Project Deliverable F: **Prototype I and Customer Feedback**
GNG 1103 – Engineering Design
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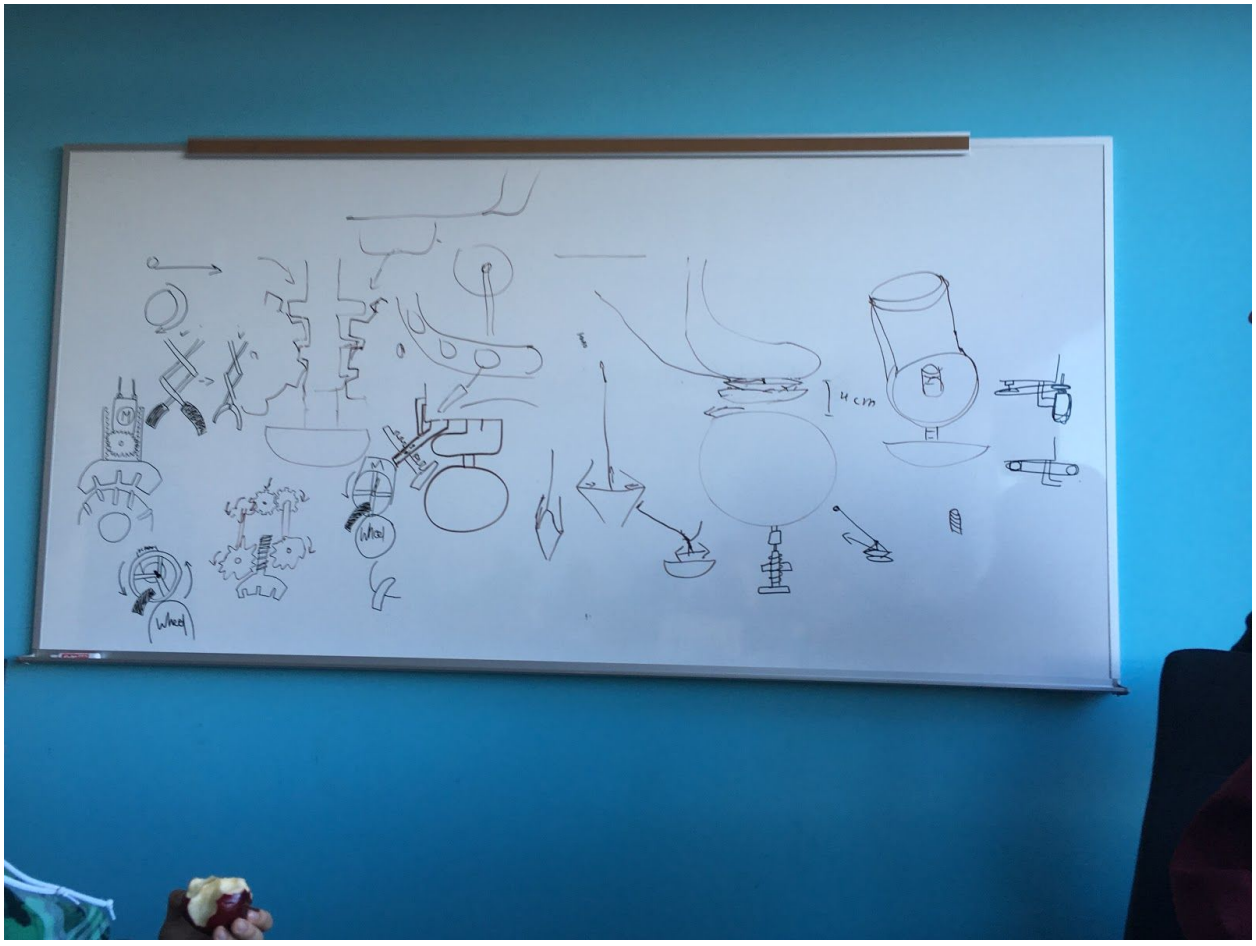
Why are we doing this test?

Our ideation process was a long and changing phase in the lifetime of the project. To create a system that applies force on the wheels in a way that creates enough friction to slow the robot down, many diverse ideas came up. Most of them involved mechanical parts with different convoluted systems. That process was recorded and can be seen in the image below.



The above ideas had many problems that were associated with them. Most of those problems were related to the placement on the robot, and the feasibility of the proposed systems. With those dilemmas in mind, a brand

new design was formulated. Instead of using a mechanical system, based on a motor, a purely electrical system could be used. This system involves a solenoid that would be used to apply enough force on the wheel to slow down Bowie in the desired way. This system will be more reliable, and be much easier to equip to Bowie due to the smaller size of the solenoid in comparison to most mechanical systems ideated. However, there are a few potential problems with this solution that could only be verified through thorough testing. The amount of force that can be applied through a given amount of voltage is an important aspect to observe. Since there are only 5 available volts for the entire system, it is important to verify that the given voltage will be sufficient to brake Bowie's wheels in the required time. Similarity, the structural integrity of the system under a perpendicular force also has to be analyzed. The general objective of the first prototype is to give insight into those potential problems by testing a system with the same general properties as the solenoid system planned, against a wheel moving at speeds similar to that of Bowie's wheels. Higher speeds can also be tested to give some space for error, and make the system usable for possible future variations of Bowie. Additionally, that prototype can be use to get the required feedback from Erin, to find the best way, if any, to place the system on Bowie.

Test Objectives Description

What are the **specific** test objectives?
-ability to stop wheels
-decision of what is needed for most efficient prototype

What **exactly** is being learned or communicated with the prototype?
-strength of solenoid relative to a general turning wheel of Bowie
-A proof of concept
-improvements to be made to the design
-mechanism

What are the possible types of result?
If our prototype goes as planned hopefully it will stop the wheel effectively. Another outcome is failure, our prototype could easily malfunction and break or not produce enough force to stop the wheel.

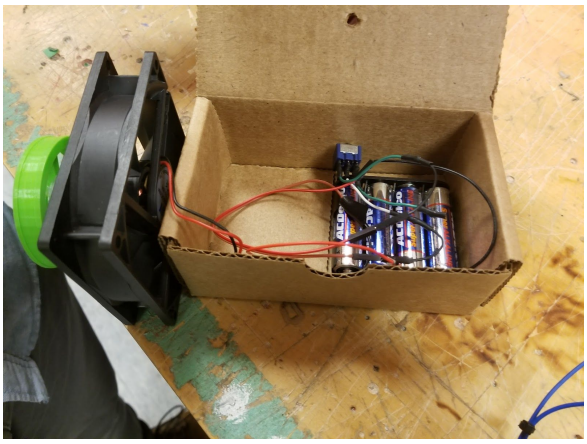
How will these results be used to make decisions or select concepts?
With these results in mind we will be more cautious with our materials, use the most efficient method, and we will prepare for the worst. Our concept can easily change, we will use our scientific and mathematical knowledge to make our decisions and select our concepts.

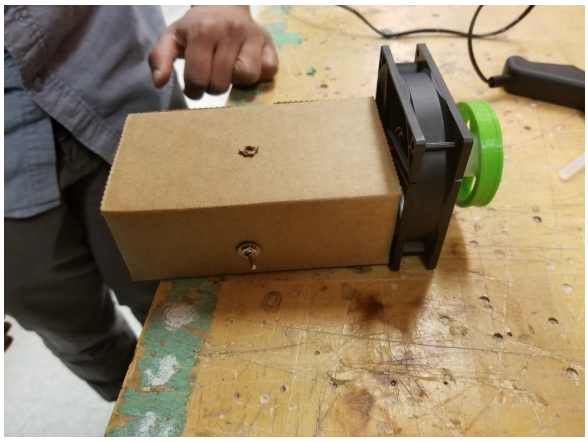
What are the criteria for test success or failure?
The main criteria for the test of success or failure is if the solenoid mechanism will be able to produce enough force to stop the test wheel.

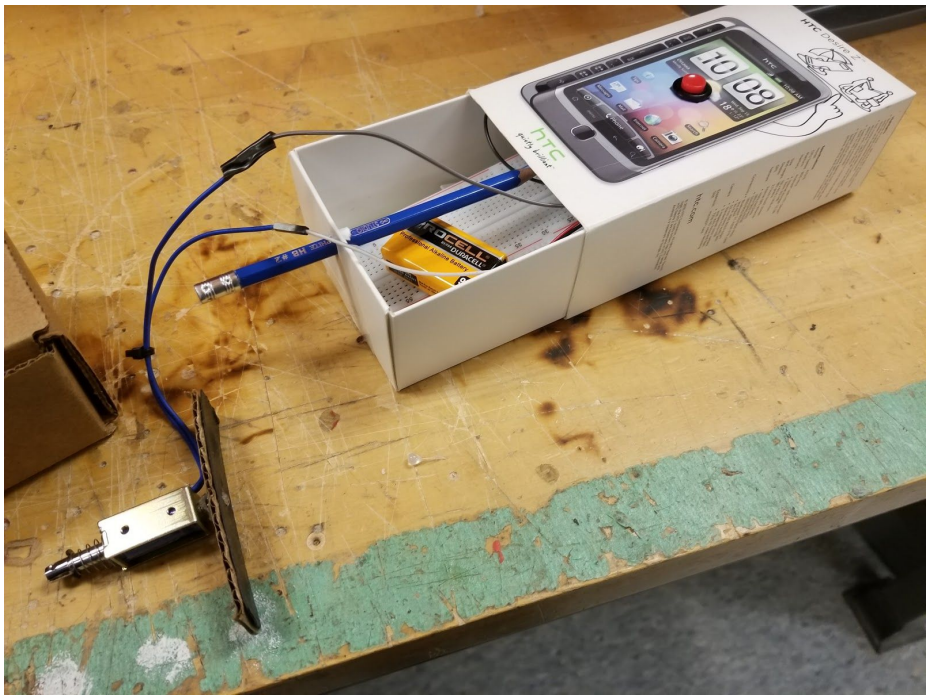
What is going on and how is it being done?

Describe the prototype **type** (e.g. focused or comprehensive) and the reason for the selection of this type of prototype.

This prototype was based off our previous brainstorming session. We came up with a list of ideas, grouped them together, then eliminated and combined certain ones to come up with the result of a rubber pad lowering onto the wheel. Essentially this idea was the most reasonable and efficient. By researching the best mechanisms in which would lower a pad onto the wheel, while producing enough force, we came across a solenoid. To make this prototype as realistic as possible we created a functioning wheel and braking system. With our original idea to make the user able to fully understand our idea the following result was produced.



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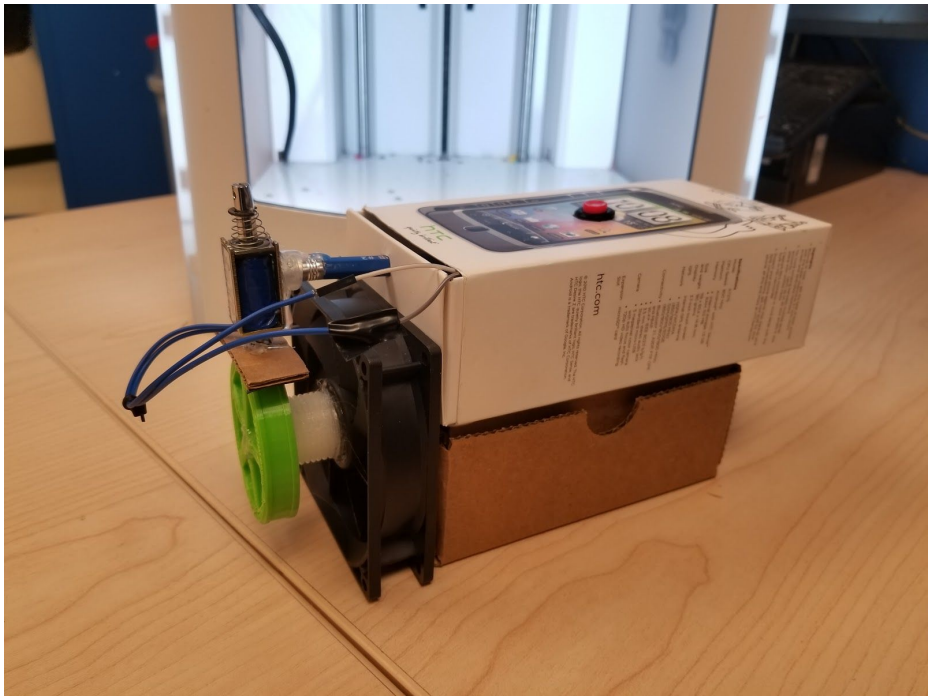


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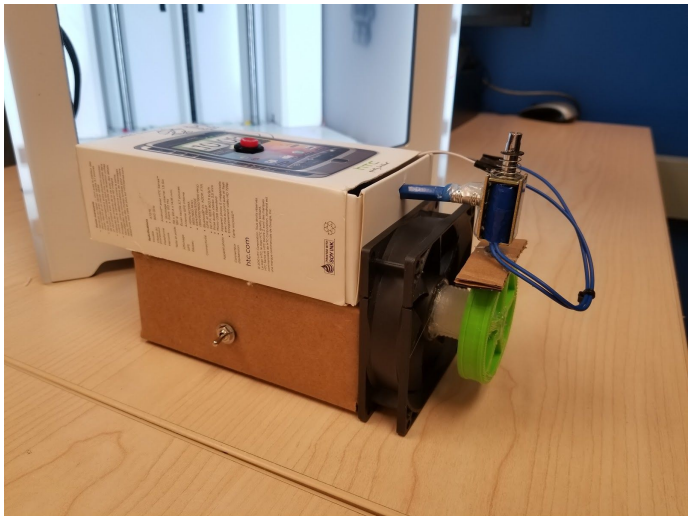

Describe the testing process in enough detail to allow someone else to build and test the prototype instead of you.

Our prototype was thought of through a long design thinking process. We started by figuring out how the solenoid functioned and what batteries produced enough forced. We came to the conclusion of using 4 AA batteries all connected using a battery holder. Next, we bought a breadboard in order to to connect the batteries to the solenoid without holding it. With the inconvenience of it constantly getting power the solenoid was locked into position, to solve this problem we found a button which we could use to choose when we wanted the solenoid to activate then stop a wheel on command. With nothing being able to create friction between the wheel and the solenoid we had to create a pad. The pad was created from a small rectangular piece of cardboard, similar to the diameter of the wheel, and a strip of rubber glued to one side of the cardboard. Furthermore, the end of the solenoid which stuck out when given power was hot glued to the center of the rectangular piece of cardboard. Still being difficult to conceptualize our idea we created a functioning wheel which would represent Bowie The Robots wheel. For this we found a functioning fan which we were able to connect to the breadboard, and use to rotate a wheel. To create the wheel we found a pre-3D printed wheel, which was unfortunately not very similar to Bowie The Robots, then we used a hot glue gun to connect it to a 3D printed cylinder, which would represent an axle. With the wheel connected to the axle we could finally connect it to the fan using more hot glue. We encountered the problem of the fan constantly being on so we had to find a switch in which we connected in-between the breadboard and the fan so we could choose when we wanted the fan to be on. Once every subsystem was functioning we wanted it to be contained and cleaner. We proceeded by finding two cardboard boxes which were small enough to be portable and big enough to fit the breadboard without movement. In one box we placed the

breadboard and the connecting wires and hot glued the fan, with the wheel, to the outside without any restricting movement. We made a hole on the side so we were able to access the switch without opening the box. In the second box we put two holes in it, one for a solid rod which would horizontally stick out the front of the box, same side as the wheel, and the other on the top of the box for the button. Finally, by gluing the first box on top of the second the only part left to attach was the solenoid with the pad. Therefore, using a rod which we secured inside the second box then poking it out of the hole. We connected the solenoid onto the end of the rod so it is facing down with the rubber pad a few centimeters away from the top of the wheel.

What information is being **measured**?

During our testing of prototype 1 we measured the time required to stop the wheel using the Solenoid with a rubber pad attached to the end. By pressing the button which activated the solenoid it took a maximum time of one second to completely stop the rotation of the wheel.

What is being observed and how is it being **recorded**?

Our progress throughout the development of prototype 1 is being observed with pictures and notes. We had to modify specific parts of the prototype by problem solving the obstacles we encountered. Finding the most efficient source of glue to attach different parts of our prototype. Making the prototype as clean and reliable as possible.

What materials are required and what is the approximate estimated cost?

Materials	**Cost $**
Rubber tape	4.32 + tax
Cardboard boxes	Free (From CBY)
Solenoid	Free (From CBY)
Breadboard	4.00
Electrical Wires	Free (From CBY)
4 AA batteries	Free (From CBY)
Battery holder	Free (From CBY)
Button	Free (From CBY)
Switch	Free (From CBY)
Fan	Free (From CBY)
3D printed wheel and cylinder	Free (From CBY)

What work (e.g. test software or construction or modeling work or research) needs to be done?

We had to research the best type of solenoid which would produce enough force to stop the wheel of Bowie The Robot. Plus a suitable rubber which would provide enough friction to stop the wheel. We had to model a foundation using the breadboard and connecting wires to the required subsystems. After we had the system working for prototype 1 we could construct the containers to hold the created circuit which powered the required subsystems. Using hot glue we finished prototype 1 in the designated time.

When is it happening?

How long will the test take and what are the **dependencies** (i.e. what needs to happen before the testing can occur)?

We set the time frame to complete prototype 1 for our lab section on February 27th. Before the testing can occur the we must gather all the materials and create an outline of our plan. We depend on an efficient and effective team in order to finish our prototype in the set timeframe. Before official testing can occur we need to contact the user and get feedback on our idea so far. From there we can create a more advanced prototype which hopefully we will be able to test on a replica of Bowie The Robots wheel.

A separate test planning Gantt chart can be created to help making sure that the testing fits with the overall project schedule or it can be defined as part of that schedule (i.e. as a sub-task).

Since we created a fairly reasonable Gantt chart to follow it has made it easy to stay on schedule so far. Therefore, to this point the testing fits with the overall project schedule.

When are the results required (i.e. what depends on the results of this test in the project plan)?

For prototype 1 our results are required to be completed by March 3rd, according to our project plan. In order to meet this requirement we scheduled to find all the compulsory materials to create a visual representation of our idea. Furthermore, we had to make an outline of prototype 1 so we had a general plan we could follow, from there we used the time given to use during our lab to create the first prototype of our braking system.