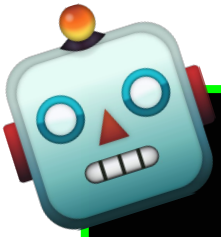
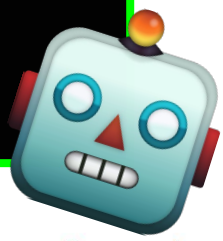
Engineering Notebook

2017



nerdy girls

FTC #12738



FIRST RELIC RECOVERY

FIRST TECH CHALLENGE

Table of Contents

Our Story

Our story is long but integral to who we are as a team!

We are FTC team Nerdy Girls #12738, and we're here to tell you about our plan to forge a new path for girls into the insanely fun and slightly magical world of competitive robotics.

It all began when team members Parker and Greta Mayer joined their high school's FRC team with the hopes of learning how to code. It turned out to be a mega challenge for them to break into technical roles on their team. They spent their first year on the team watching the guys code and build the robot while they, along with the other girls on the team… wait for it... designed t-shirts. They also noticed that there were very few girls at their competitions, (about 20-30% of FRC league participants in total) and those who were there didn't seem to work in technical roles like coding or building, but more often in social roles like awards or scouting.

As girls on a high school team, we get it. It's hard to join a robotics team and catch up to everyone else if you haven't grown up building and doing other techy things. It's discouraging if no one expects you to be interested or to understand the more complicated stuff. And if you feel kind of alone and you don't have any friends that are into it? Forget it. It's too hard and too lonely to forge ahead.

Our Story

One thing is really clear to us, though. Girls who don't come in with skills will have a difficult time breaking into technical roles in competitive robotics. And girls will never be motivated to develop those skills unless there is a culture to support it. We don't buy the idea that girls are "just not interested" in tech and that the gender gap is a reflection of some innate biological difference. We are convinced that girls aren't going into tech because it's generally not on their radar, they don't see other girls going into tech, and there's no girl culture to support it.

Enter Nerdy Girls.

Parker and Greta created Nerdy Girls to change all of that, and to forge a new path for girls into the male dominated world of robotics. They spent almost two years researching and developing their own program to help girls become master robot trainers, and with the help of team member Faith Cooper, Nerdy Girls launched on January 13th, 2017.

The program is designed to feel like a real-life video game, with 6 levels of increasingly difficult robotics projects. As a girl works on leveling up, she will also work her way through a series of increasingly complicated robot kits and programming languages, until she is building her own robots with FTC and FRC parts and coding in C++ or Java. Nerdy Girls also makes all of its own YouTube tutorials to bring together the building and coding aspects of their projects. This way, girls can work on their own robots at their own pace.

Our Story

Nerdy Girls is also carving out a new culture for teenage girls in Kittitas County. Nerdy Girls hosts weekly meetups which are essentially Friday night robot building parties, complete with a dark, industrial vibe, a disco ball, and an awesome playlist. Girls just show up, watch YouTube videos, and work together on robots. It's mind-blowingly fun.

And now, after months of robot training, Nerdy Girls has given birth to its first FTC team. We, team **Nerdy Girls #12738**, are made up of a group of eleven girls who are hard-working, scrappy, and on our way to becoming master robot trainers.

There are three things you should know about us.

1. Our goal is not to win matches or to win awards at our competitions, but rather to ensure that every single girl on our team gets active experience with building, coding, and driving the robot. You'll never see the same drive team twice at a competition, because we believe in equal access to every role.
2. We are youth-led and youth-driven. Because we live in a rural area, we don't have easy access to mentors and tech experts. YouTube is our mentor. We seek out experts as we need them, and we're not afraid to drive 100 miles to get robot help.
3. We believe that the culture that FIRST has created is powerful, and can be life-altering for a teenager. We want to create as many paths as possible into FIRST, for both girls and for teens in rural areas.

The Game

Points Analysis

To develop our game strategy, we started by creating a points analysis. We studied the Relic Recovery game animation, read through the Game Manual, and compiled information in the points analysis matrix below.

Point Analysis - Relic Recovery 2017			
Type of Point	Periods of Play: Match = 2 1/2 minutes		
	AUTONOMOUS 30 seconds	TELEOP 2 minutes	END GAME last 30 seconds of teleop
JEWEL Knock off opposing alliance's jewel	30 pts		
GLYPH Place in ANY column	15 pts	2 pts	
GLYPH Read Key and place in CORRECT column	30 pts		
SAFE ZONE Get robot back into safe zone by end of autonomous period	10 pts		
GLYPH ROW Completed glyph row		10 pts	
GLYPH COLUMN Completed glyph column		20 pts	
COMPLETED CIPHER Completed glyph pattern		30 pts	
RELIC IN ZONE 1 Relic placed in zone 1		If a cipher is completed before end game, relic can be place during Teleop	10 pts
RELIC IN ZONE 2 Relic placed in zone 2			20 pts
RELIC IN ZONE 3 Relic placed in zone 3			40 pts
UPRIGHT RELIC Relic lands on its feet			15 pts
BALANCING STONE Back on stone by the end of match			20 pts

The Game

Game Strategy

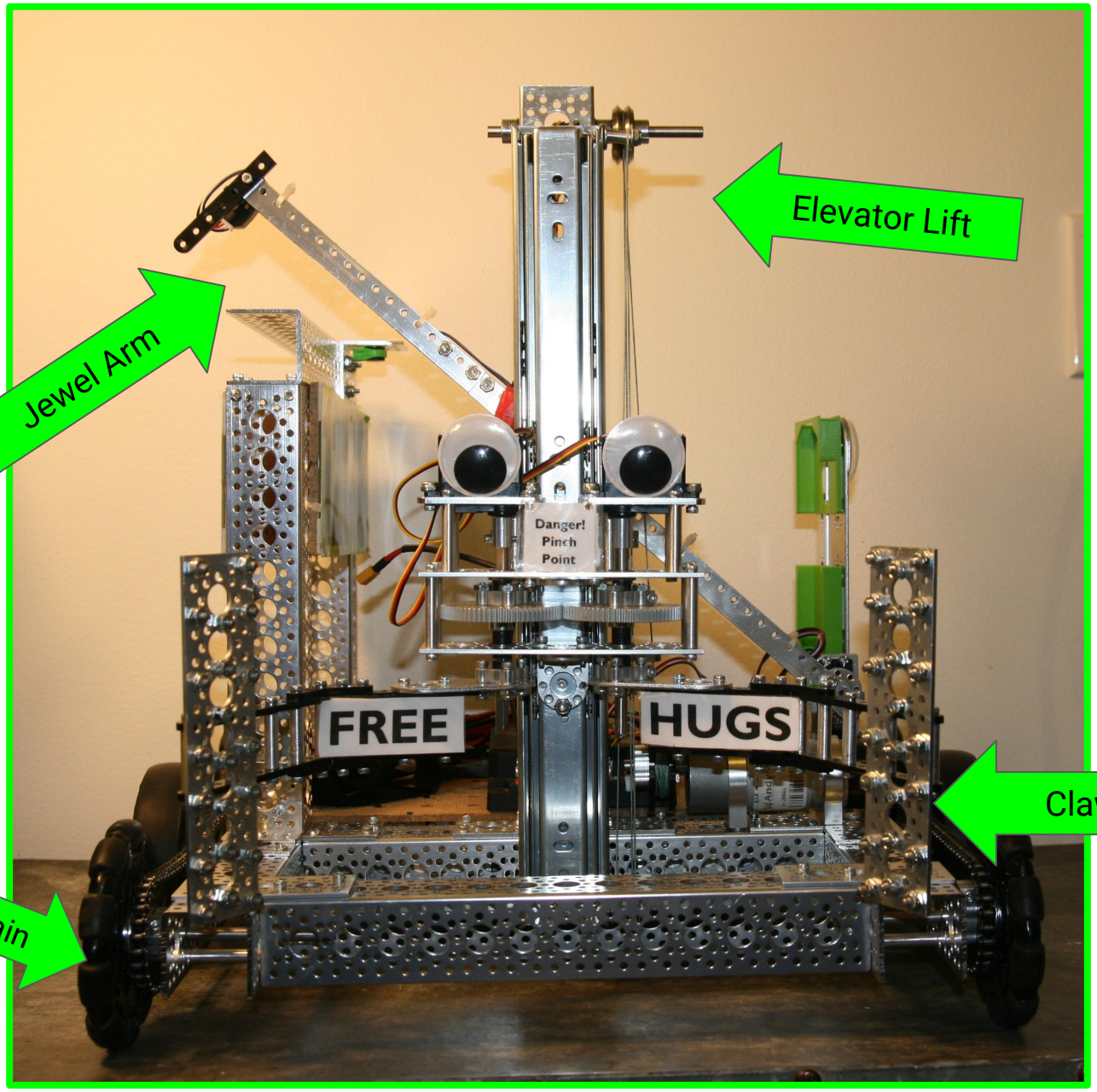
Using our points analysis on the previous page, we developed an order of priority for tackling each period of game play. We decided to perfect each priority before moving on to the next. In other words, we made sure that our robot could complete each of the following tasks before moving on to the the next priority in line.

- Park in the safe zone in Autonomous
- Deliver glyphs in columns in Teleop
- Return to balancing stone in the End Game

Game Strategy - Relic Recovery 2017			
Description	**Periods of Play**		
	Autonomous	**Teleop**	**End Game**
Seconds	30 sec	2 min	last 30 sec of Teleop
Design Considerations - Dimensions	To start: must be 18 x 18 x 18 (we'll make ours 17 x 17 x 17) After match begins, it can expand to any size		
Game Strategy	Order of Priority: 1. Park in safe zone 2. Place glyph in any column 3. Knock off jewel 4. Read key and place glyph in correct column 5. Second glyph	Order of Priority: 1. Deliver glyphs in columns 2. Deliver glyphs to create pattern	Order of Priority: 1. Return to balancing stone 2. Place relic

Our Engineering Process

The Robot



Meet our robot, Jeremy/Franklin/Bill/Carlos/Bartholomule. Don't let his cuteness fool you. He is a monster.

Our Engineering Process

Our Design Process

We used the following approach to designing each subsystem for our robot.

Step 1: Understand Requirements

- We revisited the game manual to verify that we understood game rules and requirements for each aspect of our robot design.

Step 2: Brainstorm

- We sketched individually and brainstormed as a group to come up with multiple options that would meet the requirements.

Step 3: Prototype

- We agreed on the top ideas as a group and built prototypes using materials such as cardboard, wood, duct tape, string, zip ties, and other found objects.

Step 4: Research online

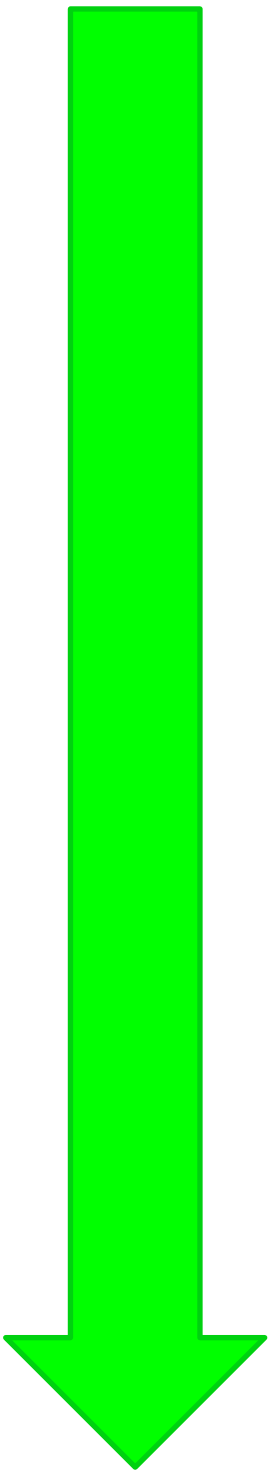
- Using online resources such as YouTube, Reddit, Chief Delphi, and others, we researched our ideas to help us make a better design decision.

Step 5: Consult experts

- Because our team does not have dedicated mentors, we traveled to other teams to consult with their coaches and mentors about our design ideas.

Step 6: Build chosen design

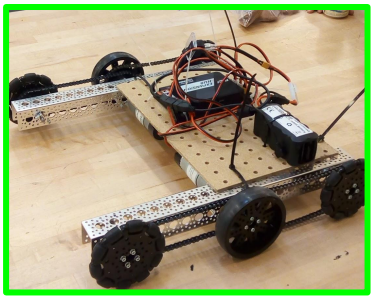
- We reviewed results of research and consultations as a team and decided on final design.
- We made a more detailed design on paper to figure out which parts we needed to order online.
- Once the parts arrived, we built the final product.



Our Engineering Process

The Drivetrain

Requirements
• Ability to drive onto balancing stone
• Ability to pivot from center for easy maneuvering
• Must only use what we have in our kit of parts



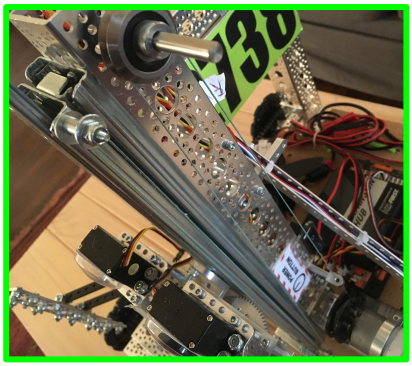
Possible Ideas		
4-Wheel Front Drive	**4-Wheel Rear Drive**	**6-Wheel Drive**
Pros: easy to build, simple design	**Pros:** easy to build, simple design	**Pros:** pivots well, can approach balancing stone from front or rear
Cons: doesn't pivot well, can only approach balancing stone from front	**Cons:** doesn't pivot well, can only approach balancing stone from rear	**Cons:** more difficult to build

And the Winner is...
We chose **6-wheel drive** with 2 standard wheels, 4 omnidirectional wheels, and chains.

What We Changed After League 1 Competition
We replaced the front large sprockets with small ones (like the back sprockets) so that the chains/sprockets could all be the same length/size.

Our Engineering Process

The Elevator Lift



Requirements

- Ability to lift claw to stack four 6” glyphs in cryptobox vertically.
- Must remain under 18” when collapsed.

Possible Ideas

4-Bar Linkage	6-Bar Linkage	Drawer Slide Elevator
Pros: good vertical reach, could extend out over wall for relic	**Pros:** better vertical reach than 4-bar linkage, could extend out over wall for relic	**Pros:** easiest to build, simplest design, takes up less space
Cons: may not reach height required to stack fourth glyph, takes up more space	**Cons:** hard to operate, requires more torque to raise, swings out when lifting, takes up more space	**Cons:** may be flimsy, hard to get relic over wall

And the Winner is...

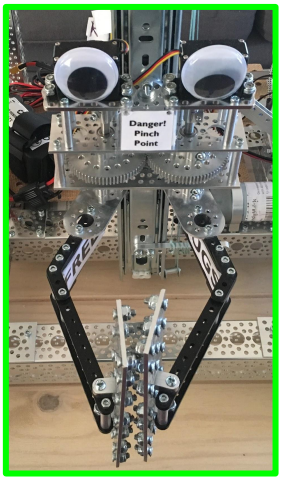
We chose the **drawer slide elevator** and used a 16” drawer slide.

What We Changed After League 1 Competition

We added a second 16” drawer slide and expanded pulley system to the elevator to increase vertical reach.

Our Engineering Process

The Claw



Requirements
• Ability to open and close around 6” glyphs
• Ability to securely grip two stacked 6” glyphs
• Ability to deliver glyphs into 4” deep cryptobox
• Must fit within 18”x18” size limit

Possible Ideas

Geared Claw with Vertical Grippers	3D-Printed Multi-Jointed Tentacles	Roller Intake/Outtake
Pros: simplest design, can deliver 2 glyphs at a time, easy to experiment with different gripping materials	**Pros:** can grab glyphs at any angle	**Pros:** can quickly intake glyphs at any angle
Cons: hard to grab glyphs at an angle	**Cons:** complicated design, must reprint for each modification	**Cons:** difficult to deliver 2 glyphs at a time, hard to fit within frame

And the Winner is...

We chose the **geared claw with vertical grippers** and used rubber bands and surgical tubing as our gripping materials.

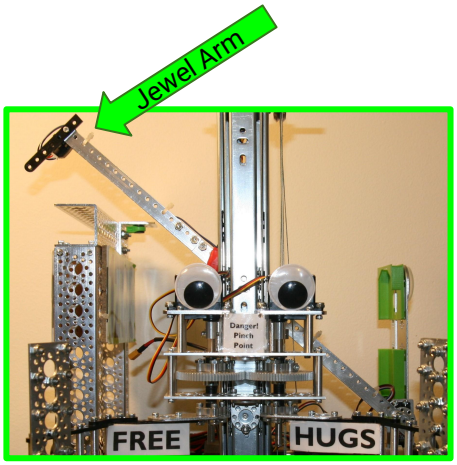
What We Changed After League 1 Competition

We made the grippers wider and changed the gripping material to screws coated in rubber cement.

Our Engineering Process

The Jewel Arm

Requirements
• Ability to reach between jewels while robot is on balancing stone
• Must be light enough to be rotated by a servo
• Must fit within 18”x18” frame when not in use



Possible Ideas	
Actobotics Beams	**Actobotics Mini Channel**
Pros: easy to build, simple design	**Pros:** easy to build, simple design, slightly lighter than beams, place to tuck cord
Cons: heavier than mini channel, may be too heavy for servo, no place to tuck cord	**Cons:** requires cutting channel

And the Winner is...
We chose to use the **Actobotics mini channel**.

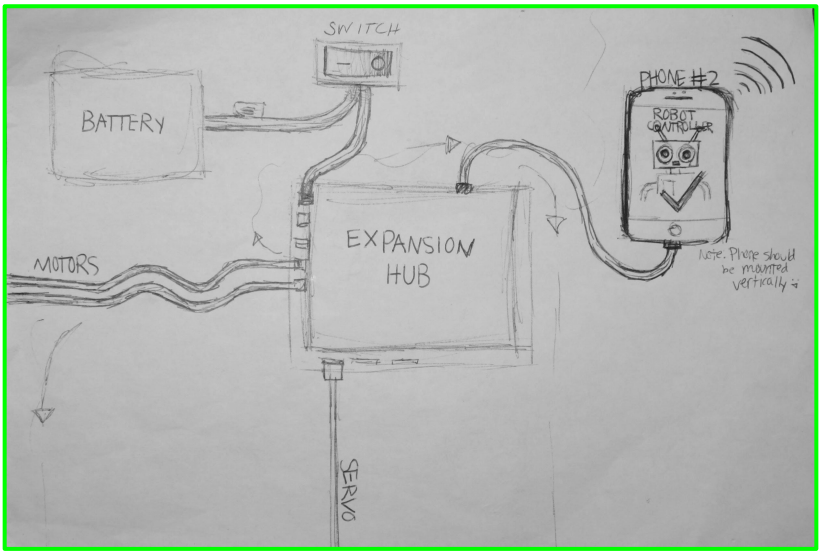
What We Changed After League 2 Competition
No changes. It worked well.

Our Engineering Process

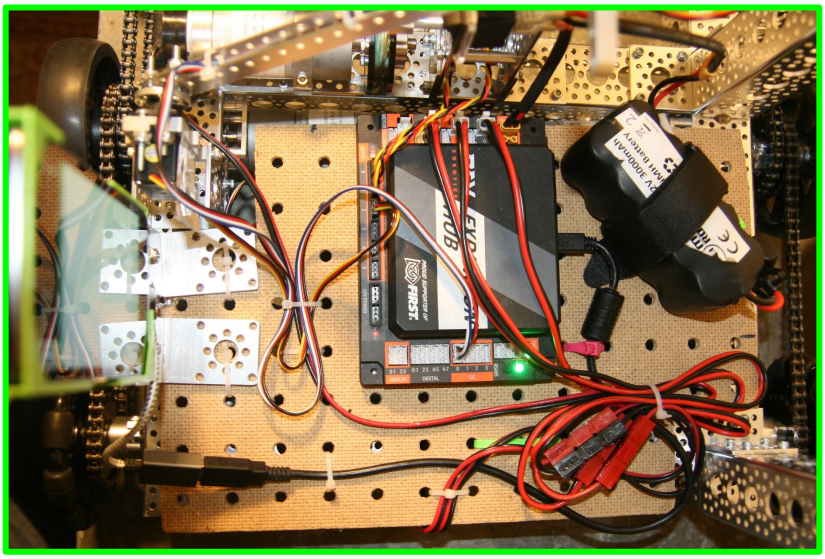
Electrical

Electronics Notables

- We used the REV Expansion Hub as our hardware interface
- We used Moto G4 Plays for our Robot Controller and Driver Station
- We used 3 NeveRest 40 motors and 2 HS-485 servos on our robot
- We are currently incorporating the use of encoders on our drivetrain motors



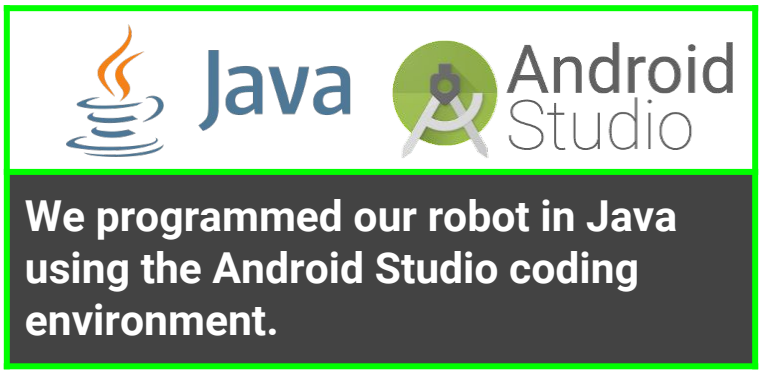
Initial Sketch



Final Product

Our Engineering Process

Coding



We programmed our robot in Java using the Android Studio coding environment.

Our Top Resources for Learning Java
• YouTube tutorials uploaded by fellow FTC teams
• The FTC Subreddit forum
• FTC coding resources from FIRST

We Tackled Our Code in Prioritized Order	
Autonomous	**Teleoperated**
1. Park in safe zone	1. Deliver glyphs in columns
2. Place glyph in any column	2. Park on balancing stone
3. Knock off jewel	3. Place relic
4. Read key using Vuforia and place glyph in correct column using encoders	
5. Place second glyph	

Our Team

Meeting Schedule

During the FTC Season

- We meet on Tuesdays, Wednesdays, and Fridays.
- The week prior to a competition we meet up to 5 times.

During the Off-Season

- Nerdy Girls hosts meetups every Friday for girls to work on individual robotics projects so that they can master the art of robot training.

Our Team

Outreach

Meetups

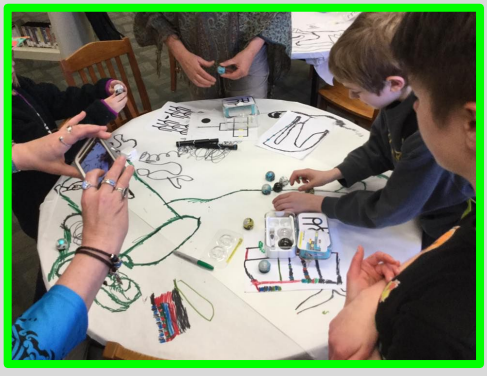
In the off-season, Nerdy Girls hosts weekly meetups for girls to conquer The Game (6 levels of increasingly difficult robotics projects).

Teen Scene 2017

In July, Nerdy Girls put on a coding workshop for 11 teens for Ellensburg Public Library's Teen Scene event.

Ozobot Workshops

Nerdy Girls hosted two Ozobot workshops at the Ellensburg Public Library for kids in Kittitas County.



Our Team

Outreach

Pikachu Takeover

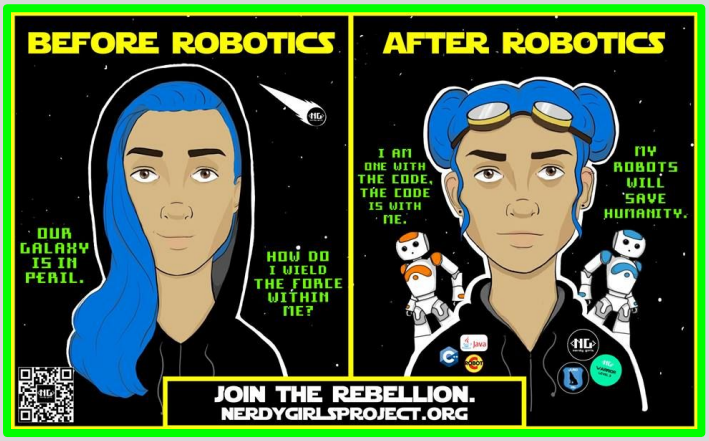
Every sixth moon, Nerdy Girls takes over downtown Ellensburg with LED origami Pikachus. The crowd always goes wild.

Drive-a-Bot Event

Nerdy Girls put on a Drive-a-Bot event at the local Farmer's Market where kids could try driving a VEX EDR or IQ robot.

Magical Posters

If you live in Ellensburg, you're bound to come across one of Nerdy Girls' recruitment posters. All artwork created by NG members.



Our Team

Fundraising

Krispy Kreme Doughnut Fundraisers

We held two fundraisers in which we sold Krispy Kreme donuts to the Ellensburg masses. In a small town that does not have access to Krispy Kreme joy, these fundraisers were a hit.

Motorcycle Quilt Raffle

One of our supporters, Beryl Kelley, organized a raffle for a motorcycle t-shirt quilt with all proceeds going to the Nerdy Girls FTC team. This raffle generated $815 for our team.

Social Media

We are extremely active on social media. Our goal is to create an online community of people who are unironically enthusiastic about robotics, and to spread robot love to our community where people don't yet understand the magical power of robots. Sometimes our posts generate anonymous donations.

The Business Plan

The Budget

Nerdy Girls Budget - FTC Team #12738		
As of 12/12/17		
Description	**Amount**	**Vendor**
Expenses		
National Registration Fee	$275.00	FIRST
State Registration Fee	$882.00	FIRST WA
Actobotics Competition Kit	$486.98	ServoCity
Additional Actobotics parts	$458.25	ServoCity
Control & Communication Set	$278.98	FTC Storefront
Electronics Modules & Sensors Set	$150.00	FTC Storefront
Practice Field (quarter)	$168.48	AndyMark
Team T-Shirts	$250.50	Shirts and More
Tools and Parts	$200.00	Various
Transportation for 3 events	$80.00	
Lunch at 3 events	$150.00	
Total Expenses	**$3,380.19**	
Funds Raised		
Grant for National Registration Fee	$275.00	FIRST Rookie Grant
Grant for Robot Parts	$428.98	FIRST Rookie Grant (usable portion)
Grant for State Registration Fee	$500.00	FTC Bezos Family Foundation Grant
Raffle Fundraiser	$815.00	Took place on 5/6
Krispy Kreme Fundraiser #1	$175.00	Took place on 8/26
Krispy Kreme Fundraiser #2	$155.00	Took place on 9/23
Farmer's Market Drive-a-bot Event	$45.00	Took place on 9/30
Anonymous Donation	$500.00	
Donation from Jerelyn VanMeter	$300.00	
Donation from Mayer family	$200.00	
Total Funds Raised	**$3,393.98**	
Bottom Line		
Surplus/Deficit	**-$13.79**	**Surplus**

This is our budget. The end.

The Business Plan

Sustainability Plan

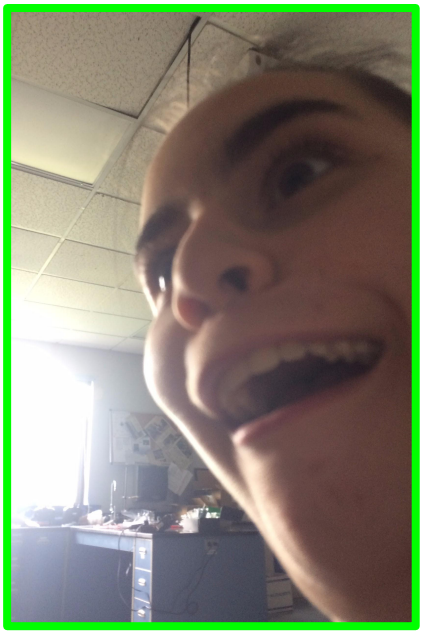
Operation “We Ain’t Never Gonna Stop”

Financial Sustainability Plan
• Putting on Krispy Kreme Donut fundraisers
• Developing and selling Nerdy Girls merchandise online to girls interested in robotics
• Hosting summer workshops and camps to kids in our community using existing Nerdy Girls robots and tutorials
• Working with Girl Scouts to bring area wide robotics events to Ellensburg, so girls can earn their STEM badges in robotics and coding.

Member Sustainability Plan
• Recruiting through collaboration with Girl Scouts
• Continuing to raise awareness in our community about the slightly magical world of robotics using our social media presence and our ongoing approach to outreach
• Bringing up leaders through the Nerdy Girls program to help run the team as older girls age out

The Future

What's next for Team #12738?
• Creating FTC tutorials so we can help other rural teams without mentors break into FTC
• Creating an online YouTube robotics community for kids around the world
• Working to start up more FTC teams for future Nerdy Girls chapters
• Hosting summer workshops and camps for kids in our community using existing Nerdy Girls robots and tutorials
• Working with Girl Scouts to host area wide robotics events so girls can earn their STEM badges in robotics and coding
• Continuing to create a new culture for girls in robotics



Artwork by Mia!