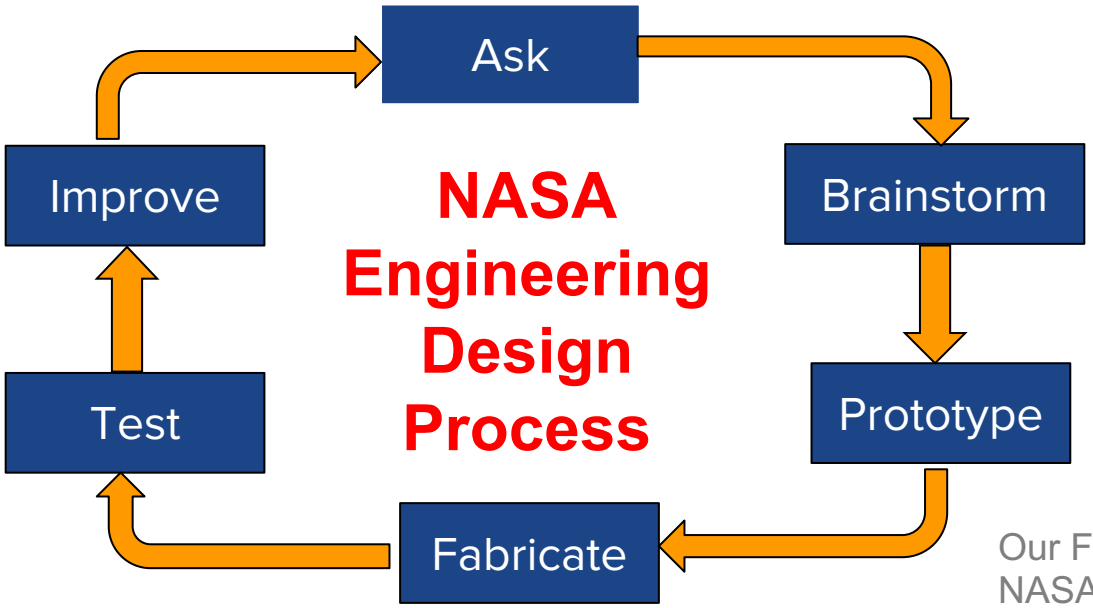
Engineering Design Process

The Antidote - FTC 14320

Engineering Design Process

- A **series of steps** that engineers follow to design a solution to a problem.
- The engineering design process helps in making decisions by applying the principles of science, math and engineering.



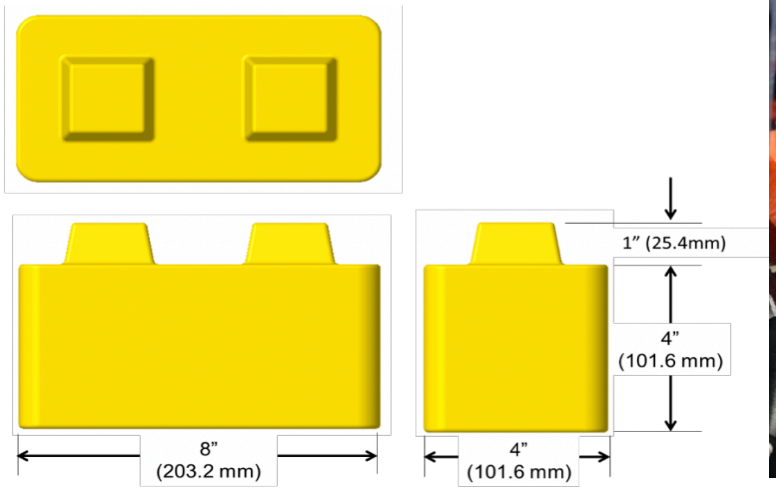
Our FTC version of the NASA Design Process

Design Process Steps

- Step 1 – **ASK** – Identify the Problem
- Step 2 – **BRAINSTORM** – Brainstorm Solutions and Research Ideas
- Step 3 – **PROTOTYPE** – Select 2 or 3 Promising Solutions
- Step 4 – **FABRICATE** – Construct a Working Model
- Step 5 – **TEST** – Test & Evaluate Solutions
- Step 6 – **IMPROVE** – Improvise, Adapt, Overcome your Design

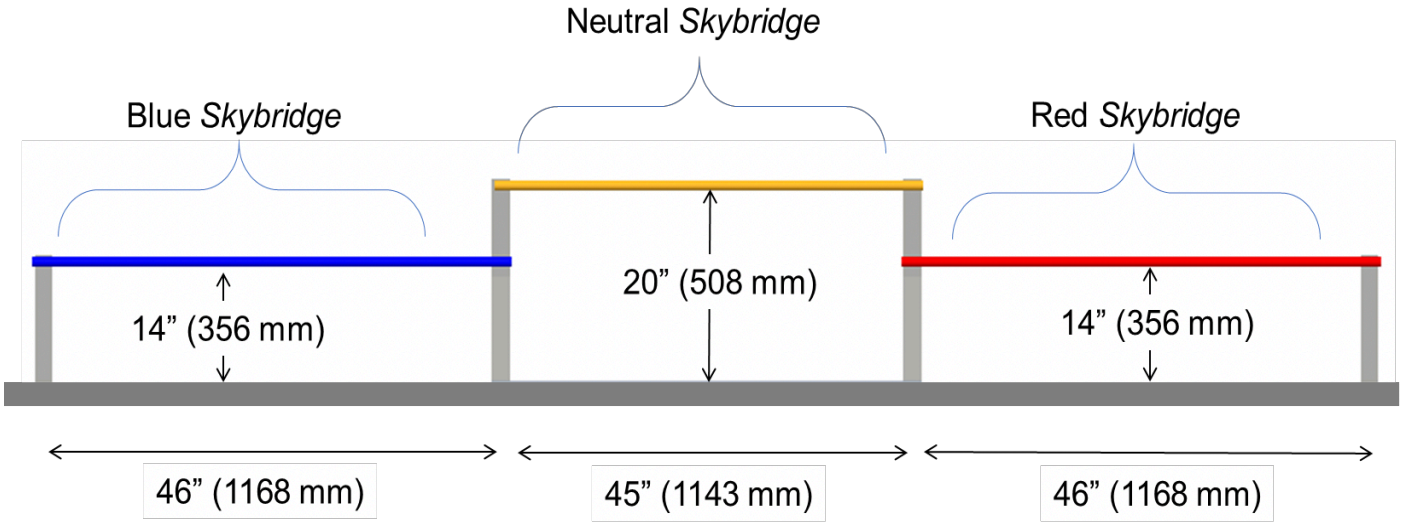
Identify the Problem

- Identify what needs to be accomplished
- What are the Restrictions/Constraints
  - Robots must not be taller than 14 inches to cross Sky Bridge
- Functional Requirements
  - The robot must be able to intake stones from all angles
- Analyze game and determine strategies
  - Identify tasks and rank in priority



Design Constraints

- Maximum robot height/weight
  - SkyStone → 18x18x14, 42 lbs.
- Number of allowed motors → 8 motors
- Maximum #of game elements
- Allowed Control Systems



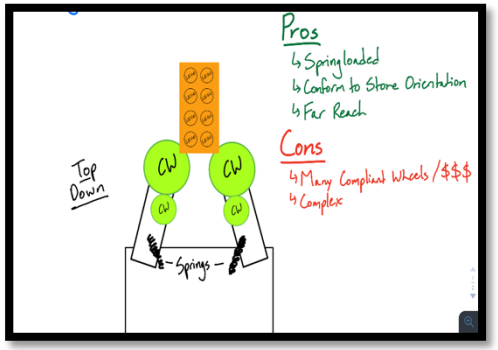
Identify and Rank Tasks

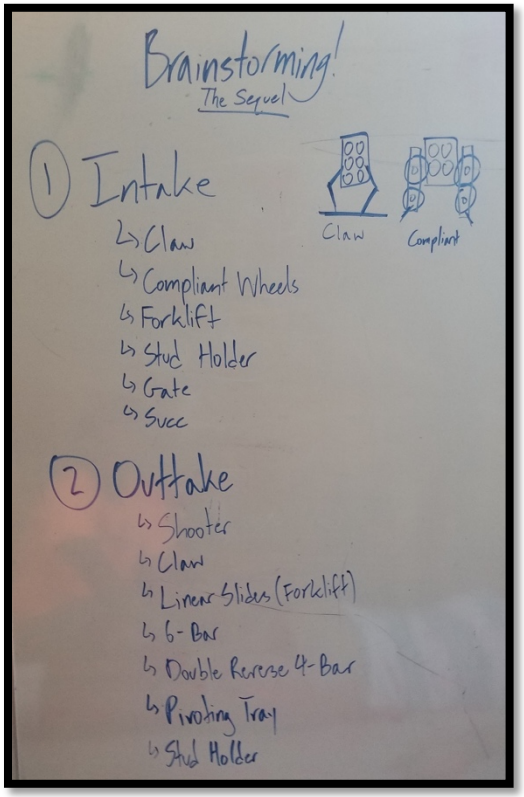
- There are numerous tasks to accomplish in each FTC Game
- List them out and analyze their point values and difficulty
  - **E = Easy** (can be completed ~90%)
  - **M = Medium** (can be completed ~70%)
  - **H = Hard** (can be completed ~50%)
  - These difficulties vary for each team!

Tasks	Point Value	Difficulty	Rank
Repositioning	10	4	**H**
Navigating	5	1	**E**
SkyStone Delivery	10	5	**H**
Stone Delivery	2	3	**M**
Placing	4	3	**M**

Brainstorm Ideas

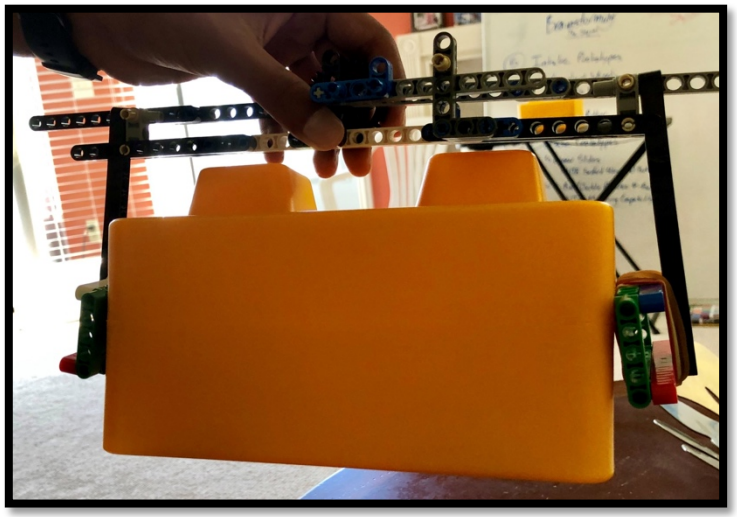
- Come up with numerous ideas to accomplish the task
  - Don't be afraid to produce unique and creative ideas!
  - No idea is a bad idea
- List each idea down on a whiteboard
- Go through the pros/cons of each idea
- Do **a lot of research** on YouTube
  - Look for real-world solutions
  - FTC teams share their ideas (previous games)

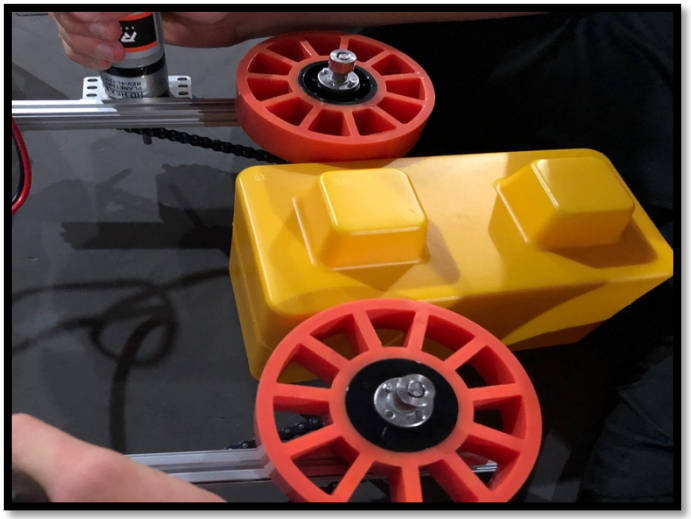




Prototype a Solution

- Select a few promising solutions to prototype
  - Does not need to be perfect
  - Rough idea of how the process works
  - *Ex: Using AndyMark Compliant Wheels as an intake*
- Use any material!
  - Cardboard, LEGOs, 3D Printing





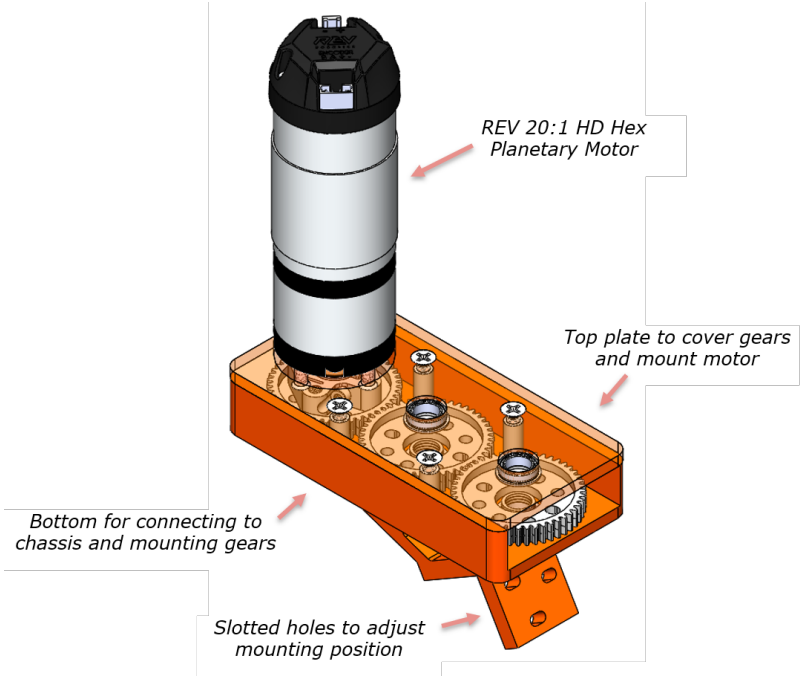
Decision Matrix

- Use a **Decision Matrix**/Weighted Objective Table to help select one method over other ideas in accomplishing a single task
  - Compares each idea regarding different criteria
  - *Ex: Different ways to hold on to the SkyStone*
- **Weights** are used to establish the importance of the criteria

Characteristic & Weight		Nub Grabber	Side Clamp	Linear Actuator
Driver Precision/Ease of Alignment	4	3	3	1
Size	3	4	3	1
Reliability	4	1	3	2
Ease to Manufacture	2	4	3	2
RESULT		36	**39**	19

Fabricate the Design

- Creating the first complete working design of the idea
  - This step is accomplished after any issues in the prototype have been resolved
- Use **Computer Aided Designing** (CAD) software to create the design
- Use any material!
  - Build Kits
    - Actobotics, goBILDA
  - 3D Printing
  - Aluminum

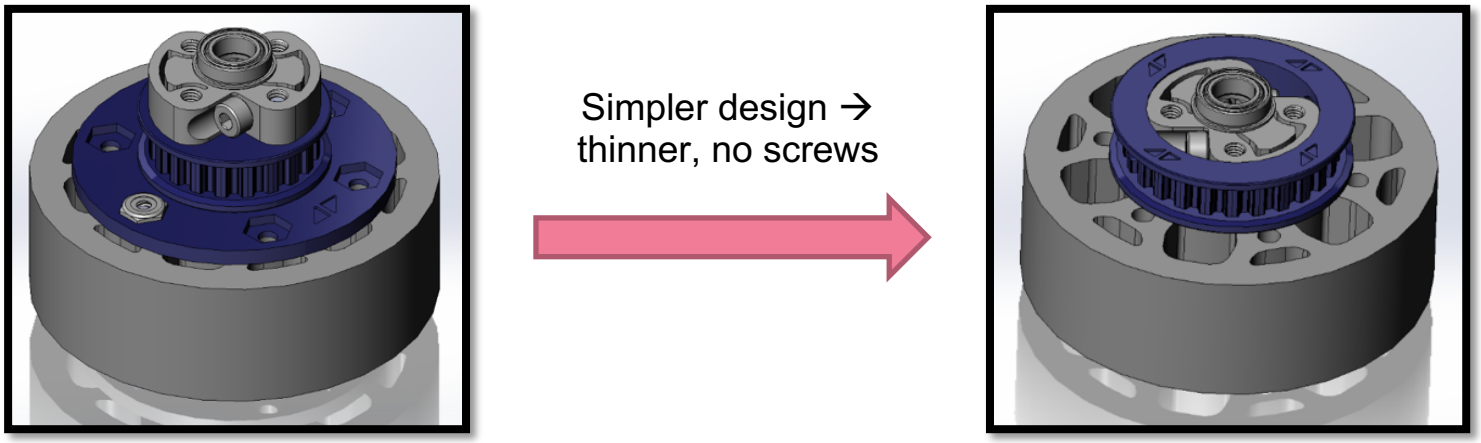


Test the Design

- Often the **most rigorous** part of the design process
- Involves pushing the design to its limits
  - Does it work?
  - Is it reliable/efficient?
  - Is it robust?
  - Is it too complicated?
  - Does it meet all specifications listed in the Ask phase?
- Record measurements and take notes as the design is tested
- Manipulate **only one variable** at a time when testing for **accurate results**
  - Changing too many things at once → Do not know what changed what

Improve and Redesign

- After testing, is there anything that can be changed to be more efficient? reliable? accurate?
- This phase is the 'end' of the process, creating the **design process cycle**
  - Endless loop of constantly improving the design (aka **iterating**)
- The process outlined here isn't the only process in designing a robot, each team typically finds a process that **works for them**



Credits

- This lesson was written by The Antidote 14320 for FTCTutorials.com
- You can contact the author at:
  - Website:
    - http://theantidoterobotics.com
  - Twitter:
    - @theantidoteFTC
  - Email:
    - theantidoteftc@gmail.com

- More lessons for FIRST Tech Challenge are available at www.FTCtutorials.com