NASA Robotics Engineers:

The Designing Process of ISS Robot Astrobee

Presented by: 1469E, United States, Northridge

Publisher Overview

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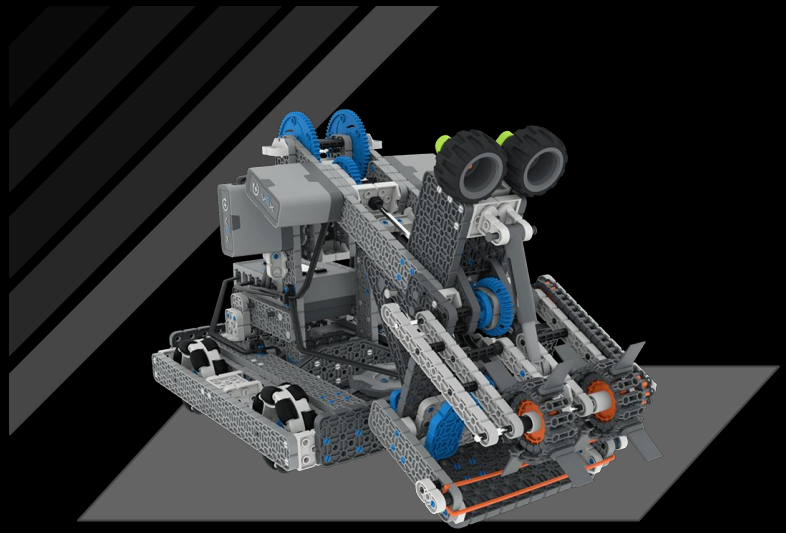
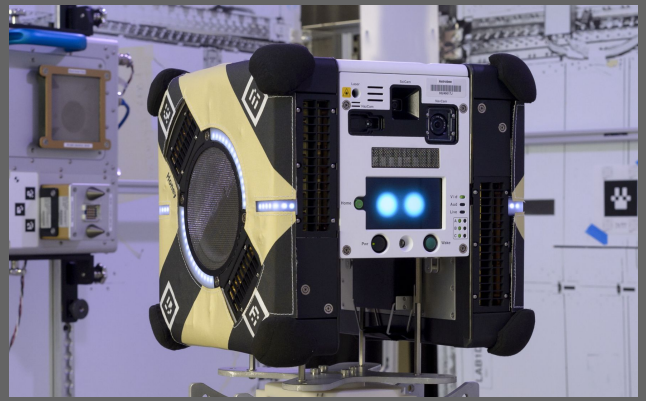
And also our coaches, parents', and teachers' moral / time support!

The Introduction...

Robotics has been a very important area of engineering these days. From the Mars Rover terrain exploration to surgical purposes, robotics affects the world in many relevant ways. VEX Robotics helps us to understand what it's like to be an engineer and employ our knowledge to our own robot. But every invention requires strategizing, so how is the junior robotics engineers' engineering design process similar to the senior engineers? In this presentation, we will investigate Astrobee, a robot that is designed by the NASA Ames Research Center Team and its origin. (We chose it because its one of my Engineering class's classwork and we think its very interesting, since robot on ISS shows the potential of robotics).



Astrobee in ISS — Maria Bualat



Maria Bualat is a robotics engineer who works at NASA Ames Research Center. Her team is currently working on a robot called Astrobee, which is a free-flying robot for the International Space Station. “The idea is that this robot will float around in a space station. It has some cameras, it can do inspections, and it will also have other sensors. For instance, a carbon dioxide sensor, so it can check the quality of the air.”

“…don’t ignore your communication skills because you don’t realize how much of your job is actually communicating your ideas to other people….” –- Maria Bualat

“ …I get to go out into the field or when we want to test our robots, we take them to places that are very stark, very lifeless.” Testing took place at last, which applied their design into real life and see if it meets the goal or not. Maria thinks communication is very important to successfully design Astrobee in the whole designing process. After reading all of their presentations about Astrobee, we think their cooperation in the whole process is also stunning.

The engineering team already has an idea for the robot. The idea for the robot helped lead the team into cooperation and a goal to strike for. Like “let robots avoid collision by themselves“ or “design a gripper“ Maria “spends a lot of time on the computer“ because she works in software systems. She does “a lot of project management and systems engineering“, which is crucial for the whole project. “So you set the goal of the project, you set the requirements for the engineers to meet.“ Which allows the engineers to gather around and brainstorm new ideas for the robot..

There are also different engineering teams that are on different parts of Astrobee.This project started as early as 2017 and the idea about Astrobee probably came earlier since in presentations they already have different engineer's goals and their source. At the beginning, the engineers could only use modeling tools to simulate what could happen on the ISS. Then in 2018, they send some prototypes to ISS and see what they can improve on. Along with Astrobee, there are also other two types of robot on ISS. They are still researching and seeking improvements now based on the feedback on ISS.

Design Process of 1469E : Version 1

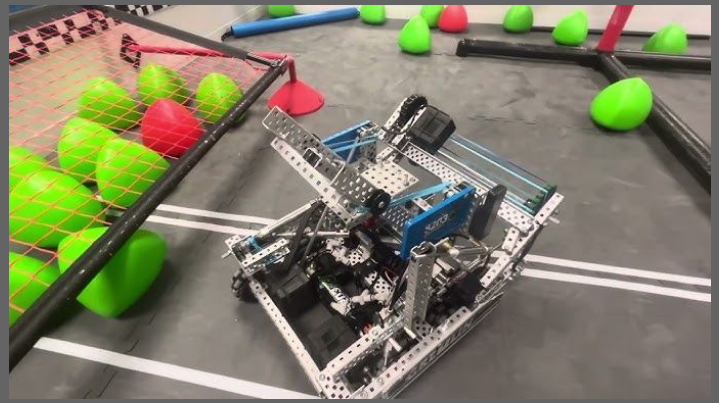
1469E, or “Squirrel” as we nicknamed it, was our robot of the “Over Under” competition for 2023-2024. We had changed its design 3 times. Each time is based upon our experiences on competitions and improving every time when we can.

We built the VEX VRC Striker bot at first. As you will see in the picture slides, we started off by building the base, then built up from that. The main idea is that it will use the back of it to push triballs into the goal and use the arm to pick up triballs. We used our Striker bot for our first competition but we didn’t make it to the finals. Although the Striker bot’s arm was very helpful for picking up triballs, it wasn’t very competitive because it wasn’t efficient enough.

Design Process of 1469E : Version 2

After the competition, we decided to do match-load so that our robot could be more efficient with triballs. Our team chose a catapult because the catapult is more accurate and seemed to have more benefits than flywheel. So we took apart our Strikerbot and changed to a six-wheel drive instead of a four-wheel drive. We replaced the Strikerbot arm with a rubber band based catapult. And later changed the base smaller to make a more compact robot. We used this final design for our second competition. It worked well, but overall the pros were outweighed by the cons. The results weren't much better than last time.

Design Process of 1469E : Version 3



After much debate and discussion, we decided to still keep the base, but remove the catapult and replace it with a flywheel. It weighs quantity more than quality so we have a higher chance of scoring due to the mass amount of match-loading it can handle. So work over the weekend to achieve that goal. We also added a hang mechanism on the arm for elevation. We might later add wings, a wedge, and/or an intake after further planning.

Comparison: Similarities and Differences

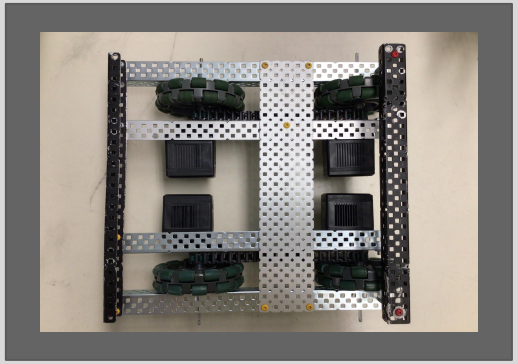
Maria's Team	Our Team
Identify	Identify
Plan	Plan
Research	Communicate
Communicate	Prototype
Prototype	

Maria's team has a very standard designing process: Identify the need, have a plan, research, communicate, create prototype, test, and start over again. While our process is: Identify the need, plan, communicate, create prototype. The process is similar but we are missing a few steps that could be crucial to success to the events we've participating in. Their designing process also included a few tricks like modeling and specialization, which our team could learn and may lead to possible success.

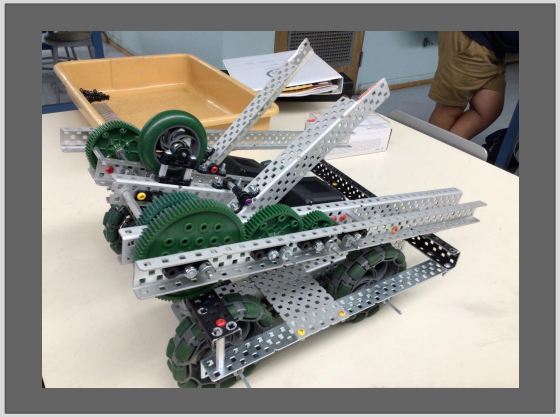
Conclusion —– Authors' Words

In the end, We think that even though our designing process isn't as same as the NASA engineers', There are still similar steps. We all identify the problem and plan for success. VEX Robotics makes us think like engineers. The main point of the VEX events isn't really a competition, but a way to communicate ideas through many teams of engineers. Even in this challenge, VEX uses this as a form of education to prepare our designing process with the professionals' and thus helping us improve the quality our robot. By making us think like robotics engineers, it prepares us for our future career, and therefore helps us benefit and guide the next generation's engineers.

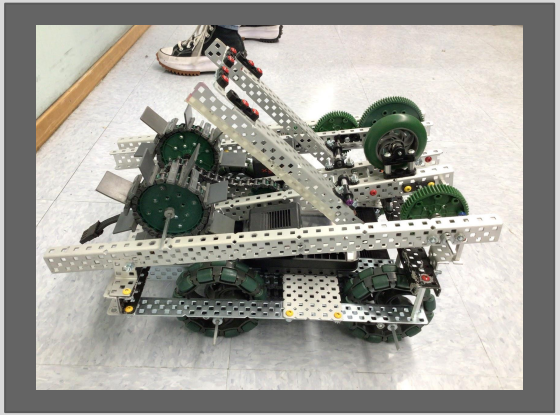
"All of the great achievements have remarkable building process." ——---- 1469E Team



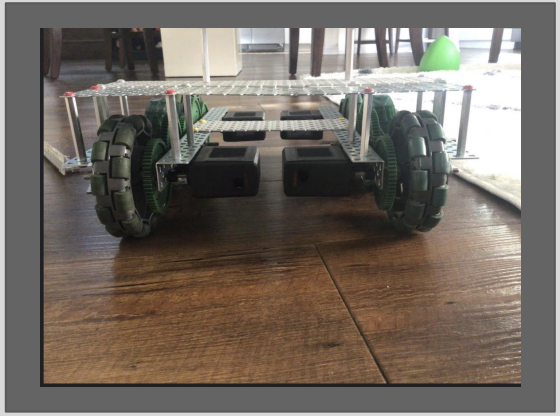
First Prototype base



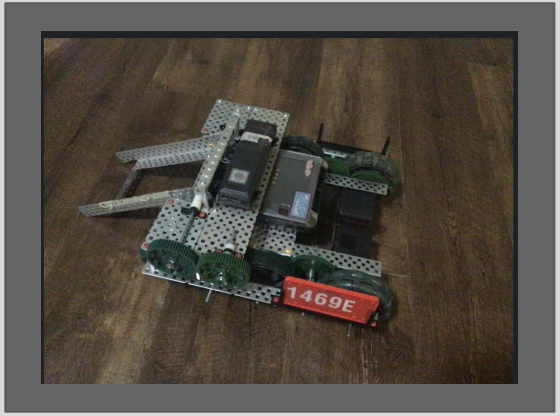
First Prototype without flywheels



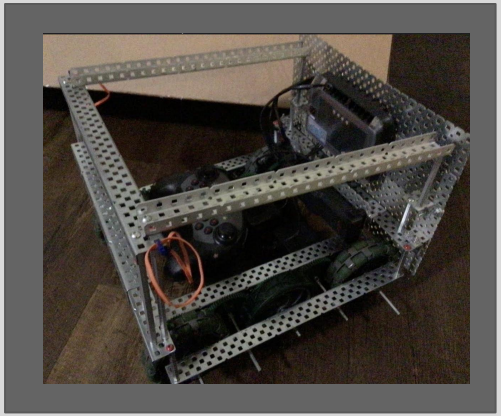
First Prototype finished



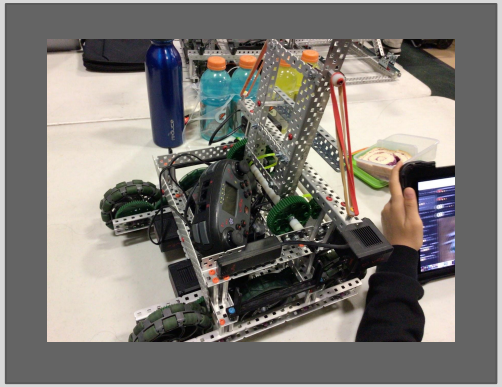
Second Prototype base (front)



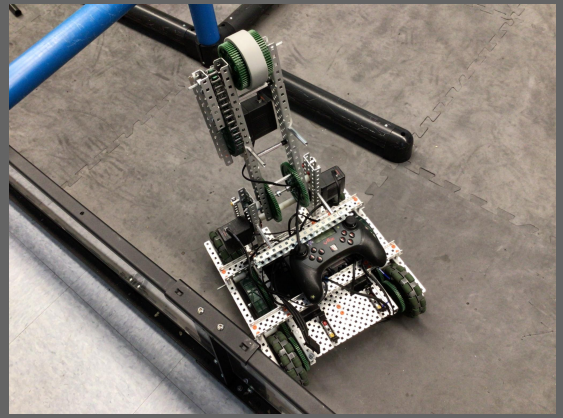
Second Prototype with catapult



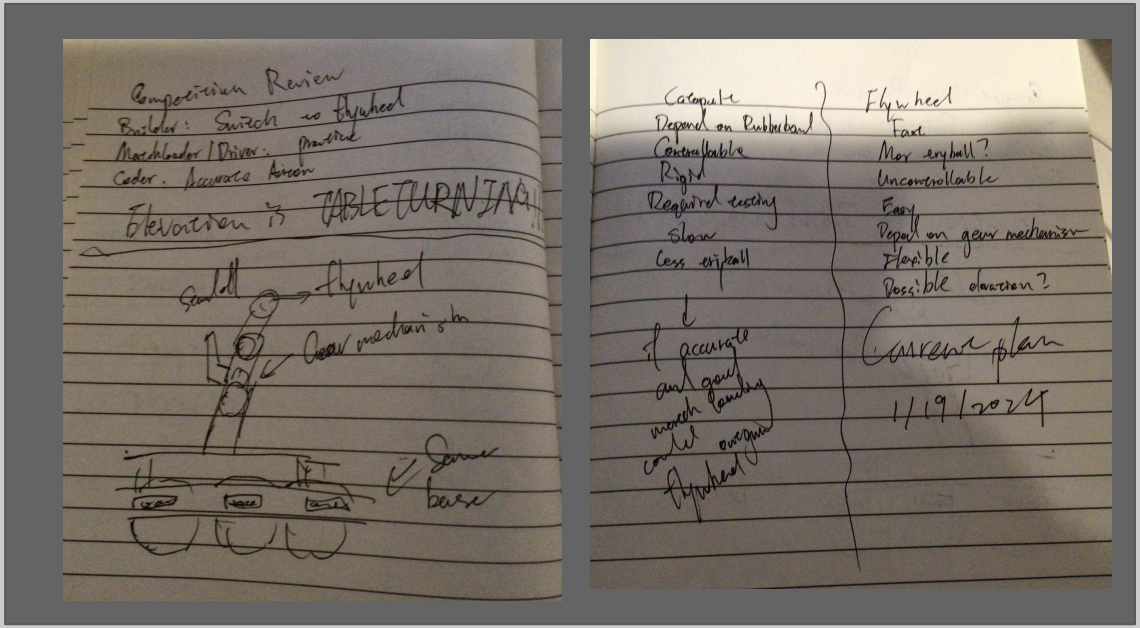
Second Prototype with wide base



Second Prototype at an event

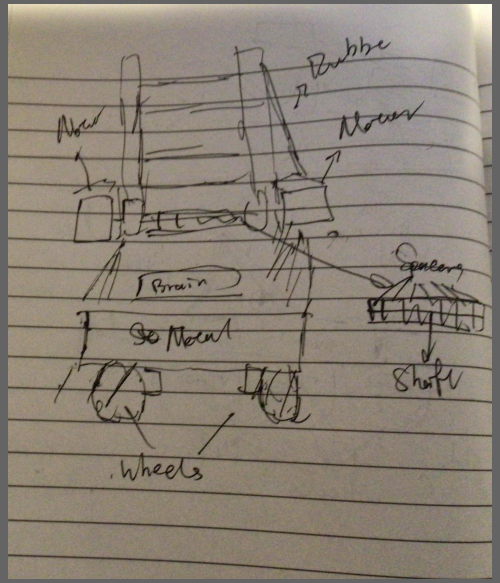


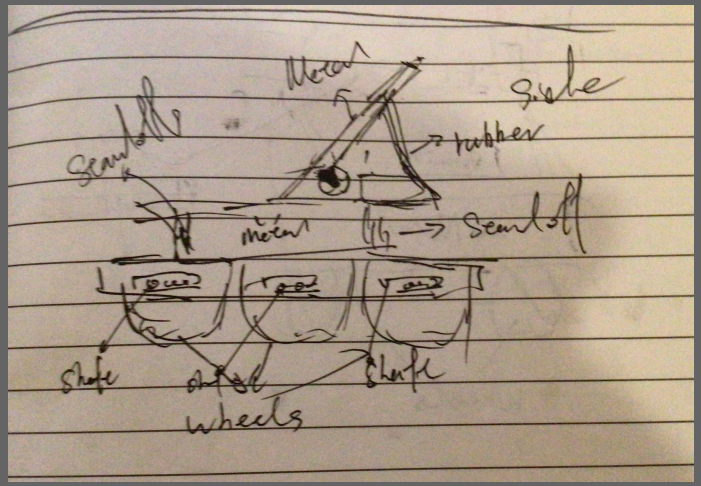
Third Prototype



Third Prototype drawing with list about catapult and flywheel

(Sorry for bad writing/drawing)





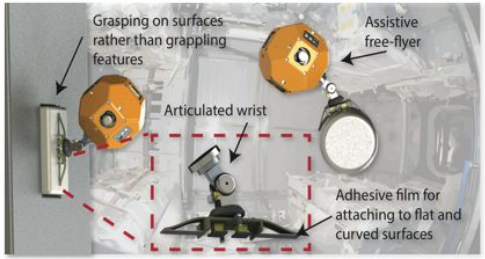
Second Prototype (back and side)

ESI Technical Research Objectives

Objective 1: Design, analyze, and test mechanisms for grasping and manipulation that employ controllable dry adhesion

Objective 2: Devise control and planning algorithms that allow free-flyers to grasp and manipulate payloads with adhesion-based appendages

Objective 3: Validate the technology on a state-of-the-art test bed at Stanford and on the Astrobee platforms

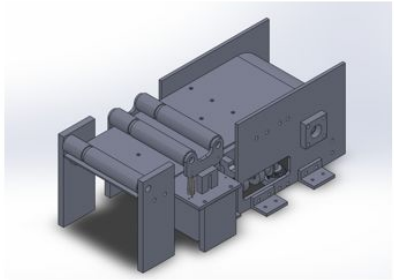


Objective for Astrobee's arm design

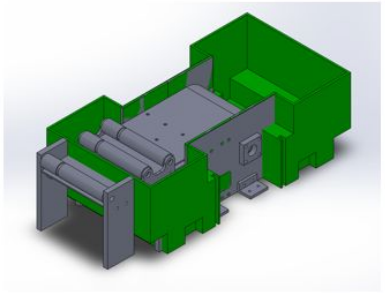
Metis Technology Solutions

SBIR/STTR Small Business Innovation Research / Small Business Technology Transfer

POC Vs. Astrobee Payload Volume

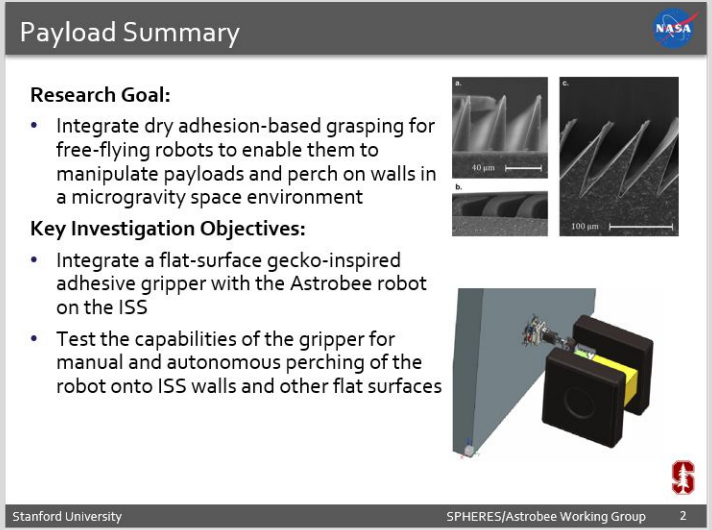


POC

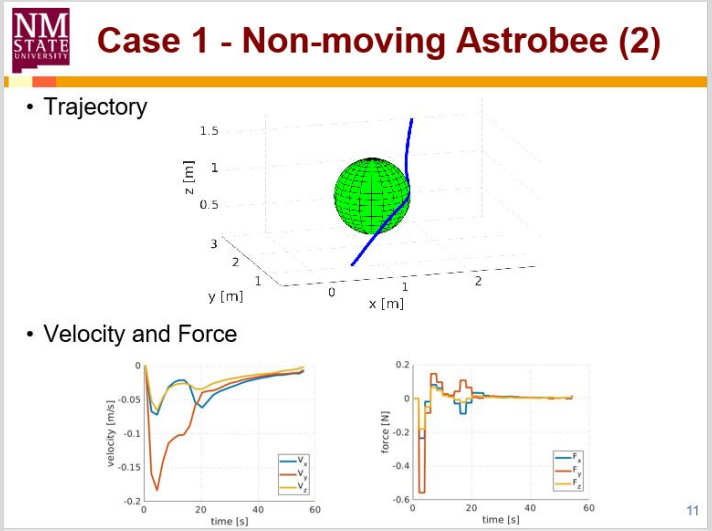


POC w/ Astrobee Payload Volume

Modeling for Astrobee's movement



Goal and Objective for Astrobee's arm design



Calculation for Astrobee's smart movement

Meet the team: 1469E

Ava Arreola

Team builder/driver. Likes lizards and piano. Been in VEX robotics for 2 years. The team leader of the robotics team. Plays important role for the whole team.

Ava Fong

Team match loader /notetaker. Likes drawing and birds. Been in VEX robotics for 1 year. New to VEX Robotics. Helper to the builder.

Jiamin Tang

Team coder/notetaker/ VEX challenger finisher. Likes pigeons and chess. Been in VEX robotics for 1 years. New to VEX Robotics. Tries his best for the team.

Makayla Chung

Team notetaker/ VEX challenger finisher. Likes reading and dogs. Been in VEX robotics for 1 year. New to VEX Robotics. Helps everyone in the team.

Citations

Information:

CAREER SOURCES or https://www.nasa.gov/astrobee/
https://careerdiscovery.sciencebuddies.org/science-engineering-careers/engineering/robotics-engineer
https://www.youtube.com/watch?v=sUOY3JZ-9C4
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