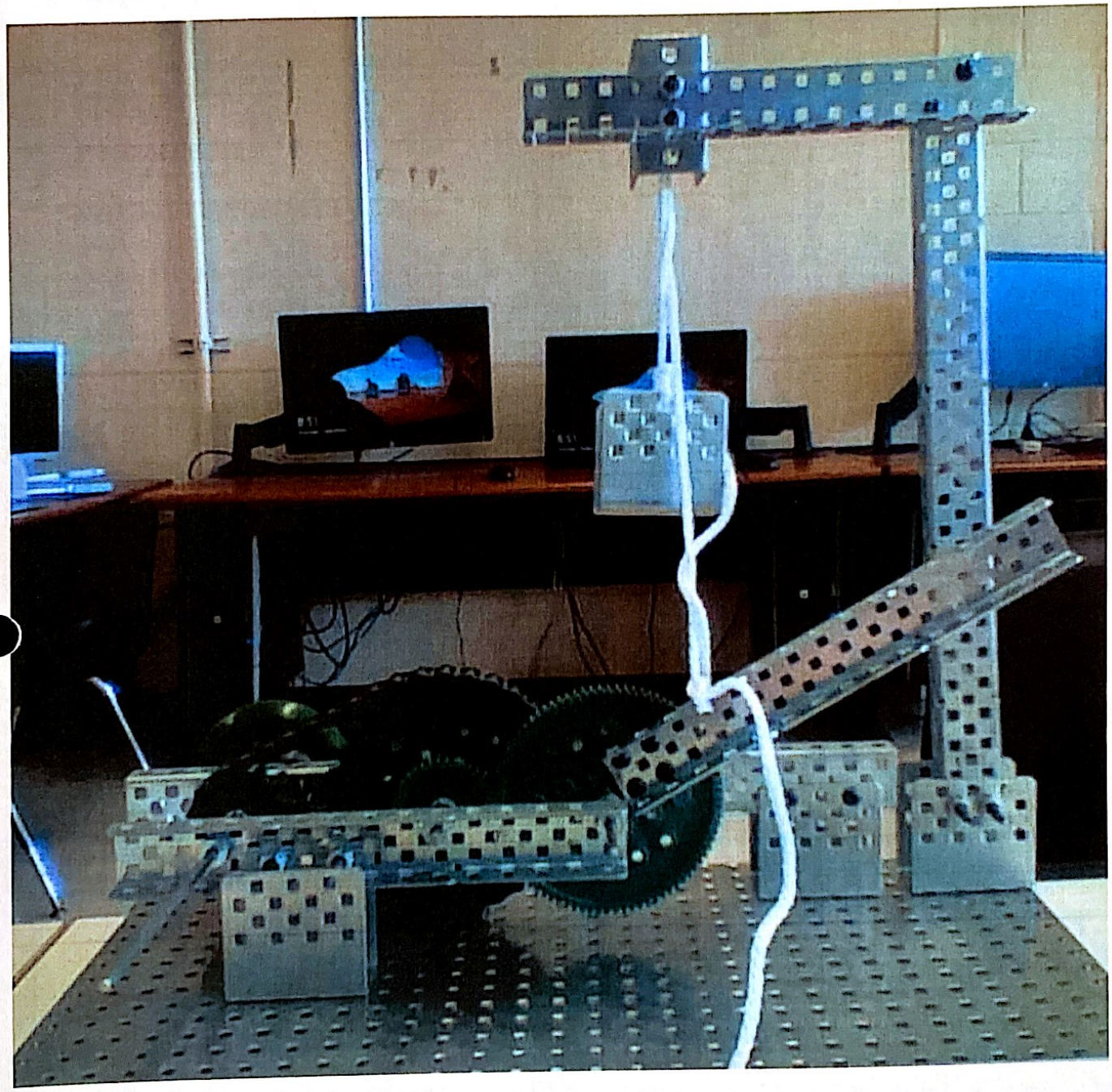
Project 1.1.6 Compound Machine



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Introduction

In this project, students will use what they have learned about simple machines to create a Compound Machine that will fulfill their own made up task. They will be required to construct a machine using three or more simple machines, one of which must be a gear train. Then they will have to calculate the Mechanical Advantage and the Gear Ratios of the entire Compound Machine.

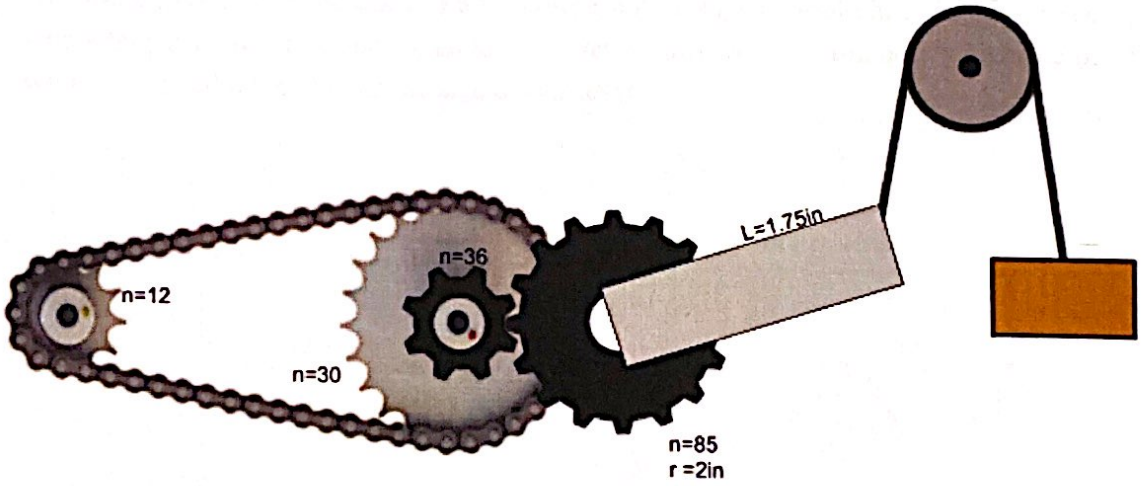
Design Process

Problem: A way to lift a large/heavy object in the vertical direction using very little rotational force is needed. Ideally we would like to lift a weight one to two inches.

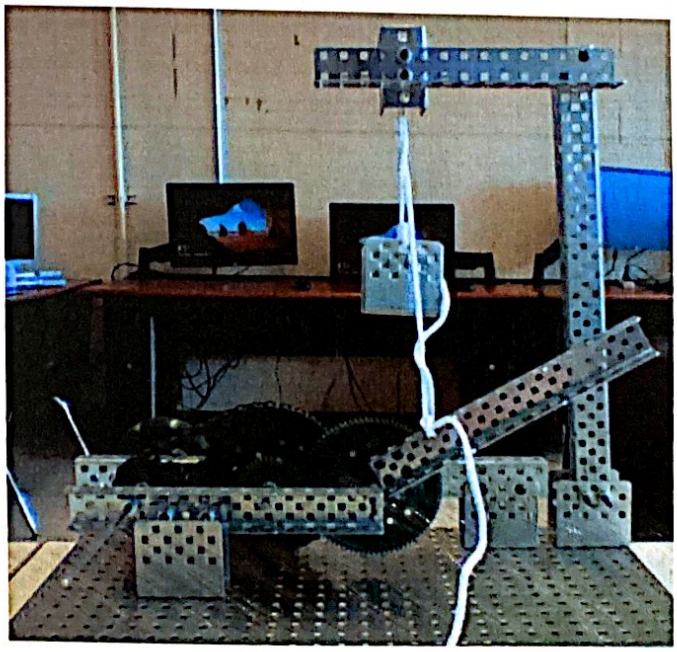
Brainstorming:

- We want to have more than three simple machines included.
- We could have had a mobile machine.
- We wanted to include a pulley as the final stage in our machine.
- Our machine could have a movable inclined plane with a pulley on the end.

Solution:

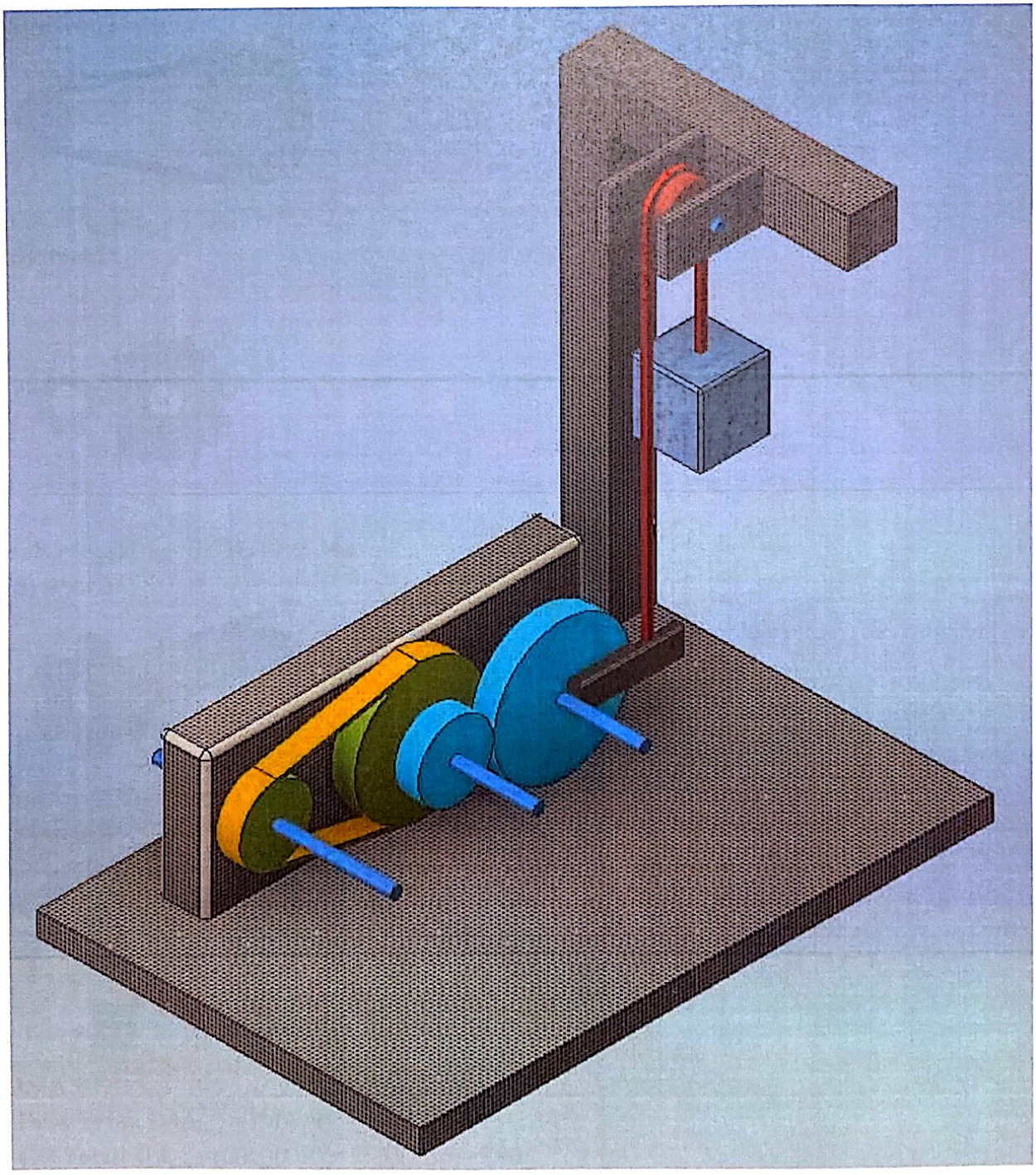


Prototype:



Evaluate Solution: During the construction of our prototype, we initially had some difficulties. At first, we created the gear and lever system separate from the base, but this led to some problems when we were going to connect the two pieces. Eventually, we were able to securely attach the two parts, but we then had some difficulties with the positioning of the pulley system. We needed to rearrange the orientation and add an extruding support beam to position the pulley in the best place. Once construction was complete, we started to calculate our gear rations and the mechanical advantage of our machine. Once we had finished our calculations, we discovered that our mechanical advantage was only ⅓, so then we were forced to revisit ways that would change our mechanical advantage to be higher than one. We finally realized that if we moved the position of the string on the lever, it would dramatically change our MA. Once this change was complete, we found that our new MA was greater than one. However, there are still a few different modifications that we would have like to make given the time and the right materials. We would have like to include a crank as our input. Also, we would have liked to have a gear with a larger diameter be connected to our lever, as this would dramatically increase our MA without us needing to change the size of our lever.

Model of Design



Mechanical Advantage Calculations

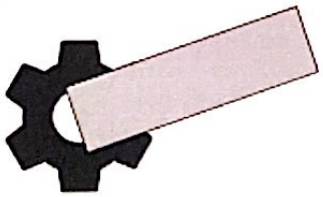
System 1:

$GR_1=(n_{out})/(n_{in})=(30/12)=5/2=2.5$

System 2:

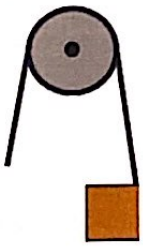
$GR_2=(n_{out})/(n_{in})=(85)/(36)=2.36$

System 3:



$IMA_1=D_e/D_R=(2in)/(1.75in)=1.14$

System 4:

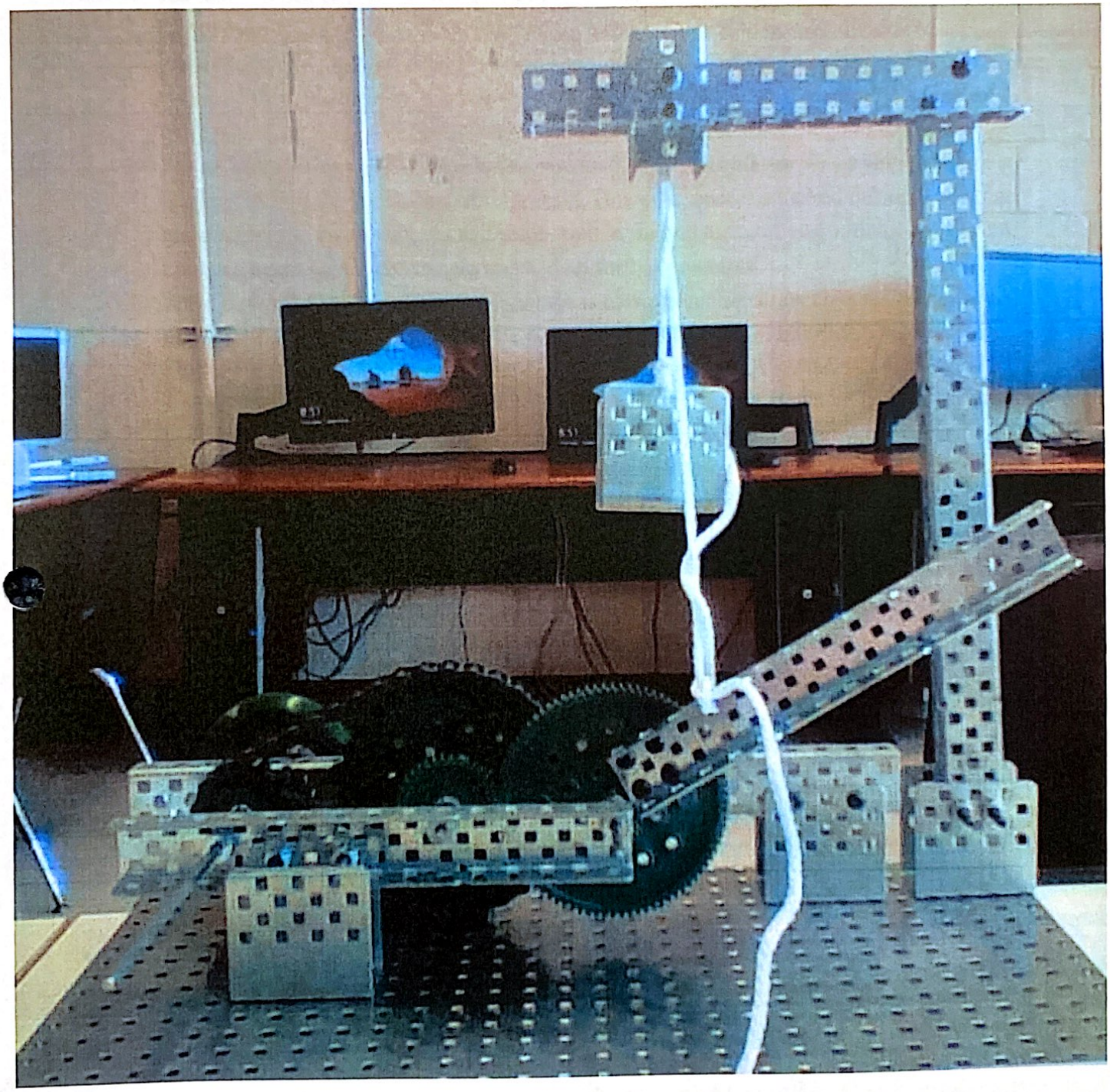


$IMA_2=1$

IMA Total: $IMA_{total}=(IMA_1)(IMA_2)=(1.14)(1)=1.14$

GR Total: $GR_{total}=(GR_1)(GR_2)=(2.5)(2.36)=5.90$

Picture Of Working Design



Conclusion

1. For all of the systems in our compound machine, there was no value that was difficult to calculate. When calculating the gear ratios, all that was needed was to see how many teeth were on each gear, and after that, all we were required to do was divide. When calculating IMA, we just needed to measure the distances of the lever length and the radius of the gear, then we just needed to divide. This lead to very easy calculations, so there is no part that was explicitly easier than one another.
2. For all of the values that we needed to calculate, the hardest factor was trying to figure out how to find the gear ratios of a sprocket. However, once we looked this up we had no more problems. After that, we had some trouble finding the total gear ratio of the system, but once again we looked this up and had no further problems.
3. Since our calculated mechanical advantage is close to our actual mechanical advantage, we can use it to solve for force. If we put ten pounds of force into the system, we can estimate how much force will be outputted by the system. IMA=AMA=1.14; $AMA=F_R/F_e$; $1.14=(F_R)/(10lb)$; $F_R=(1.14)(10lb)=11.4lb$. So if we put ten pounds of force into our machine, theoretically, 11.4 pounds would be produced.
4. There are many ways that we could have made our system more efficient, one way is to increase the size of the gear that the lever arm is attached to. This would have increased the mechanical advantage without us needing to change the length of the lever. Another way to change the mechanical advantage would be to decrease the size of the lever arm.