Career Readiness Challenge:

Environmental Engineering Usage of the Engineering Design Process

22250C

Anaheim, California

"We are continually faced by great opportunities brilliantly disguised as insoluble problems."

- Lee Iacocca

Exploring how Environmental Engineers utilize the Engineering Design Process in the real world.

Word Count: 998

(Excluding Title Page, Titles/Headings, and Citations)

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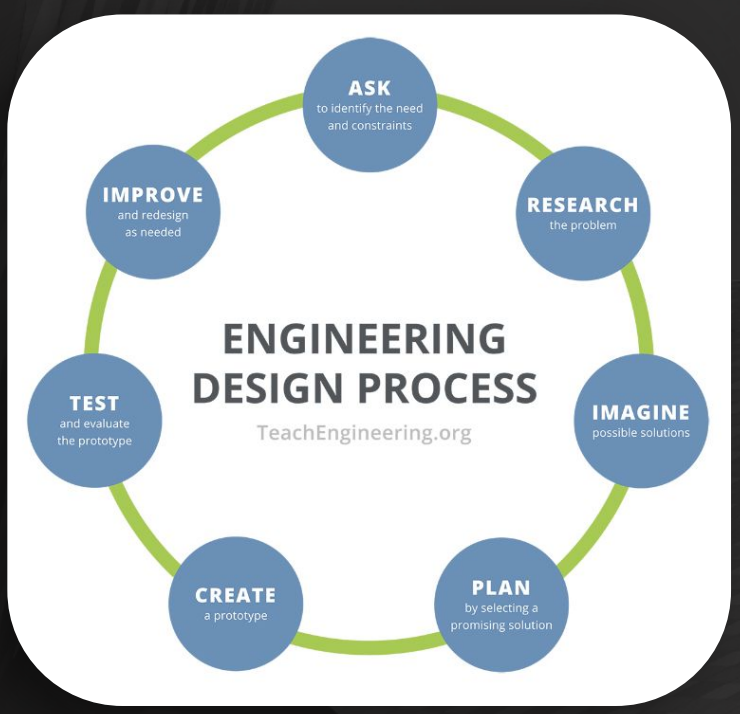
Environmental Engineering

Why did we choose this career?

We chose this career because environmental engineers have helped preserve the Earth's nature and ecosystems. Their achievements have enhanced, protected, and preserved Earth through their use of data and science. Our team hopes to make an impact like this in the future.

How VEX IQ Prepares Us for the Future



Teamwork

Working with a team during the robotics season allows us to learn how to communicate with other people and collaborate on projects. These fundamental principles are necessary for the future when working in jobs that require working closely with others.

The Design Process

During the robotics season, the design process is constantly used for designing, testing, etc. Learning the fundamentals of the design process now is substantial to a bright future in jobs that require its usage.

Education

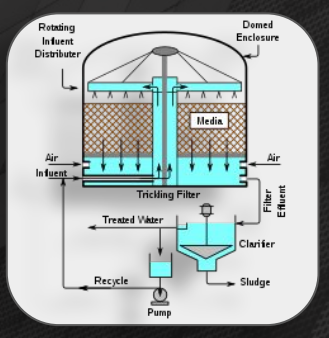
The VEX IQ robotics program allows students to understand better how devices and machines work and provides background knowledge for specific jobs.

Achievements

Environmental engineers have advanced Earth's systems. They constantly work to preserve nature and encourage a bright future for the Earth. Climate change and zero waste projects are in progress to help do this.

Aqueducts

Sewers



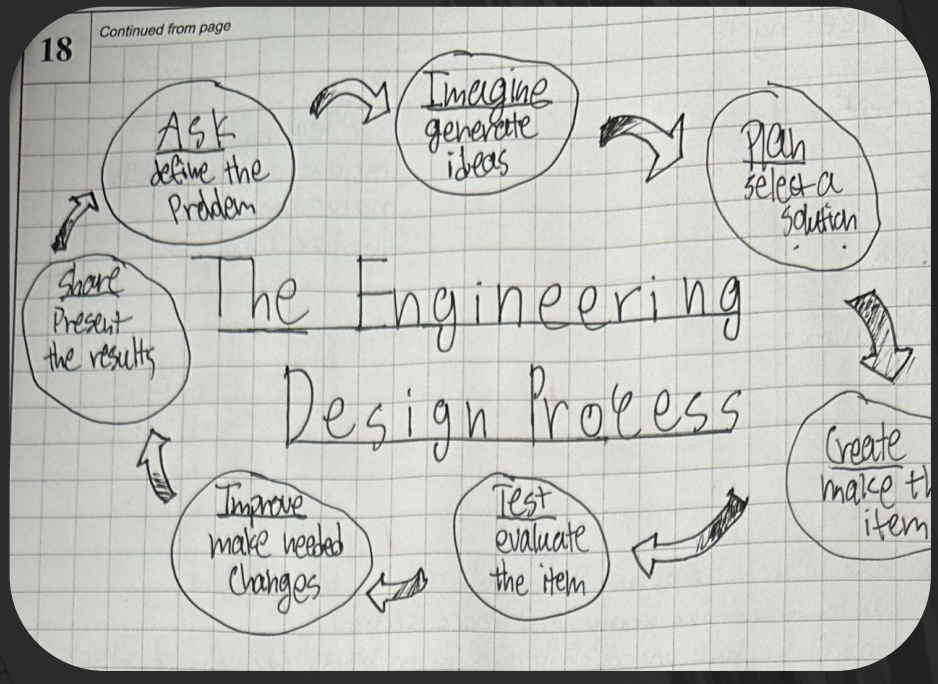
Biofiltration Systems

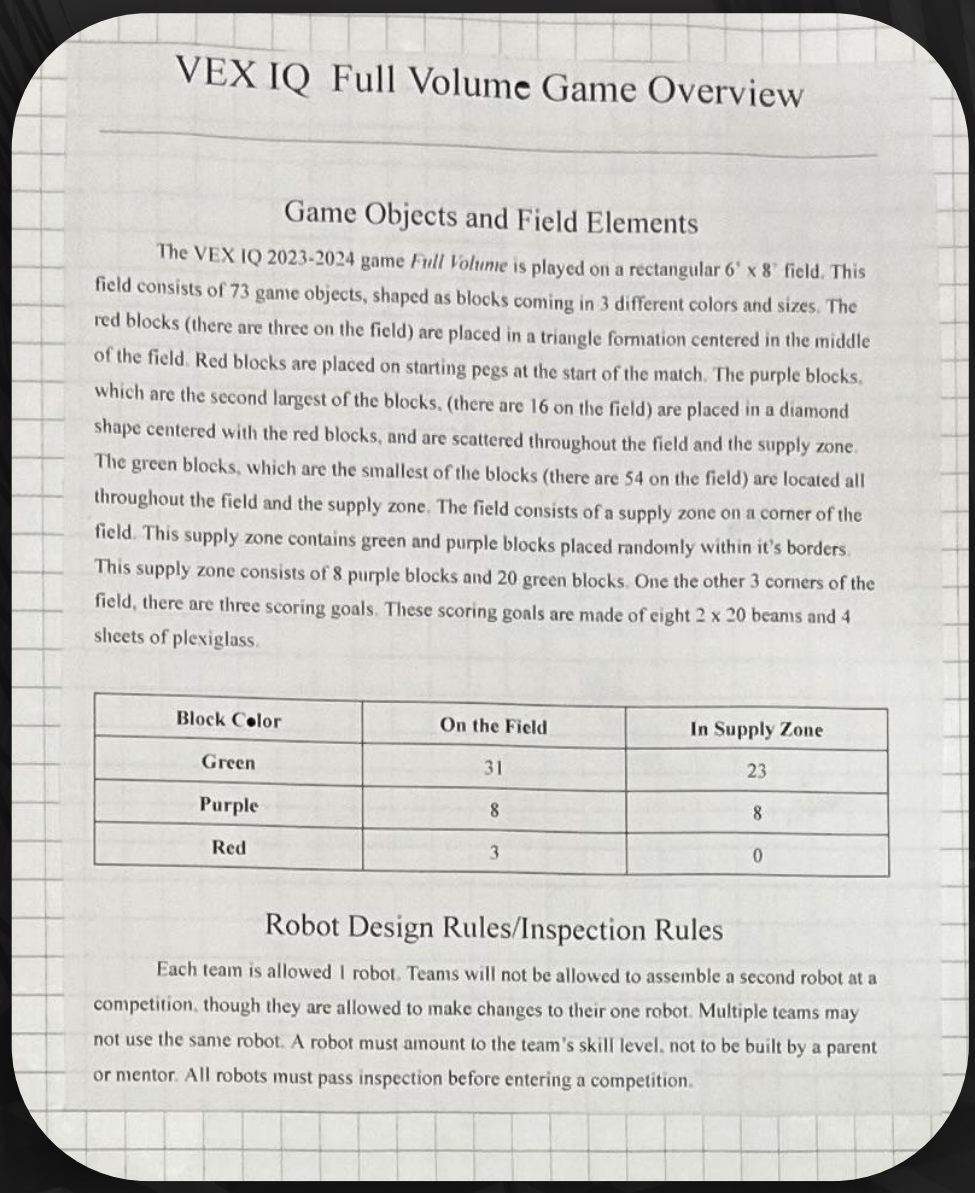
Ask / Research

Environmental engineers ask questions to get their brains running about different solutions and ideas. These questions are based on an existing problem or a way to improve a current solution. This is usually the first step of the design process, helping generate ideas for designs to execute the rest of the design process. In both VEX IQ and engineering, the identification and research of the problem is the most crucial part of the design process.

Example:

Environmental engineers ask questions such as, “How can we conserve and carry water efficiently?” while researching existing solutions and data.





VEX IQ Full Volume Game Overview

Game Objects and Field Elements

The VEX IQ 2023-2024 game *Full Volume* is played on a rectangular 6' x 8' field. This field consists of 73 game objects, shaped as blocks coming in 3 different colors and sizes. The red blocks (there are three on the field) are placed in a triangle formation centered in the middle of the field. Red blocks are placed on starting pegs at the start of the match. The purple blocks, which are the second largest of the blocks, (there are 16 on the field) are placed in a diamond shape centered with the red blocks, and are scattered throughout the field and the supply zone. The green blocks, which are the smallest of the blocks (there are 54 on the field) are located all throughout the field and the supply zone. The field consists of a supply zone on a corner of the field. This supply zone contains green and purple blocks placed randomly within it's borders. This supply zone consists of 8 purple blocks and 20 green blocks. One the other 3 corners of the field, there are three scoring goals. These scoring goals are made of eight 2 x 20 beams and 4 sheets of plexiglass.

Block Color	On the Field	In Supply Zone
Green	31	23
Purple	8	8
Red	3	0

Robot Design Rules/Inspection Rules

Each team is allowed 1 robot. Teams will not be allowed to assemble a second robot at a competition, though they are allowed to make changes to their one robot. Multiple teams may not use the same robot. A robot must amount to the team's skill level, not to be built by a parent or mentor. All robots must pass inspection before entering a competition.

How Our Team Integrates this Step

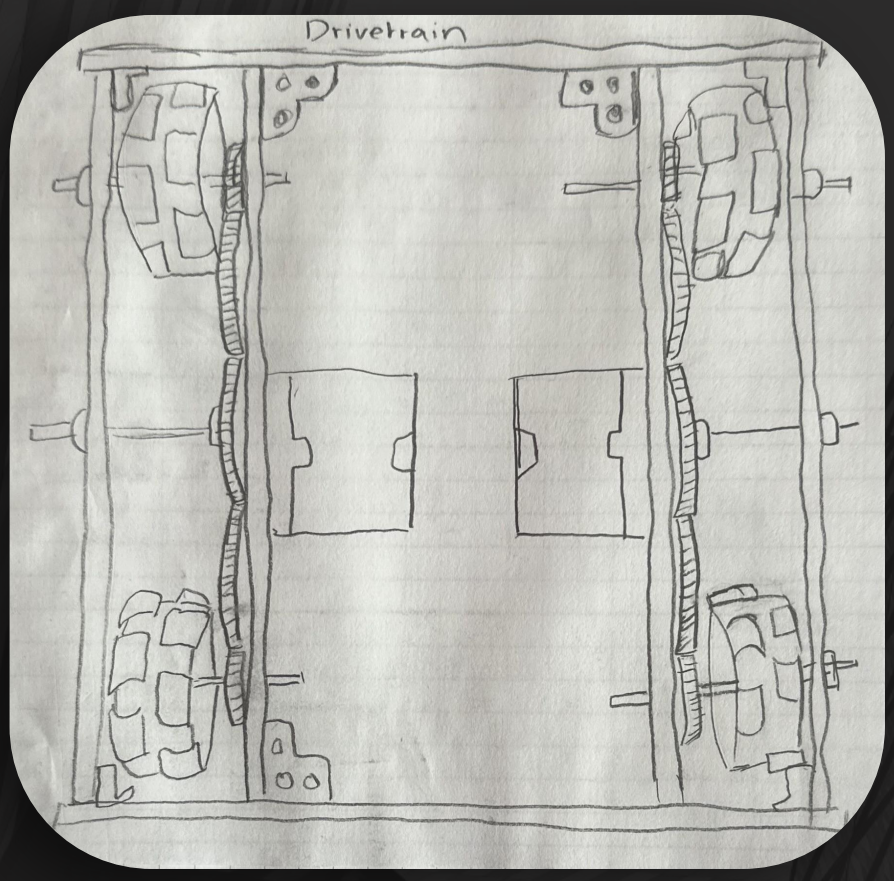
Before brainstorming robot designs, our team asks, “How can we satisfy the requirements for this season’s game with a high score in the littlest time?” and researches the requirements for the game.

Figure 1: An overview of this season’s game in our engineering notebook.

Imagine

After identifying the problem, environmental engineers begin the research and design phase, which plays a significant role in the engineering design process when a product or design is intended for prototyping. They carefully record their ideas and start sketching design solutions and enhancements. We perform a similar process when designing our robot.

Figure 2: A sketch we created of our initial drivetrain.

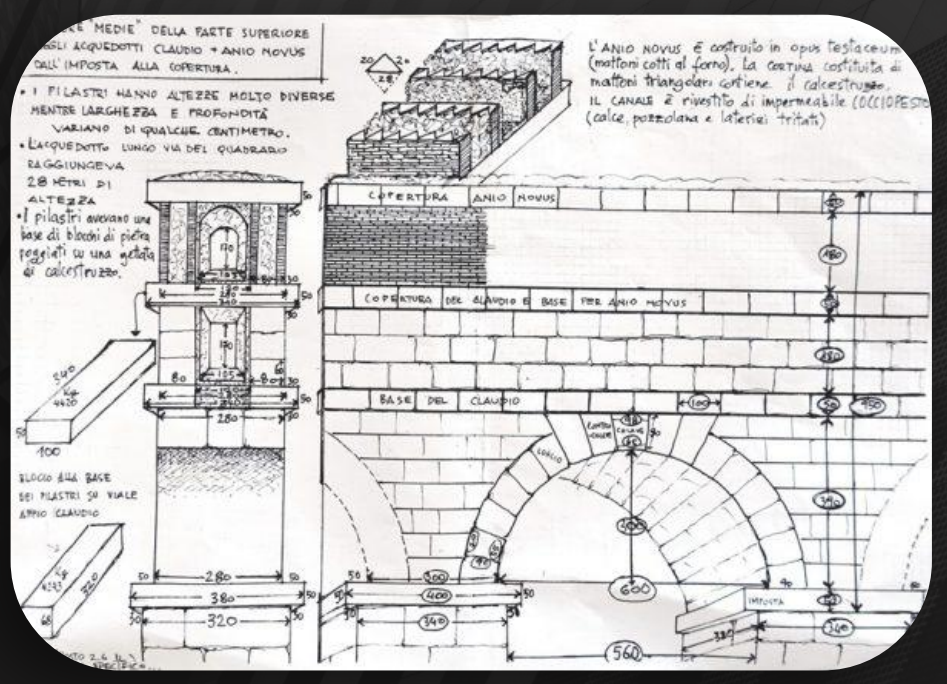


How Our Team Integrates this Step

Once we identify the requirements and necessities for the game, we research and draw out ideas and designs for our robot.

Example:

After identifying the problem, environmental engineers research sustainable solutions and come up with a sketch of their design.



Create

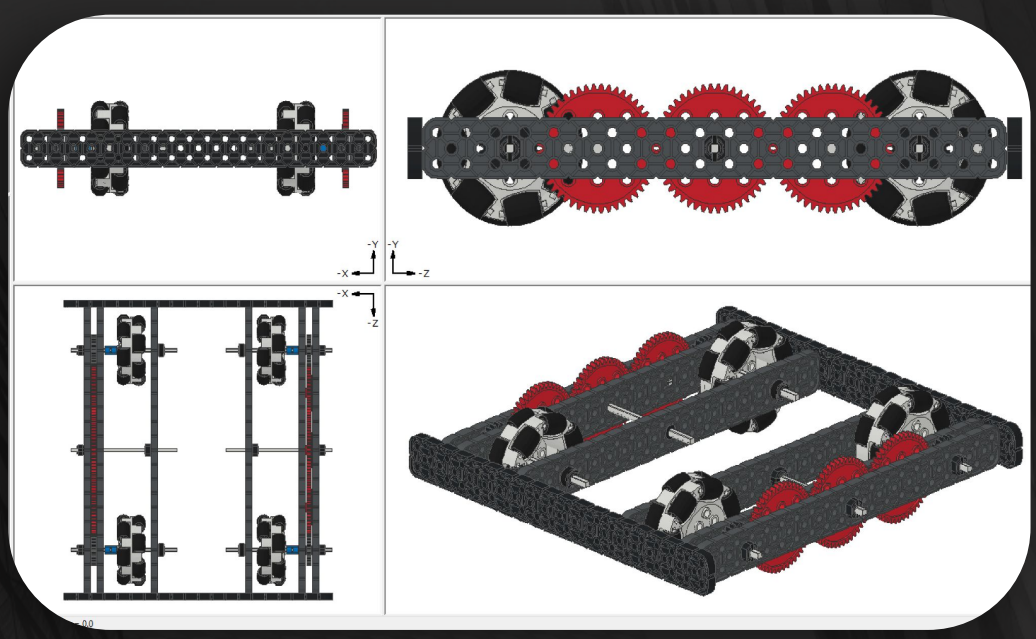
This step of the design process involves creating a prototype of one or many solutions that should meet most criteria to solve the problem. The prototype is made using a variety of materials, which can also include online applications. In both engineering and VEX IQ, these prototypes are improved later on.

Example:

Environmental engineers first created a sewer prototype before improving the wastewater system over time.

Figure 4: The original aqueduct was created years ago, in 312 B.C.

Figure 3: A CAD of our drivetrain. We use SnapCAD to test out designs before building prototypes.



How Our Team Integrates this Step

Once we have our designs sketched out, we create prototypes of different mechanisms, which are later improved and changed. This step is the primary building block of any robot.

Test

Environmental engineers assess their design solutions during this phase of the design process. They conduct experiments and put solutions in the field to monitor performance under real-world conditions. Monitoring these tests helps engineers understand environmental impacts and helps optimize their designs. In both VEX IQ and engineering, data is collected and is crucial for ensuring that these solutions meet desired objectives as needed.

Figure 5: *Testing a new prototype of our intake system using a purple block.*

How Our Team Integrates This Step

Once our prototypes for each part of the robot are completed, we test them using the game elements to see which areas need improving and then document our findings.

Figure 6: *Vibration-based and neural network tests are conducted to assess the structural integrity of various components of the aqueduct.*

Example:

After the initial building of the aqueduct, environmental engineers perform tests to identify structural soundness, distribution of water, conditions against harsh weather, etc.

Improve

Once the prototype is tested, engineers carefully analyze its performance and identify areas that could need work. During this stage, they make modifications to specific variables as required. The ultimate goal is to gradually refine their design by altering variables and observing their effects. By taking this approach, engineers can evaluate the influence of each modification in a controlled manner. We perform a similar process and refine our design solutions by repetitive testing and improving to optimize performance.

Figure 7: The Aqua Alexandrina, built in 226 C.E.

Example:

Aqueducts are now designed with climate change resilience, ensuring they withstand extreme weather and adapt to any changes. Additionally, they use sustainable materials to reduce maintenance cost and minimize the environmental impact of the construction.

How Our Team Integrates This Step

We constantly work to improve our robot and make the subsequent trial better than the last. Our robot is continuously being modified and improved over time to maximize performance.

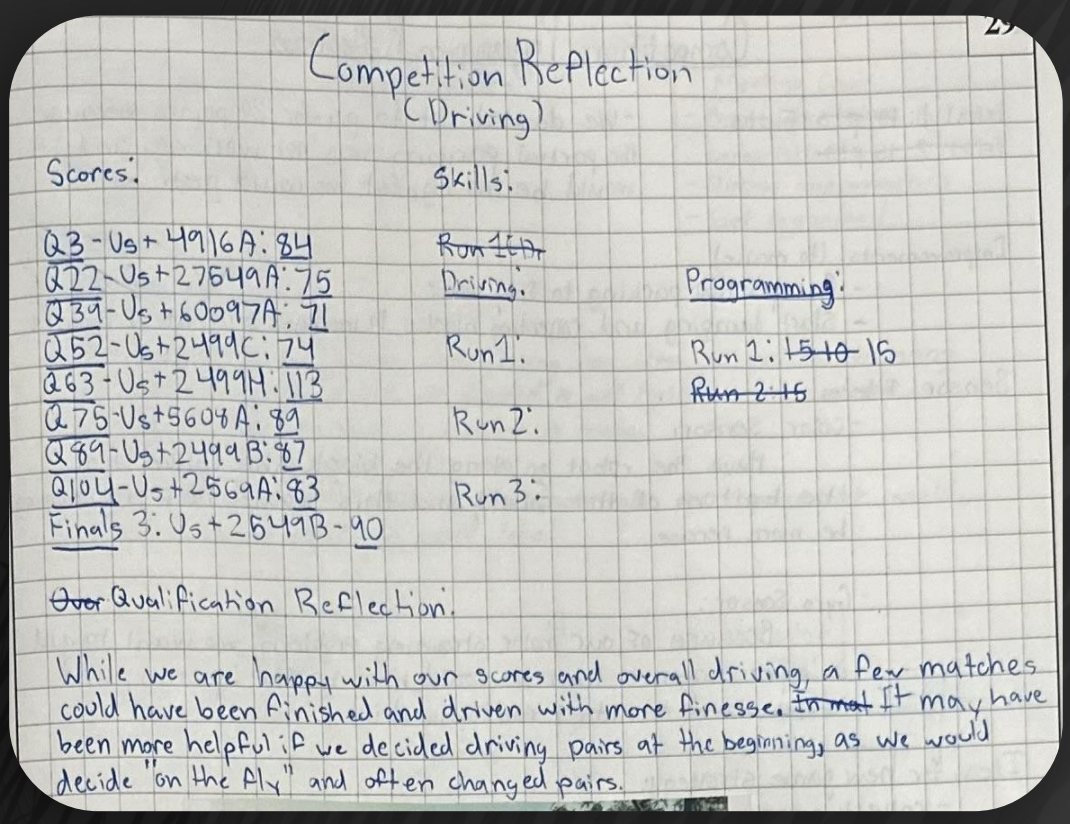
Figure 8: The California Aqueduct finished in 1974. The significant improvement can be seen by comparing Figure 7 to Figure 8.

Share

After developing and refining solutions, engineers emphasize sharing and implementing their findings. This involves communicating their ideas to various people and executing their innovations in the real world. By sharing their expertise through reports, presentations, and publications, environmental engineers contribute to a discussion on sustainable development. These innovations are also implemented into the real world to address the problems they were created for, raising awareness for the initial problem.

Example:

Environmental engineers share their creations with the world to spread information. These designs are shared through companies, organizations, and the Internet. The aqueduct has been spread all around the globe and has many online resources.



Competition Reflection
(Driving)

Scores:

Q3 - Vs + 4916A: 84
Q22 - Vs + 2754A: 75
Q39 - Vs + 6009A: 71
Q52 - Vs + 2499C: 74
Q63 - Vs + 2499H: 113
Q75 - Vs + 5608A: 89
Q89 - Vs + 2499B: 87
Q104 - Vs + 2569A: 83
Finals 3: Vs + 2549B - 90

Skills:

~~Run 1 (1)~~
Driving:
Run 1:
Run 2:
Run 3:

Programming:

Run 1: ~~15 10~~ 15
~~Run 2: 15~~

~~Over~~ Qualification Reflection:

While we are happy with our scores and overall driving, a few matches could have been finished and driven with more finesse. ~~In mat~~ It may have been more helpful if we decided driving pairs at the beginning, as we would decide "on the fly" and often changed pairs.

Figure 9: Reflection of our first competition.

How Our Team Integrates This Step

At competitions, we share our robot design with other teams during alliance matches and look at different designs. Our designs are also shared during the team interview and through our engineering notebook.

Citations

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"Research is formalized curiosity. It is poking and prying with a purpose."

- Zora Neale Hurston