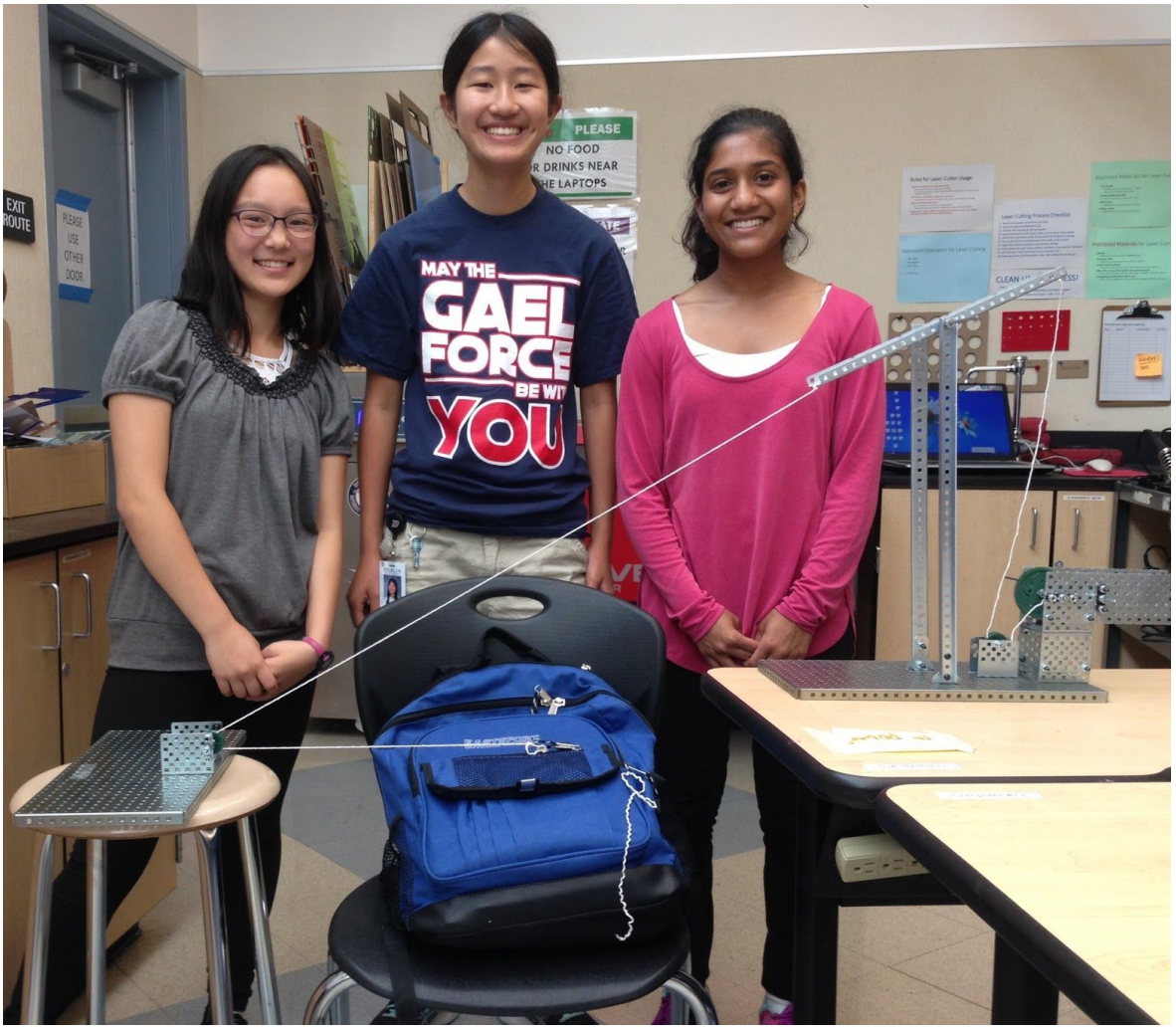
Roshni Vakil, Melody Wang, Jessica Yu
08/30/17-09/08/17
Principles of Engineering 2017-18
Chou 7°

P.1.1.6 Project Compound

Zip It



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Design Brief

Client: Undercover Individuals Living in the Compound

Designers: Roshni Vakil, Melody Wang, Jessica Yu

Problem Statement: It's too difficult to zip up a backpack by hand. It requires far too much effort, and it needs to be a simpler and easier process.

Design Statement: We will design, build, and test a machine that will be able to zip up a backpack with a single human input.

Constraints:

- 6 days
- Fischer Tek, VEX, and other approved parts
- Only 1 outlet for human input of effort force
- Product must be composed of at least 4 simple machines

Team Deliverables:

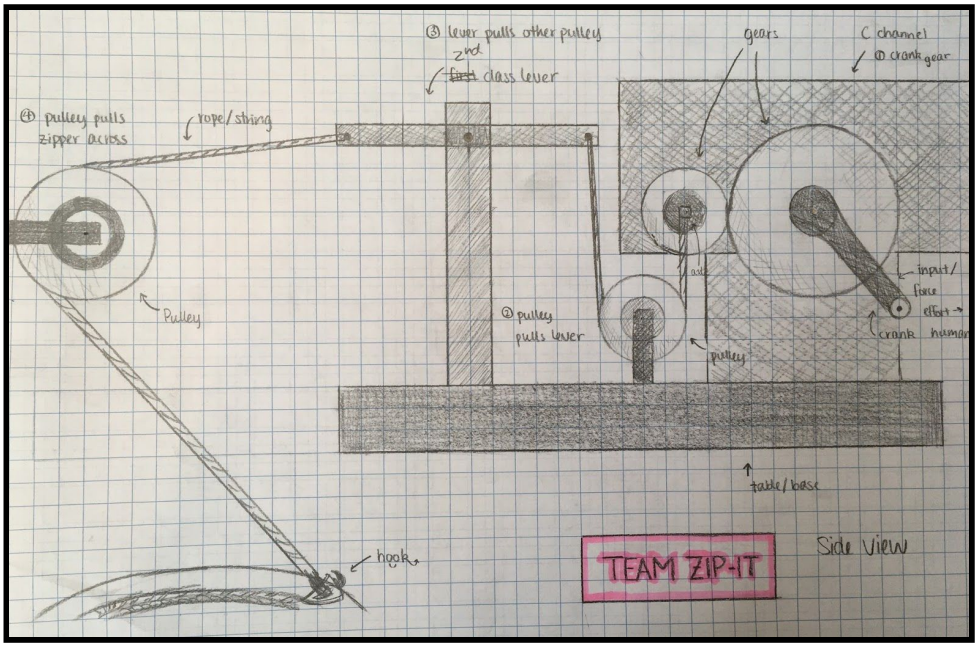
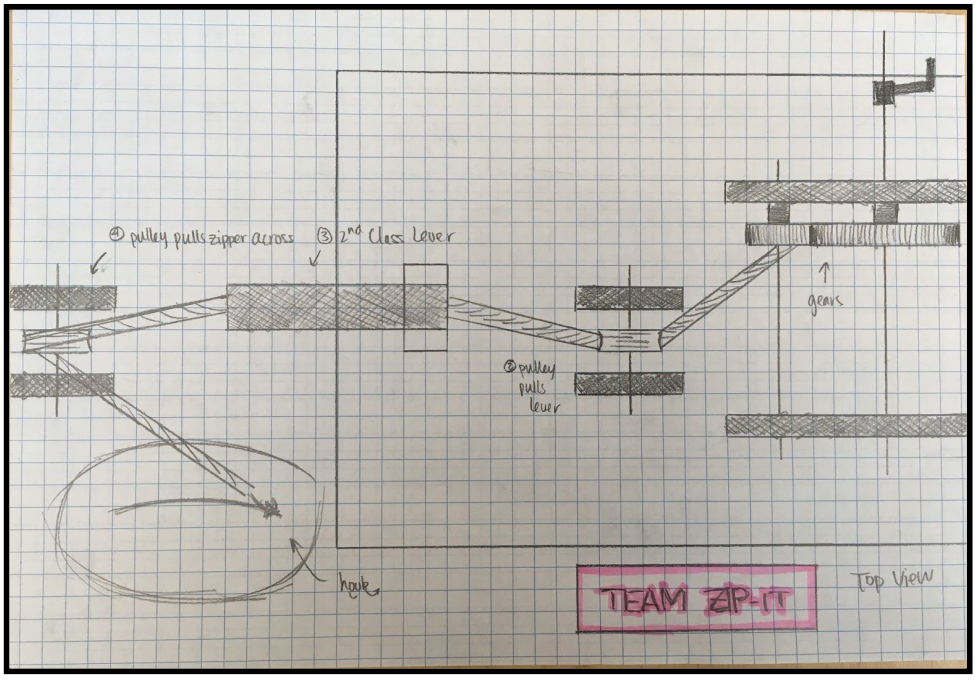
- Working Prototype
- Online Report
    - Title Page
    - Table of Contents
    - Design Brief
    - Design Proposal
    - Prototype Modifications
    - Final Design
    - References

Individual Deliverables:

- 2 brainstorming sketches
- Project Log of specific tasks completed each day
- Calculations of mechanical advantage for the final design
- Conclusion Questions

Design Proposal

Sketch:

Front View	
Top View	

Description:

The system starts on the right with a single human input of turning the axle connected to a simple gear system of two gears, using some kind of crank. The gear system will be geared for velocity, so that the backpack can be unzipped quickly. The second gear has a string tied to the axle, which will be pulled as the gears turn. The string goes through a pulley, which is attached to one side of a first class lever, allowing it to be pulled down, lifting the other side. The other side of the first class lever has a string tied on as well, which then goes through a

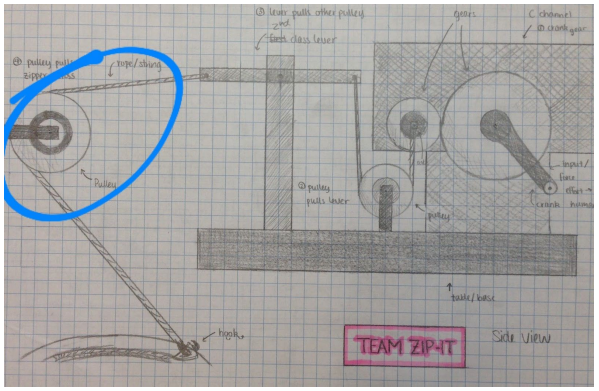
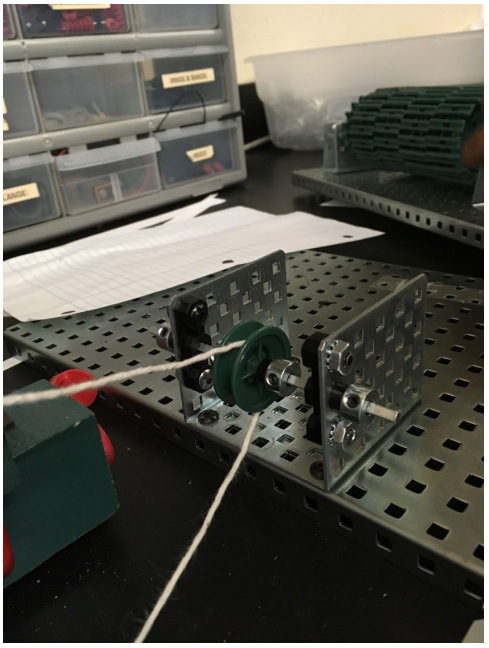
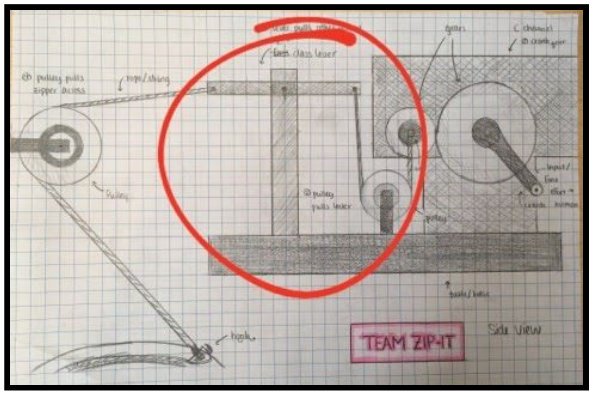
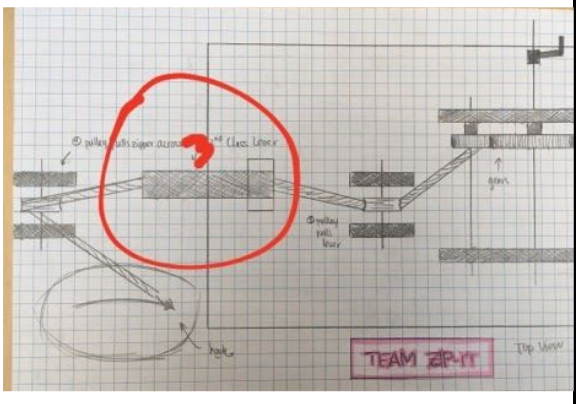
pulley, changing the direction of the string which is tied onto a hook. The hook is clipped onto the backpack zipper so that when the string is pulled, the backpack will be unzipped.

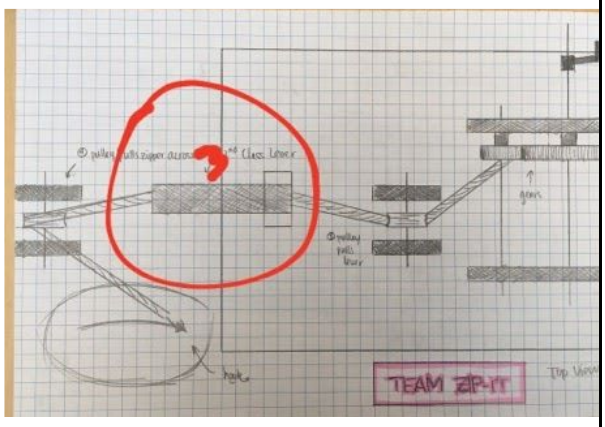
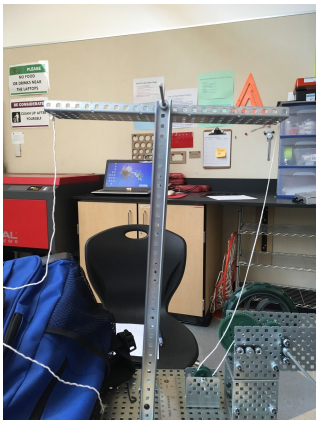
Signatures:

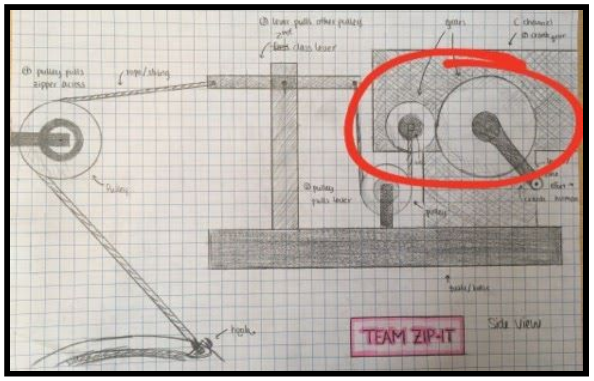
		

Date: 09/04/17

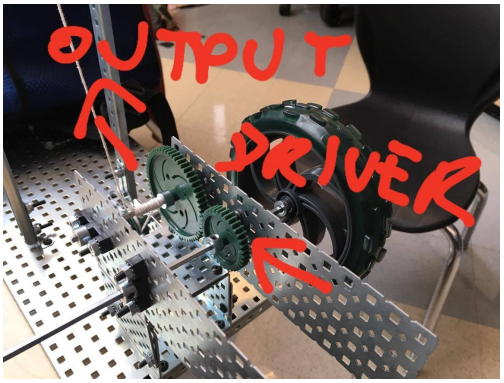
Prototype Modifications

Original Design:	Modifications Made:
 Description of Above: The first sketch had the final pulley suspended in midair, perhaps hung on the wall somehow. But we determined that this wasn't possible, and would restrict the overall mobility of our system. Signature: Date: 09/05/17	 Description of Above: So, we placed the pulley on a separate base from the rest of the mechanism, and put the backpack between the two platforms. Signature: Roshni Vakil Date: 09/05/17
 Description of Above: We initially planned to have a 1st class lever connecting the first and second pulley, but we realized that a 1st class lever may not be able to pull the string connected to the zipper far enough to unzip it all the way.	 Description of Above: With this in mind, we changed it to a 3rd class lever (at this point the lever had not been built yet) so that the overall system would work more effectively. With a first class lever, there would've been a limit to

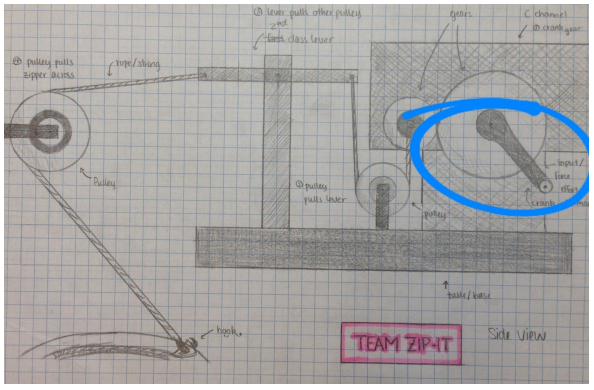
Signature: Date: 09/05/17	how much the string attached to the zipper could pull: only as much as the DE side of the lever pulled. With a third class lever, the IMA would be lower, ensuring that the ratio of the string pulled by the DE side in comparison to the DR side would be smaller. We would have to pull a smaller amount of string on the DE side, but the DR side would pull the string connected to the zipper a considerable amount more. Signature: Date: 09/05/17
 Description of Above: We built the 3rd class lever, but after testing it by turning the gear system, we determined that it was too heavy for our gear system to pull. Although theoretically, a third class lever should have been more mechanically advantageous, we realized the lever would not lift because it required more force effort, something our gear train could not provide. Signature: Date: 09/05/17	 Description of Above: Knowing that the gear system would not be able to pull the string attached to the 3rd class lever, we decided to change it back to a first class lever. Although it did not pull as much string as a third class lever would have in an ideal situation, given our limited effort force, a first class lever proved itself to be the most effective and practical solution. Signature: Date: 09/05/17



Description of Above:
We initially designed the gear system for velocity (speed), using the larger gear as the driver, but after determining that we needed more torque (strength) to lift the lever, we changed it.
Signature:
Roshni Vakil
Date: 09/06/17

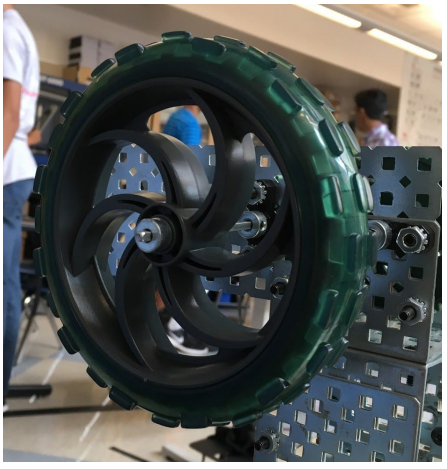


Description of Above:
To harness more torque from our gear system, we switched the position of the gears, using the smaller one as the driver, therefore allowing the system to produce more torque.
Signature:
Roshni Vakil
Date: 09/06/17

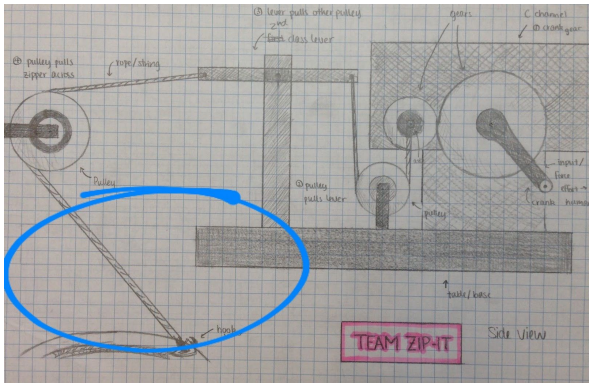


Description of Above:
We were lacking a 4th simple machine, and we still needed a crank for the gear system so that we could turn it faster, and use less effort.

Signature:
Roshni Vakil
Date: 09/06/17



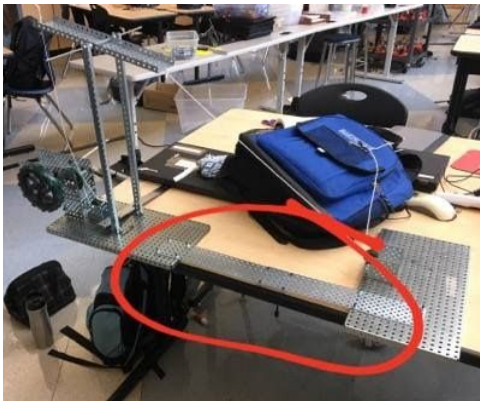
Description of Above:
To solve both of our problems, we added a wheel and axle to the end of the axle of the driver gear, which functioned as both a 4th simple machine and a crank.
Signature:
Roshni Vakil
Date: 09/06/17



Description of Above:
In our design, we needed to have the pulley on the left on a separate platform, and the backpack sitting between that pulley and the main base. We realized the platform that the other pulley sat on would be pulled instead of the backpack, so we had to change it somehow.

Signature:

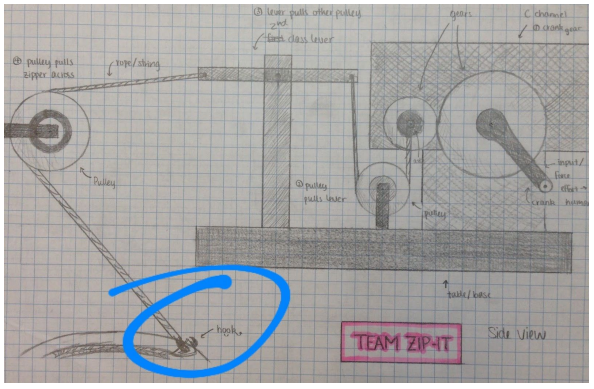
Date: 09/07/17



Description of Above:
We decided to use a thin metal plate to connect the two platforms, and put the backpack on top of it. With this change, the two platforms would stay fixed, and the pulley wouldn't end up pulling the platform instead of the backpack zipper. This way we could also sit the entire system on one table.

Signature:

Date: 09/07/17

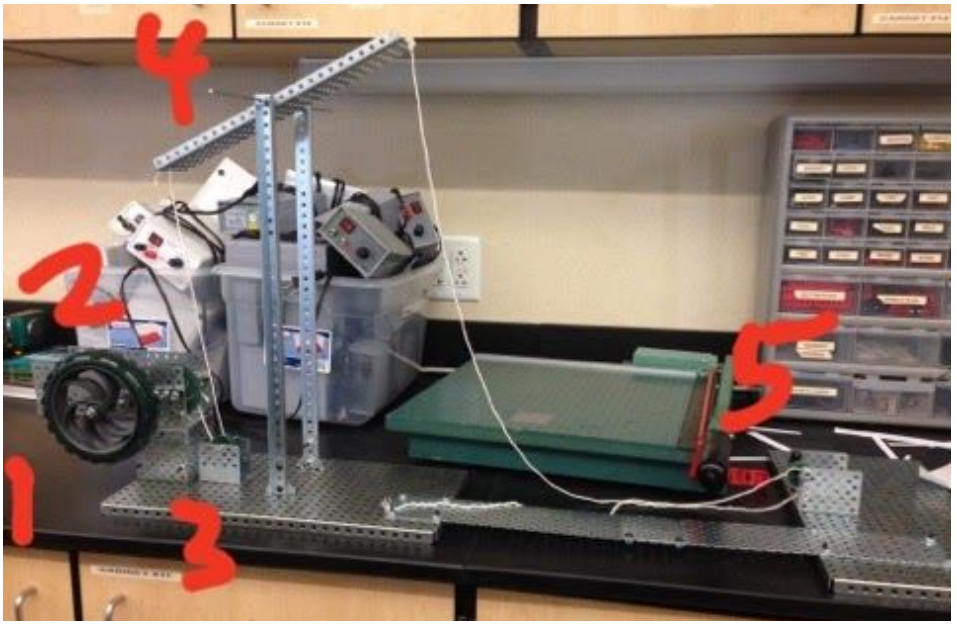
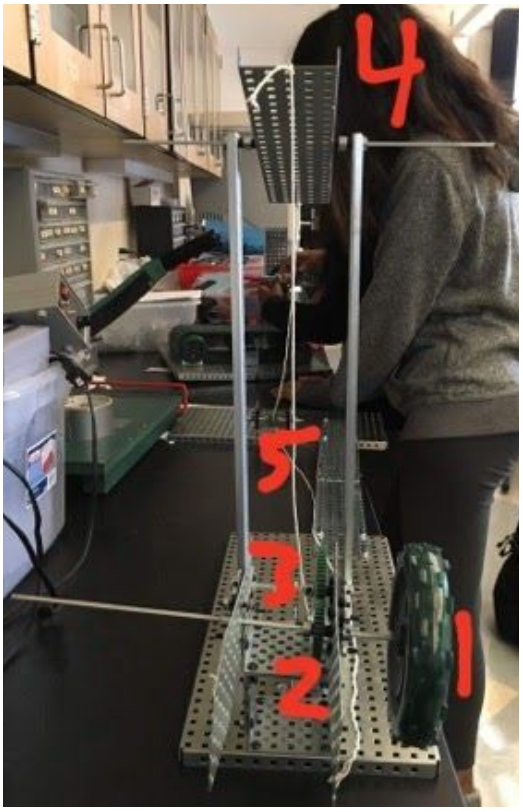


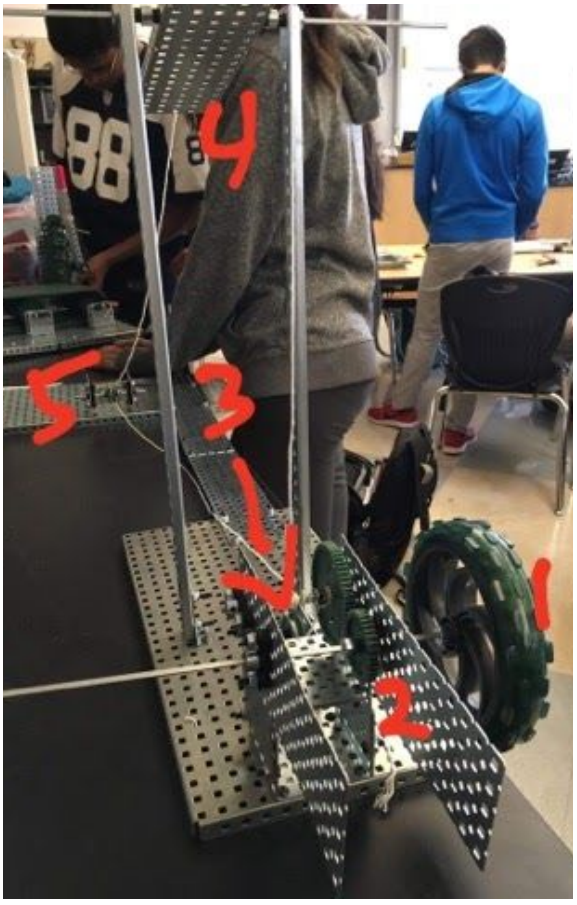
Description of Above:
We originally planned to bring in some sort of small hook to be able to hook onto the backpack zipper, so that the mechanism could quickly switch from one backpack to another. However, we didn't know where to get a hook, and we weren't sure how we would attach it to the string.

Description of Above:
At this point, the hook seemed fairly unnecessary. It didn't affect the overall efficiency of the system when unzipping the backpack. It was also not too difficult to just tie and untie the string from the backpack zipper each time. So, we decided to remove it from our design.

Signature:  Date: 09/07/17	Signature:  Date: 09/07/17

Final Design

Key	1 - Wheel and Axle 2 - Gear Train 3 - Pulley 1 4 - First Class Lever 5 - Pulley 2
Front View	
Side View	

Isometric View	

Description:

Our final design works effectively to open and close zippers. The zipper of the backpack is attached to the loose end of the second string. The only human input that is utilized is in turning the first wheel, which rotates the axle that it is attached to. This first simple machine has an IMA of about 40.94. The axle also houses a 36 tooth gear, which drives a torque gear train with an IMA of about 1.67. There is a string tied to the axle of the final gear. It wraps around the axle as it rotates and is pulled through a pulley with an IMA of 2. The second string in the pulley connects to a first class lever with an IMA of 1. When the string is pulled by the gear, the DE side of the first class lever is pulled down. As a result, the second string tied to the DR side of the lever is pushed up, like a see-saw. It rotates through a lower second pulley with an IMA of 2. The second pulley is strategically placed on a different base plate so that the backpack can be put in the space between the two plates. It is also level with the backpack zipper so that when the string is pulled, the zipper is zipped and the string does not attempt to lift up the weight of the backpack instead. So, when the DR side of the pulley moves up, the string attached to the zipper is pulled, pulling the zipper and zipping up the bag along with it. Our complete system has an IMA of 272.79.

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		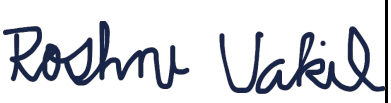

Date: 09/07/17

Final Mechanical Advantage Calculations