Introduction

The objective of the assignment is to develop the first prototype using the feedback we have received from client meeting 2. The first prototype will be tested and documented using components from our bill of materials and detailed images to make sure the prototype achieves the objectives we created in the prototype 1 test plan. Finally, a prototype test plan for prototype 2 will be created to gain a better understand of the materials we need and the objective of the prototype.

Review of last client meeting

Overall, the client was satisfied with our concept for our final solutions and agreed with our main subsystems. There were some improvements they suggested for some of our concepts and ideas that we will investigate further to come up with solutions for. They thought our height was too small, which it was, and we discussed height limits with them, our original height was small because we were unsure of how high or low our device should be. Now we have a better idea of how high our final concept will be from our detailed design concept which we created after the meeting. There were also concerns from the client that our device would get stuck in a board if somebody pulled the power to the machine or if the power out, and suggested we include some sort of home system which brings the drill head back to a "home" position. We did not think of this situation at first but now we know that that is a concern of the client, and we will try and accommodate that new need. In our concept we were uncertain how we will stack the boards at the end, we asked the client about different ideas we had, and we decided after some feedback that stacking them at the end is the best idea. At first, we also didn't have anything to clean the sides of the board, but in further design choices we will find a way to clean them because otherwise our device doesn't meet our most important functional need of cleaning the board. The client thought our idea for a moving drill head and spinning wheel automation system wasn't bad so we will continue with that idea and try to further prove how it will work in more prototypes, such as prototype 1 will try and reduce the uncertainty of how our automation system will push the boards through our entire cleaning device.

Prototype 1 Test Plan and Results/Answers

Test ID	***Test Objective (Why)***	***Description of Prototype used and of Basic Test Method (What)***	***Description of Results to be Recorded and how these results will be used (How)***	***Estimated Test duration and planned start date (When)***
1	Verify if our 3-inch diameter wheels properly grip the raft as it comes out of the dirty pile and moves the raft forward. Based on the results of this	Prototype type: Focused and Physical. We selected this type because we want to focus on only one aspect of our whole system to ensure it works. It is to early in	Test number of times wheels successfully grips raft and moves it 32 inches. Wheel performance will be tested when the wheels are	This test should take about an hour on November 5. Before the test can occur, we require: Our finished

	test we will find out if we require larger wheels, a more powerful motor for the wheels and/or different wheel placement. This test reduces uncertainty surrounding how the boards will move through the system and go out of the stack we have them in at the start. *Criteria for success:* Question: wheels contact the raft on both sides and moves the raft 32 inches without losing contact. Analysis: The prototype was lower fidelity, but it was focused and physical. It reduced uncertainty that our wheels wouldn't properly grip our boards and push it through the system	the prototype stage to do a comprehensive prototype covering all aspects. We will require 2 spinning rubber wheels of 3-inch diameter, the raft as well as two stepper motors that will rotate the wheels. We will fix the stepper motors on a wooden surface to make sure the wheels stay in place as the raft moves between the 2 wheels. Estimated cost: $40 for the motors, Arduino and wiring Actual Cost: $0 all parts were found around the house	wet and dry. The number of times the wheels successfully grip the raft in wet and dry conditions will be recorded in a spreadsheet. The distance the board moves will also be recorded. This data will be important because the wheels are the ones moving the board through the cleaning system and out the other end of the machine to the clean side of the table.	prototype 1, which should have two spinning wheels that are controlled by two motors, and a measuring device to calculate distance moved. The results of the test will be available in time to make a difference in the project (we are testing 1 month before the final solution is due).
2	At the beginning of our cleaning system the user will place a stack of dirty boards on the table. Our objective will be to test if a 6-inch rigid object attached to a servo motor will spin when the motor rotates and if the has enough power from	Prototype type: focused and physical. We selected this type because we want to focus on only one aspect of our whole system to ensure it works. Its to early in the prototype stage to do a comprehensive prototype covering all aspects. We can also	We measure if the spinning piece can move the raft 6 inches forward (distance where the 3-inch spinning wheels should grip the raft). We will record the information. One column will have	30 minutes; November 5. Before the test can occur, we needed all of prototype to be done. The results of the test are available in time to make a difference in the solution because

	the motor to push the bottom raft from the stack to the rotating wheels. This test will allow us to learn about the capabilities of a stepper motor and this prototype can also help us communicate our automation idea better to the client. If the test isn't successful, we need to rethink the type of motor we use, or the type/length of object attached to the motor that is pushing the bottom raft. This will also help with letting us know how many boards we can stack on the device, so it'll still work. *Success criteria:* Question: Bottom raft is removed from the stack with one rotation of the motor and the raft moves straight. Analysis: The piece was connected to a stepper motor and pushed the board into the wheels while keeping it straight. It was low fidelity, and the material was different that the materials used in the proper system so	do this test analytically by calculating the force the top boards exert on the bottom one and than calculating the force the ridge object exerts on the bottom board and make sure through calculations this force is greater than the force of the top rafts+ force of friction. We will require one stepper motor, 5-10 objects of similar shape, size and weight of the raft (if we don't have access to the actual raft). We will need to mount the stepper on a fixed surface, attach the wooden object to the stepper motor and place the stack of rafts in front of this system. Estimated cost: $5 for piece that is attached to the motor. The motors and other wiring will be paid for in other stages of our prototyping Actual Cost: $0 all parts were found around the house	the distance the bottom raft moved (in inches) and the second column will have the number of rafts that were stacked on the bottom raft to see if there is a correlation between distance the raft moves and the increase in stacked rafts=>higher weight. This is consistent with our objective.	we will still have 1 month to revise future prototypes and change our concept.

	there was unneeded friction and different weight to it.			

Analysis of Prototype 1:

This prototype has 2 main objectives:

1. Verifying if a ridged object attached to a stepper motor at the beginning of the cleaning system has enough power from the motor to push the bottom raft from the stack in a straight line until it contacts the rotating wheels.

2. Verifying if our two, 1-inch diameter rubber wheels properly grips the raft under wet and dry conditions and move it forwards 32 inches without loosing contact with the raft.

About the prototype:

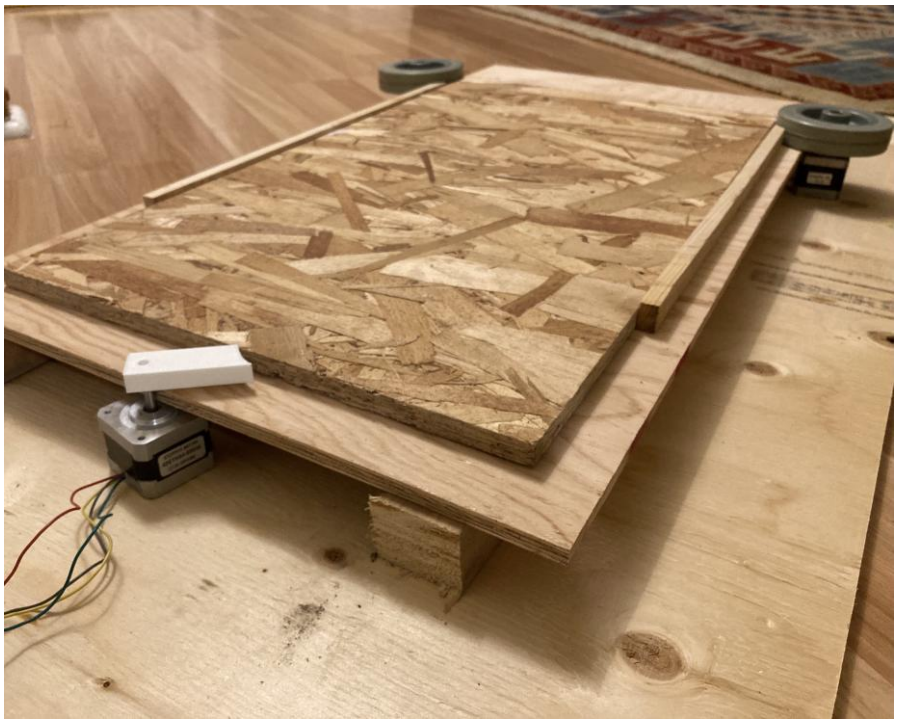
- Majority is made of wood since it's easily accessible
- Raft (the top wooden board) is raised 2.5 inches from the ground to allow the 3 objects (2 rubber wheels and 1, 3d printed rigid rectangle) attached to the 3 stepper motors to contact the raft properly.
- Two thin(0.5x16.5in) wooden pieces on each side of the raft act as guiding rails to ensure the raft travels in a straight path towards the wheels.
- Motors were also secured to the wooden base board using screws so they wouldn't shift as the motors spin.
- An Arduino and motor shield were used to rotate the motors. Each of the two objectives above were tested individually because a motor shield can only power two stepper motors at a time, and we only have 1 motor shield and 3 stepper motors.

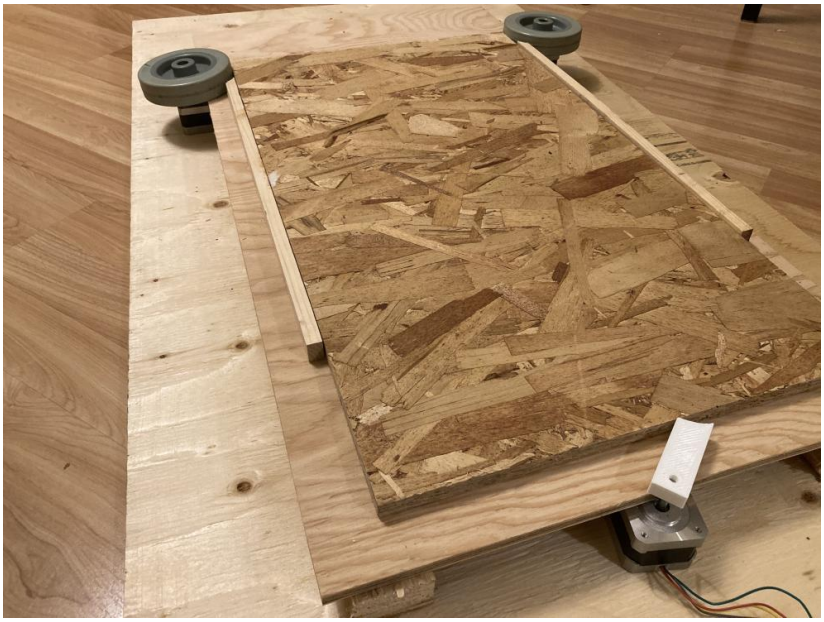
- Objective 1 Results
    - The 3d printed ridged object attached to the stepper motor manages to successfully move the raft until it contacts the wheels.
    - The raft successfully travels in a straight line with the help of the guiding rails attached on each side.
    - However, the more weight added to the raft the harder it is for the servo motor to push the rafts. It seems like the motor seems to struggle having to push more then 12 pounds which is the equivalent of 6 rafts.
        - To solve this problem, we can look for a more powerful motor or try the find a more efficient feeding system (eg. Pushing the top raft instead of the bottom one because the top raft isn't under as much weight).
        - Another solution could be to include a glossier surface for the raft to travel on which would reduce friction because currently this protype has wood sliding on wood which hinder the movement of the raft as it slides towards the wheels.

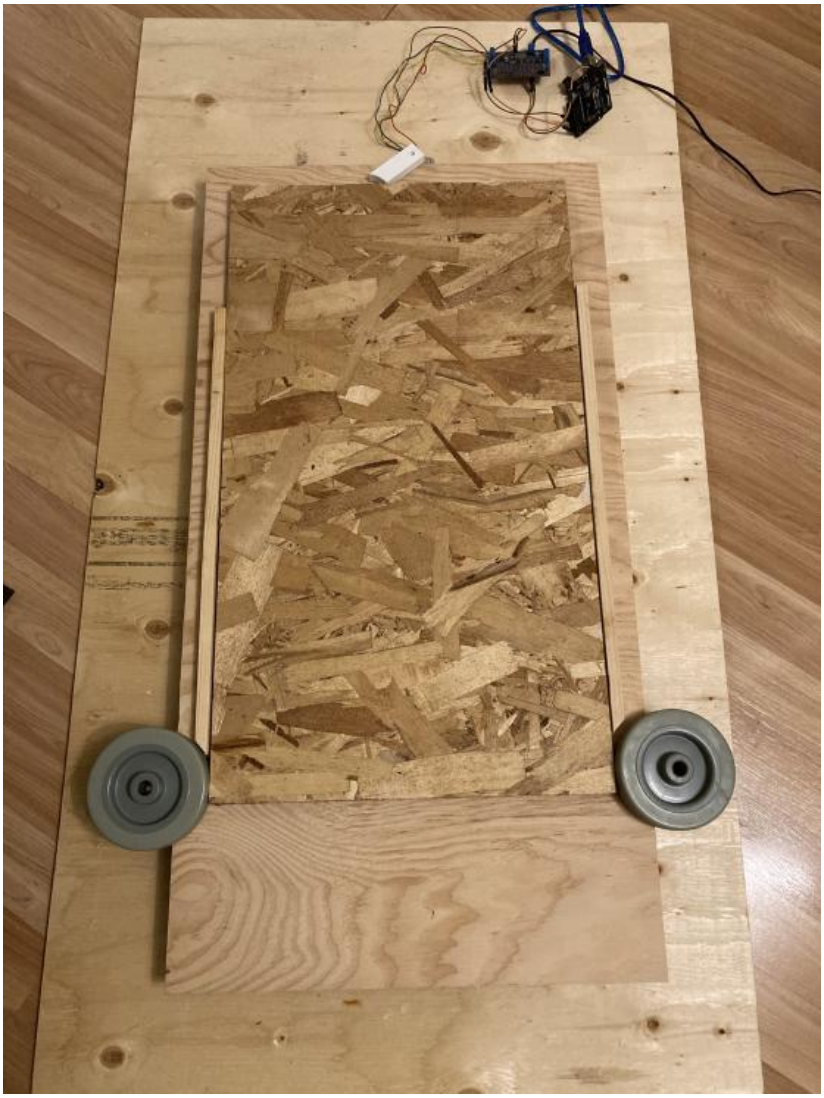
- Objective 2 Results
    - Both wheels manage to grip the raft successfully when the raft and the wheels are dry and move the raft the full 32-inch distance without losing contact with the board.
    - Under the conditions of wet wheels and raft as well as when there is lots of weight on the bottom raft from the rafts on top the grip of wheels on the board decreases
        - An improvement would be to find a way to reduce the weight the top rafts exert on the bottom raft
        - Another improvement for this problem would be to change the wheel size(larger wheels) and grip quality->refer to picture below

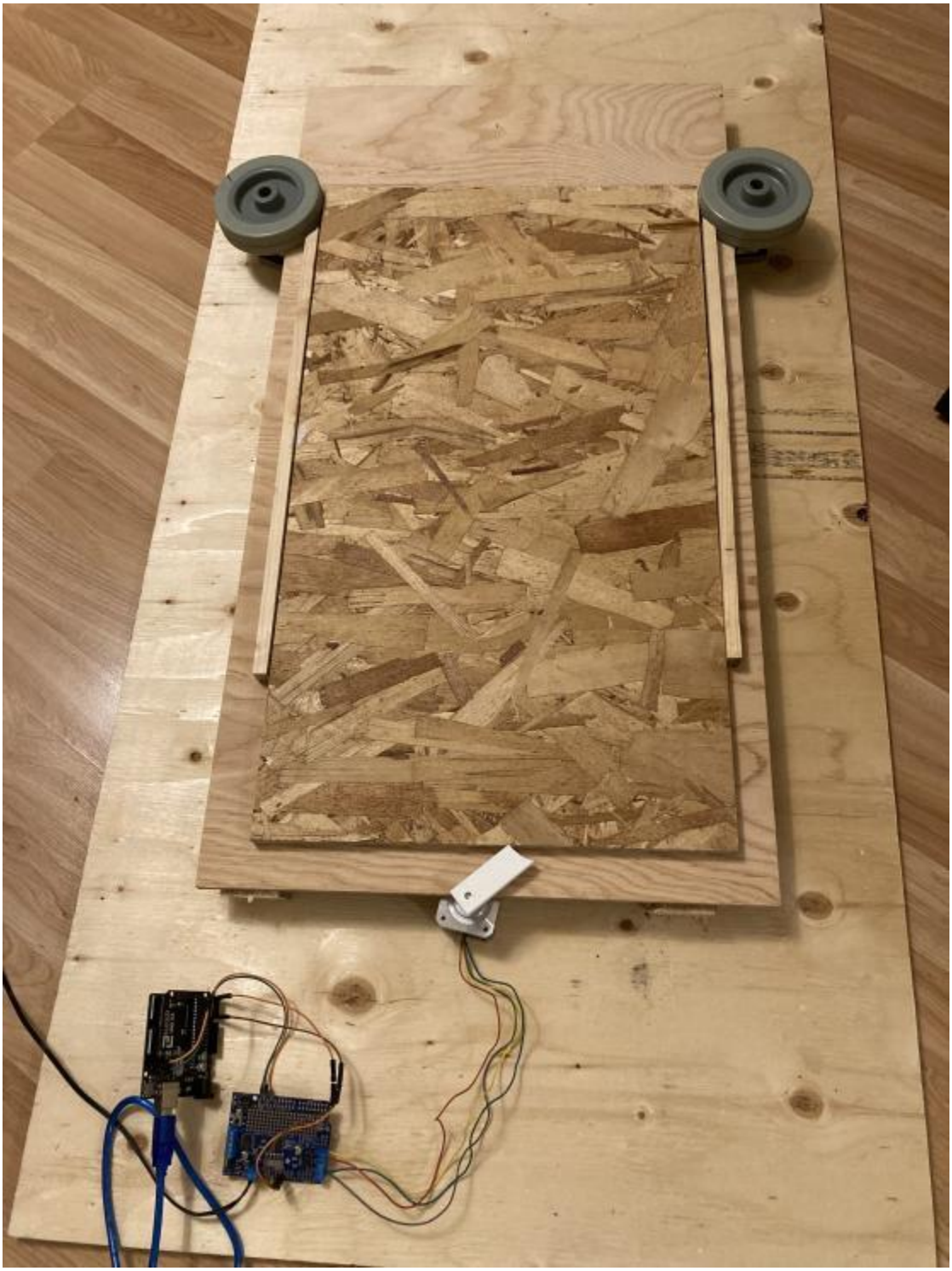
This type of wheel will contact the board not only on the sides but also the top and bottom allowing for improved grip as well as stability as the raft moves through the cleaning system.

Prototype 1: Photos









Bill of Materials was updated (https://docs.google.com/spreadsheets/d/1lCQ2YnYQaJGvfn9f1k6H-oeWfJqrgsRzSLlUE4dv7ek/edit#gid=0)

If I was the client, it would be important for me to know how many boards I can stack on the system and that I know the boards can go through our system unattended by a farmer.

Project Plan (Green are completed, dependencies can be found on wrike)

Tasks	Duration	Who's Responsible
Prototype 1		
Create test plan	Start 10/21 Due 10/23	Gabe
Plan assembly of prototype one including all parts we will need	Start 10/21 Due 10/25	Gabe, Sharmarke, Aiden
Gather Materials for prototype one	Start 10/23 Due 10/30	Gabe
Assemble Prototype One	Start 10/30 Due 11/2	Gabe, Sharmarke, Aiden
Test Prototype One using our test plan	Start 11/3 Due 11/3	Gabe, Sharmarke, Aiden
Analyze Test results	Start 11/3 Due 11/5	Gabe, Sharmarke, Aiden
Prototype 2		
Review Feedback from prototype one	Start 11/10 Due 11/10	Gabe, Sharmarke, Aiden
Create Test plan	Start 11/1 Due 11/6	Sharmarke
Plan assembly of prototype two including all the parts we'll need and how we will assemble it together	Start 10/23 Due 11/7	Gabe, Sharmarke, Aiden
Gather Materials for prototype two	Start 10/23 Due 11/7	Gabe
Create subassembly of prototype 2	Start 11/6 Due 11/11	Gabe
Create subassembly of prototype 2	Start 11/6 Due 11/11	Aiden
Create subassembly of prototype 2	Start 11/6 Due 11/11	Sharmarke
Assemble the whole prototype	Start 11/11 Due 11/12	Gabe, Aiden, Sharmarke
Test Prototype Two	Start 11/12 Due 11/12	Gabe, Aiden, Sharmarke
Analyze Test Results	Start 11/13 Due 11/13	Gabe, Aiden, Sharmarke
Prototype 3		
Review Feedback from prototype two	Start 11/17 Due 11/17	Gabe, Aiden, Sharmarke
Create Test Plan	Start 11/11 Due 11/14	Aiden
Plan assembly of prototype three including all the parts we'll need and how we will assemble it together	Start 10/23 Due 11/16	Gabe, Aiden, Sharmarke

Test Plan for Prototype 2

Test ID	*Test Objective (Why)*	*Description of Prototype used and of Basic Test Method (What)*	*Description of Results to be Recorded and how these results will be used (How)*	*Estimated Test duration and planned start date (When)*
1	The second part of our system that we will be testing will be about if the 3 main brushes clean the boards. We will be doing this testing to see how well the brushes clean the board, the time it takes for the brushes to clean the board, and if one of the brushes can fit inside the board's hole. One brush will be the one that goes inside the board's holes, the second brush will be the one that cleans the bottom of the boards, and the last one will be the one that cleans the top of the board. Each of these brushes will be cleaning a part of the board that we had 3D printed. This test will be for learning since we want to see the best brushes that can fit inside the holes and clean the top and bottom of the boards within a short time. The way the result will be	The prototype type for this test will be focused and physical since we want to only focus on this aspect of our prototype and the best way for us to get good results will be to have a physical prototype type for this testing. The main materials that we will be needing for this testing will be a 3D print of some part of the board, 1 brush that can go inside the holes, a long brush that can clean the whole top surface of the board, and another long bush that can clean the bottom surface of the board. Basically, two brushes will have the same dimension but they will be doing different jobs and the other one will need to be long vertically so that it can easily go in and out of the holes. We will be printing a 3D of the board but only a small part since we only need to know if the brushes can clean and fit inside the hole. We will cover mud on the board and let it dry. The main reason for this is to see if the brushes can get rid of the mud. This we	The pieces of information that will be measured are: How fast the brushes cleaned a board covered with mud and if the brush fit inside the hole. The performance of the brushes will be tested when the board is covered with wet mud and when it's covered with dry mud. The data that will be gathered is how fast the board got cleaned, how clean the board is, and how well the inside hole is cleaned. This data will be recorded on a spreadsheet. One column of the spreadsheet will have the time it took for the brushes to clean the board, another column will have the percentage of how many times the brushes cleaned the board, and another column will include the overall result of	This test will occur on Thursday, November 10. This test will take about one hour since we want to get the best result we can. We will be needing a drill that makes the brush spin, 3 brushes, 1 servo motor, 10 wires, and a 3D print of part of the board before this testing occurs. The result of this testing will be available on time to create a difference to our project since our project is due more than a month we will be able to make changes to our project. If this testing fails, we will have to change the type of brushes we used or increase how fast the brushes are spinning.

	made is that there will be a spreadsheet file that has all the data for the testing. The file will include the time it took for the brushes to get rid of the dirt on the board and will have an observation of how cleaned the board looks with the time it took. Using the file data will help us decide if one brush is fitting inside the hole and can clean the boards fast, and if the others can clean the top and bottom. Criteria for success: The brushes clean off the dirt on the board in a short amount of time and the brush can easily fit inside the hole.	help us know the time it will take for the brushes to clean the board and how well cleaned the board will look. In the beginning, we will start testing the brush that needs to clean inside the hole. There will be a drill that is connected to the brush which will make the brush spin and cleans the holes. Then, move on to the brushes that are supposed to clean the top and bottom of the board. There will be a motor that is connected to the brushes which will make them spin and clean the top/bottom of the hole. The motor, wires, drill, and the 3 brushes will cost about $25.	this test. This data is important since the most important thing that our system must do well is the cleaning part which is why this data is needed. Also, this data is important because we must do testing on the brushes so that at the end of our project the client is happy that each board is being cleaned well by the brushes. This is consistent with our defined objectives for the test.	

Conclusion

Our prototype helped us reduce uncertainty in one of our most important subsystems of the device, and our test was successful. We understand how part of our concept works and can reduce the uncertainty that it may not work even though it's a lower fidelity prototype. We now also have a plan for next week on our prototype two and are on track with our project plan all while keeping things reasonably measured.