# Final Project: Design Evaluation

MCHE 201: Mechanical Design
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[redacted]
Department of Mechanical Engineering
University of Louisiana at Lafayette
Lafayette, LA 70504
[redacted]@louisiana.edu

[redacted]
Department of Mechanical Engineering
University of Louisiana at Lafayette
Lafayette, LA 70504
[redacted]@louisiana.edu

[redacted]
Department of Mechanical Engineering
University of Louisiana at Lafayette
Lafayette, LA 70504
[redacted]@louisiana.edu

# Abstract

The final project, known as the S ~~star~~ W wars competition, challenged the capabilities of each participating teams in designing and constructing a rover operating under strict parameters and specifications to complete set tasks. The tasks included having to find and collect small balls and a pin and transfer them to a set location, drop small 3 LED lights into a small moving roundabout hole in a rotating cylinder, ~~and~~ removing small sponges from the area, and obtain 4 blocks on the outer edge of the course while getting back to the starting area in the allotted time. Design tools ~~sheets~~ were used to appropriately evaluate the necessary solutions needed to solve these problems, such as a house of quality and specification sheet. Among the ~~solutions~~, durability and the functionality of the equipment were of the utmost importance, ~~both shown from the design tools~~. A function tree utilized the information found in the design tools and showed an outline on how the solutions worked and flowed together to design the device, assessing the challenges provided. Some of the most critical things found in the design tools mentioned are the removal of the sponges and dropping the LED lights into the cylindrical base at the center of the course to score points. The collection of the blocks on the perimeter was deemed not important enough and allowed for focus on the other course tasks.

Customer req.

The devices ~~performance with the chosen design aspects~~, while preforming adequately, did not meet the full expectations of the estimated parameters. The device won second place in the first round of performance and moved on to the next round, however lost in third place in the preceding rounds. Finally, the device disqualified at the end of the final round it performed in due to a mechanical malfunction that left one of the grabbing arms still shaking which the device had to stay still ~~as a rigid body~~ when completed. The device placed 17th overall with a judge's score of 6.11. Design tools could have been altered along with time management with a shift in focus on other aspects of the tasks which could have improved the devices score in the competition.

stay formal

awkward

# I. Introduction

For the final project, 31 teams design and create a device to contend in a competition based on the Star Wars franchise. Each device must operate under certain restrictions and be able to perform a variety of tasks on a pre-constructed square track while 3 other teams also participate in the competition simultaneously. The objectives on this track include moving a plastic pin, Lightsaber, from a determined point on the track into a “Jedi Training” zone located in front of the starting zone, moving tin-foil balls or force points from the track into the Jedi Training zone, moving sponges or TIE fighters from predetermined locations out of the team zone, moving plastic blocks or droids into the team zone from the edges of the zone, depositing three small LED lights or proton torpedoes into a raised circular area in the center of the track named the Death Star, and completely exiting the team zone within 30 seconds after the round begins. Geometric specifications restrict the device to be contained within a volume base of 12 inches by 24 inches and height of 18 inches, and must be a rigid body while not utilizing any awkward elastic potential energy before the round begins. The device must also be constructed from materials with a total value under $100 excluding any aesthetics or supplies given to each team, including a variety of motors, controlling boards, and other miscellany electronics.

Central challenges associated with designing a device which can operate under the contest rules and be able to score adequately in the competition include implementing a device which can perform the objectives with number ~~amount~~ of motors provided. The device, needing to complete a large set of tasks to score, needs to have a function for every sub task, which having a limited number of components hinders. The track itself being 4 feet in width alludes the device to need appendages that extend past the initial volume set for the device creating a geometric constraint for the final design, allowing the elimination of the TIE fighters. With each moving appendage, timing and or sensors judge when each of the design’s functions is to be utilized, so the effectiveness of the entirety of the device performance is dictated by the implementation of the sensors and coding. the next section good

stay formal

In ~~Section II~~, the final design of the device will be presented and broken down to show its functionality. Section III details the design tools and process used as evidence for the final devices final design chosen. Then, in Section IV, alternative designs are presented and the rationality of why the presented design was chosen is explained. Section V will discuss the performance of the device in the competition and how the design process affected this performance.

# II. Final Design

The final design was constructed in order to complete a majority of the tasks in the Star wars competition. When conceptualizing the design, it was determined that all the tasks were achievable, It however, the rescuing droids task would be the most difficult to compete with the size restrictions and provided motor power. Consequently, in order to design the most efficient device the “Save Droids” task was ignored. As seen in Figure 1, the device is controlled by a PyBoard and motor shield located on the central body towards the rear. The PyBoard is the brain of the device and controls all of its functions. In order to allow it to control the rover effectively, it is positioned as close to the motors as possible. It is also placed near the rear of the device in order to run the cables which connect the device to the track off its back end and prevent these cables from getting caught under the wheels or any of the moving parts near the face of the device. It is placed in close proximity to the motors to minimize the possibility of some moving part disrupting a wire and disconnecting that motor. A support beam extends normal to the top face of the body directly in front of the PyBoard and motor shield and and connects 90 degrees to an arm that is positioned towards the front of the device and extends out past the body. At the end of this arm is a box which contains the three proton torpedoes. A servo motor rests on the underside of the arm and is used to move the base of the box in order to drop the torpedoes into the designated area, to complete this task the drive motor is timed to brake so that the torpedo release system sits over edge, but the grabber does not collide into the Death Stars base. Once it is positioned, the release servo motor is activated, dropping the torpedoes into the Death Star's edge.  A power adapter is also placed near the PyBoard and motor shield and is used to power the device via an outlet. Shown in Figure 2, a large DC motor is mounted to the interior of the body and controls the front wheel axle by connecting gears. This motor is used due to its higher speed and torque allowing higher speeds and power, despite it being more difficult to accommodate in geometry. It is connected to the axle using a 1:1 ratio gearing to drive the front axle. While the front axle is being powered by this motor, the rear axle spins freely ~~as a dead axle~~. In front of the drive axle are two parallel servo motors which control the rotation of two arms whose function is to grasp the Lightsaber. These arms additionally have rods jutting vertically from their tops which are necessary in order to form a cage around Lightsaber and prevents it from tipping over while the device moves about the track. Grabbing the Lightsaber is the first objective the device completes once it begins moving, and the servos are timed to close the arms around the Lightsaber when the device is in range. The drive motor is also timed to brake when the device has positioned the Lightsaber in the Jedi Training zone to allow a stable departure of the lightsaber when the servo motors open over the zone. Holes are drilled in the top face of the body near the PyBoard in order to run wires from the DC motor and two servo motors mounted to the underside of the body up to the PyBoard. In figure 3, the remaining smaller DC motor is mounted vertically to the main arm and has two belts bound to its axle. These belts are connected to dead axles which sit vertically on wings that extend out past the wheels on opposing sides of the front of the body. Arms are mounted to these axles and can be rotated about the front corners of the body on as seen stretched out fully in figure 4. When the DC motor is activated the bands rotate the spools, which in turn rotates the arms around the two front corners of the device. These arms are cut short right before the rear wheels to allow them to freely open without pushing the TIE fighters out of the reach of the device, while still maintaining enough reach to sweep the TIE fighters backwards off the course.

Break into paragraphs

The code running device is setup to be as simple and modifiable as possible using micro python. It mainly consists of a while loop which runs as long as the track is activated. A counter is placed in this loop in the form of "n = n + 1" and the loop has a 10 milliseconds sleep timer at its end. Additionally, the time in seconds can be calculated from this n value and an "if-else" statement can be used to brake all motors and prevent the code from continuing to run if this time value exceeds 30 seconds. The counter can be used to precisely time when each function activates by using "an, if" statement (e.g. if n==100).

M — no space MicroPython

a Flow chart of this would help your reader

## III.    Problem Understanding

From the challenges and limits given, a range of view of all the customer requirements vary with the characteristics that can be measured. The House of Quality design tool does this by making a composite array of all the challenge requirements and correlates them with the characteristics that the device regards. As seen in Table 1, Critical areas from the design tool showed that the functionality of the code and the amount of points scored in competition relate the strongest to the challenges provided. Furthermore, transporting the LED lights, or torpedoes, along with maintaining a controlled power output are the critical areas of the requirements needed for the competition, where saving the droids is ranked the lowest in the requirements for obtaining points. ~~Observing this area of the design tool it is clear that control of the overall rovers functions are demanding.~~ By having exceeding control of the functions using a precise code and power output to the devices on the rover will allow a better capability to handle the challenges at hand. Another crucial area from the requirements is the rover must having a controlled rigid body, as also seen in table 1, so that the rover has no stored potential energy before the start of the course. This means that all the functionality must come from the pyboard and its connected devices only.

good

Applying the critical requirements to the design process another design tool, the specification sheet as seen in table 2, can compile all the demands and wants needed for the rover to operate in the competition. In the compilation the dimensions and the tasks show the most demands needed for the star wars competition, and most other specifications found in other areas are directly related to the point scoring tasks for the competition as well. From the specification sheet it is determined that the tasks given by the competition are of utmost crucial importance to the design process such as destroying the death star and removing the TIE fighters. To reinforce this idea, the function tree, seen in figure 5, shows the allotted specifications and breaks them down making a clear cut planning tool that shows what needs to be completed and what stage it needs to be completed at. From this design tool a clear function is shown from the relations as the main competition goal of achieving the maximum amount of points is broken down into each task from the specification sheet, which the competition requires, and allows the rover to be most efficient. Form these small sub functions, allowing the device to move forward and back, and the sweeping arms to engage are the main and first focuses.

why?

Just present as fact: "They are" instead of "we determined"

Does a spec sheet outline tasks?

## IV. Concept Evaluation

~~Alternative designs were formulated from the house of quality as well as the final design. These designs were ultimately evaluated against one another, allowing a clear look at each one.~~ One of the alternative designs, as seen in Figure 6, utilizes a similar sweeping arm as the main design, though adds small appendages on the arms to form a kind of box when closed. This allows the pieces picked up to be contained within a controlled bounds. The design also contains a spatula to grab the pin in an easy manner and theoretically place it back upright when needed by wedging under it like a dolly. Finally the linear actuator is utilized as a launch mechanism for the torpedoes, throwing the torpedoes into the hole from a distance, overall still using the same drive function as the initial device.

avoid this style... Introduce all independently

The second design known as the drop box design, as seen in Figure 7, negates the sweeping arms by employing a box arm that will create a barrier to collect all of the board's pieces and drag them back into the starting zone. The design also requires more force to drive the rover, so both axles are driven by motors with no dead wheels. Finally a linear actuator is mounted on front to extend the LED lights, or torpedoes, into the Death Star as an arm.

Each of the designs, including the final design, are utilized in the evaluation matrix, as seen in table 3, which compare the customer requirements to the three designs discussed. Design A in the matrix, being the final design, scored significantly higher than the other two designs when compared to the other alternative designs. Reasons the other designs failed was due to

refer to them by their names

them not being able to dependably complete the tasks given. ~~The first alternative design, Design B~~, the boxed sweeping arm design could not produce enough force to throw the torpedoes at all. The small barriers on the arms were too difficult and time consuming to match up and created an awkward geometry when closed. ~~Design C~~, the drop box design, evaluated a bit better but was also not dependable. The pin had too high of a chance to fall out of the contained box, and the axles were too difficult to be driven by two separate motors. Finally both alternative designs did not meet expectations in retrieving the droids as neither one of them would have the needed reach.

## V. Design Performance Evaluation

In the final competition, the device performed well, but not to the quality expected of it. In the first round, the device placed in second. Then, in the second round, the device failed to accumulate enough points and was dropped down to the loser's bracket placing only in third. In the third round, the device received an amount of points to win the round, but a critical error occurred in one of the grabber servo motors. During that round, the servomotor became faulty and started twitching after the round time ended. This twitching caused the device to be disqualified from the round and drop from the loser's bracket. Overall the device ranked 17th in the end, with receiving a judges score of 6.11, with the highest attribute being the devices presentation before the competition.

Assumptions were made during the design process with some of them being correct and others being faulty to the overall design process and build. The utmost incorrect assumption made was that the droids task was a waste of resources. As an indicator of how misleading this assumption was, every device in the final round had a system for collecting the droids. The House of Quality in Table 1 does list the reach of the device as one of the most important characteristics, however, the Specification Sheet, in Table 2, only specifies an expanded width of 24 inches which was not enough to reach the outer spaces on the board to acclimate the droids. It was assumed having an expanded reach any longer would be unnecessarily difficult to design around and the specified width would be adequate to complete the remaining tasks. Another design idea had an original intention of the device to drop a net over the Death Star exhaust port in order to prevent other teams from scoring points there. This design idea was dropped due to the assumption that most teams will not try to precisely drop their torpedoes in the port due to the difficulty of the task. This assumption proved to be correct; out the three rounds the device competed in, no other team scored points from the exhaust port. The poles placed on the grabber arms were installed under the assumption they would help the grabbing arms better secure the Lightsaber. During the competition, the poles did help the device grasp the Lightsaber when the arms were able to close around it, but other problems arose in this area. Initial positioning of the device proved to be critical when attempting the Lightsaber task. If the arms were not aligned with the Lightsaber correctly, it would not properly be secured by the poles and be knocked over instead and, if the device was positioned too far back the arms would close too soon. A device designed based on what was learned from these assumptions would have a couple of changes made. First, the sweeping arms would be longer and would have to be stationed at the back of the device. Elongating the arms where they currently are positioned would make it impossible for them to be rotated out without pushing the TIE fighters further into the team zone. Second, these arms would have to form a box to contain the objectives in. lastly, a device that relied more on sensors rather than timing to perform each task would in itself be more reliable. Having a device that utilized these sensors wouldn't have to depend entirely on its initial position, but rather on

awkward

very good

why not use some sensing to be more robust to this?

avoid contractions

its functionality. This would allow the device to obtain the points and be able to have an overall better performance. It can be expected that a device designed with these changes would also be more reliable and much better in the competition.

## VI. Conclusion

Overall, out of the 31 teams participating, the device ranked 17th with a judges score of 6.11, which did not meet the full expectations of the design given. While the device did out score the other two alternative designs, the process of the design should have been altered to accommodate the entirety of the challenges presented by the competition. Saving the droids should have been more of a priority than was conceived, while the mechanisms should have utilized more than just simple timing. Minor changes in the house of quality and specification sheet would have greatly improved the performance, though the device itself could have had better installments. The servo motor twitching disqualified the device from the last round it competed in, and the grabbing mechanism wasn't fulfilling its task. Though the design had many areas where improvement was critical, there were areas the device performed adequately. The dropping mechanism and timing did allow the device to move up through the rankings enough past 32 percent of the rest of the competition. ~~The design process though did prove as a good learning experience to locate the proper requirements and characteristics acquainted with a specific situation and set of challenges.~~

stay formal

Good, but not appropriate for this report.

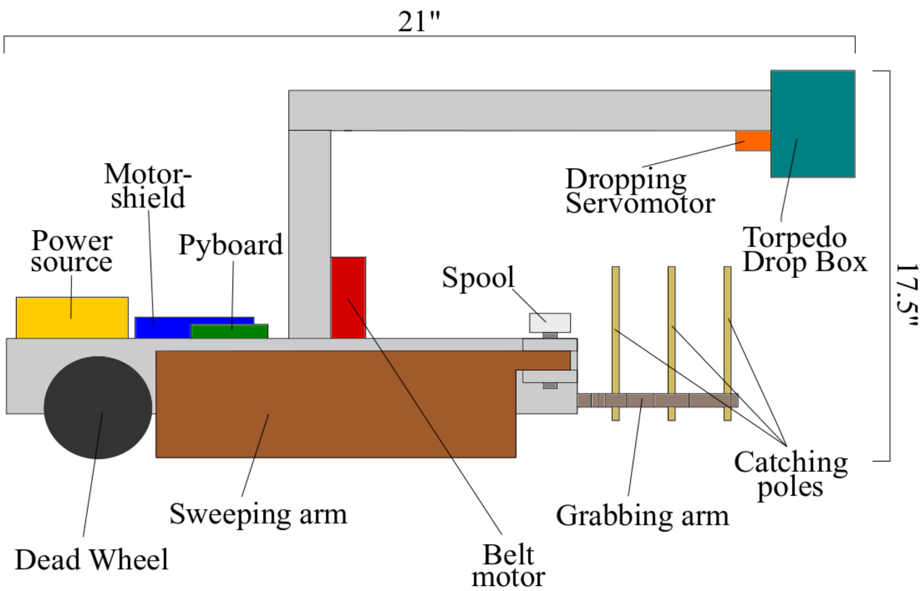



Figure 1: Side view and arm

Good

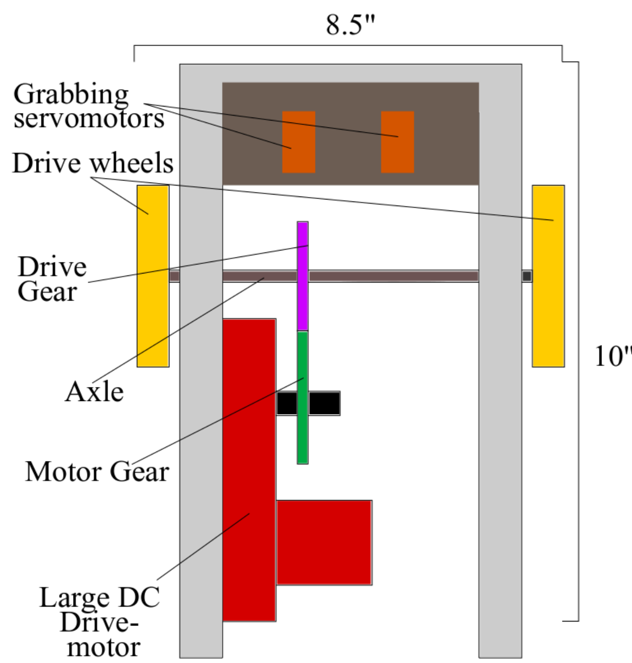



Figure 2: Bottom view of drive system

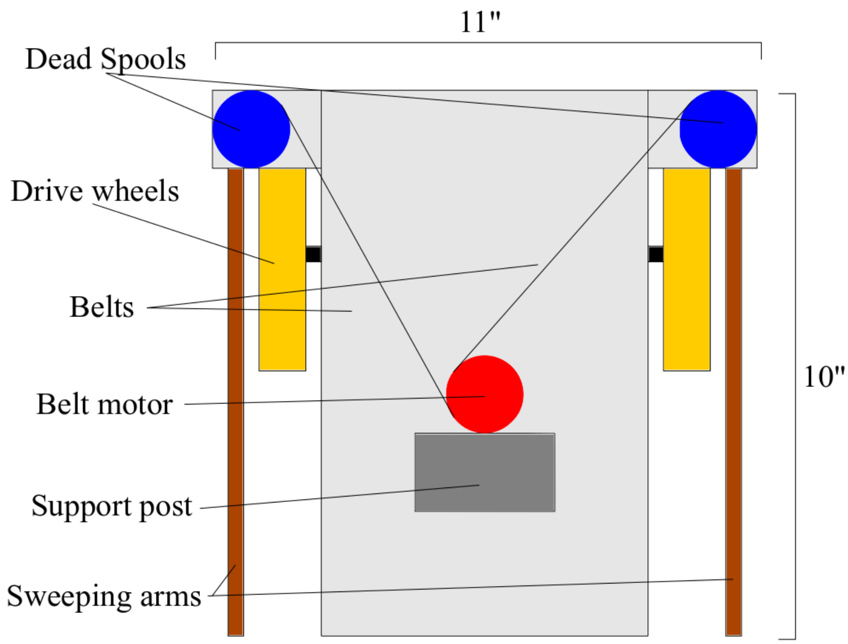



Figure 3: Top view of belt system

Good

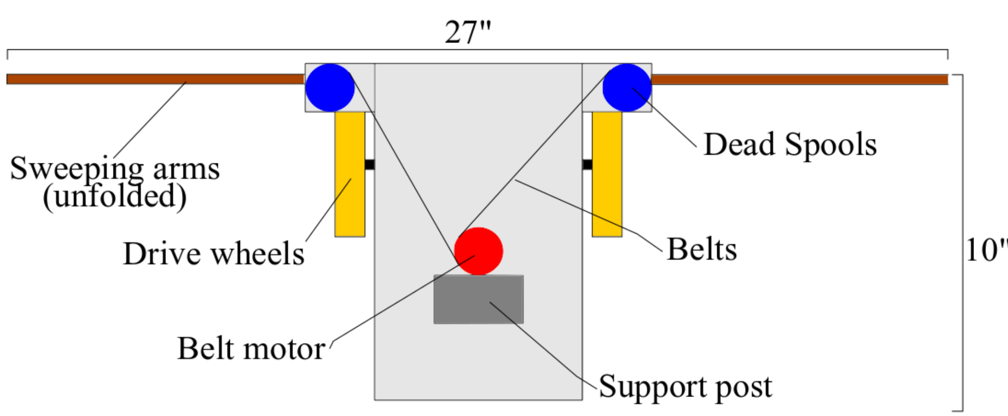
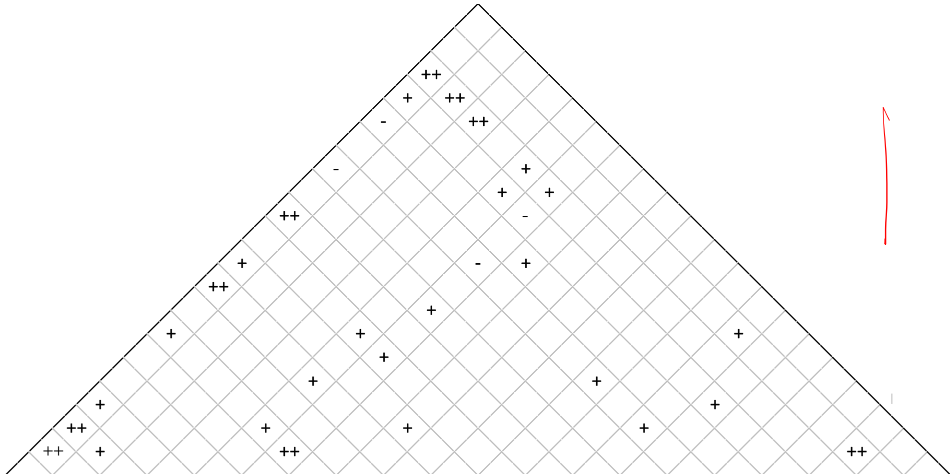



Figure 4: Fully extended arms

Respect page margins... match document style

# Table 1: House of Quality



E'n

| Importance | Customer Requirements | Total height of device | Total length of device | Total width of device | Total weight of device | Total cost | Strength of structural material | Reach of the device | Amount of possible points scored (Number) | Durability of structural materials | Speed of device systems (measured how?) | Number of systems the code can operate at once | Lines of code needed to complete a task | Device set-up time | Average max speed of device | Time to complete all tasks | Distance device can travel | Efficiency of the motors (measured how?) | Amount of material needed to construct device | Time needed to construct device | Sta ges of code indicated by LED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Direction of Improvement | ▼ | ▼ | ▼ | ▼ | ▼ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▼ | ▼ | ▲ | ▼ | ▲ | ▲ | x | ▼ | x |
| 10 | Length less 24 inches | | ◉ | | | △ | ▣ | ▣ | | △ | | | | △ | | | | | ▣ | △ | |
| 10 | Width less than 12 inches | | | ◉ | | △ | ▣ | ▣ | | △ | | | | △ | | | | | ▣ | △ | |
| 10 | Height Less than 18 inches | ◉ | | | | △ | ▣ | | | △ | | | | △ | | | | | ▣ | △ | |
| 8 | Functioning Start Switch | | | | | | | | | | | | ▣ | | | | | | | | |
| 10 | Operate Autonmously | | | | | | | | | | △ | ▣ | ◉ | | | ▣ | △ | | | | △ |
| 4 | Light Weight | ▣ | ▣ | ▣ | ◉ | ◉ | ▣ | | | ◉ | | | | ▣ | ▣ | △ | ▣ | | ◉ | △ | |
| 5 | Design with Durable materials | ▣ | ▣ | ▣ | ◉ | ◉ | ◉ | | | ◉ | | | | | | | | | ▣ | | |
| 6 | Collect all droids | | △ | △ | | | △ | ◉ | ◉ | | ▣ | △ | △ | | | △ | △ | | | | △ |
| 7 | Collect Lightsaber, move to training zone | | △ | △ | | | △ | | ◉ | | ▣ | △ | △ | | | △ | △ | | | | △ |
| 7 | Deliver all force points to training zone | | △ | △ | | | △ | ◉ | ◉ | | ▣ | △ | △ | | | △ | △ | | | | △ |
| 4 | System code is provably autonomous | | | | | | | | | | ▣ | ▣ | ◉ | | | △ | | | | △ | △ |
| 7 | Remove all TIE fighters | | △ | △ | | | △ | ◉ | ◉ | | ▣ | △ | △ | | | △ | △ | | | | △ |
| 3 | LED which indicates what stage code is in | | | | | | | | | | | | | | | | | | | | ◉ |
| 4 | Maintains a controllable speed (Meaning?) | △ | △ | △ | ◉ | ▣ | △ | | ▣ | ▣ | ◉ | | | | ◉ | ◉ | ▣ | ▣ | | ▣ | |

Table 1 (cont.): House of quality

| | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9 | Price does not exceed $100 | △ | △ | △ | ▣ | ◉ | ▣ | | | ◉ | | | | | | | | | ◉ | | |
| 2 | Frame is easily controlled | ▣ | ▣ | ▣ | ◉ | | ▣ | ◉ | ▣ | | ◉ | △ | ◉ | | ▣ | △ | | △ | | ▣ | |
| 2 | Easy maintainence Meaning? | ◉ | ◉ | ◉ | ◉ | | | | | △ | | | | ◉ | | | | | | ◉ | △ |
| 9 | Transport proton torpedoes to Death Star | ◉ | | | | | | ◉ | ◉ | | ▣ | | △ | | | △ | △ | | | | △ |
| 6 | Locate objectives | | | | | | | ▣ | ▣ | | ▣ | | | | | △ | | | | | |
| 8 | Move back to starting zone | | △ | △ | ▣ | | | | ◉ | | ▣ | | | | ▣ | ▣ | ▣ | △ | | | △ |
| 8 | Run within alotted time | | | | | | | | | | ◉ | ◉ | △ | | ◉ | ◉ | | ▣ | | | |
| 9 | Device does not harm spectators | | | | △ | ▣ | | | | ▣ | | | | | | | | | | | |
| 10 | Device can be set up within 4 minutes | ▣ | ▣ | ▣ | | | | | | | | | | ◉ | | | | | | | |
| 10 | Device can be removed within 2.5 minutes | ▣ | ▣ | ▣ | | | | | | | | | | ◉ | | | | | | | |
| 9 | Device contains no elastic potential energy | | | | | | ▣ | | | ▣ | | | | | | | | △ | | △ | |
| 10 | Device remains steady-state after round ends | | | | ▣ | | | | | | | | | | | | | | | | |
| 2 | Device is aesthetically pleasing | ◉ | ◉ | ◉ | | ▣ | △ | | | | | | | | | | | | | | |
| | **Absolute Importance** | 313 | 267 | 267 | 243 | 237 | 240 | 357 | 432 | 260 | 298 | 143 | 212 | 240 | 150 | 214 | 94 | 55 | 222 | 83 | 87 |
| | **Relative Importance** | 7% | 6% | 6% | 6% | 5% | 5% | 8% | 10% | 6% | 7% | 3% | 5% | 5% | 3% | 5% | 2% | 1% | 5% | 2% | 2% |

Why so blurry?

Table 2: Specification sheet

| | | Specification for: Star Wars Concept Design | Issued: | 10/23/2017 |
|---|---|---|---|---|
| | | | Page 1 of 2 | |
| **Changes** | **D/W** | **Requirements** | **Responsibility** | **Source** |
| | | MCHE 201 students will design and build devices that will Learn to Use the Force, Learn to Use a Lightsaber, Save Droids, Destroy TIE Fighters, Destroy the Death Star, and Safely Escape the Death Star Explosion. | | |
| | | **Dimensions** | | |
| | D | Height <18" | Design Team | Contest Rules |
| | D | Width < 24" | Design Team | Contest Rules |
| | D | Length <12" | Design Team | Contest Rules |
| | W | Height 17" | Design Team | Design Team |
| | W | Width 24" | Design Team | Design Team |
| | W | Length <10" | Design Team | Design Team |
| | W | Device has expanded width of at least 24" | Design Team | Design Team |
| | | **Forces** | | |
| | W | Device weighs less than 20 lbs | Design Team | Design Team |
| | W | Device can withstand 50 N of force | Design Team | Design Team |
| | | **Kinematics** | | |
| | W | Speed less than 1 m/s | Design Team | Design Team |
| | D | Moves forward total distance of 23" | Design Team | Contest Rules |
| | D | Return to starting point within 30 seconds | Design Team | Contest Rules |
| | | **Operations** | | |
| | W | Operates with no user imput | Design Team | Contest Rules |
| | D | 1 Activation switch | Design Team | Design Team |
| | D | Power by DC motor | Design Team | Contest Rules |
| | D | Operates in 30 seconds or less | Design Team | Contest Rules |
| | W | Device systems take less than 8 seconds to operate | Design Team | Design Team |
| | D | Code can operate at least 3 systems at once | Design Team | Design Team |
| | W | No more than 5 lines of code per operation | Design Team | Design Team |
| | D | Device takes less than 4 minutes to set up | Design Team | Contest Rules |
| | D | Device takes less than 2.5 minutes to pack up | Design Team | Contest Rules |

Table 2 (cont.): Specification sheet

| | | Specification for: Star Wars Concept Design | Issued: | 10/23/2017 |
|---|---|---|---|---|
| | | | Page 2 of 2 | |
| Changes | D/W | Requirements | Responsibility | Source |
| | | MCHE 201 students will design and build devices that will Learn to Use the Force, Learn to Use a Lightsaber, Save Droids, Destroy TIE Fighters, Destroy the Death Star, and Safely Escape the Death Star Explosion. | | |
| | | **Task** | | |
| | W | Deliver 3 proton torpedoes to destroy Death Star | Design Team | Contest Rules |
| | W | Remove 2 TIE fighters from zone | Design Team | Contest Rules |
| | W | Collect 4 Droids in Zone | Design Team | Contest Rules |
| | W | Collect 5 Force points and place in the training zone | Design Team | Contest Rules |
| | W | Collect 1 Lightsaber and place in Training zone | Design Team | Contest Rules |
| | D | Device can score at least 30 points | Design Team | Design Team |
| | | **Materials** | | |
| | D | Use 3 servo motors or less | Design Team | Contest Rules |
| | D | Use 2 DC motors | Design Team | Contest Rules |
| | D | Uses 1 Pyboard | Design Team | Contest Rules |
| | D | Materials cost less than 100$ | Design Team | Contest Rules |
| | W | Device can be constructed within 5 days | Design Team | Design Team |
| | | **Signals** | | |
| | W | 1 LED indicates if device on and off | Design Team | Design Team |
| | W | 1 LED per stage to distinguish which stage the code is running | Design Team | Design Team |
| | | **Safety** | | |
| | W | Does not harm 3 of the other devices on track | Design Team | Design Team |
| | W | No parts flung past 3 feet surrounding track | Design Team | Design Team |

**Why so blurry?**

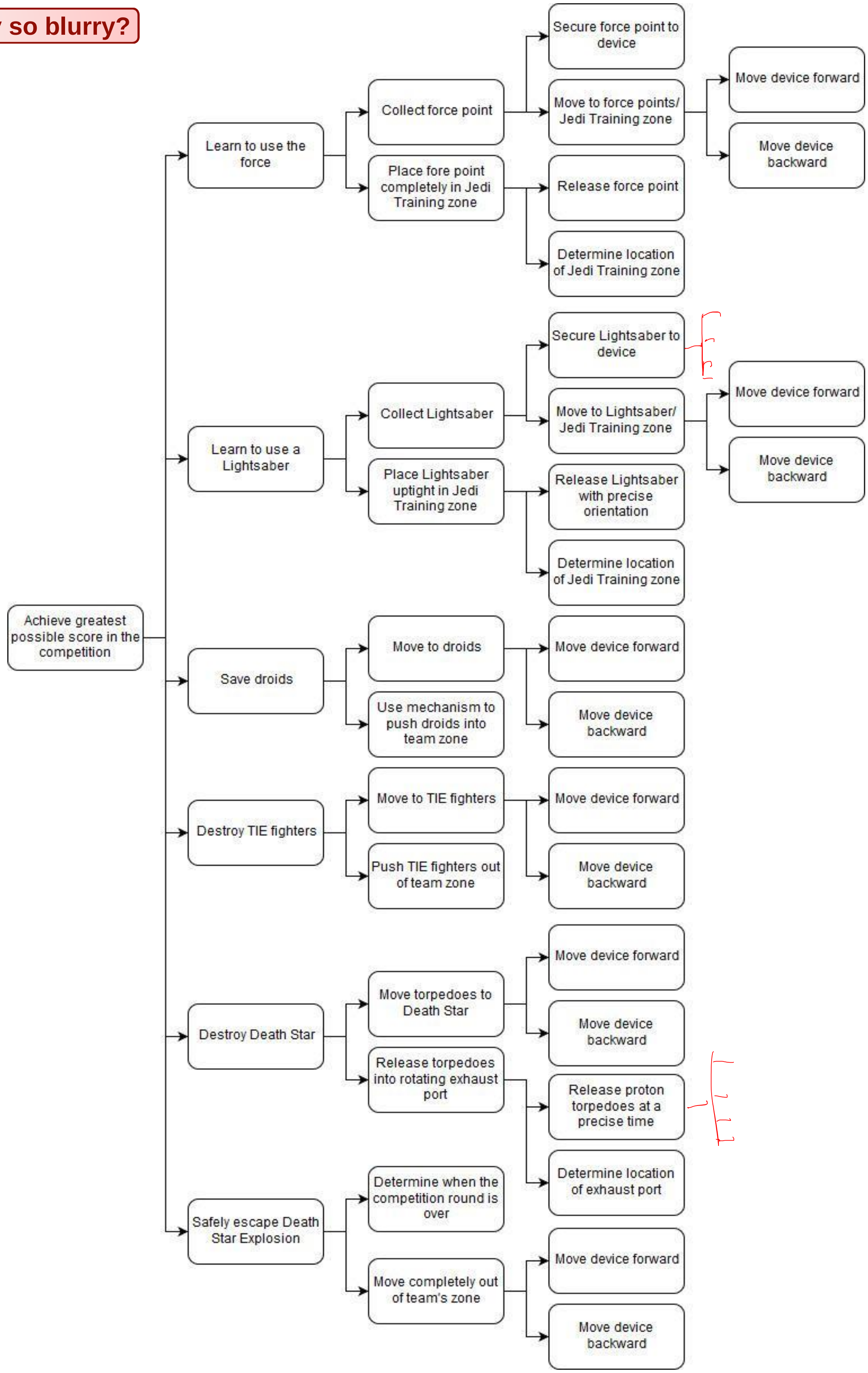
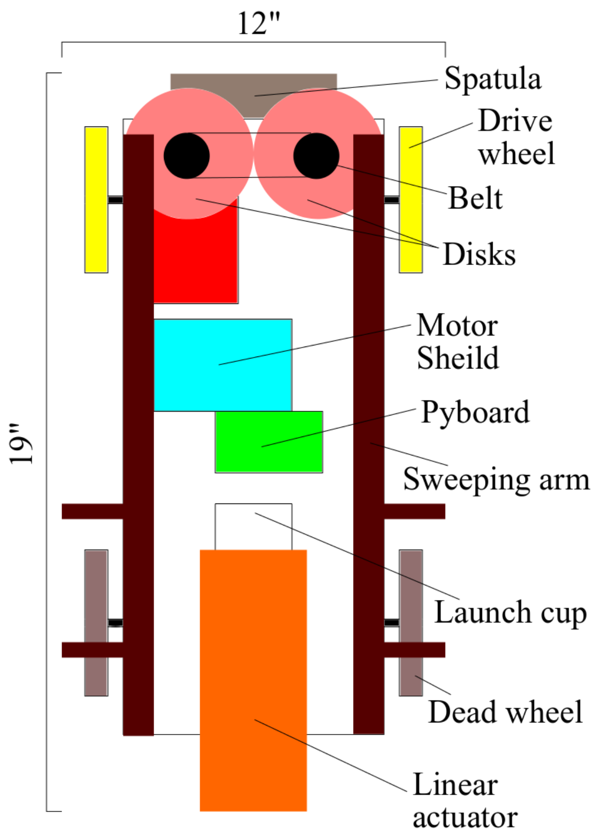



Figure 5: Function tree




no code needed

Figure 6: Alternate design A, boxed sweeping arm

These colors are a bit loud.

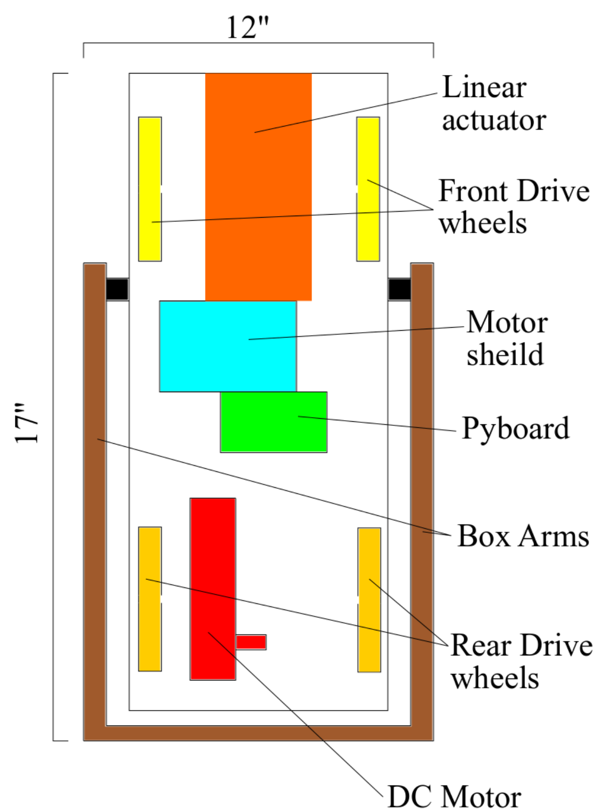



Figure 7: Alternate design B, drop box

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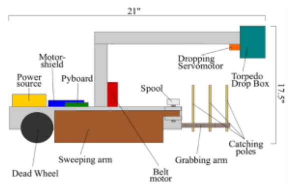
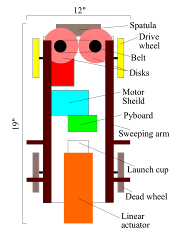
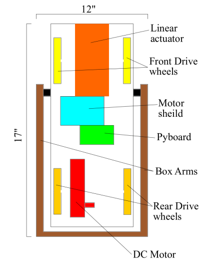
Table 3: Evaluation matrix




| Importanace | Customer Requirements | Final Design | Boxed Sweeping Arm Design | Drop Box Design |
|---|---|---|---|---|
| 10 | Length less 24 inches | 9 | 9 | 10 |
| 10 | Width less than 12 inches | 9 | 5 | 5 |
| 10 | Height Less than 18 inches | 9 | 9 | 9 |
| 8 | Functioning start switch | 10 | 10 | 10 |
| 10 | Operate autonmously | 10 | 10 | 10 |
| 4 | Light weight | 8 | 6 | 6 |
| 5 | Design with durable materials | 7 | 7 | 7 |
| 6 | Collect all droids | 1 | 1 | 1 |
| 7 | Collect Lightsaber, move to training zone | 8 | 6 | 1 |
| 7 | Deliver all force points to training zone | 8 | 7 | 10 |
| 4 | System code is provably autonomous | 10 | 10 | 10 |
| 7 | Remove all TIE fighters | 10 | 10 | 10 |
| 3 | LED which indicates what stage code is in | 10 | 10 | 10 |
| 4 | Maintains a controllable speed | 9 | 9 | 9 |
| 9 | Price does not exceed $100 | 9 | 9 | 9 |
| 2 | Frame is easily controlled | 9 | 9 | 6 |
| 2 | Device is easily repaired | 9 | 8 | 8 |
| 9 | Transport proton torpedoes to Death Star | 8 | 7 | 6 |
| 6 | Locate objectives | 7 | 7 | 7 |
| 8 | Move back to starting zone | 10 | 10 | 10 |
| 8 | Run withing alotted time | 10 | 10 | 10 |
| 9 | Device does not harm spectators | 9 | 9 | 9 |
| 10 | Device can be set up within 4 minutes | 9 | 8 | 9 |
| 10 | Device can be removed within 2.5 minutes | 9 | 8 | 9 |
| 9 | Device contains no elastic potential energy | 10 | 10 | 10 |
| 10 | Device remains steady-state after round ends | 7 | 5 | 8 |
| 2 | Device is aesthetically pleasing | 6 | 6 | 4 |
| | **Total** | 1635 | 1515 | 1542 |
| | **Relative Total = Total/Number of Criteria** | 40% | 37% | 38% |