

1.1.5.1. Alyssa Kochendarfer - Lead Project Manager



Alyssa Kochendarfer

Alyssa splits her time between being a part-time sophomore at Imago Dei Academy and a home-school student. She decided to join the Project Management Team both as a way to see the various areas of Team 11587, and as a way to use her organizational skills to benefit the Team. Alyssa is a 4th generation licensed amateur radio operator and plans on studying engineering in college. She is interested in a career in radio engineering and broadcasting.

1.1.6. Coaches and Mentors

1.1.6.1. Kurt Kochendarfer - Head Coach



Kurt Kochendarfer

Kurt is an Air Force Reserve F-16 instructor pilot and Department of Defense contract F-16 subject matter expert with more than 3200 flight hours and six combat deployments under his belt. Kurt's technical background comes primarily from more than 30 years of aviation experience, multiple IT management projects, and lots of self-instruction. Kurt's hobbies include long-range shooting, mountain biking, long-distance running, and anything related to aviation. Kurt is also a 3rd generation licensed amateur radio operator with an interest in software-defined radio and digital signal processing. When not nerding out, he loves a good cup of coffee on the front porch enjoying God's creation with his wife, Teena, and their dogs.

1.1.6.2. Teena Kochendarfer - Assistant Head Coach



Teena Kochendarfer

Teena is Registered Dental Hygienist, and the organizing force behind the administrative functions of the team. As a mother who has been home-schooling children since 1998, her mentoring and organizational skills have been indispensable in keeping the *Starry Knights* on task this season. Prior to this season, Teena had precisely zero experience with robots but has learned much throughout the development process.

1.1.6.3. Michael Hitchcock - Programming/Build Team Mentor



Michael Hitchcock

Michael "Hitch" Hitchcock served for 9.5 years as a US Navy Submarine Navigation Electronics Technician. After his discharge from the Navy, he received an Associate's Degree in Electronics Technology, and credits towards a Bachelor's Degree in Electrical Engineering. He now works as a civilian Electronics Technician for the US Air Force High Speed Test Track at Holloman Air Force Base, New Mexico. His hobbies include programming, circuit design, 3D modeling, repurposing hardware, and Hash House Harriers.

1.1.6.4. Deneen Black - Founding Head Coach



Deneen Black

Coach Deneen Black is a retired Engineer and Program Manager who worked most of her career as a US government civilian. She organized this team and secured a DoD grant for Imago Dei Academy to get started. She has been working with STEM education outreach since 2007 through AIAA and Air Force STEM. Coach Black smoothed the way for team sponsors, and was the driving force behind the team's formative months. She gives God all the glory for all of her blessings and accomplishments.

1.1.6.5. Steven James - Build Team Mentor



Steven James

Steven was fundamental in mentoring the build team in the redesign of the robot for the second half of this season. As the owner of Eureka CNC, a precision aircraft parts manufacturing firm, Steven brought thousands of hours of CAD experience and structural engineering to the project. His expertise with 3D printing was vital to the design and production of the scissor lift assembly.

1.1.6.6. Chris Black - Programming Team Mentor



Chris Black

Mentor Chris Black is a college student pursuing his Masters Degree in Electrical Engineering from New Mexico State University. He has assisted this team primarily with programming. He will work for the Department of Defense-Air Force when he graduates in May 2017. He hopes to continue mentoring young people in STEM disciplines. His interests also include softball, basketball, and hunting.

1.1.6.7. Roger Black - Build Team Mentor



Roger Black

Mentor Roger Black is a Veterinarian. He also spent many years in construction and as a building contractor so his skills in building the robot and using tools was of great assistance to the team. He assisted with robot design and functionality. His interests are athletic coaching and hunting. His son, Nate, is on the team and his wife, Deneen and other son Chris are coaches/mentors to the team. This was his first exposure to robots and programming.

1.1.6.8. Erin Steckler - Community Outreach / Fundraising Mentor



Erin Steckler

Mentor Erin Steckler is a homeschooling mother and wife. Her son, Gabe, was curious about robotics which led to her involvement with the team. This was her first exposure to robotics and programming. Mrs. Steckler was instrumental in helping the Community Outreach Team and Fundraising Teams develop momentum to jump to the next level in *Starry Knights* team history. In her spare time, she enjoys hiking, spending time with family and friends, and photography.

1.1.6.9. John Steckler - Build Team Mentor



John Steckler

Mentor John Steckler became involved with the team upon returning from deployment and hearing his son's excitement over the robot. He is employed by the USAF and although his job keeps him busy, he is happy to spend his spare time helping the team.

2. Engineering Section

2.1. Engineering Tools

2.1.1. *groff* Document Processing

After reviewing several different options for engineering documentation, the Project Management team settled on using *GNU troff*, or *groff*, for documentation of our project. *groff* has a history which goes back to the implementation of the *troff* program at AT&T Bell Labs Patents Division in 1971. Engineers at the Patents Division sought an efficient, consistent way to document patent applications, which often contained images, diagrams, complex equations, and other highly technical content. *troff* was developed as a way to produce complex documents with a simple, easy-to-learn markup language. Considering the lack of word processors at the time it was developed, *troff* was revolutionary in its day.

groff is the GNU version of the original AT&T *troff* code. *groff* differs from a modern word processor primarily in the fact that content is somewhat divorced from formatting. In a modern WYSIWYG (what you see is what you get) word processor, the formatting displayed on the screen is a close approximation of the formatting that will show up in a print version of the prepared document. While this method is suitable for casual use and simple applications, scripted document processing using a markup language generates more consistent results with complex documents such as engineering/technical writing.

In addition to producing beautiful output, *groff* was selected because input can be accomplished with a simple text editor, or even directly in the Edit function built into the website at our GitHub repository. This allowed easy editing and input without the requirement for complex or expensive editing software. Using simple text input, the Team was able to quickly capture meeting notes, ideas, and other documentation. Prior to final production, the notes could be scrubbed and *groff* markdown applied to quickly and properly format project documentation. *groff* also gave us the ability to not only output our documentation in .pdf format, but with the application of various post-processors we had the ability to port our Engineering Notebook to HTML, and other web-friendly formats.

2.1.2. GitHub Website

The Team utilized the GitHub website (<https://github.com>) as a cloud-based library to house various aspects of our project. GitHub is a front-end for the *git* version control system, and adds some simple, but effective project management tools. In addition to the control code for our robot, the Team found that GitHub could be used to store, and even edit, the *groff* markup for the electronic copy of our Engineering Notebook. This made multi-user contributions to the Engineering Notebook easy to manage, while ensuring everyone had the latest update. GitHub was also useful for storing the source code to project components designed in OpenSCAD, allowing Team members to quickly access components for modification or 3D printing.

2.1.3. CAD Software Suites

The Team used several different CAD software suites to aid in the design of our robot. OpenSCAD was used for individual component design due to its relatively simple code-based user interface and ability to output multiple file types. The OpenSCAD code was stored on GitHub to allow multiple Team members to access and easily modify the code. AutoDesk and AutoCAD were both used for the design of the scissor lift, due to their capabilities to model motion with the 3D structures.

2.2. Engineering Overview

2.3. Scissor Lift Design

The cap ball lift presented an engineering challenge in that we had to get a 21" diameter ball into a holder that required almost 47" of clearance from the floor, all while being lifted by an assembly that would fit into an 18"x18"x18" package (Figure 1.)

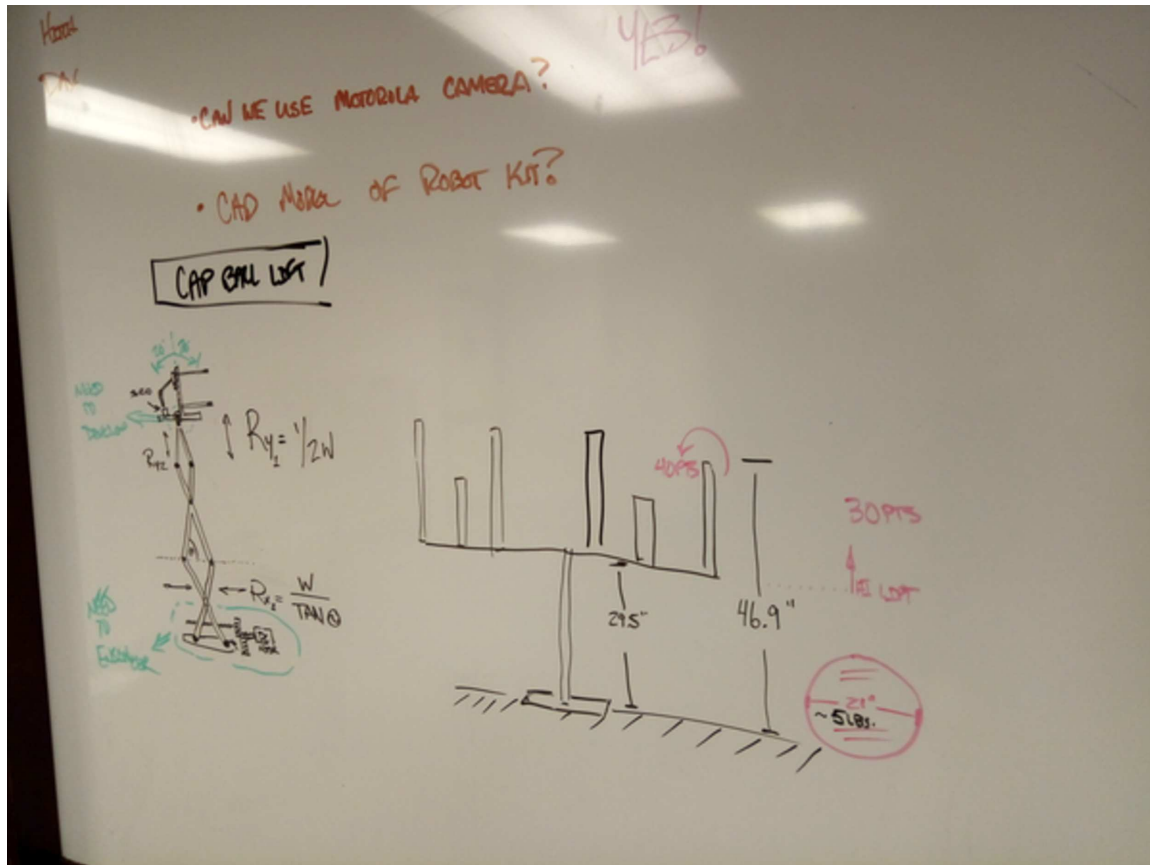


Figure 1.
Cap Ball Lift Planning

To accomplish our objective of executing the cap ball lift into the Center Vortex during End Game, the Build Team decided to utilize a scissor lift mechanism to raise the cap ball into the Center Vortex. While several other designs were considered, including a cascading pulley lift, the Build Team favored the scissor lift for its simplicity and strength (Figure 2.)

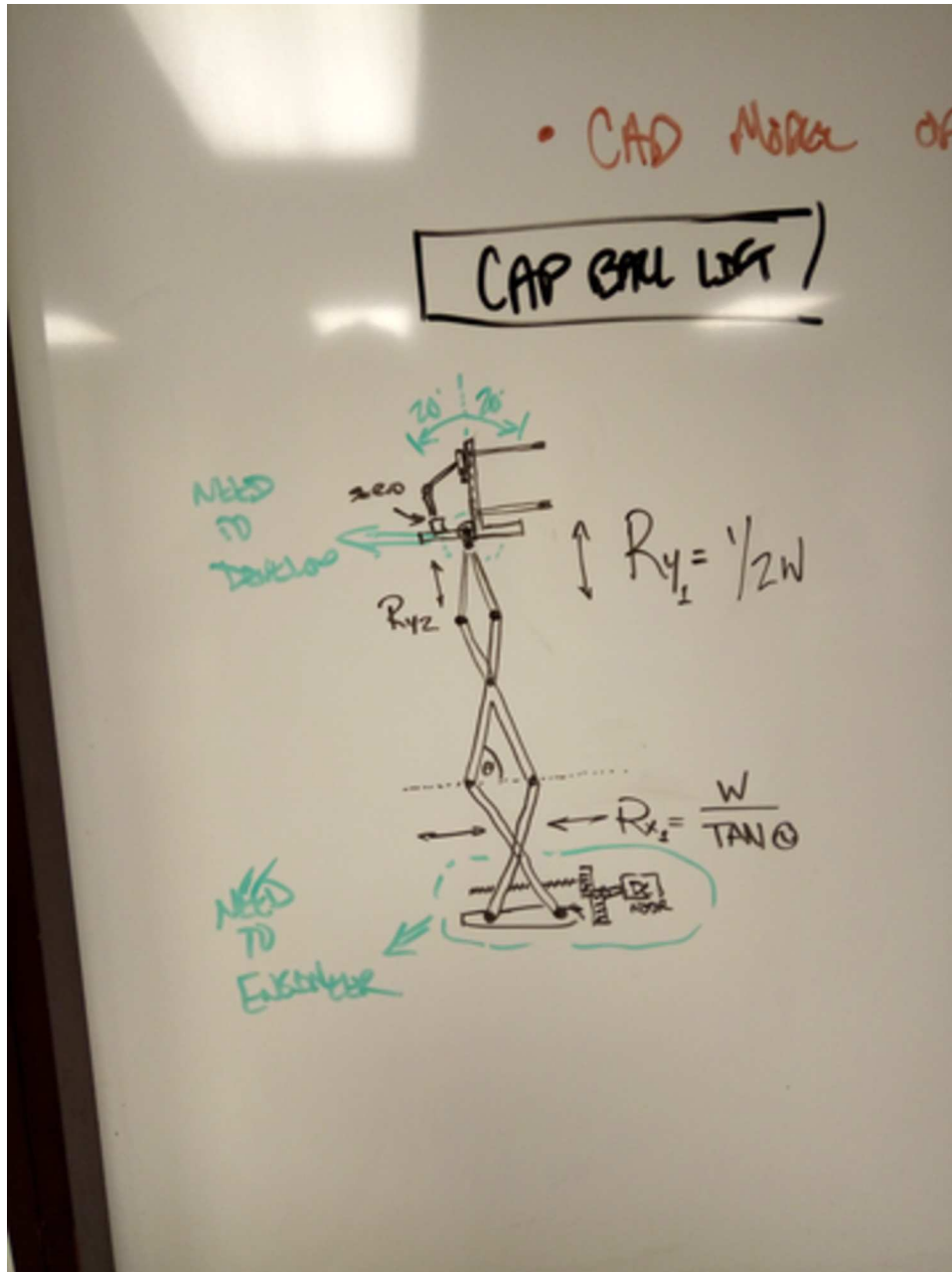


Figure 2.
Cap Ball Lift Sketch

Significant engineering research was required to ensure that components in the scissor lift would safely support the load of both the cap ball and the grapple assembly. The sketch at Figure 2 is a component diagram of the structural assembly with factor variables denoted. Assuming the grapple assembly would be attached at two points at the top of the scissor mechanism, two equations were used to calculate the loads imposed on the lifting structure:

$$L_{y_1} = L_{y_2} = \frac{W}{2}$$

$$L_{x_1} = L_{x_2} = \frac{W}{\tan \theta}$$

Figure 3.
Scissor Assembly Load Calculations

where L_x and L_y are the x and y components of the lift load, w is the total weight to be lifted, and θ is the interior angle of the scissor arms.

As we attempted to fit the scissor lift on the robot chassis, we discovered the side-loaded single leg scissor lift design took up too much room on the robot chassis, making it difficult to stay within the 18"x18"x18" space constraint. After reviewing the design, we settled on modifying the scissor lift to a center-load lifting mechanism with dual sliding leg supports at both the top and bottom of the scissor assembly. The formula used for the lift load on the redesign was:

$$L_y = \frac{W \times D \times \cos \theta}{2}$$

Figure 4.
Scissor Assembly Re-calculations

where L_y is the y component of the lift load, W is the total weight to be lifted, D is the total lifting distance of all lift arms, and θ is the interior angle of the scissor arms.

The redesign of the scissor lift presented its own challenges. With dual sliding scissor arms at both the top and bottom of the scissor lift assembly, we needed to develop a mechanism to keep the lift centered on the robot chassis while executing the lift. After several design considerations, we finally settled on utilizing strategically placed rubber bands to provide the small centering force needed to keep the lift aligned.

The arms used in our scissor lift were designed with the OpenSCAD software, which allowed us to 3D print the final components. The 3D printer available to us had a 255mm lateral print limitation which forced a component redesign after our initial attempt. Our first scissor arm was designed to be printed as one piece on the 255mm print bed, but the resulting 240mm scissor arm was not sturdy enough to support the weight of the cap ball plus our grapple mechanism.

Our second scissor arm design broke the arm component into two 235mm pieces with an overlap joint which could be bolted together post-print (Figure 5.) With the designed overlap, this gave us a final scissor arm length of 440mm. The scissor arm was designed using a simple I-beam construct with a 12.5mm flange width and a 6mm thick web. The through-bolt pivot joints were cylindrically reinforced for torsional strength:

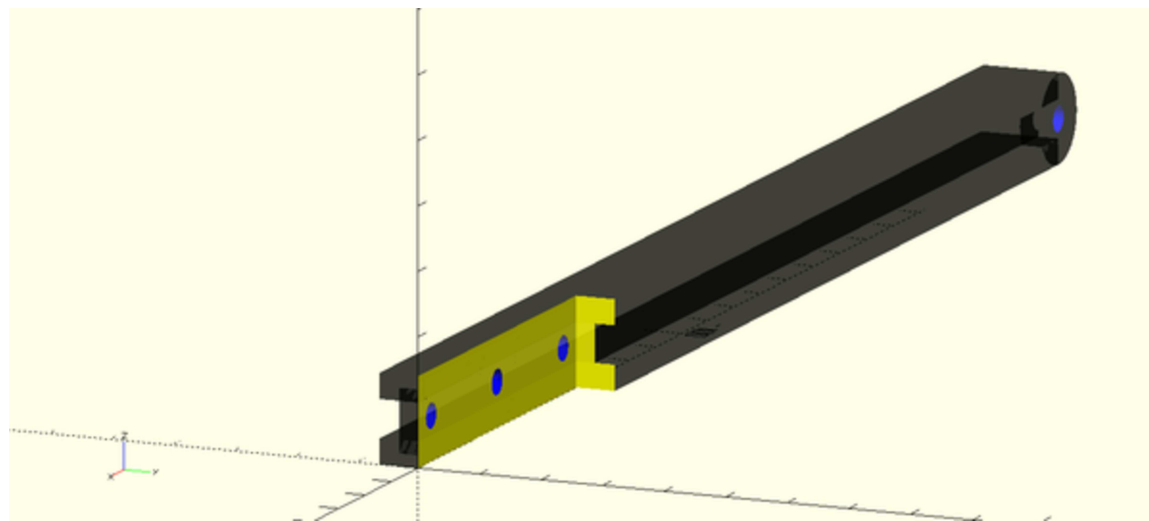


Figure 5.
Scissor Arm I-Beam Cutaway View

Although the I-beam design was structurally strong, the Build Team found that 3D-printing the I-beams was more complex/slower than printing a simple structural beam, so the design was modified accordingly. The primary challenge with printing the I-beam design was the issue of "overhang", where the 3D printer could not print on top open space. Although techniques for printing "fills" were investigated, ultimately we found little structural benefit from printing the I-beam design and instead opted to print a simple rectangular structure.

Our initial scissor lift design utilized a side-load leadscrew design to actuate the scissor lift; however, after some discussion, the Build Team settled on a vertical center-load design with dual sliding bases to raise the Cap Ball. This design allowed the use of a single, centrally mounted DC motor connected to a leadscrew. The primary benefit of this design was the ability to use a simple single point of attachment for the leadscrew, while maintaining a low center of gravity and small lateral footprint on the robot chassis. We decided to utilize a dual scissor design with scissor arms cross-tied by aluminum tube for strength (Figure 6.)



Figure 6.
Assembling the Scissor Lift

2.4. Grapple Design

The grapple attached to the scissor lift went through several revisions before settling on the final design. The Build Team considered several options, including a 3-claw grapple, a mechanized sloping ramp, and the final 2-claw grapple design. Two grapple actuation methods were considered. Initially the Team considered a grapple actuated by a single bar connected to a servo and both grapple arms. Due to engineering difficulties, we eventually settled on a twin-servo actuator design, as working the actuators in software was easier than designing a lightweight, compact mechanical actuator.

2.5. Programming Overview

2.5.1. Software Installation

The Programming Team committed early in the process to using Android Studio as the development environment for our robot code. Android Studio has robust hooks into GitHub, which we had already chosen for our code repository. In addition, Android Studio is a cross-platform application which worked well as programmers utilized computers with Mac, Linux, and Windows operating systems for coding.

2.5.2. Programming Difficulties

The Team found that configuring the various versions of the Android APK in Android Studio was initially challenging. One of the programmers did not have the appropriate SDK's loaded for the Android OS version on our Motorola controller phones, causing initial compile difficulties for building basic OpMode code.

The Team found a wide variety of controller libraries available on GitHub for the various tasks which needed to be accomplished. One of the primary challenges was committing to a particular support library for accomplishing the desired task. For example, in accomplishing the Autonomous mode Beacon Claim task, the team considered several virtual vision options before settling on the FTCVision library developed by Lasarobotics. Projects which contained full Javadoc documentation were considered above others due to our unfamiliarity with Java programming.

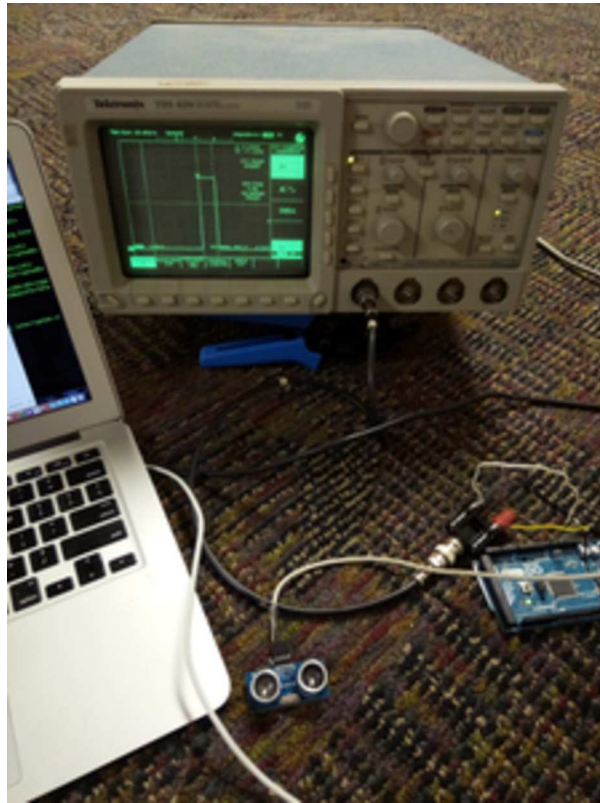


Figure 2.
Sonar Oscilloscope Testing

Our primary challenge with the ultrasonic ranging system was eliminating false returns and providing a smoothed average range that could be used to update the robot's actual position based on the rotary encoder's estimated position in the arena. The Programming Team is still developing this navigation update system and hope to have it implemented by the Flagstaff regional competition in February.

2.5.4. Driver Mode Programming

After coordinating with the Project Lead and Build Team on the design goals for Driver mode, the Programming team decided that a simple tank drive program with additional DC motor and servo control functionality was all that was required to build a functioning Driver OpMode. Our robot started life as a Pushbot prior to our re-design, so we elected to utilize the Pushbot OpMode as the basis for our Driver Mode program.

In addition to the basic Pushbot program, our Driver Mode program added a DC motor control to activate the scissor lift leadscrew motor. We elected to use digital device inputs into the Core Device Interface for upper and lower limit switches to limit travel on the scissor lift arms. Finally, we added inputs for two servo motors to operate the grapple arms to accomplish the cap ball lift:

```
//Define hardware for task functions//
    DcMotor          lift_motor;
    Servo             left_grapple_servo;
    Servo             right_grapple_servo;
    DigitalChannel    upper_limit_switch;
    DigitalChannel    lower_limit_switch;

//Initialize aux hardware//
    lift_motor        =      hardwareMap.dcMotor.get("lift_motor");
// build config profile
    left_grapple_servo    =      hardwareMap.servo.get("left_grapple");
// build config profile
    right_grapple_servo   =      hardwareMap.servo.get("right_grapple");
// build config profile
    left_grapple_servo.setPosition(leftGrapplePosition);
    right_grapple_servo.setPosition(rightGrapplePosition);

    upper_limit_switch    =      hardwareMap.digitalChannel.get("upperLim-
itSwitch");    // build config profile
    lower_limit_switch    =      hardwareMap.digitalChannel.get("lowerLim-
itSwitch");    // build config profile
```


Implementing the auxilliary hardware into the Pushbot code was a moderately simple process. We desired to maintain the ability to control the entire robot using a single driver. As such, we elected to assign servo grapple and lift motor functions to the controller D-pad assembly. This would localize the controls for all aux functionality while allowing a single driver to operate the robot:

```
/*Code to open/close Cap Ball grapple servo*/
//Use Gamepad 1 D-pad L/R to actuate the grapple servo//
    if (gamepad1.dpad_right) {
        leftGrapplePosition += GRAPPLE_SPEED;
        rightGrapplePosition -= GRAPPLE_SPEED;
    }

    else if (gamepad1.dpad_left) {
        leftGrapplePosition -= GRAPPLE_SPEED;
        rightGrapplePosition += GRAPPLE_SPEED;
    }

    leftGrapplePosition = Range.clip(leftGrapplePosition,0.0,1.0);
    left_grapple_servo.setPosition(leftGrapplePosition);

    rightGrapplePosition = Range.clip(rightGrapplePosition,0.0,1.0);
    right_grapple_servo.setPosition(-rightGrapplePosition);

    telemetry.addData("L Grapple: ", "%.2f",leftGrapplePosition);
    telemetry.addData("R Grapple: ", "%.2f",rightGrapplePosition);
    telemetry.update();

//Use Gamepad 1 D-pad Up/Down to actuate the lift motor//
    boolean uLim = upper_limit_switch.getState();
    boolean lLim = lower_limit_switch.getState();

    if (gamepad1.dpad_up)
        if (uLim = false)
            lift_motor.setPower(lift_motor_power);
        else if (uLim = true)
            lift_motor.setPower(0.0);

    if (gamepad1.dpad_down)
        if (lLim = false)
            lift_motor.setPower(-lift_motor_power);
        else if (lLim = false)
            lift_motor.setPower(0.0);
```

2.6. Engineering Logbook

Stardate 20161226

Attendance: Emmet Burks, Brandon McLaughlin, Alyssa Kochendarfer Coaches: Michael Hitchcock, Kurt Kochendarfer

In preparation for the Flagstaff competition in February, the Project Manager in conjunction with the coaches decided to take the robot down to the basic drivetrain and rebuild it to accomplish the following specific objectives:

- Lift and place the cap ball during the final 30 seconds of the match
- Claim two beacons during the Autonomous period of the match
- Place two pre-loaded particles into the Vortex during the Autonomous period of the match

At this meeting the Build Team deconstructed the existing robot to the drivetrain. The Build Team also reviewed possible engineering solutions to the cap ball lift problem and formulated a basic design for the particle shooter. The Programming Team inventoried parts and came up with a list of parts needed to accomplish the new objective tasks.

Stardate 20161227

Attendance: Emmet Burks, Brandon McLaughlin, Josh Bryant, Alyssa Kochendarfer Coaches: Michael Hitchcock, Kurt Kochendarfer

We started out meeting by updating our team members on what each team was doing and what there tasks were. The Build Team talked about how they were rebuilding the robot in order to add the batteries, motors, and servo boards. The Project Management Team edited the Engineering Notebook and documented everything they were doing. The Programing Team set up the Android Studio software and Github on their computers and started working on the beacon claim task.

Stardate 20161228

Attendance: Emmet Burks, Brandon McLaughlin, Dax Bash, Alyssa Kochendarfer Coaches: Micheal Hitchcock, Kurt Kochendarfer

We started the meeting off by assigning everyone their jobs and tasks. Afterward we separated to work on team tasks. The Build Team started organizing their parts in all the boxes. Afterward, they continued to frame the robot and come up with their finalized plan for the cap ball lift, particle shooter, and beacon changer. The Build Team also planned where each thing was going and got measurements. The Programming Team op-tested the sonar ranging and op-mode code for our Autonomous mode tasks, utilizing an oscilloscope to view the pulse ranging signal. The Project Management Team worked on uploading the Engineering Notebook to the Github website. They also made sure everyone was staying on top of their job.

Stardate 20170102

Attendance: Dale James, Emmet Burks, Brandon McLaughlin, Dax Bash, Alyssa Kochendarfer Coaches: Michael Hitchcock, Mr. and Mrs. Kochendarfer, Mr. and Mrs. James

The Build Team striated the structure and clarified the designs for the core controllers and maintained the controllers. They also decided the design for where the controllers would be mounted. The Programming Team installed the robot controls and worked on the sonar. The Fundraising Team worked on how much money we need to raise for Flagstaff. They also talked about what businesses we could ask for donations or who might allow us fund-raise there.

Stardate 20170103

Attendance: Emmet Burks, Josh Bryant, Brandon McLaughlin, Michael Wooldrige, Araya Blaylock, Dale James, Alyssa Kochendarfer, Coach Michael Hitchcock, Coaches Mr. and Mrs. James, Mr. and Mrs. Kochendarfer

We started the meeting off by talking about each team's current tasks. The Build Team discussed the new robot design. They came up with three main ideas for the cap ball lift, particle shooter, and beacon changer, then voted on which idea would benefit us the most. The Fundraising Team talked about transportation to Socorro and Flagstaff, hotels, and who was going. We sent out emails to everyone asking who would be traveling with their parents and which dates they would be going to. The Fundraising Team also emailed the head administrator for the Imago Dei PTSG (Parent Teacher Support Group) to ask if we could provide a presentation to the Group to solicit donations. The Community Outreach Team set up a Facebook account. Programing started to downloaded more software and helped Build Team decide which design would benefit.

Stardate 20170104

Attendance: Emmet Burks, Dax Bash, Brandon McLaughlin, Araya Blaylock, Dale James, Michael Wooldrige, Josh Bryant Coaches: Mr. and Mrs. James, Coaches Mr. and Mrs. Kochendarfer, Michael Hitchcock

We started the meeting by talking about the schedule the Project Management team created. We talked about Team pictures on Monday the 9th at 1pm. We talked about the outreach to help IDA teachers move desks, tables, and other classroom items into their new modular building. The PM Team tasked the Build Team to finalize their design for the cap ball lift, particle shooter and beacon changer. The Programming Team worked on getting the beacon program together. They figured out how to get the camera to recognize the colors blue and red. The Community Outreach Team came up with ideas on outreach and team costumes. They decided to do a presentation at the Alamogordo Library, help at the elderly nursing homes, and at the CDC (Child Development Center) at Holloman Air Force Base.

Stardate 20170109

Attendance: Emmet Burks, Dax Bash, Araya Blaylock, Gabe Steckler, Brandon McLaughlin, Josh Bryant, Alyssa Kochendarfer Coaches: Mr. and Mrs. Kochendarfer, Mrs. Steckler, Mr. Hitchcock

The Starry-Knights Team started our meeting by asking where each group is at. The Build Team reported that they were still working on finishing the robot design and planned to finalizing to design by the end of the meeting. The Programing Team taught one of the members how to use the Android Studio post module and where the sensors are located on the robot. The Fundraising Team estimated how much we need to fund-raise for parts, travel, and other expenses.

Stardate 20170110

Attendance: Emmet Burks, Dax Bash, Brandon McLaughlin, Gabe Steckler, Dale James, Alyssa Kochendarfer Coaches: Mr. James, Mr. Kochendarfer, Mrs. Steckler, Mr. Hitchcock

We asked where we were at and then tasked everyone their jobs and goals for today's meeting. The Build Team finalized the design for the scissor lift and sketched it out. The Programing Team designed the sensors and decided where they were being placed. Community Outreach came with ideas for outreach to the community and designed a few costume ideas.

Stardate 20170114

Attendance: Emmet Burks, Dale James, Adrian Martinez, Alyssa Kochendarfer Coaches: Mrs. Steckler, Mrs. Martinez, Mr. James, Mr. Kochendarfer, Mr. Hitchcock

Build Team mounted the servos and discussed how the 3D parts were be to be constructed. Mr. James assisted the Build Team in engineering the parts to be 3D printed for the scissor lift. Programming Team continued to develop the ultrasonic ranging algorithms needed to move the robot around the Area in Autonomous mode.

Stardate 20170116

Attendance: Emmet Burks, Dale James, Brandon McLaughlin, Alyssa Kochendarfer Coaches: Mr. Kochendarfer, Mr. James, Mr. Hitchcock, Mrs. Steckler

The Community Outreach Team designed a presentation for our outreach at the Alamogordo Library on the 26 of January. Programming Team mapped out the arena and developed ideas to read the white lines on the floor with an IR sensor. They also worked on the sonar and the vision system using the camera on the phone to find and claim the beacons.

Stardate 20170117

Attendance: Emmet Burks, Dale James, Adrian Martinez, Araya Blaylock, Gabe Steckler, Brandon McLaughlin, Josh Bryant Coaches: Mr. Hitchcock, Mrs. Steckler, Mr. and Mrs. Kochendarfer

We started the meeting off by talking about where we are at with the Build Team. Then we tasked everyone and set goals for the day. By the end of the meeting the Build Team mounted the Core Power Module, and built a temporary phone holder to mount the phone at the front of the robot. Programming Team continued to process FTCVision programming code and tested the code on a test beacon in our practice arena.

Stardate 20170121

Attendance: Emmet Burks, Dale James, Adrian Martinez, Gabe Steckler, Josh Bryant, Alyssa Kochendarfer

Coaches: Mr. and Mr. Kochendarfer, Mr. James, Mr. Hitchcock, Mrs. Steckler

We started the meeting off by asking where we were at with the robot and programming. After each team gave their report, we set goals and gave the teams their tasks to accomplish. The Community Outreach Team worked on their slides for the Library presentation on 26th of January. Project Management worked on getting the Engineering Notebook up to date. Build Team worked on designing a paddle for the Cap Ball and tightened the temporary phone holder. The Build Team also took a foam soap holder cut it in half, and zip tied the two foam parts to two long metal parts for the beacon changer. They also started to glue and assemble the printed 3D parts to form the scissor lift.

Stardate 20170123

Attendance: Dax Bash, Brandon McLaughlin, Emmet Burks, Josh Bryant, Gabe Steckler, Dale James, Araya Blaylock, Adrian Martinez, Alyssa Kochendarfer Coaches: Mr. and Mrs. Kochendarfer, Michael Hitchcock, Mrs. Martinez, Mrs. Steckler

We started the meeting off by telling everyone the goals for the day and where everyone was at. Fundraising Team worked on writing the business letter. Community Outreach went over the presentation slides, to make sure they knew what they were talking about. The Build Team formatted the structure to mount the scissor lift rail, mounted the servos to the grapple for the Cap Ball and had to redesigned a new idea for the grapple. They also tried mounting the lead-screw for the CAP Ball but that did not work. The Build Team also got precise measurements for mounting the scissor lift.

Stardate 20170124

Attendance: Emmet Burks, Dax Bash, Brandon McLaughlin, Araya Blaylock, Adrian Martinez, Gabe Steckler, Josh Bryant, Alyssa Kochendarfer Coaches: Mrs. Steckler, Mr. and Mrs. Kochendarfer, Mr. James

We started the meeting by talking about how we only have a few days till Socorro and a lot of work to be done. The build team worked on using the angle iron to cut 16 inch pieces to anchor the scissor lift. They finished putting together the scissor lift and center-mounted the threaded cross brace. They also measured and drilled holes in the rails to mount the scissor lift on the robot. The Community Outreach Team updated the Team storyboard with new photos.

2.7. Community Outreach Overview

2.7.1. Imago Dei Academy Teacher Service Project

Imago Deo Academy, one of the team's sponsors, recently expanded their facilities and was in desperate need of help in setting up the new building over the Christmas holiday. *Starry Knights* Community Outreach Team discussed the school's needs with several teachers and the Headmaster and decided the Team could help the teachers at the school get settled into their new facility before the end of Christmas Break. Organizing the rest of the Team, over several days of the Christmas Break Community Outreach orchestrated moving classroom furniture, desks, books, shelves, and other classroom materials into the new facility. The Team also helped set up tables in the school's new Computer Lab (Figure 1) and helped install a microwave wireless link between the satellite school facility and the main campus, allowing the new Computer Lab to have Internet access.



Figure 1.
Imago Dei Computer Lab Setup

Thanks to the work of the *Starry Knights*, the Imago Dei teachers were able to get set up in the new classrooms with just enough time to be ready for school to start back after the Christmas Break!

2.7.2. Alamogordo Public Library Presentation

As part of our public outreach program, as an effort to spread the word about the benefits of FIRST® Tech Challenge, the Community Outreach Team contacted the Alamogordo Public Library and asked if we could come to the library and present information on FIRST® robotics to any of the library's youth programs. The library welcomed the offer and scheduled a time for the Team to come make our presentation. The Community Outreach Team put together an informative slideshow providing information about our efforts with the Velocity Vortex game this season and delivered the presentation at the library (Figure 2.)



Figure 2.
Alamogordo Library Presentation

The library presentation generated several questions from the audience about the goals and objectives of FIRST® Tech Challenge, as well as some of the mechanical specifics of the robot. Members of the Project Management and Build Team were in attendance at the presentation and were able to answer the questions raised.

2.8. Fundraising Overview

The Fundraising Team organized halfway through the season in a effort to secure the materials and funding we needed to make it to the Flagstaff regional competition in February. The Team quickly brainstormed places from which to seek funding and put together a presentation to take to prospective sponsors. In addition, the Team developed a tri-fold handout which could be used to give potential sponsors a quick-reference guide to the team and facilitate contacting the team to offer support.

2.8.1. Imago Dei Academy Parent-Teacher Support Group

The Team decided the first stop on the funding path should be the Imago Dei Academy Parent-Teacher Support Group (PTSG). The PTSG is a non-profit entity whose purpose is to provide financial and material support to teachers and students of Imago Dei Academy. The PTSG provides support where the school's budget is either gapped or falls short of annual needs. The Fundraising Team scheduled a visit with the members of the PTSG at one of their monthly meetings and made a presentation about the benefits of FIRST® Tech Challenge for students (Figure 1.)

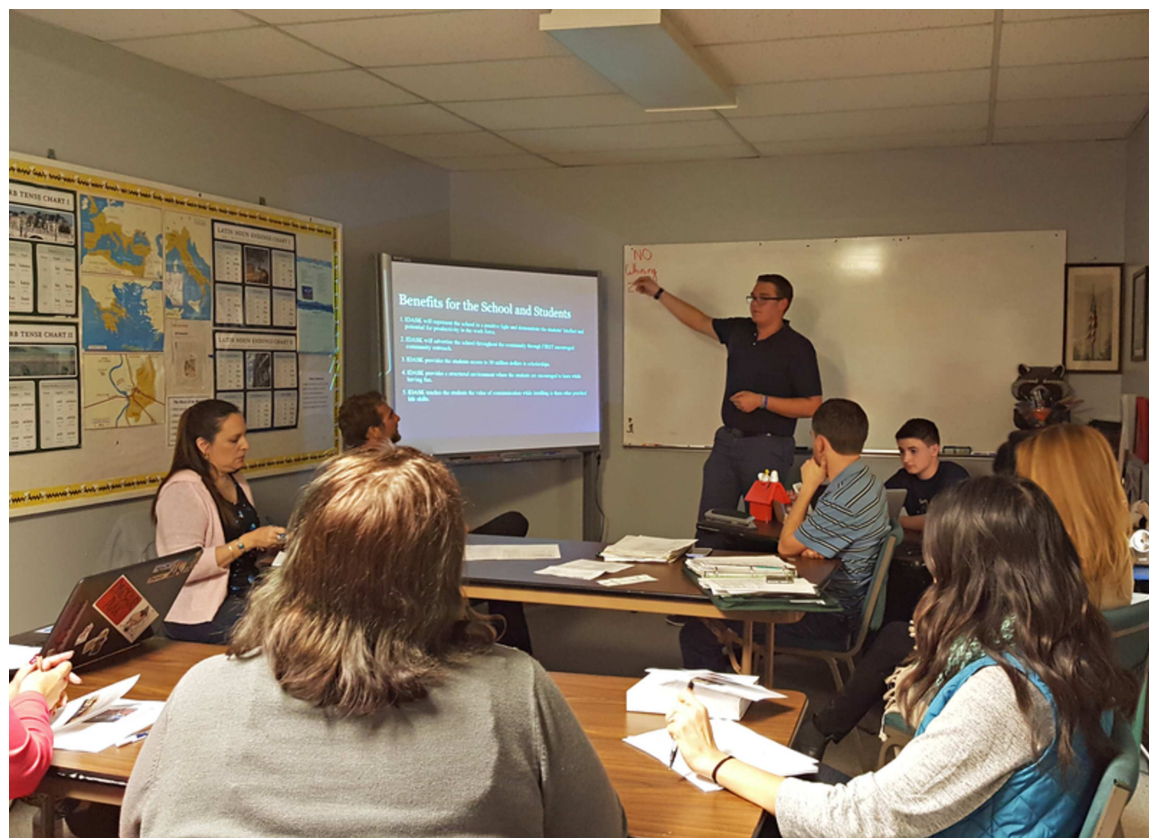


Figure 2.
Parent-Teacher Support Group Presentation

The PTSG was very impressed with the FIRST® Tech Challenge program and decided to provide the majority of the financial support needed to get the team to Flagstaff in February. Thank you Imago Dei Academy PTSG!

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