Issue 839

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839A

SpaceX is making history in space exploration

SpaceX's new technology reveals possibilities aerospace engineers didn't even think were possible. Today we'll go behind the scenes to find out more about SpaceX's design process

First Principle
thinking from the ground up

SpaceX v 839A
engineering design process

VEX Robotics
preparing kids for a life in STEM

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TEAM 839A

SpaceX Rapid iterative Design Process

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By Justin Tan

INTRODUCTION

This project demonstrates how engineers at SpaceX utilize their rapid iterative design process to become one of the most innovative companies on earth. Our interviews and research will discuss how this process is superior, how it compares to our design process, and how VEX helps lay a foundation for future STEM careers.

WHY SPACEX?

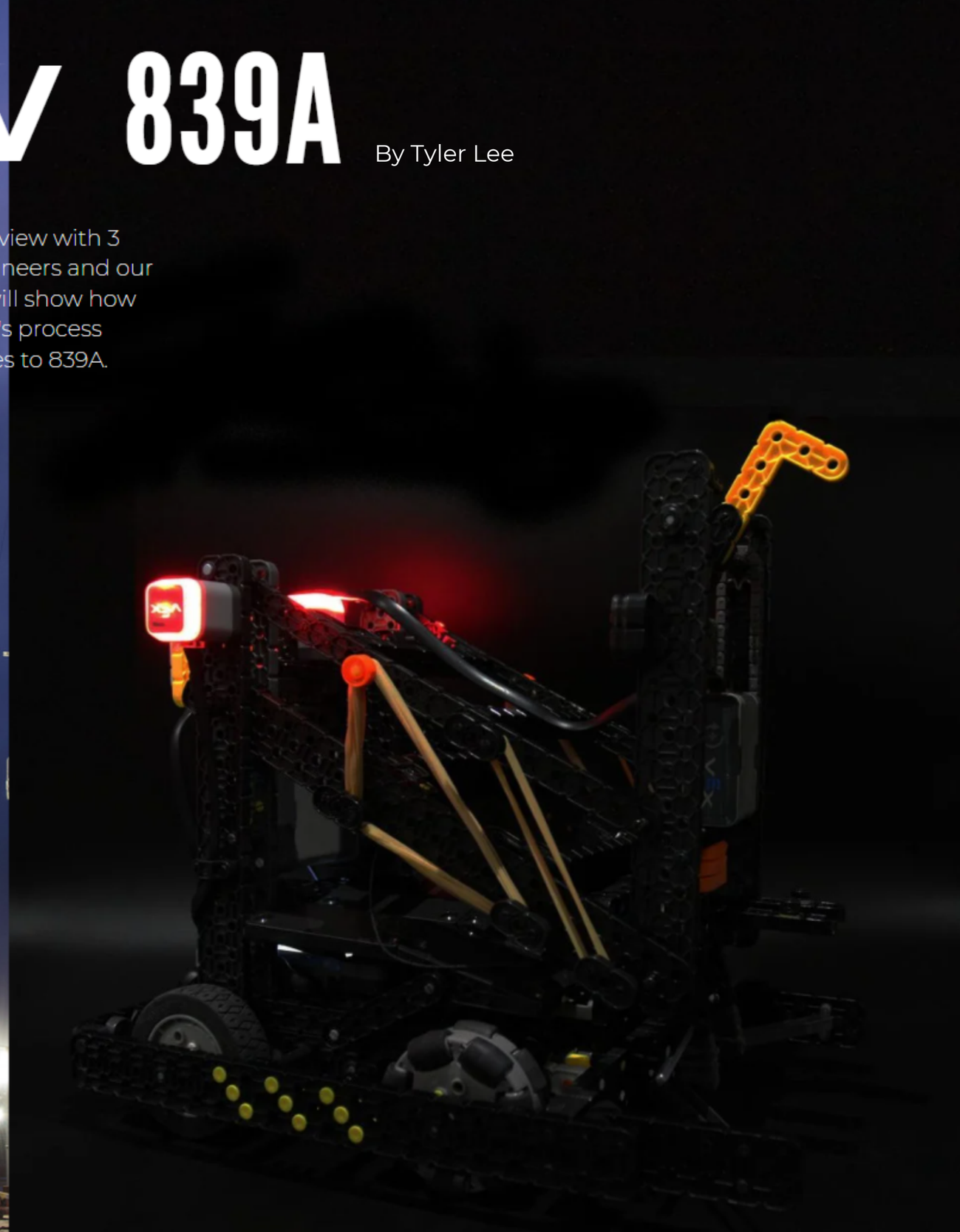
By Justin Tan

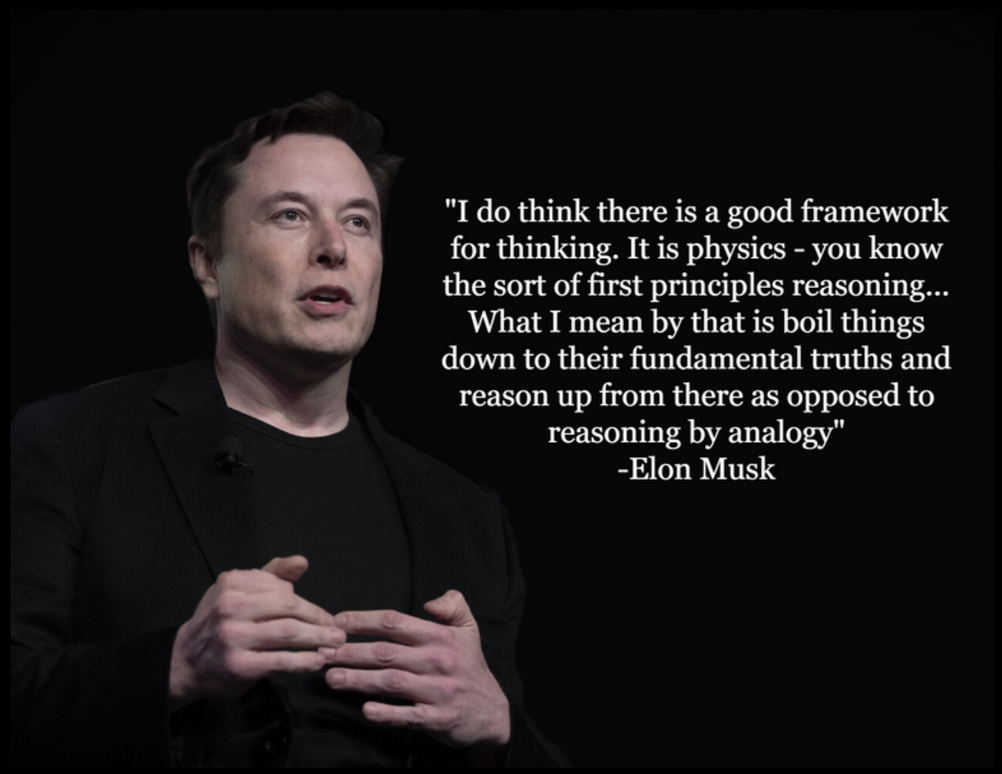
For this online challenge, we decided to research a company's engineering design process to see if it can help improve our own. We chose SpaceX as they revolutionized space exploration and solved problems never imaginable. By lowering cost and increasing innovations through their rapid iterative design process, SpaceX is among the greats of space travel. To this day, SpaceX had hundreds of successful launches and has the first orbital class rocket capable of reflight. (SpaceX, 2021).

SPACEX V 839A

By Tyler Lee

Our interview with 3 SpaceX engineers and our research will show how SpaceX's process compares to 839A.



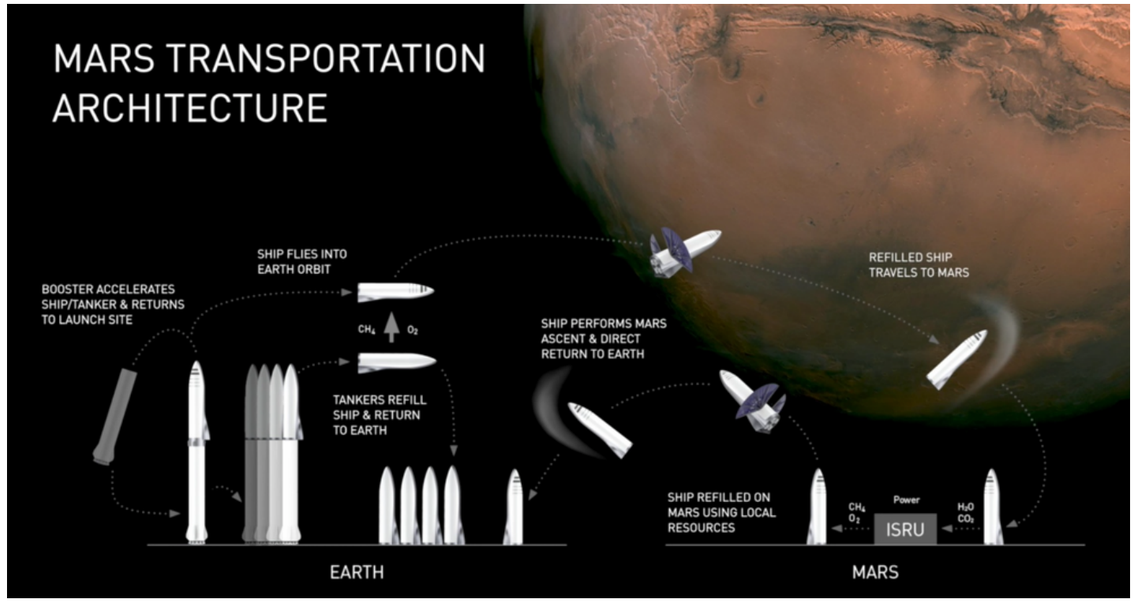


FIRST PRINCIPLE THINKING

SpaceX uses First Principle Thinking to find new innovative solutions that have not been thought of before. Both SpaceX and 839A use first principle thinking during the design process.

PLAN

When planning, SpaceX has meetings and looks at the task. They find the limits, question the requirements and resources that are available. They use first principle thinking to identify the fundamental truths. Afterwards, they start brainstorming solutions. They as a team decide and prioritize the work



Game Analysis

Like SpaceX when a new game comes out we have meetings and evaluate the goals of the game. We then identify the requirements, limits and question assumptions. Unlike SpaceX we have many limits such as size and motor constraints . Industries like SpaceX have a budget but don't have as many constraints. Next, we break the game down to it's fundamental truths, this helps us have a deeper understanding.

Brainstorming

After we break down the game we start brainstorming. When brainstorming we use first principle thinking, like SpaceX, to come up with more innovative ideas like our string choo choo.

Research

We research ideas from past robotic games or industries. We also research other mechanisms.

Plan

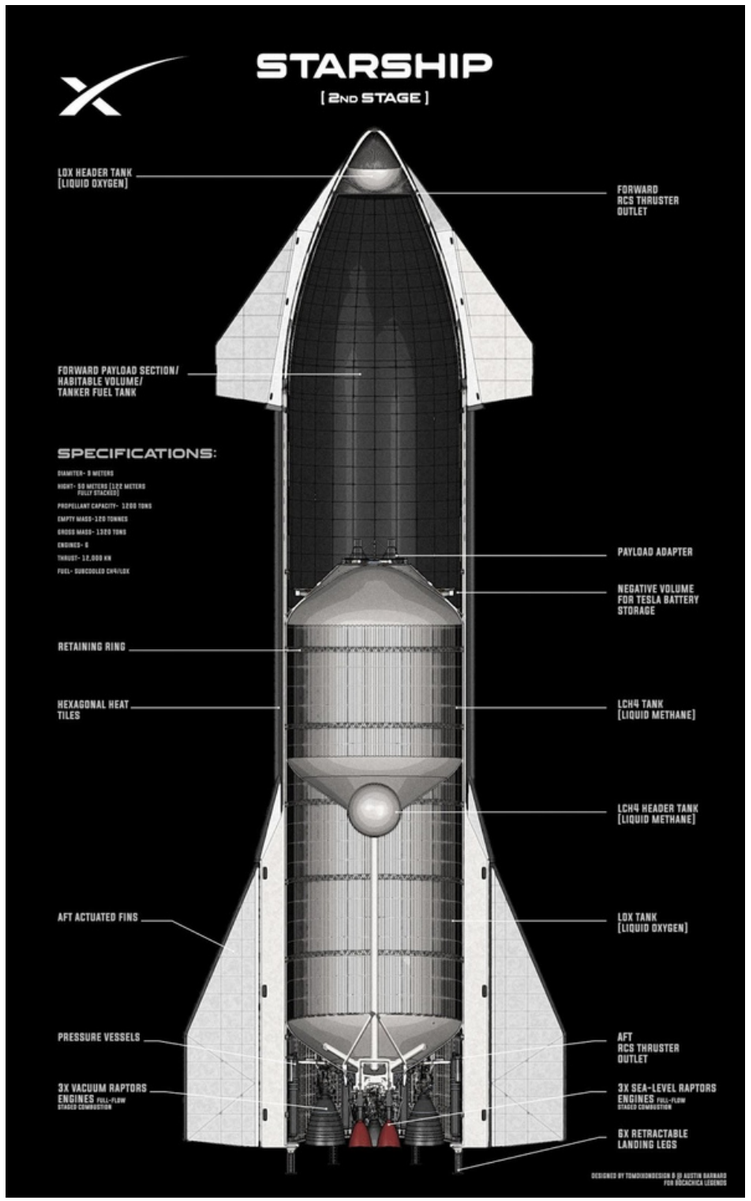
After we find ideas to build and test we start setting deadlines. TeamGantt, which is a scheduling app that helps us manage and divide our time.

Game analysis meeting, finding the limits and the goals of the game

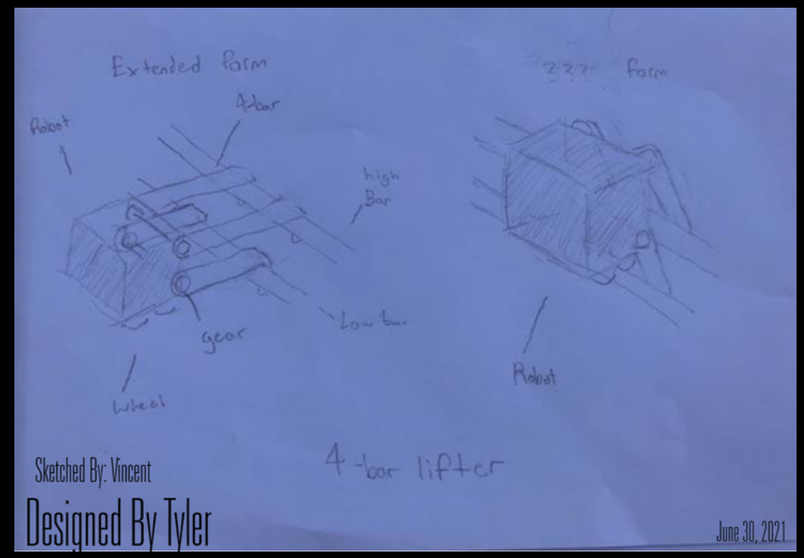
DESIGN

When designing, SpaceX eliminates some ideas that will for sure not work. Also, they CAD and 3d print components. SpaceX will approve ideas that have a 51% success rate, sometimes lower. Other space flight companies spend 50-60% of their time on just designing and planning. Whereas SpaceX spends 20% because they are not afraid to fail.

Similar to SpaceX we relook solutions and eliminate some. After we finish eliminating we then sketch and sometimes CAD ideas.



SpaceX's design for Starship



This is our four bar lifter idea, sketched by Vincent , designed by Tyler, created June 30, 2021

BUILD

3D Printers are used for designing prototypes while being cost effective

SpaceX will either build, simulate or 3d print at a very rapid pace. Simulations and 3D printing help them because it saves cost and is faster. Frequently while building they realize problems. When this happens they try to find a way to solve this problem and sometimes it's not worth solving, so they move onto another idea.
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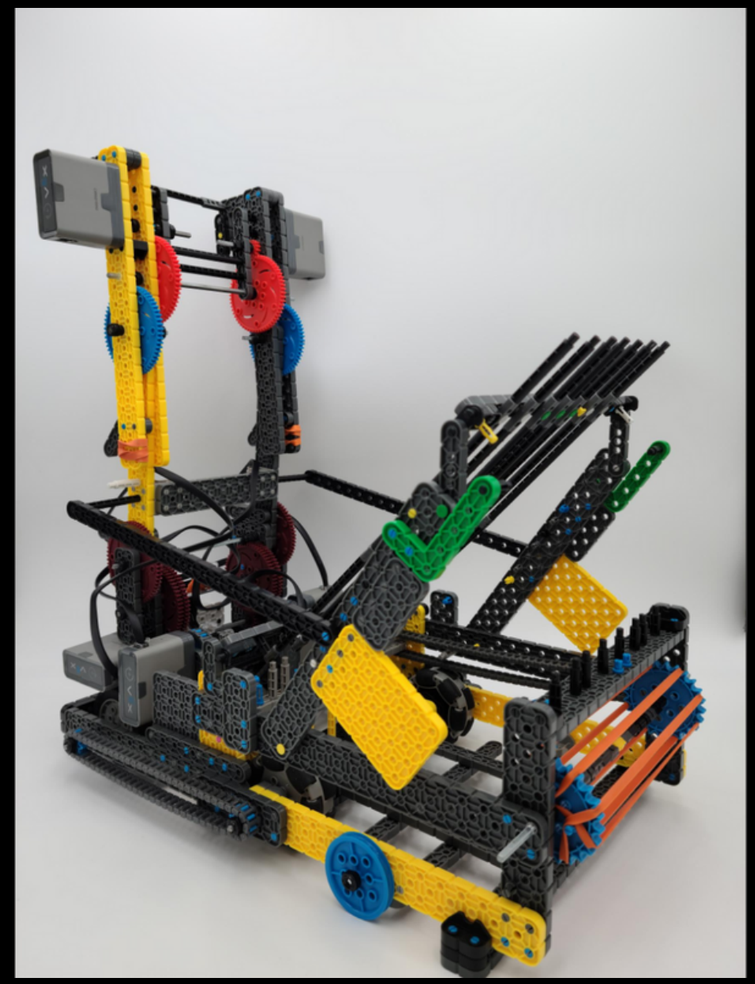
Like SpaceX, we rapidly build proof of concepts, subsystems, prototypes, and other competitive robots to test out new ideas. To rapidly test different ideas we have different teammates build different solutions for the same problem.



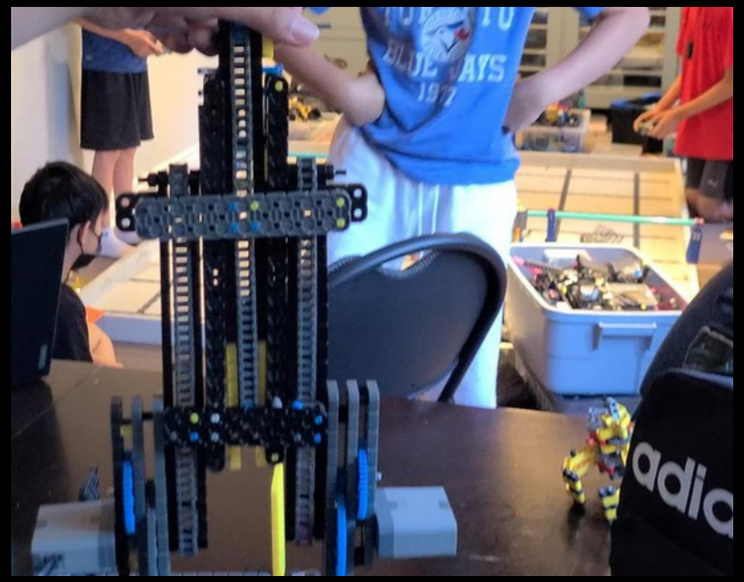
Collapsible dumper bot

TEST

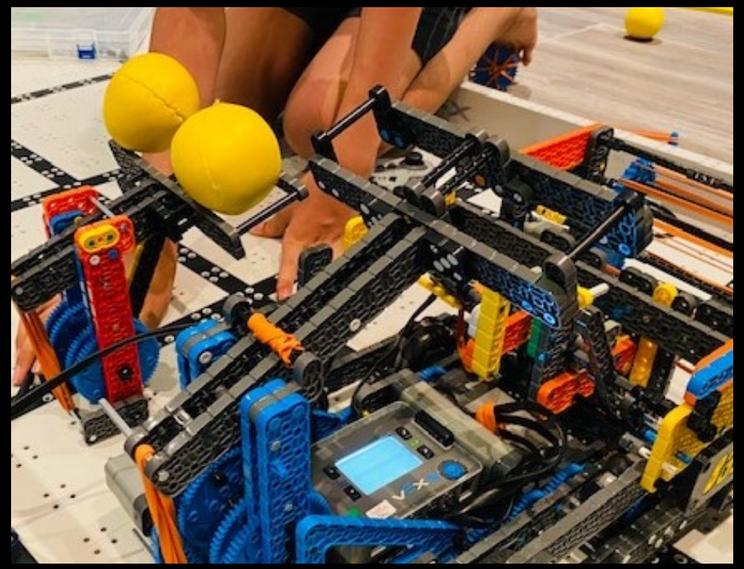
SpaceX Engine Tests

Testing is very important at SpaceX, testing is so important they spend 70% of their time testing! SpaceX tests each of their components. SpaceX tests many things fast because it's a win-win situation, either they succeed or they gain more information. This information is later used to redesign solutions.

When testing we look if the subsystem is able to do its job effectively and reliably. We then do integration testing. SpaceX does a similar process but more complicated.

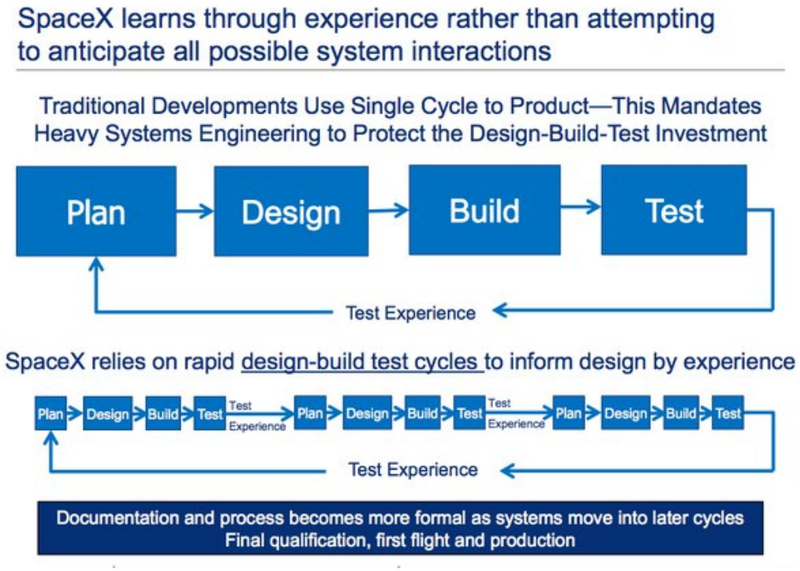


Cascade prototype testing



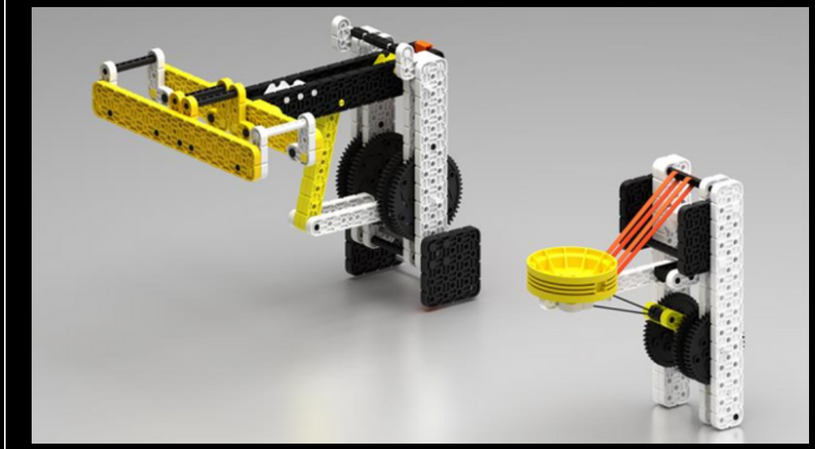
Different catapult iteration comparison

REPEAT



SpaceX isn't afraid to fail as they learn after each mistake. After they complete or fail a task, they repeat the process, by improving and building their solution again. They repeat this at a rapid pace so they can test more ideas.

Similar to SpaceX, we learn and gain experience from each iteration. We follow SpaceX's rapid iteration process, which helps us innovate and build faster. We built 9 working robots so far this season.

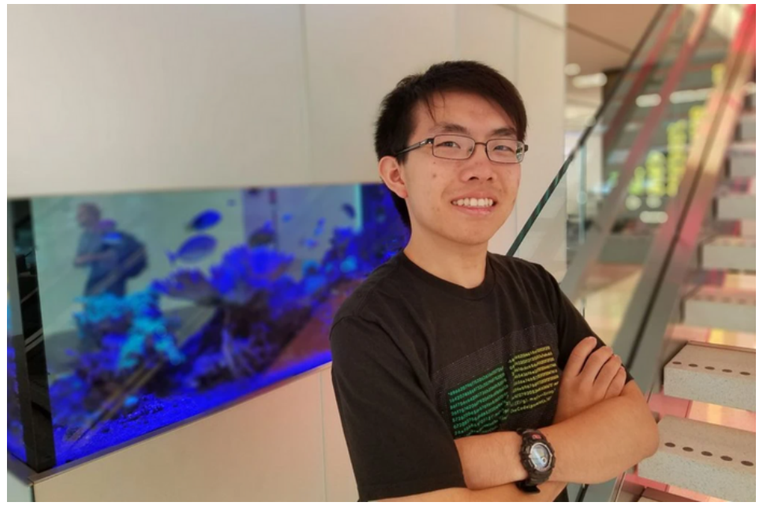


Gen 1 catapult to gen 4 catapult. First gen catapult is heavier and holds two balls at a time. We changed to 2 independent catapults and make it lighter and more efficient.

DOCUMENTATION

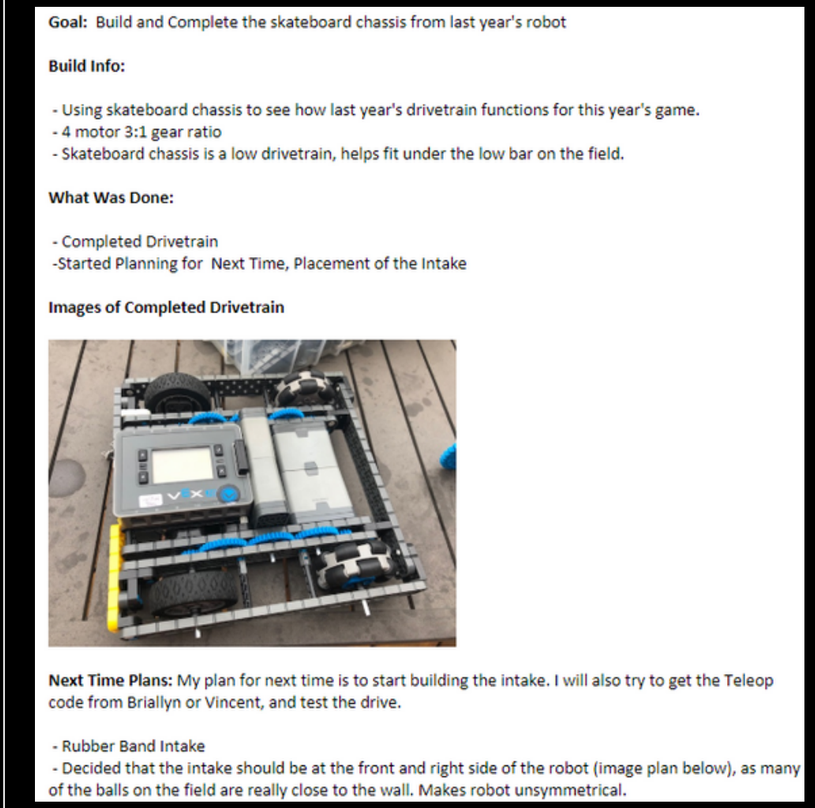
Documentation is so important to SpaceX. SpaceX engineers document and upload to the server. SpaceX documentation is less in the beginning because of how fast they are going.

We document everyday and upload to a OneNote server so that our teammates can see our work.



"Documents are sort of like automatic communication"
-Clive Chan
Propulsion Intern, Liquid Engine Deveplopment

"You never know when you're going to have an idea, so you have to make sure that you write it all"
- Alejandro Divella
SpaceX Integration Technician Dragon ETCS



Goal: Build and Complete the skateboard chassis from last year's robot

Build Info:

- Using skateboard chassis to see how last year's drivetrain functions for this year's game.
- 4 motor 3:1 gear ratio
- Skateboard chassis is a low drivetrain, helps fit under the low bar on the field.

What Was Done:

- Completed Drivetrain
-Started Planning for Next Time, Placement of the Intake

Images of Completed Drivetrain

Next Time Plans: My plan for next time is to start building the intake. I will also try to get the Teleop code from Briallyn or Vincent, and test the drive.

- Rubber Band Intake
- Decided that the intake should be at the front and right side of the robot (image plan below), as many of the balls on the field are really close to the wall. Makes robot unsymmetrical.

Researching for the best intake design


Failure is an option here. If things are not failing, you are not innovating enough.
Elon Musk
quotefancy

HOW WILL VEX BENEFIT OUR FUTURE?

By Justin Tam

Technical Skills

Each team member in 839A learns and specializes in an area. For example, Briallyn does coding. Clive, the software engineer we interviewed, went from a robotics team member to working at SpaceX.

Documentation

VEX encourages us to document all of our work. This teaches us to stay organized and manage our time efficiently.

Competition

In the real world there is a lot of competition. SpaceX is currently competing with NASA, Blue Origin, etc. Competition motivates us to work hard and teaches us to work under pressure. At VEX Worlds, we competed against the best of the best.

Practice Design Process

VEX also encourages us to practice the design process that will be applied to a real STEM career. By practicing the design process at an early age, we are able to brainstorm, build, and test effectively.

Teamwork

A team is superior to a person working alone. In a real career, teamwork and collaboration are crucial to getting tasks done fast and efficiently.

THE TEAM

Tyler

LEAD BUILDER & SYSTEM INTEGRATION, PRIMARY DRIVER, AUTONOMOUS ROUTE CODER
AGE 12, GRADE 7, MIDDLE SCHOOL, 4 YEARS VEX, 2 YEARS FLL, 3 YEARS FLL JR., 2 VEX WORLDS

Briallyn

LEAD CODER, OUTREACH
AGE 13, GRADE 8, GIFTED MIDDLE SCHOOL, 3 YEARS VEX, 2 YEARS FLL, 2 YEARS FLL JR., 2 VEX WORLDS; PROFICIENT ROBOTC, VEXCODE

Justin

LEAD DOCUMENTER, PRIMARY DRIVER, BUILDER, AUTONOMOUS ROUTE CODER
AGE 13; GRADE 8; UPPER CANADA COLLEGE; INTERNATIONAL BACCALAUREATE MIDDLE YEARS PROGRAMME; 4 YEARS VEX, 3 VEX WORLDS

Vincent

TELEOP CODER, ROUTE PLANNER, BUILDER
AGE 13, GRADE 8, MIDDLE SCHOOL ARTS PROGRAM, 3 YEARS VEX, 2 VEX WORLDS, PROFICIENT ROBOTC

Kensen

REVERSE ENGINEERING BUILDER, SECONDARY DRIVER, AUTONOMOUS ROUTE CODER
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James

CAD & BUILDER
AGE 12, GRADE 7, MIDDLE SCHOOL ARTS PROGRAM, 2 YEARS VEX, 2 VEX WORLDS

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