'Snow Problem Prototype Concepts for DESTINATION: DEEP SPACE

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Abstract—This white paper summarizes our prototypes for DESTINATION: DEEP SPACE, including our HATCH PANEL, CARGO, and HAB PLATFORM concepts, and how those concepts translated to prototypes in order to address concerns we had before implementing them.

1 Introduction

Our prototyping was divided equally between the HATCH PANELS, the CARGO, and the HABITAT (Fig. 1). For the HATCH PANELS, we focused on secure ways to pick up the HATCH PANELS by gripping the edges in various ways and score them onto the HATCHES. We also looked at grabbing the center hole of the HATCH PANEL to score on the HATCH. For the CARGO, we discussed variations of a ramp to roll the CARGO from the LOADING STATION to each of the BAYS. We also discussed a type of intake that could pivot from the floor up to the first levels of the BAYS. Finally, we discussed different approaches to climbing ranging from stilts to a large clamp and pivoting system.

2 'Snow Problem's Strategy

We will begin by recapping 'Snow Problem's overall robot strategy/functionality requirements:

1) Drive (over the bump and up the platform included)
2) Score the HATCH PANELS
3) Score the CARGO
4) Climb on the HABITAT PLATFORM

You will note that we did not prioritize the ROCKET above level 1 at all. This is not because we do not see it as an important part of the game, but because we thought that unless teams pick a strategy that focuses on the ROCKET it is not necessary to score in the ROCKET. This eliminates the need for a lift mechanism which is also an advantage.

In addition, we would seriously recommend that teams consider taking a similar view of their robot strategy– being able to do 1 or 2 things effectively is almost always a better strategy for a team desiring to do well in competition than attempting to do everything. This game presents a challenge in which ignoring certain aspects to the game allows teams to build much simpler and potentially more effective robots.

3 HATCHES

Scoring the HATCH PANELS is an important part of the challenge because it sets up the scoring of the CARGO in each BAY. Our prototypes consisted of a Velcro-popper mechanism and a edge clamp mechanism to test where the best spot is to grab the HATCH PANELS.

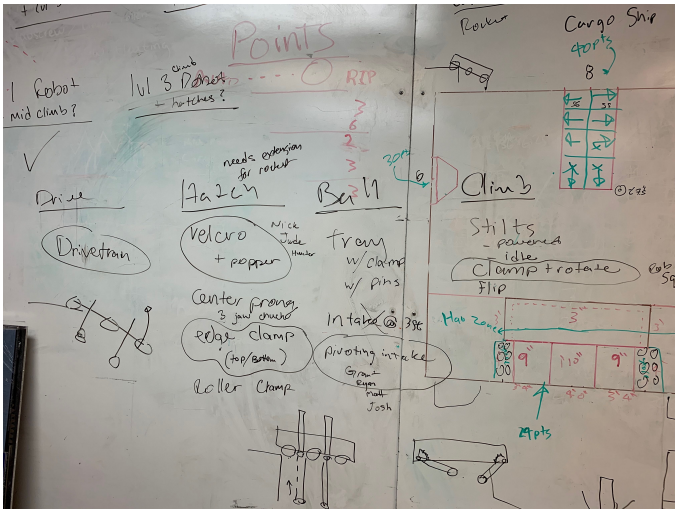

Fig. 1. Ideas for prototypes for each section of the game

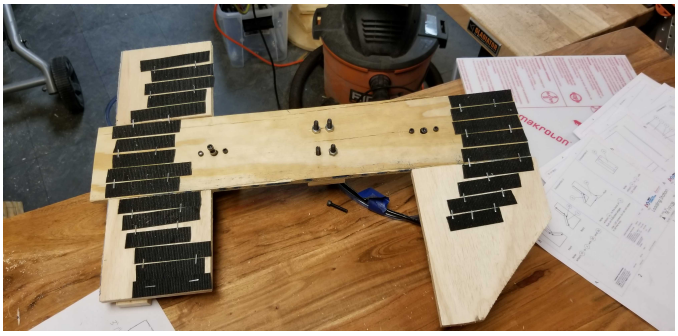

Fig. 2. Initial prototype of Velcro and Popper

3.1 Velcro and Popper

3.1.1 Concept

The initial concept for this prototype came from the attachment method used to score the HATCH PANELS onto the HATCHES. Since the HATCH PANELS are held in place on the sides of the BAYS with two Velcro strips, we decided to create a prototype of a mechanism that uses Velcro to

grab onto the HATCH PANEL while the ROBOT is driving. We also used this prototype to experiment with a pin that pushes against the HATCH PANEL, prying the panel off form the ROBOT Velcro and latching it onto the HATCH Velcro.

3.1.2 Physical Prototype

The prototype that we tested of the Velcro and Popper design consisted of some spare wood that was cut into several smaller sections to create the approximate size of the HATCH PANEL and a surface to attach the Velcro. For simplicity, we created a Tie-Fighter shape for the surface instead of the whole circle to save time. We added two pancake cylinders across the middle of the center line of the wooden surface between the outer edge near the Velcro and the center hole. The attachment rods on the cylinders will act as the Poppers that will push the HATCH PANEL off of the side of the ROBOT. We did not do many iterations of this prototype due to the success of this prototype. The combination of the amount of Velcro that we used and the two pancake cylinders acting as our Poppers provided a very clean release of the HATCH PANEL from the ROBOT.

Fig. 3. Tubing of Velcro and Popper

3.2 Other HATCH PANEL Prototypes

We discussed other HATCH PANEL designs in Fig. 1 like a drill chuck that grips the center hole of the HATCH PANEL and different designs that grip the outer edge of the HATCH PANEL. Since our initial tests of the Velcro and Popper Prototype were extremely effective, we decided not to pursue additional prototypes of the other design mechanisms.

4 CARGO

When we discussed ways to handle the CARGO the team decided to forgo a floor pickup as it was a common design in many previous games and instead focus on something new. We came up with a few ideas as seen in Fig. 1. We decided to prototype the Pivoting Intake (Fig. 5.) as it seemed a great way to build a new mechanism that teams could learn from.

4.1 Pivoting Intake

4.1.1 Concept

The pivoting intake concept was to pivot between 2 positions the first position (Fig. 7.) would be angled up as

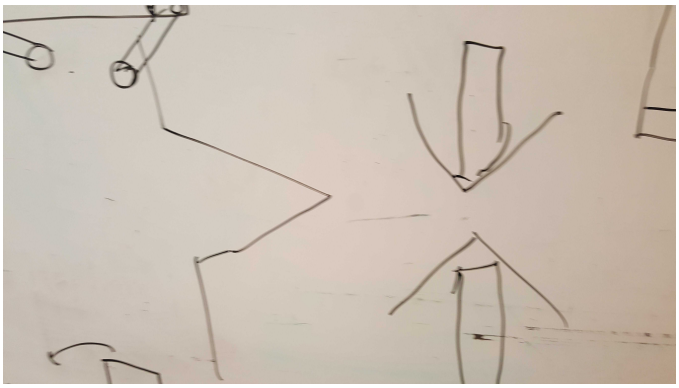

Fig. 4. Concept of Clamp Mechanism

to intake the CARGO from the LOADING STATION. This angle would also allow us to launch the CARGO into the BAYS on the CARGO HOLD. The second angle (Fig.8.) would allow us to launch the CARGO into the first level of the ROCKET. We also considered a third angle that allow for pickup from the floor but we decided to focus on the first two before we try for floor pickup.

4.1.2 Physical Prototype

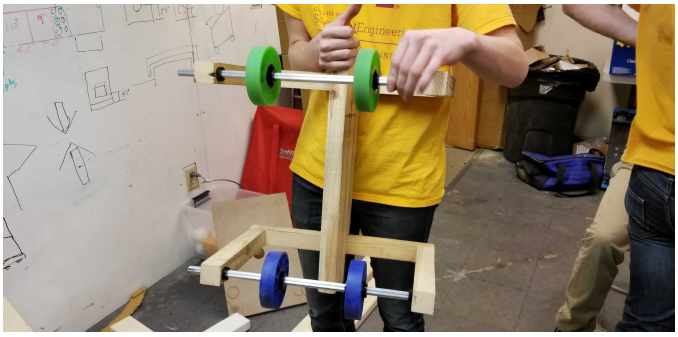

Fig. 5. Full Intake Prototype

4.1.3 Physical Prototype

The intake that we designed uses 4 wheels to hold the CARGO as seen in Fig. 5. In Fig. 7. and Fig. 8. we demonstrate how the intake would pivot using a piston. We used 35a and 50a compliant wheels for the prototype and used a drill to simulate spinning the wheels.

4.2 Other CARGO Prototypes

We considered a few other ideas as seen in Fig. 1. Mostly we talked about making a floor pickup intake versus a LOADING STATION intake. The other design we looked at seriously was a tray that would have some way of holding the CARGO in the middle and either let it fall out into the CARGO HOLD or launch it out the top of the ramp (Fig. 9.) We decided not to use the ramp bot as it would take up a great amount of space on the robot and we still planned to make a mechanism for climbing the HAB and manipulating the HATCH PANELS.

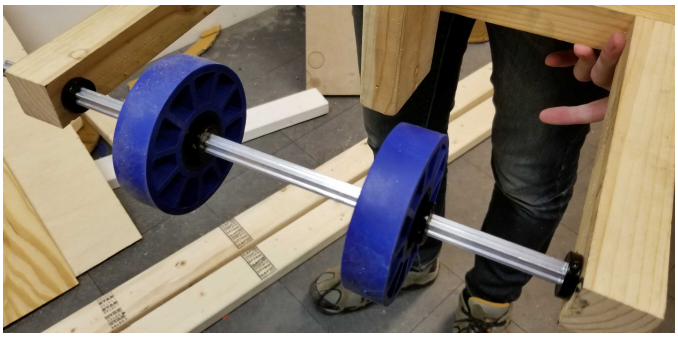

Fig. 6. Closeup of Wheels for Intake

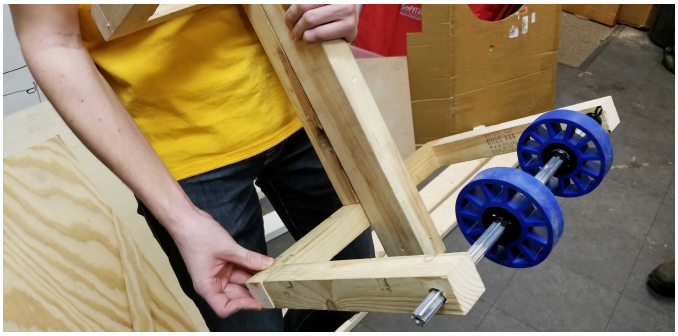

Fig. 7. First Angle of Intake

Fig. 8. Second Angle of Intake

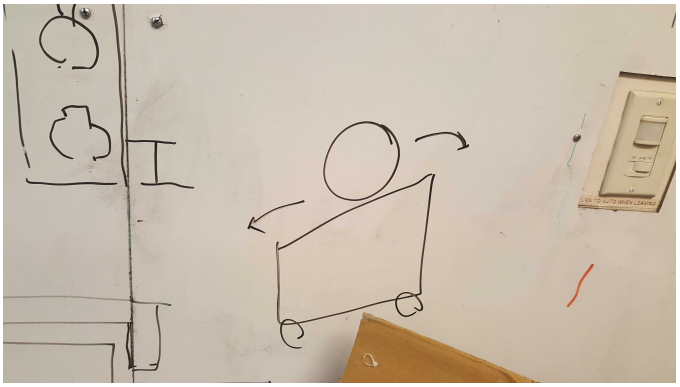

Fig. 9. Concept of Ramp Bot

5 HAB Climb

Climbing up onto the HAB PLATFORM is an important aspect of the game because it yields a lot of points and presents the difficult challenge of climbing up onto a tall platform. Our prototypes consisted of different types of manipulators that would assist the robot in pulling up its chassis onto the HAB PLATFORM (Fig. 1). We decided to create prototypes to to test which appendage was the simplest to push the chassis up onto the HAB PLATFORM.

5.1 Clamp and Pivot Climb

5.1.1 Concept

This climbing mechanism design came from the robots that have performed back-flips by rotating their entire chassis around a central hinge to climb up onto very tall platforms. We liked the simplicity of this mechanism to climb up onto the HAB PLATFORM but we were worried about how secure our robot would be when pivoting its chassis up onto the HAB PLATFORM. We decided to prototype a mechanism that would clamp onto the sides of the third level of the HAB PLATFORM and then design a central hinge into our frame for our robot to pivot up onto the HAB PLATFORM (Fig. 14).

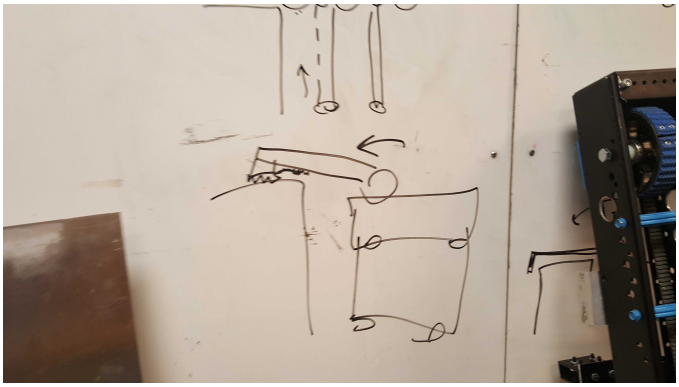

Fig. 10. Concept of Clamp and Pivot

5.1.2 CAD

The CAD design for the "Clamp and Pivot" prototype began from the starting configuration dimensions of the robot chassis. Since the robot can only extend 30 inches from each side of the robot, we used this to create a large clamp that would drop down during the match. This drop down mechanism consists of extrusions with 45° cuts on the ends to create a mating surface for the clamps to rest at the start of the match. Once the clamps are flat on the robot, two pneumatic cylinders push one of the rubber clamps into the side of the HAB PLATFORM (Fig. 11). By doubling up our cylinders, we create a stronger clamping force that allows us to securely hold onto the HAB PLATFORM. This prototype was created in CAD to test the external dimensions of the size of the clamping arms and we were confident that with two pneumatic cylinders we had enough force to hold our robot in place while climbing.

Fig. 11. CAD for the Clamp and Pivot System

5.2 Other HAB Climb Prototypes

We discussed some other climbing designs in Fig. 1 that involved additional appendages that would extend outside the chassis of the robot to assist the robot in climbing up onto the HAB PLATFORM. One design involved stilts that would extend beneath the chassis and elevate the robot up to the height of the third level of the HAB PLATFORM (Fig. 12) We did not prioritize prototyping this design because it would take most of our time to acquire additional pneumatics or rack and pinion parts for a linear elevation mechanism. Another design that we discussed was a pair of wheelie bars on the front and back of the robot (Fig. 12). These actuated rollers are used to push the chassis of the robot up to the elevation of the third level of the HAB PLATFORM, starting with the front and ending with the back. We decided that the angle combined with the force required to push into the ground and lift the chassis was too much for an efficient climbing mechanism.

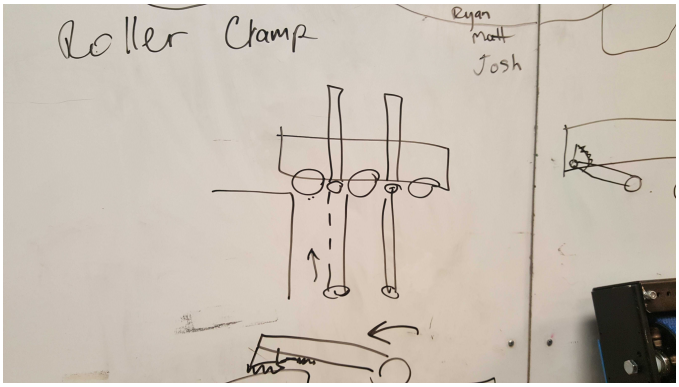

Fig. 12. Concept of using Stilts

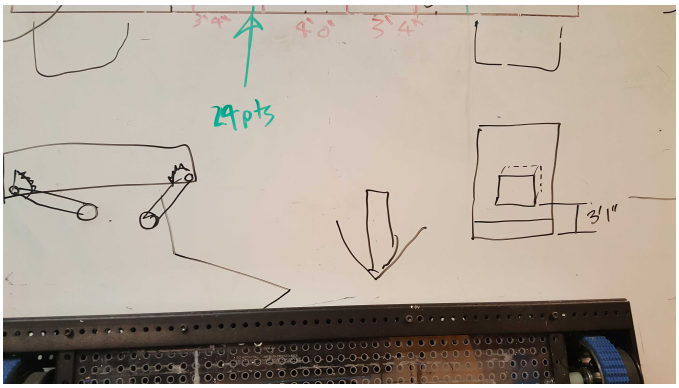

Fig. 13. Concept of Rotating Stilts

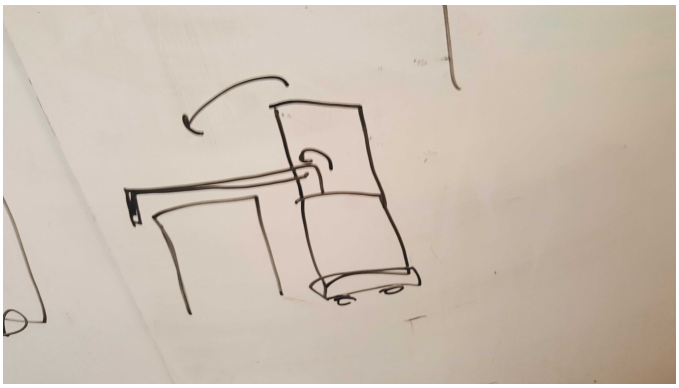

Fig. 14. Original idea of some sort of Pivot mechanism

6 Contacting the Authors

Team 'Snow Problem may be reached in order to ask questions on our Twitter (@SnowProblemz), or via our Twitch stream during the three day build. After the build, we will still be answering questions on the thread and via email (at gofirst@umn.edu). We are doing this for you, the FRC community, and are happy to answer questions and discuss our designs with you.

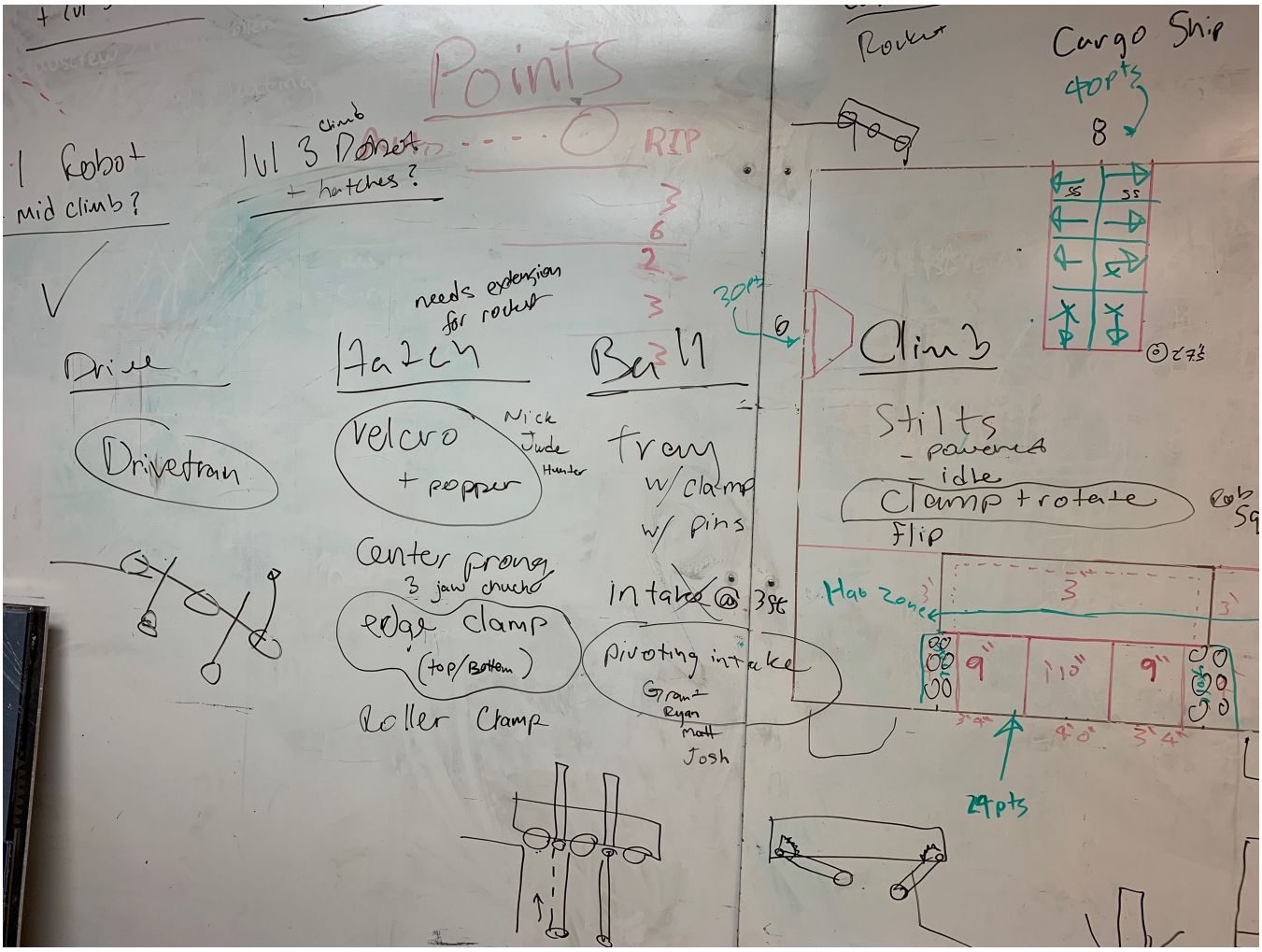

Fig. 15. Ideas for prototypes for each section of the game

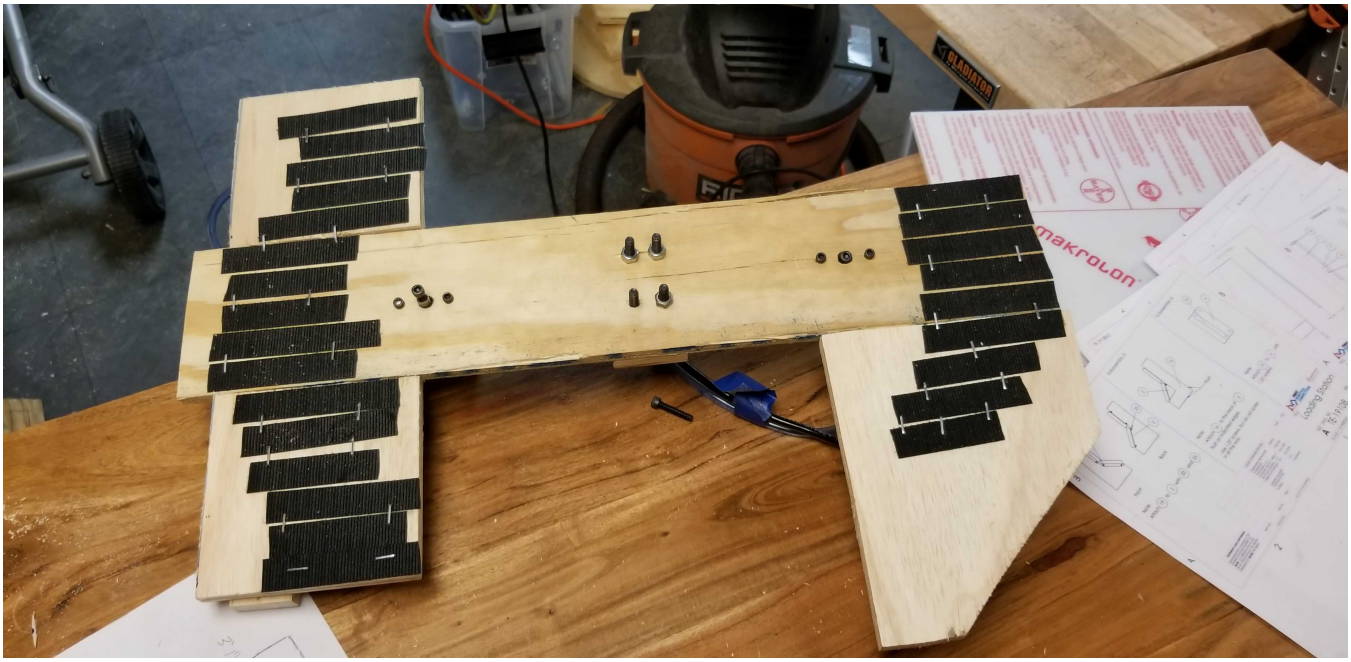

Fig. 16. Initial prototype of Velcro and Popper

Fig. 17. Tubing of Velcro and Popper

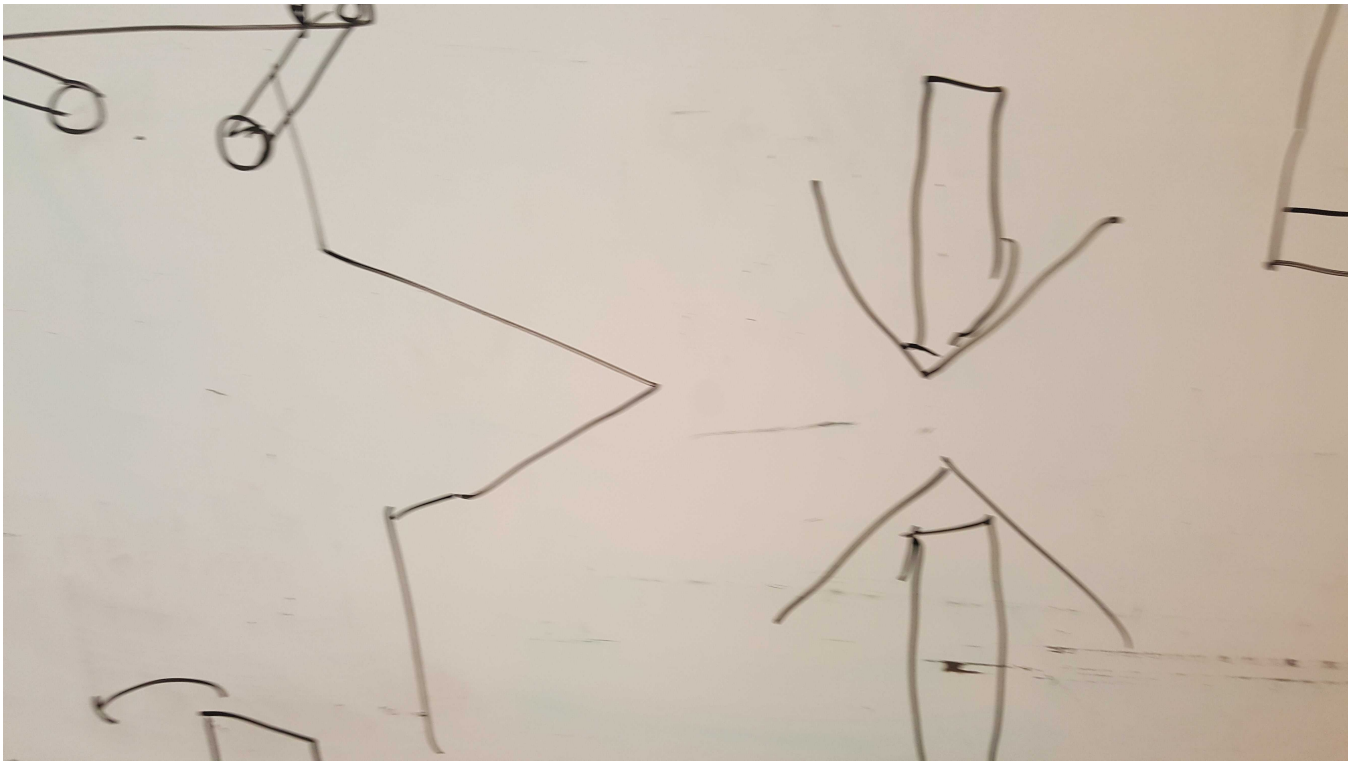

Fig. 18. Concept of Clamp Mechanism

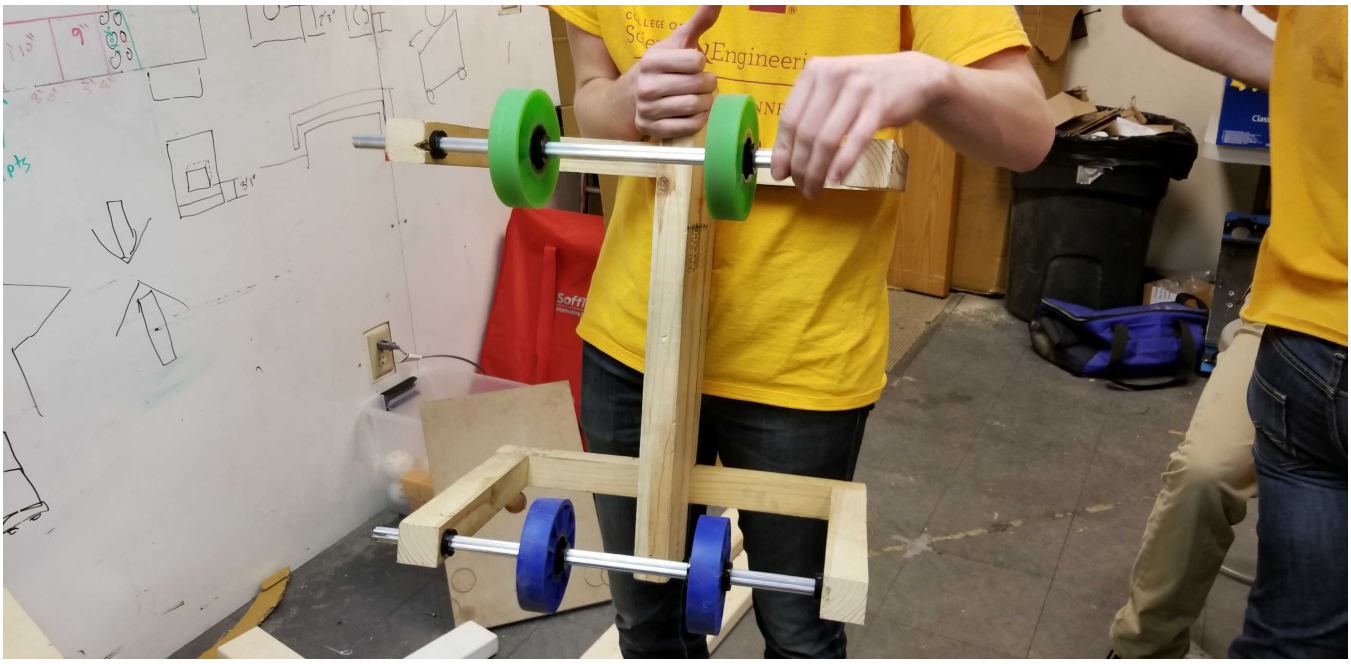

Fig. 19. The entire intake with both sets of rollers

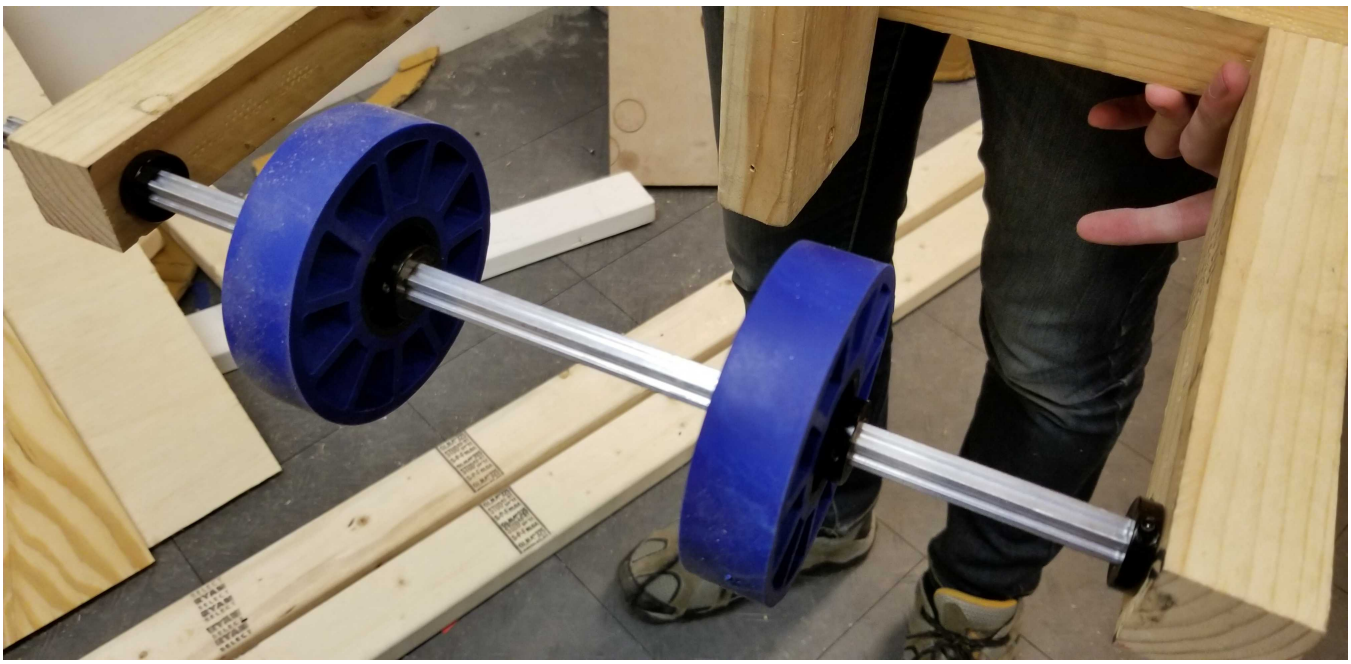

Fig. 20. A closer look at a single roller on the intake

Fig. 21. Showing the location of the pivot point on the pivoting intake

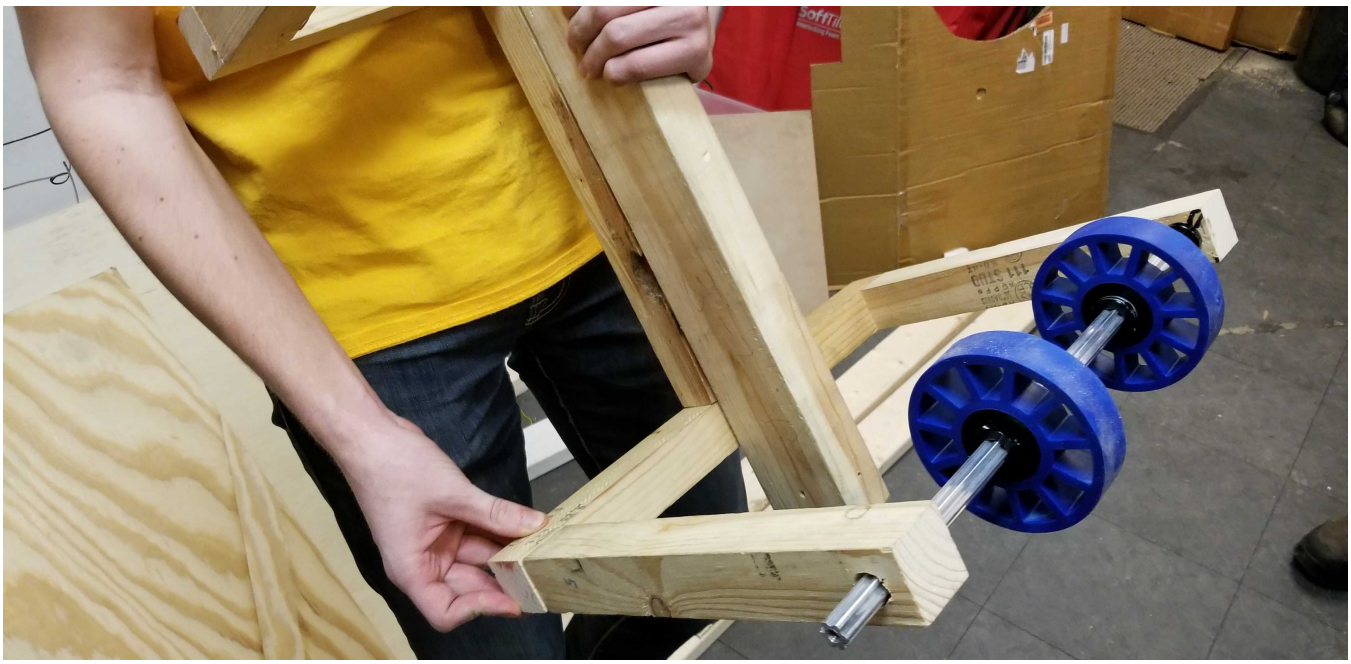

Fig. 22. The upper position of the pivoting intake

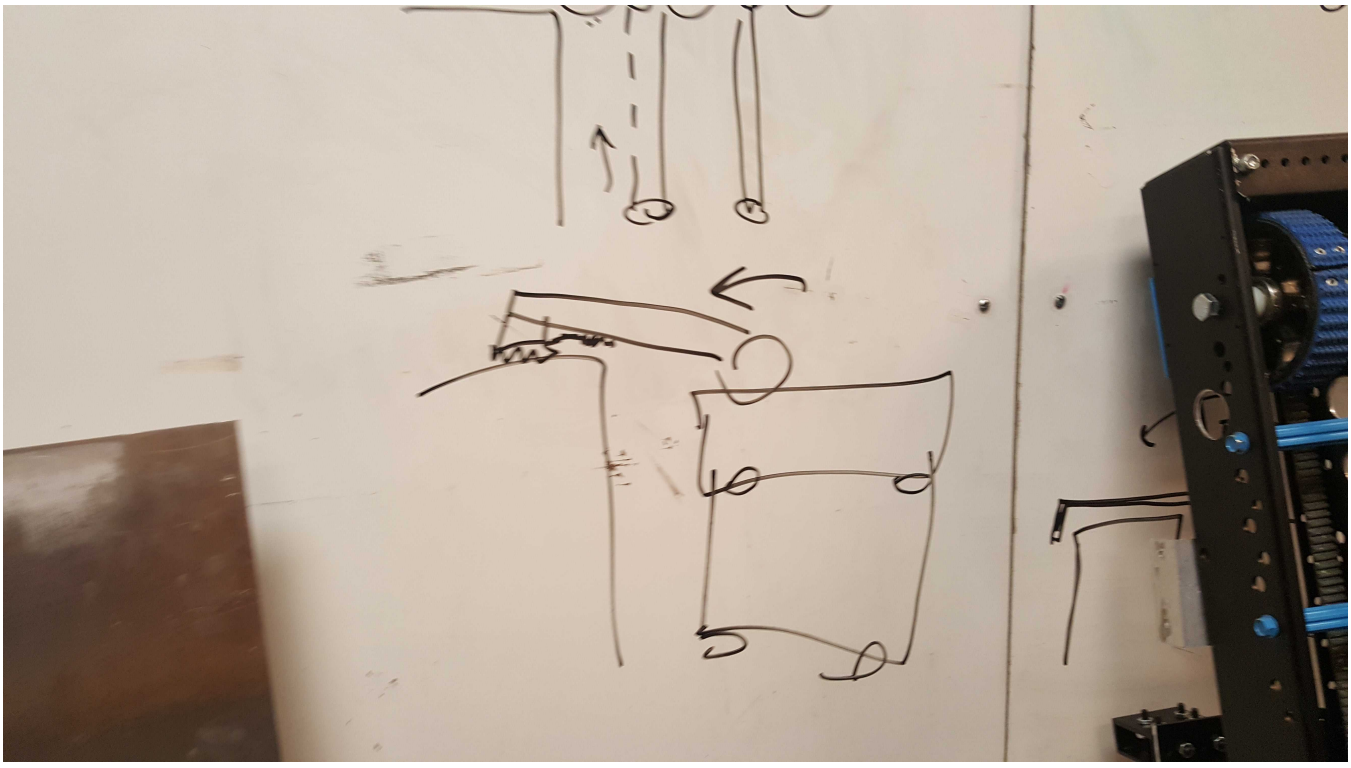

Fig. 23. Concept of Clamp and Pivot

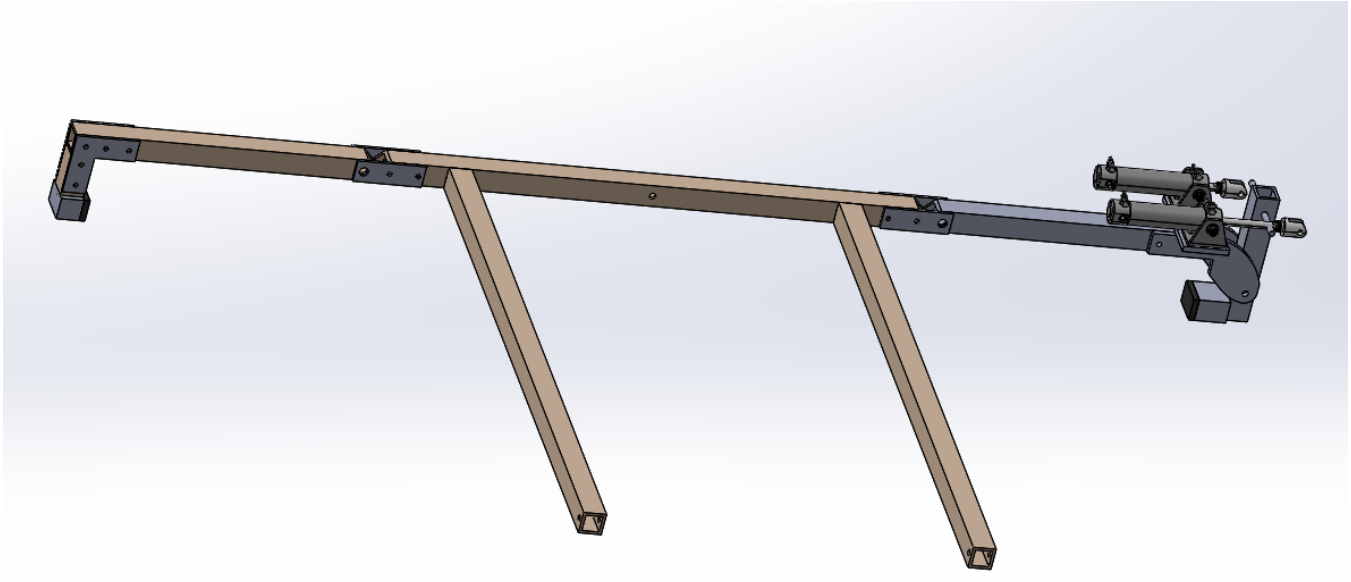

Fig. 24. CAD for the Clamp and Pivot System

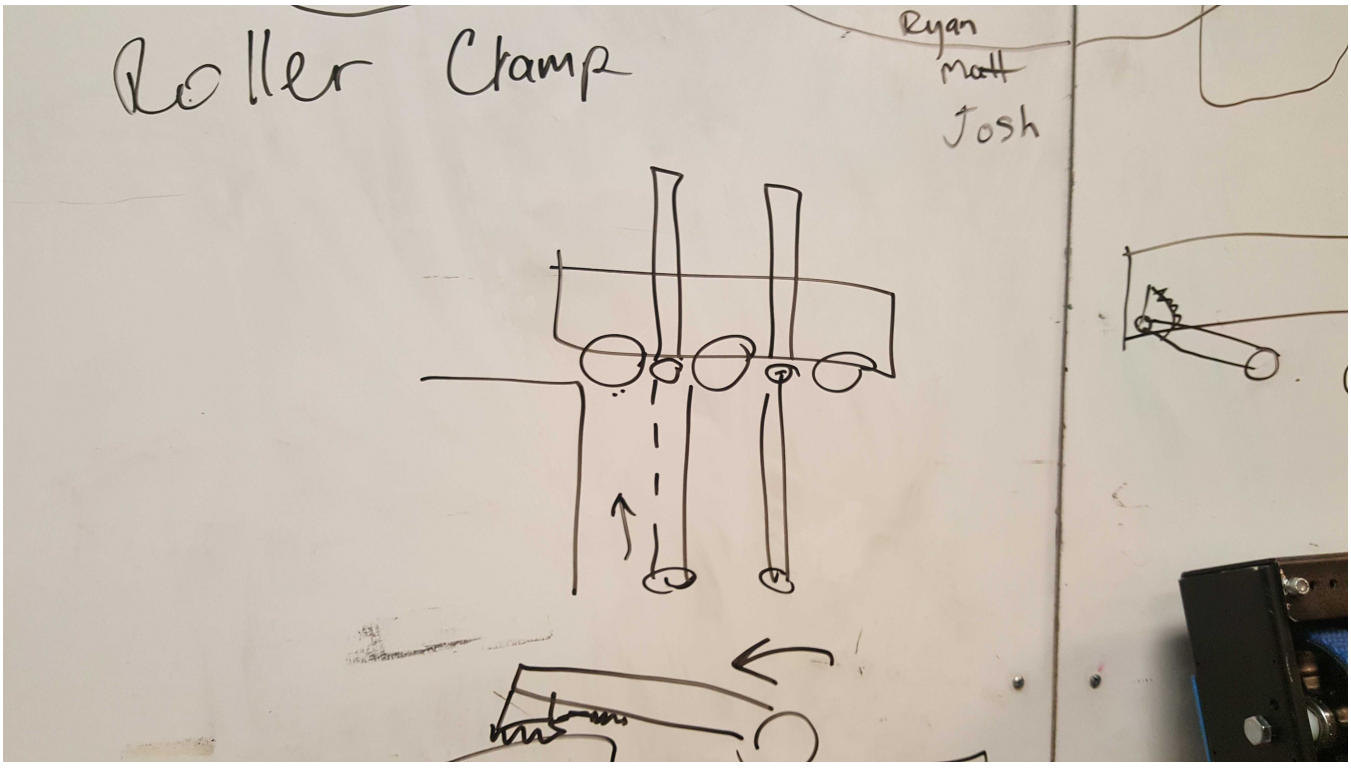

Fig. 25. Concept of using Stilts

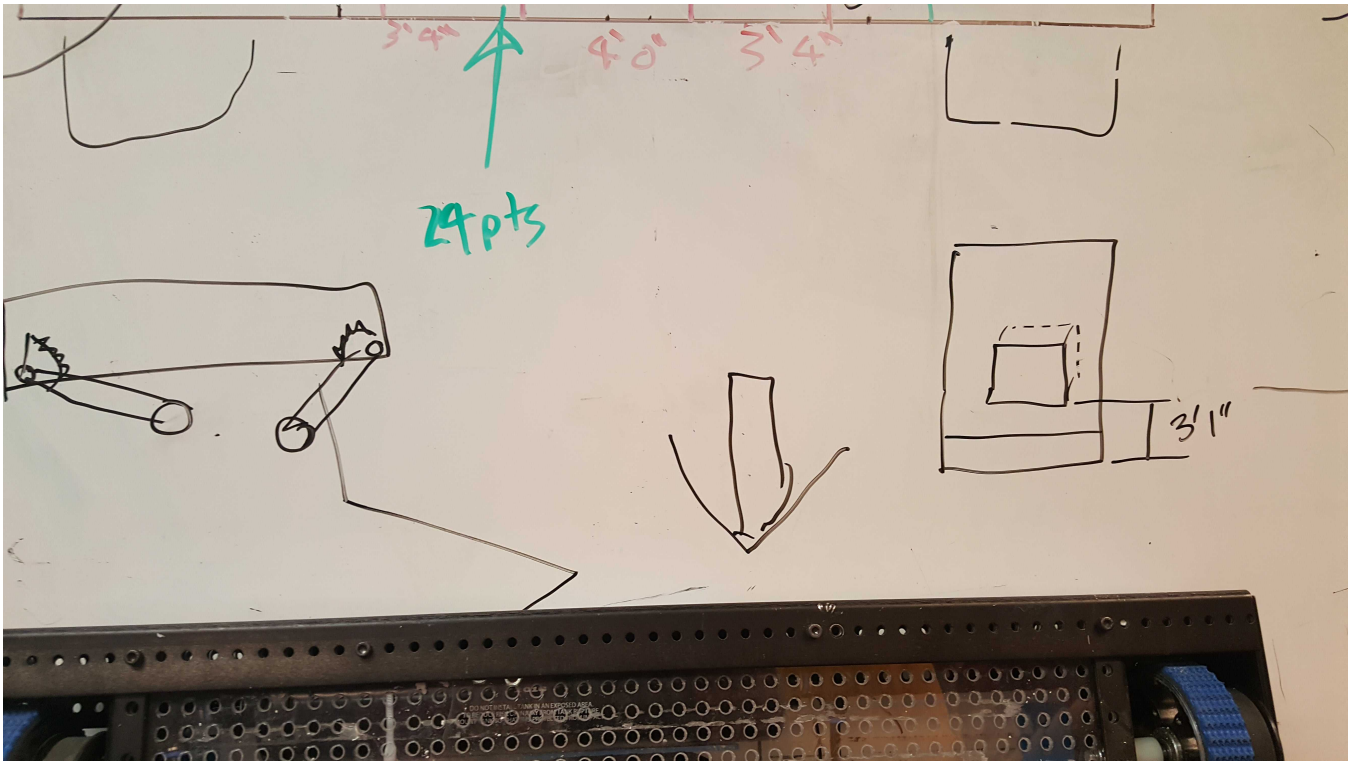

Fig. 26. Concept of Rotating Stilts

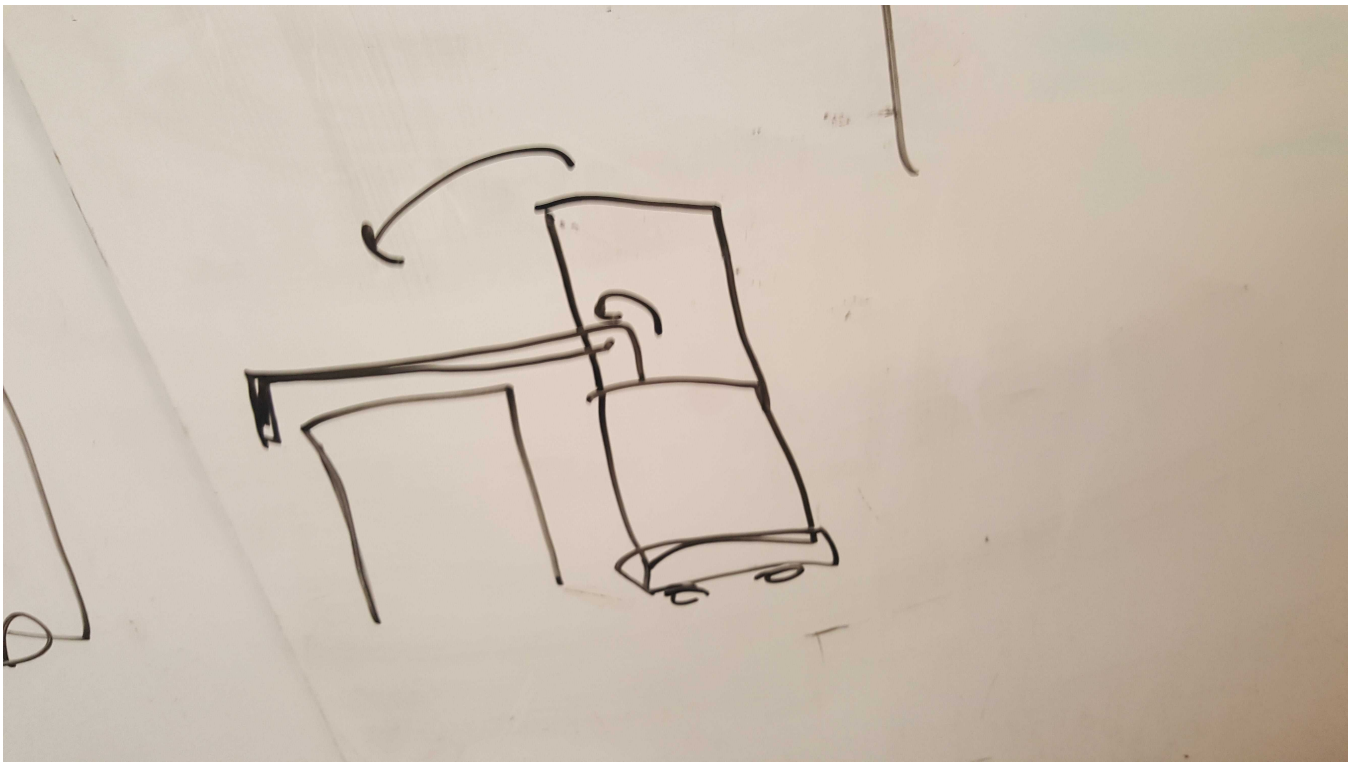

Fig. 27. Original idea of some sort of Pivot mechanism