Final Analysis Report

MCHE 201

Team N

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Don't number the title or abstract pages.

Basically = "we"
Avoid

Abstract:

For the final MCHE 201 project, various teams were assigned to build an autonomous robot capable of carrying out various tasks in order to aid the rebellion in crushing the Galactic Empire's cruel rule. For the project being presented in this report, the team was tasked with, destroying the Death Star, saving droids, destroy TIE fighters, use the Force, and learn how to use a lightsaber. The final design implemented went for only specific components in mind due to how other designs would affect the time. Since other designs went for the droids with long, destructive arms, the final design chosen had short arms as to not risk being destroyed by other robots. The proton torpedo delivery system was also simple in that it was a mechanical trigger the drop the torpedoes into the Death Star, to save on time and coding error. Driving and powering the robot were two DC motors, two servo-motors, and a python pyboard running python code. In order to understand the project and its goals, several problem understanding tools were used, including, the House of Quality, the Specification Sheet, and the Function Tree. From these helpful tools, the team devised three concepts that would suite the project's and competition's needs. From there, a Third Level Evaluation Matrix pitted the three design concepts against each other to determine which satisfied the most requirements. The design that avoided collisions, lessened complicated coding, and theoretically gave the team the most points possible, was chosen.

Awkward

Doesn't really fit in abstract.

Final Contest Results (including judging)?

The abstract should summarize what is presented in the report, including key results.

Introduction

You need to introduce the context. It's problem being solved.

For the MCHE 201 final project, teams were tasked with building autonomous robots capable of carrying various specified tasks for competition points. Due to the complexity of the project assigned, multiple design tools had to be used in order to properly assess the problems and to arrive at an efficient solution. ~~From a previous report,~~ A ~~a~~ house of quality, specification sheet, and function tree were used to determine the understanding of the problem, which is to build an autonomous robot capable of completing the tasks of the competition. Selection of the final design was based on not only the amount of customer requirements, but also the numbered rank of importance of each customer requirement. The first section of the report discusses the final design and gives a clear, concise breakdown of its anatomy and physiology. The third section breaks down the problem understanding the project using the house of quality, specification sheet, and function tree. The third section is the concept evaluation section where the two alternative designs will be introduced. Also in this section, the selection of the final design will be supported by a third-level evaluation matrix. Section five will be the conclusion of the report.

Focus on the design not the assignment

What are the engineering challenges?

Final Design

The final ~~selected~~ design is a simple rover vehicle driven by a large DC motor and constructed from yardsticks and thin plywood. Connecting the DC motor to the rear axle, as shown in Figure 1, are two gears, one gear secured to the motor and the other secured to the axle. The two gears then mesh together and turn the axle, which then turns the fixed wheels, enabling forward and backward motion of the rover. Delivering the proton torpedoes to the Death Star, is a simple mechanical dump, shown in Figure 2. At the apex of the device, a box sits on a pivot and has a long rod connected to the bottom. When the device is at the Death Star, the Death Star pushes the rod and the bucket is flipped, causing the proton torpedoes to drop in. One drawback of a simple design for the proton torpedo deliver system is that the proton torpedoes are not guaranteed to make it into the exhaust port. The last component of the rover is the arms, which are going to be used to collect force units, droids, and the lightsaber. Powering the two arms is an upright mounted small DC motor. The two arms have a secured pivot point on the back of the rover, enabling the opening and closing action of the sweeper arms. Secured to the small DC motor, is a gear and a disk. From the disk, joints extend to hold the arms up and provide motion. At the end of the arms, is a servo-motor conjoined to a wooden member. The servo-motor functions as a joint, and the wooden member functions as a hand that sweeps objects out the way

Same for concept eval. section & relate to eval matrix and also collects objects.

Problem Understanding

To ensure that the understanding of the problems for the Star Wars competition was thought through completely, three design tools were used. These design tools consisted of a House of Quality, a Function Tree, and a Specification sheet.

~~The first tool used to evaluate the problem was the House of Quality.~~ The House of Quality lists customer requirements and engineering characteristics and compares them by giving them a strong, medium, or weak correlation. The customer requirements were mostly derived from the rules for the competition along with a few things that the team felt should be taken into consideration. One example of a customer requirement is the that the machine must be autonomously controlled in order to compete. Since the device would not be able to compete without this feature, the requirement obviously appears in the list of customer requirements. The house of quality also consists of a list of engineering characteristics which are features of a design which can be measured, maximized, and minimized. One example of an engineering characteristic is the length of the robot. Since the competition gives a size restriction of twelve inches by twenty-four inches, this characteristic is extremely important so the device does not get disqualified. The house of quality also measures the importance of each customer requirement, which is then related to the correlation of a requirement with an engineering characteristic which then gives an absolute importance of the characteristics. ~~From all of the features it is possible to determine which characteristics and requirements have to be taken into strongest consideration when designing.~~

Avoid. Basically = we here

~~Another tool used to help understand the problem is the specification sheet.~~ The specification sheet is a list of requirements which organizes these requirements into different sections and determines of they are demands or wishes. The perfect design would satisfy every requirement on this list. However, some things are extremely difficult to include when considering other more important details. For example, one wish on the specification sheet is that the device be easily assembled incase quick repairs need to be made; howeverf the device needs to be strong enough to compete so things need to be permanently secured to the device making it difficult to remove parts. The most important requirements are the ones that are labeled as demands on the specification sheet, such as the device must be less than eighteen inches tall. This is a demand because if this requirement is not met, it results in disqualification from the competition.

The final design tool used was the Function Tree. The purpose of the function tree is to figure out which basic functions are needed in order to make the device operable. The function tree works by stating the main function of the device "functioning robot able to compete", and then breaking it down into smaller and smaller functions until only basic functions are left, such as "sensors to indicate location". ~~This allows us to be able to conquer each of these small and manageable functions individually to end up with a functioning device in the end.~~

what are the important functions for this design process?

Concept Evaluation

~~Part of creating a successful design for anything is comparing multiple ideas then choosing the best options. For the Star Wars project, an extensive problem understanding was needed to identify exact functions for a successful machine. The very simple functions can be found on the function tree in figure 4. With the identification of the individual functions, designs were made. Three designs became slightly different due to the fact that there were multiple ways to achieve the simple functions on the function tree.~~

Alternate Design 1, ~~as~~ shown in Figure 5, is a moving design. The basic idea of the design is that the robot goes to the objects instead of reaching out to the objects. The farthest objectives would be this robot's strength. These objectives include the force balls and the death star. Design 1's movement power came from the large DC motor, and the motor would directly connect to the axel making the axel move. The motor drives the robot to the Death Star. Once the upper arm is over the exhaust port, a servo will open the gate allowing the torpedoes to drop. Since the robot is so close to the Death Star, it should easily be able to drop the torpedoes. This is one of the arguments to having a moving device and was noted in the evaluation matrix. To keep the design simple, the collection arm on the front of the design drops using a small DC motor to collect the force balls. The robot then returns to the Jedi training zone to release the force balls before returning to the start zone. The basis behind design one is to collect as many points possible, but the design is as simple as possible. This idea is presented to get easy points.

stay formal

Alternate design 2, shown ~~by~~ in Figure 6, is also a moving robot. The idea that it is easier to achieve objectives when the robot moves to the objectives was also in place for this design. Design 2 moves to the objective using the large DC motor as well. From the problem understanding, movement of the device scored very highly. This device works towards scoring the easy points toward the middle section of the track. The DC motor drives the robot to the

stay formal

exhaust port where a servo moves a flap dropping the torpedoes into the exhaust port. After the torpedoes are dropped, two arms close on the force balls trapping them within the device. Once the force balls are within the robot's grab, it drives the balls backwards and releases them in the Jedi training area. Since the arms should be able to move a full 180 degrees, the robot can also ? try and reach for the sponges on the way back to the start zone. Alternate Design 2 is still not complicated, but it is more complicated than alternate design 1.

Although alternate design 2 gets more points than Design 1, it would still be hard to achieve a competing score with these two designs. The design needs to be able to compete against other robots. In order to have a successful robot, it needs to score well. Although simplicity makes the design easier to build, maintain, and run, scoring more points than the opponents is needed. For this reason, the two alternate designs were not as dominate as the final design chosen. From the evaluation matrix in F figure 9, the final design got a dramatically better score than the two alternate. The customer requirements that pertain to points, force balls and sponges specifically, the final design greatly dominated the alternate designs. From the scoring, we can see that the final design is the best design.

Avoid 1st person

Design Performance Evaluation

The final design achieved two wins and two losses during the final competition. In the first match, the final design was matched with the top two competitors due to poor qualification rounds. The first match resulted in a 3rd place finish pushing the design to loser's bracket. After being placed in the loser's bracket, the final design posted two wins before losing the second time. The design scored a ranking of 13th of 25 for the competition.

The judges found the final design to have a score of 7.72 out of 10. The score was an average of three categories; ingenuity, aesthetics, and presentation. Each category was out of ten then averaged. Ingenuity was a 7.67. Aesthetics was also a 7.67. Presentation was slightly better with a 7.83.

Why the change in paragraph style?

Although the design preformed decently, some assumptions were made that dampened the success of the robot. It was assumed that not many teams would have success with getting the points for the droids. It was also assumed that the teams going for the droids would smash into each other during the competition. From these two assumptions, it was chosen that the final design would not need to reach the droids. During the competition, many teams ranked above the final design found success with getting the droids. The House of Qualities in Table 1, clearly showed that it was wrong to make this assumption. Another assumption that was wrong was that other teams would not go for the exhaust port. This was clearly wrong in the final competition

Bold period?

and the House of Qualities in Table 1. The Specification Sheet in Table 2, shows the geometry of the design: one-foot-wide, two feet long, and eighteen inches tall. The final design was little too small. If it was closer to the specification listed in the spec sheet, the design most likely could have reached the droids.

The final downturn of the final design was its durability. According to the House of Quality in Table 1, the durability of the device was not as important as other requirements. Since this ultimately killed the robot, more characteristics and requirements should have been centered on durability.

You have to make assumptions in any design process

If the House of Qualities was followed closer and no assumptions were made, the final design would have been different. The arms in figure 2, would be much longer so that they could reach the droids. The device dropping the torpedoes would also be more complicated most likely by a sensor to detect the exhaust port. ~~The assumptions took the design farther from the House of Qualities than needed.~~

Conclusion

too team-centric + narrative

By compiling multiple evaluation techniques, such as the house of quality and function tree, the team was able to distinguish the most important requirements in order to be successful in the competition. From these tools, conceptual rovers were conceived and pitted against each other to see which satisfied the most requirements using a third level evaluation matrix. Ultimately, a small rover with a simple mechanical delivery system was used. Opening the arms was a small DC motor attached to a CD, which rotated and in turn made the arms open. The arms of the rover were small in nature to avoid collision with other robots. The final design took the team to a rank of thirteen out of twenty-five for the competition. Judging Results

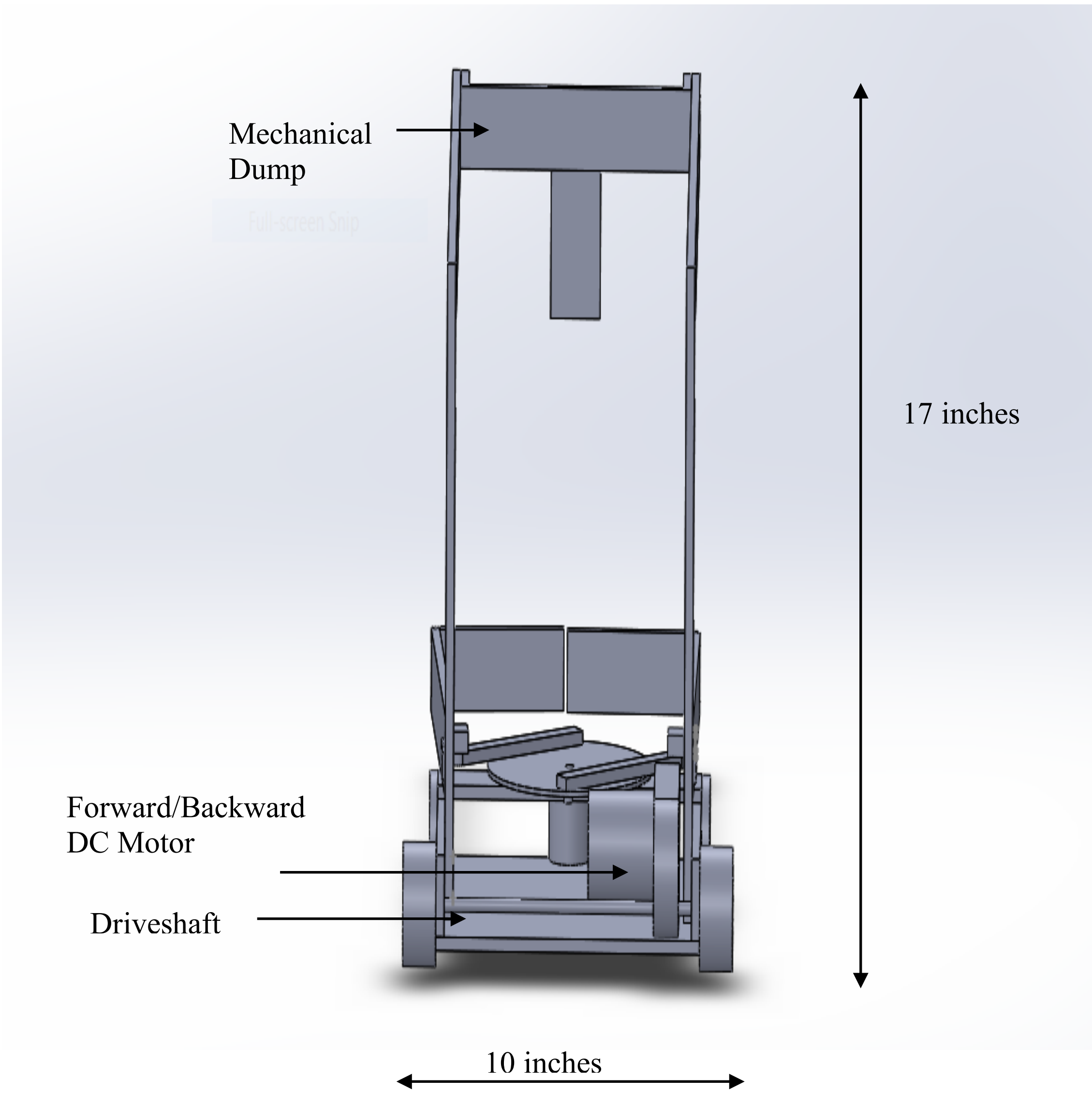


Figure 1: Final Design Back View

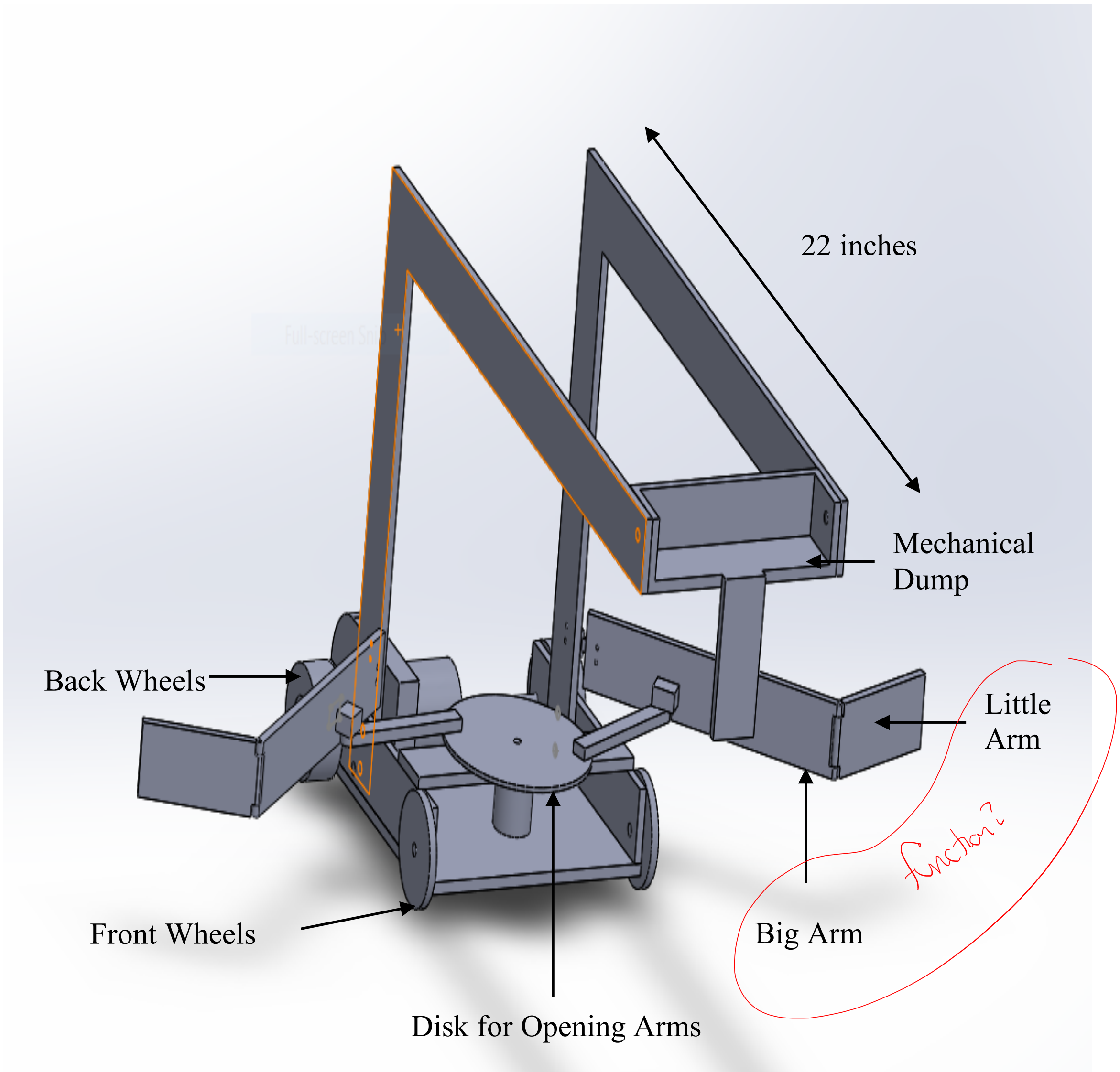


Figure 2: Final Design With Open Arms

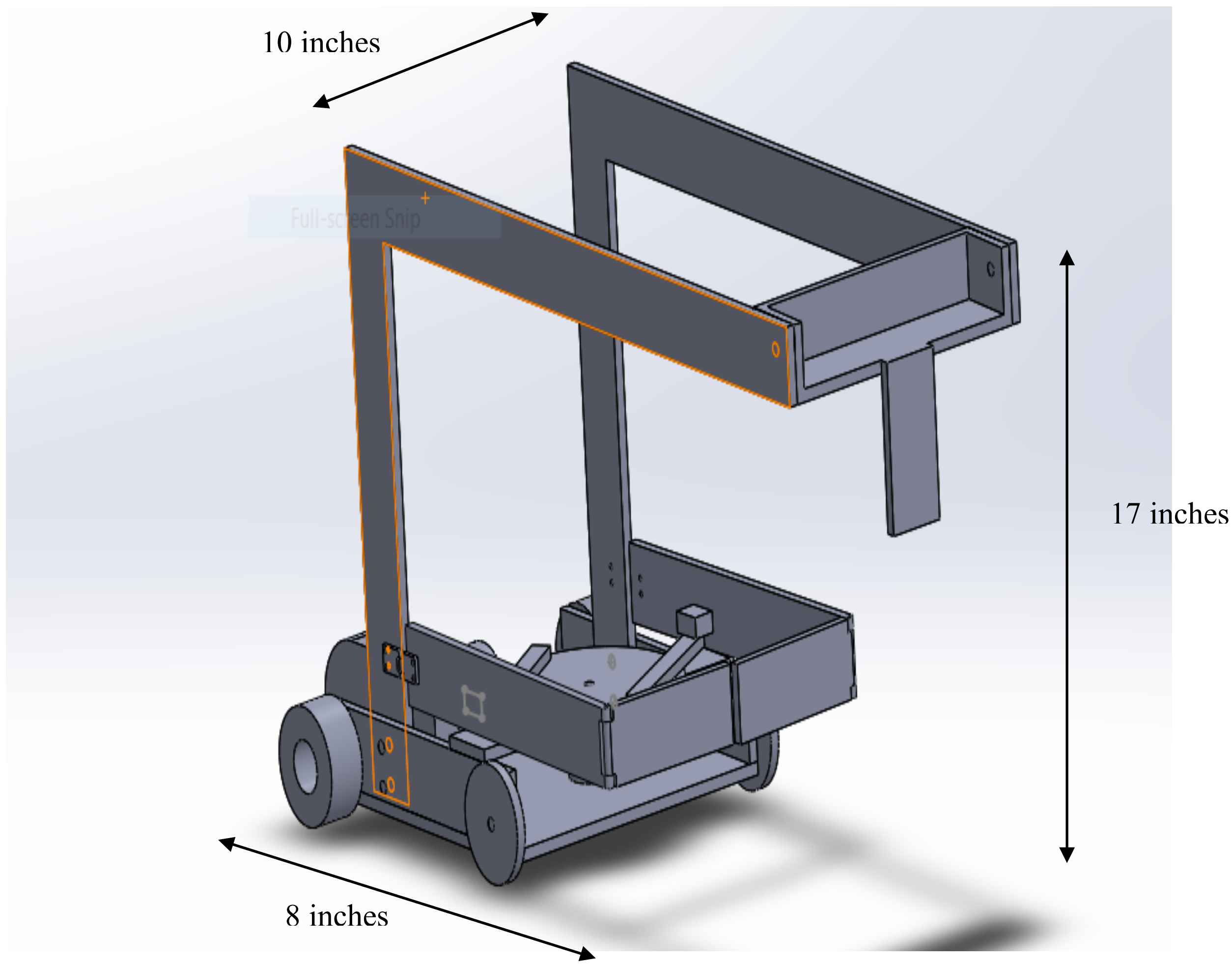


Figure 3: Final Design With Closed Arms

Expand

There are more cust. req than these.

Table 1: House of Quality

Importance	Customer Requirements \ Engineering Characteristics	cost of materials	computing power of microchip (measured how?)	low average set up time	sensors with low variences	accuracy of mechanical motion	length of python code	accuracy of python code	strength of structure materials	accuracy of mobility	size of device (← expand)
	Direction of Improvement	▼	X	X	▲	▲	X	X	▲	▲	▼
9	Detect and grab bowling pin		π		△	π			▣	π	
9	detect and retrieve foil table tennis balls		π		△	π			▣	π	
9	detect and retrieve toy blocks		π		△	π			▣	π	
9	detect and brush aside two sponges		π		△	π			▣	π	
9	deliver keychains to the death star		π		△	π			▣	π	
9	Safely back off of the team zone		π			π	▣	▣		π	
9	less than 2 feet in length										π
9	less than 18 inches tall										π
9	less than 1 foot in width										π
9	autonomously navigate		π		▣		π	π		▣	
7	cost effective	π									
4	aesthetically appealing	π									
8	able to set up in less than 3 minutes			π							▣
9	complete all tasks in under 30 seconds						π	π		π	
6	be able to withstand multiple uses								π		
7	able to take down in less than a minute			π							▣
	Absolute Importance	99	648	135	72	486	189	189	189	594	288
	Relative Importance	0.0343	0.224	0.047	0.025	0.168	0.065	0.065	0.065	0.206	0.1

π	9
▣	3
△	1
▲	Maximize
▼	Minimize
x	Target

center symbols in cells

Avoid screenshots

Expand

Many more specs than this.

Table 2: Specification Sheet

		Specification for:	**Issued:**	**10/22/17**
		Final Project	**Page 1 of 1**	
Changes	**D/W**	**Requirements**	**Responsibility**	**Source**
9/26/17		create a robot capable of competeing		
		Geometry		
9/26/17	D	must be less than 1 foot wide	Team	Competition
9/26/17	D	must be less than 2 feet long	Team	Competition
9/26/17	D	must be less than 18 inches tall	Team	Competition
		Materials		
9/26/17	W	cost below $100	Team	Team
10/28/17	W	materials weighing less than 50 kg	Team	Team
10/28/17	W	tensile strength of 40 Mpa	Team	Team
		Signals		
10/28/17	W	sensors with variances between -1 and 1	Team	Team
10/28/17	W	100% accuracy of motor movement	Team	Team
		Assembly		
10/28/17	D	must be set up in less than 4 minutes	Team	Competition
10/28/17	W	set up time in 1 minute	Team	Team
10/28/17	W	take down time less than 1 minute	Team	Team
		Transport		
10/28/17	W	able to fit within 2.5 foot by 1.5 foot box for easy transport	Team	Team
		Operation		
9/26/17	D	must compete for 30 seconds	Team	Competition
9/26/17	D	Must be powered by a 12 volt converter from a wall outlet	Team	Comptetition
9/26/17	D	must operate autonomously	Team	Competition
		Costs		
9/26/17	D	Building materials must cost less than 100 dallors	Team	Competition

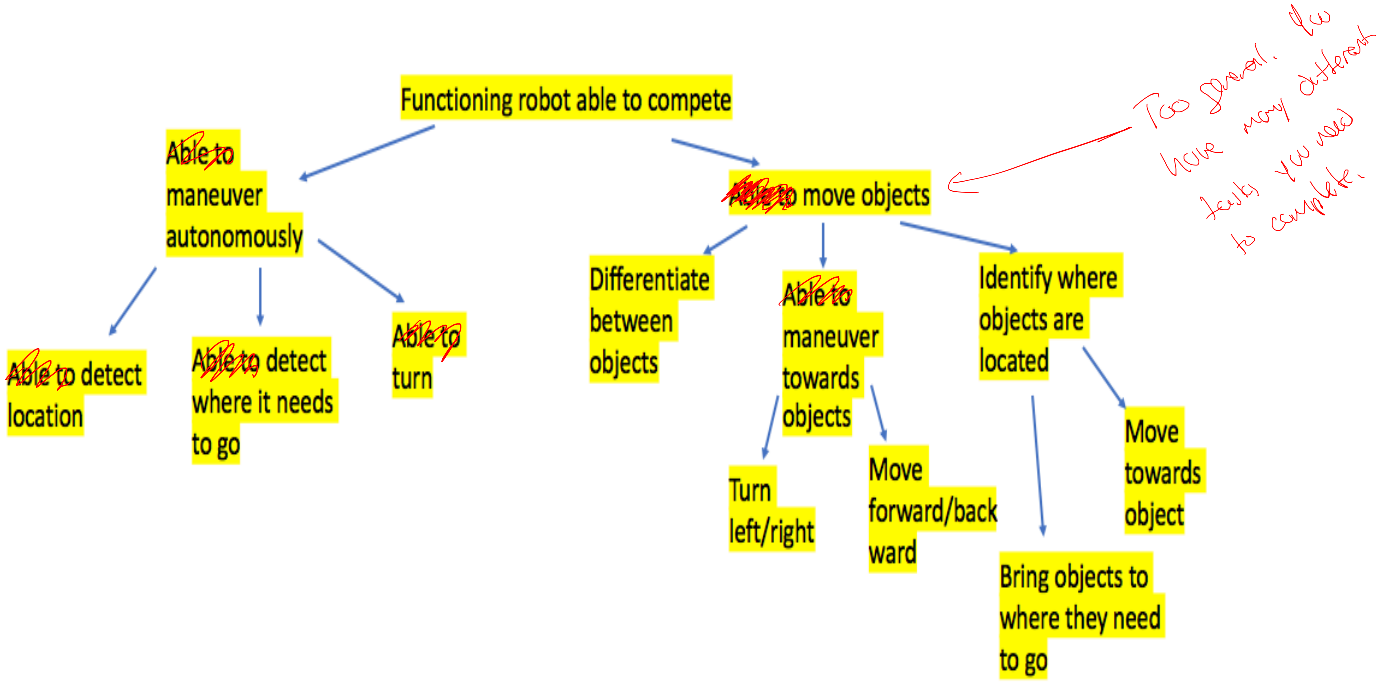


Figure 4: Function Tree

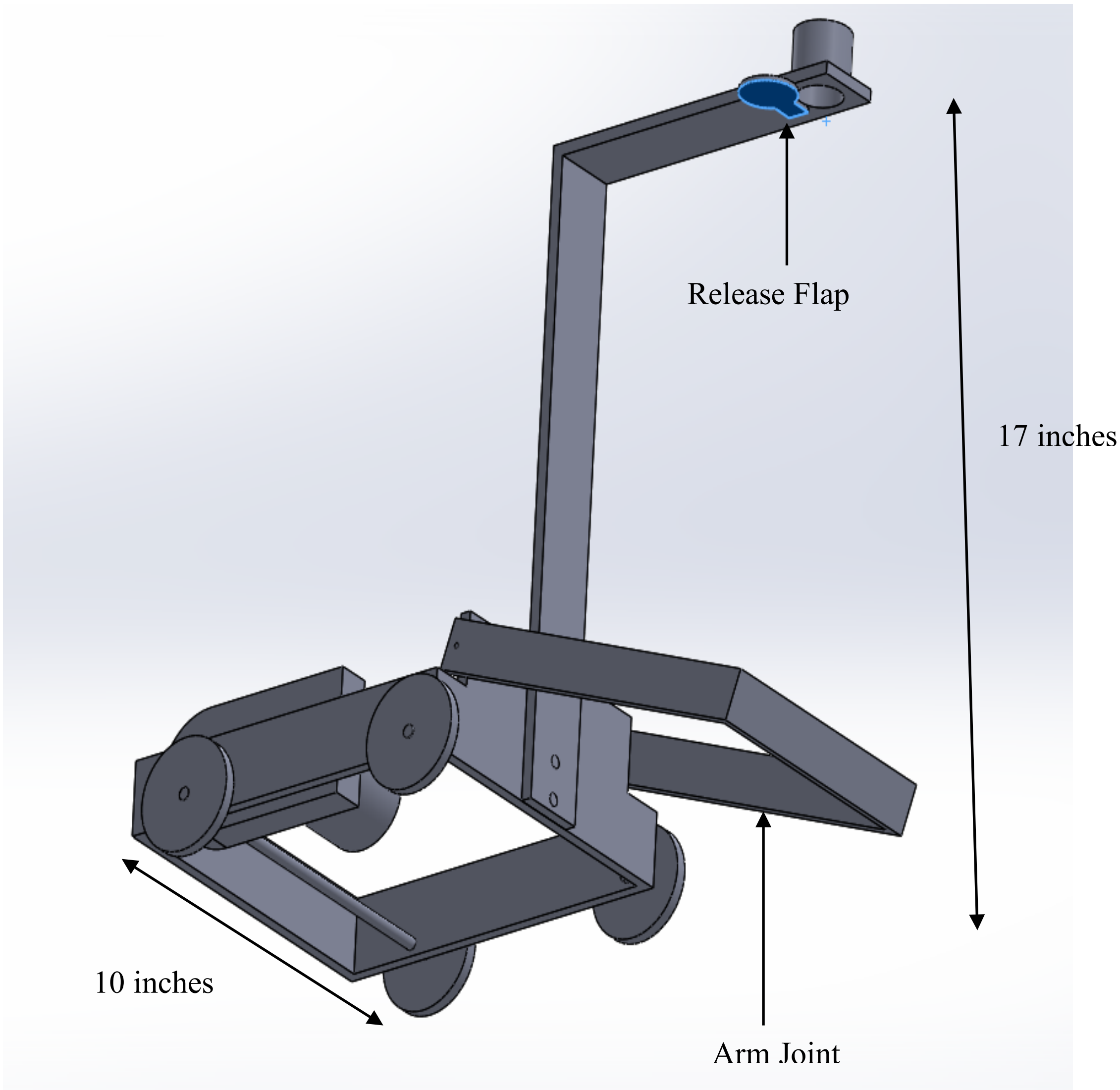


Figure 5: Alternative Design 1

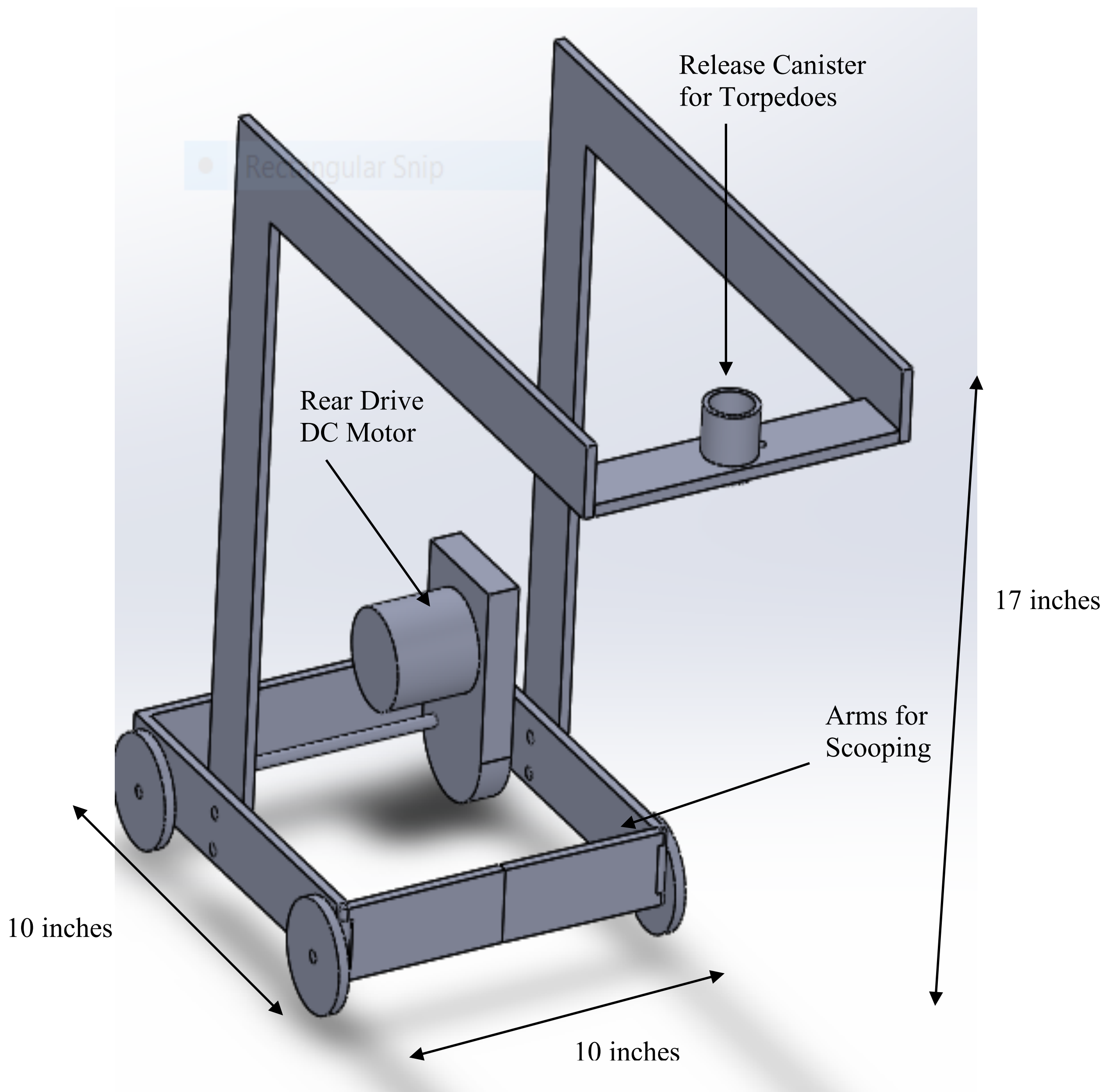
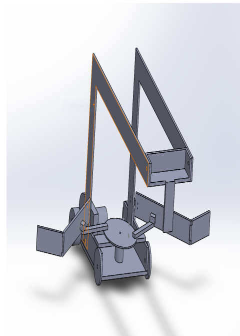
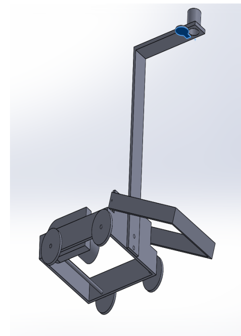
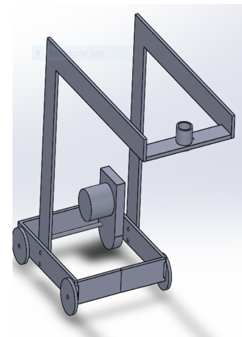


Figure 6: Alternative Design 2

Table 3: Concept Evaluation Matrix

Those should match the HoQ

0 Customer Requirements	Importance			
Detect and grab a bowling pin	9	3	3	3
Detect and retrieve foil tennis balls	9	6	4	2
Detect and retrieve the toy blocks	9	0	0	0
Detect and brush aside two sponges	9	8	0	2
Detect and deliver keychains to the Death Star	9	7	7	7
Safely back off of the team zone	9	8	8	8
Length is less than 2 feet	9	9	9	9
Less than 18 inches tall	9	9	9	9
Easy set up	7	6	6	6
Autonomously navigate	9	7	7	7
Cost effective	7	6	7	7
Aesthetically appealing	4	6	5	5
Efficient	9	8	5	6
Durable	5	7	8	8
width is less than 1 foot	9	8	8	8
No external power	7	9	9	9
Safe	7	7	7	7
Absoute Total		933	803	830
Relative Total		0.816	0.703	0.726

0	Unsatisfactory
1	Inadequate
2	Weak
3	Tolerable
4	Adequate
5	Satisfactory
6	Desent, Not Quite
7	Good
8	Very Good
9	Ideal

Center in cell