# Deliverable H – Prototype III

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**Abstract**

*This document includes our final prototyping plan, system analysis and updated specifications, design, and bill of materials, chosen after the final presentation. A plan is then listed for tasks which will need to be completed in the design process This is followed by a new prototyping schedule, with a list of tests scheduled for the following weeks until the final concept must be shown to the client. This schedule also includes stopping criterion and the objectives of tests.*

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# 1 Introduction

This document presents the final detailed prototyping plan and cost for the proposed design, incorporating insights from the second client meeting, and further feedback from classmates. It outlines the key phases of development, updates to our design, and a structured prototyping schedule. By providing a clear roadmap, this document ensures that the team can efficiently execute the project.

# 2 Feedback Reflection

After our meeting with the client our design underwent some changes. The client was concerned about our wheels slipping upon entering the pipe, which would make calculating the proper distance travelled difficult. As a result, we decided to add a tether which is exactly 15 feet so the sampler cannot overshoot and doubles as a failsafe method. We also used his feedback to finalize some of our concepts which we would include in our final design. In our second meeting our client was worried about our sampling system not being able to scrape steel with a motor. After further testing we have landed upon a mousetrap design for our sampling system.

# 3 System Analysis

Drive:

The drive system for our design includes wheels which allow the device to move further into the pipe when the pipe is oriented horizontally. There will be 2 motors which spin the bottom wheels the desired direction and 4 rollers to line up with each of the motors. When the pipe is oriented vertically the device will be lowered with the spool and will use gravity and the tether to reach the 15-foot target.

Collection:

For our collection system we will be using gravity and the momentum of the mouse trap, once the sampling is completed the sample will fall into a indent in the electronics tray and be ready to be retrieved. The mousetraps will lead have sheet metal over the arm which will act as a lid when the design is closed.

Feedback:

During each stage of the collection process the interface will update to show the current stage. This information will be displayed on a laptop and will be retrieved through a long chord which will run from the device to the laptop. The interface also controls the device itself, it controls whether the wheels turn clockwise or counterclockwise. The interface also has a stop function which can be used to automatically stop the device from progressing further down the pipe, in case of tether failure.

Sampling:

We will be using a scraper to collect our sample, which is propelled by a mousetrap. The mousetrap is set off by a motor via the operator control page. The laith bit at the end of the mousetrap will contact the metal surface and collect a small sample in one activation.

Retrieval:

Once sampling is completed and the sample had been properly collected, the wheels will turn the opposite direction to allow the device to return to the opening of the pipe. If this system fails, the spool can also be used to manually retrieve the device. Once returned the whole device can be shipped for testing. The spool and rope have already been tested and prototyped and are ready to be implemented into the final design.

# 4 Completed Prototype Testing

| Prototype | Name | Date Finished | Testing Description | Result |
|---|---|---|---|---|
| 1 | Spool | March 1 | Tested if the spool and rope could pull up a ~800g mass, by tying a water filled bottle to the tether and trying to reel it in. | Spool was successful. Determined the spool handle was in an inconvenient position and remodel to put it on the outside. Parts all fit together well. |
| 2 | Interface | March 1 | Tested whether the interface would make the motors spin the selected direction and stop when the buttons were pressed. | Wheels sometimes failed. Decided to make the interface more visually appealing by adding a background. Was successfully able to make test motors move. |
| 3 | Updated Spool | March 8 | Completed the same 800g mass test but tried to reel as fast as possible. | Spool was successful with minimal slack in the rope once reeled in. Using this design for the final project but reprinting all the parts at rocketry for an improved part quality. |
| 4 | Major Components Case | March 8 | Tested whether the case could fit inside the 4-inch pipe and whether all of our internal components could fit inside. | The case was able to fit inside the pipe and all the of the components can fit inside. |
| 5 | Updated Interface | March 8 | Tested whether the interface could make the motors move, | The interface was still able to make the motors move/stop. Feedback was given to |

| | | | | |
|---|---|---|---|---|
| | | | asked how it could be improved. | change the buttons to say forward/backward instead of clockwise and counterclockwise. |
| 7 | Drive System | March 12 | Test if the device can move through 15 feet of the pipe and return safely | Other than some minor resistance from the weld line, the device was very efficient in conversing down the pipe. We may need to make a small adjustment where the device rubs against the weld line. |
| 8 | Vertical Test | March 15 | Propel the device down the pipe 15 feet then see if the spool can pull it back out. | The spool was able to easily pull the weight of the device in and out of the tube, we learned that the spool being as high as possible works best for vertical, and being perfectly in line with the tube works best for horizontal |
| 9 | Sampling System | March 18 | Test if the sampling system can sample steel, by manually scraping the steel, then trying with the mouse trap. | We have great difficulty scraping the pipe, even manually. We tried many different materials, and none were able to get a solid burr. |
| 10 | Collection System | March 19 | Try collecting the sample taken with the sampling system in both the vertical and horizontal orientation | The collection system would have worked well if we had a large enough sample. But the system worked well with the sample size we had. |
| 11 | Operator Response | Mar 21 | Test the operator response system combined with the rest of the prototype. | As expected, the operator response worked well. The next step is to implement some more feedback. |

Figure 1: Spool 1

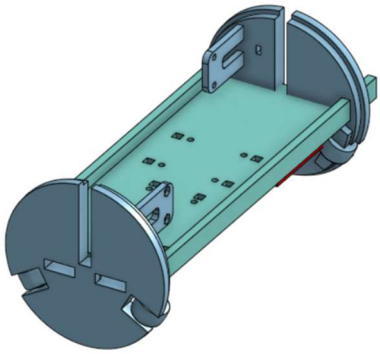


Figure 2: Major Components Case

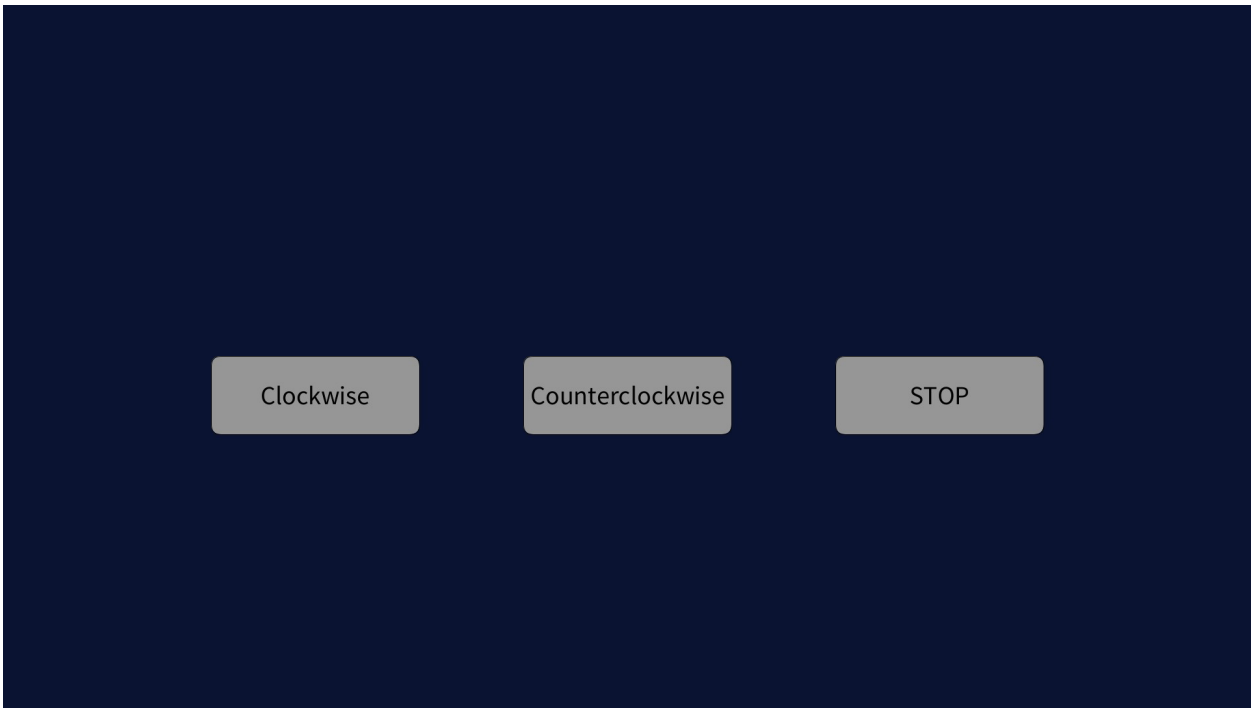


Figure 3: User Interface

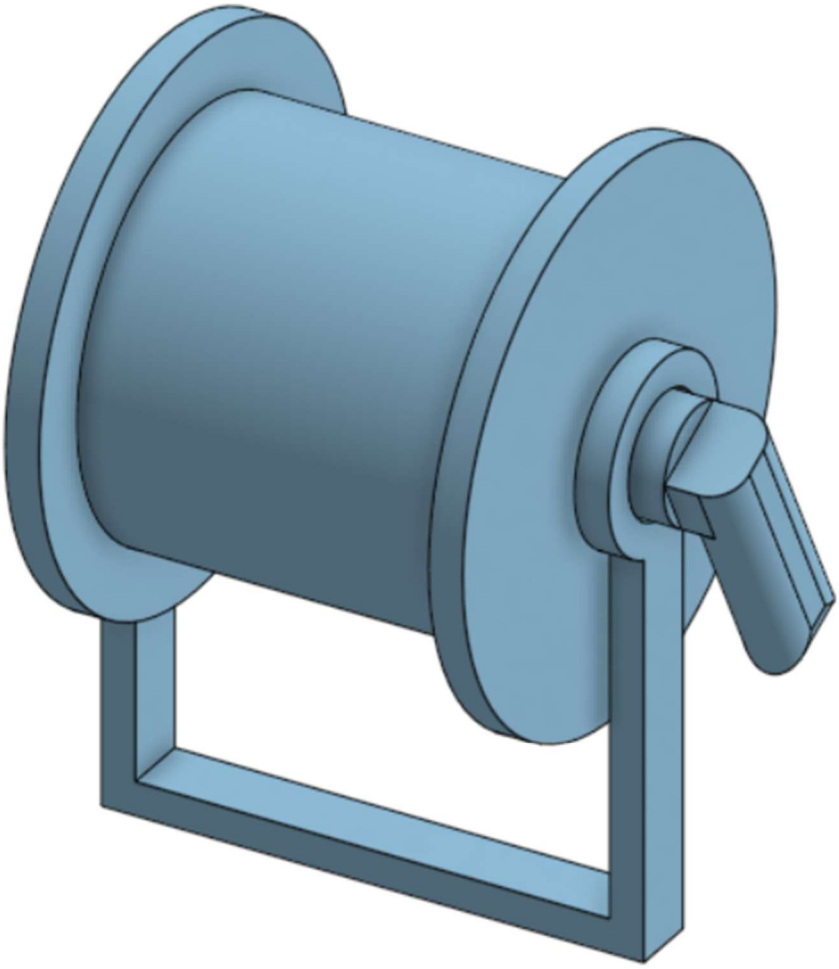
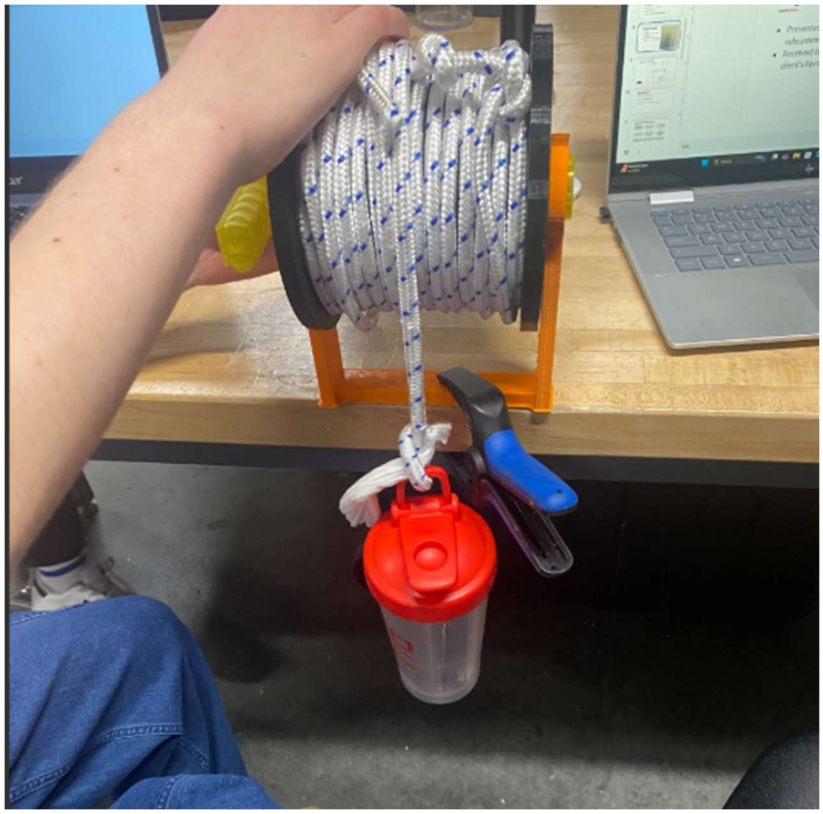
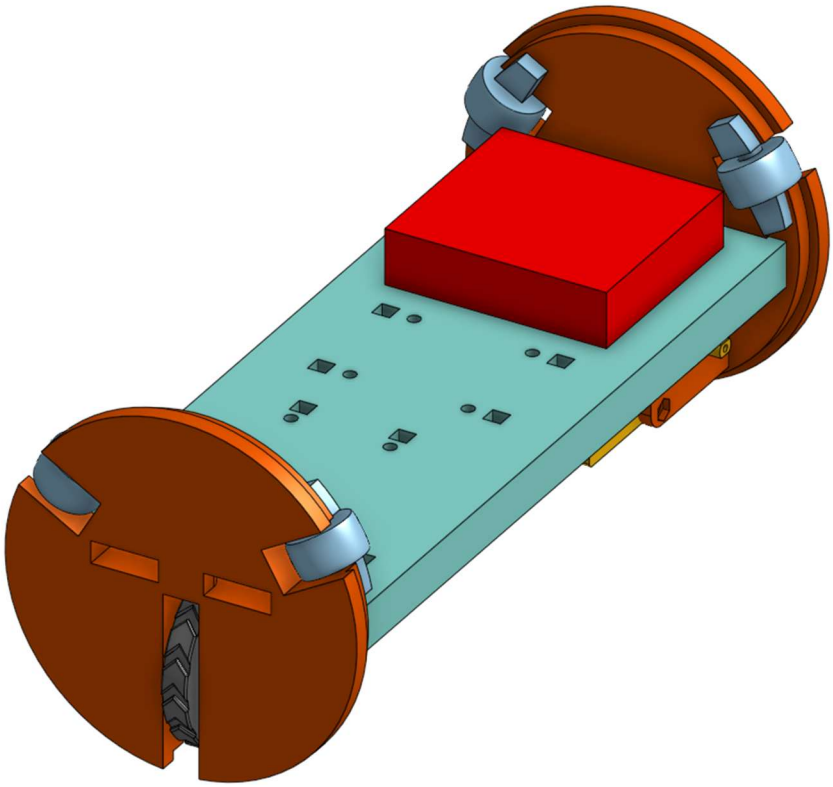
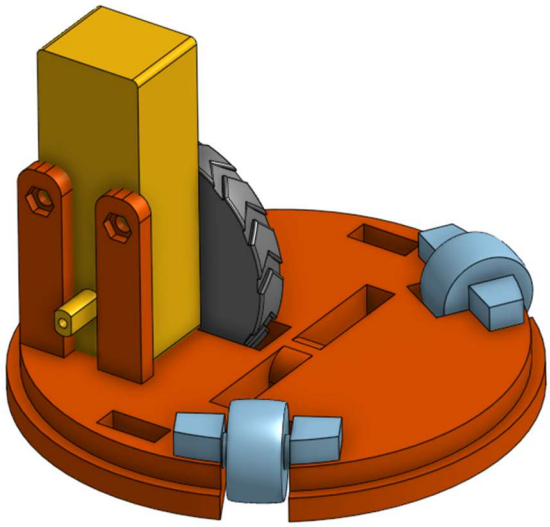


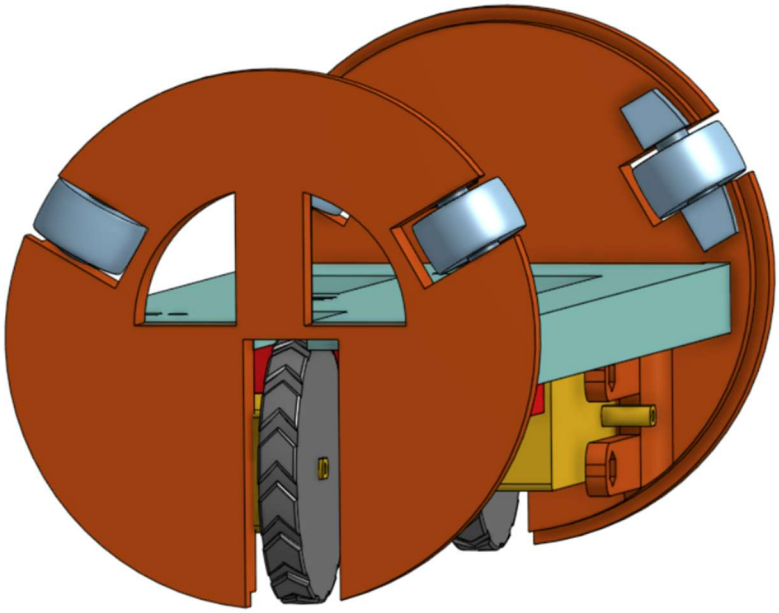
Figure 4: Updated Spool

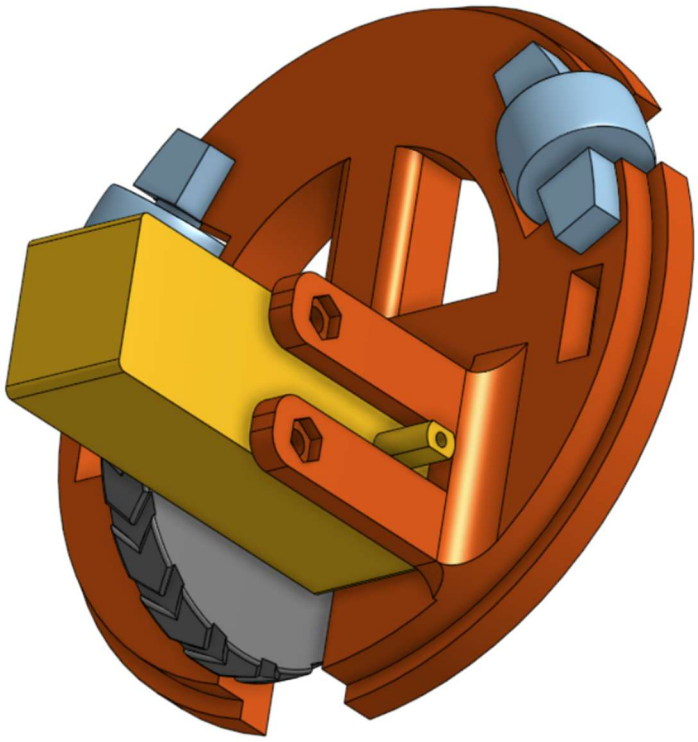


s.C.R.A.P
Sample Collection & Retrieval Automated Probe
Forward
Backward









# 5 Feedback From Potential Clients

Some feedback which was found was that that samplers typically leave behind small pieces of missed samples which leads to buildup. We will try to find a way to minimize the number of debris left behind after sampling. One major problem potential client had with our spool prototype was that the 3D

printed parts were not the same colours, when we Finnish our final design we are going to use the rocketry printers which use black filament. The feedback for our interface was positive, they enjoyed being able to control the device from a laptop, but did not enjoy having the buttons say clockwise and counterclockwise. We are working on changing the wording and possibly adding arrows to indicate direction. The feedback from professor in the final presentation was that he was worried about how much force would be needed to remove the device from the tube with the spool. This along with some testing did not seem to be an issue.

# 6 Updated Design

Client Meeting 1:

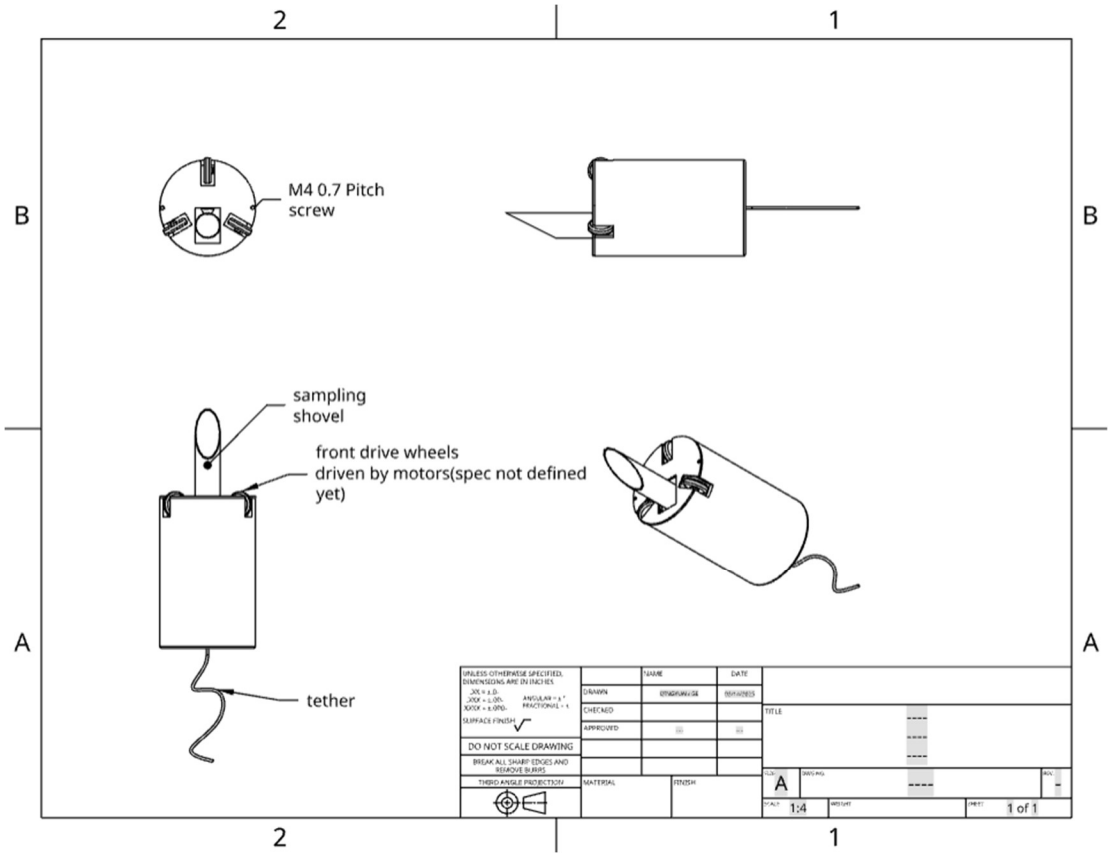
The design has been changed after the client meeting to include a tether and a ui interface instead of just LEDs. After some prototyping, we discovered some issues with some of our designs and have had to rethink some aspects. The spool has been redesigned, and we are now looking for a mechanical solution for the sampling system. Our updated model will be reviewed and given feedback in our next client meeting, as a result updates are applicable to change.

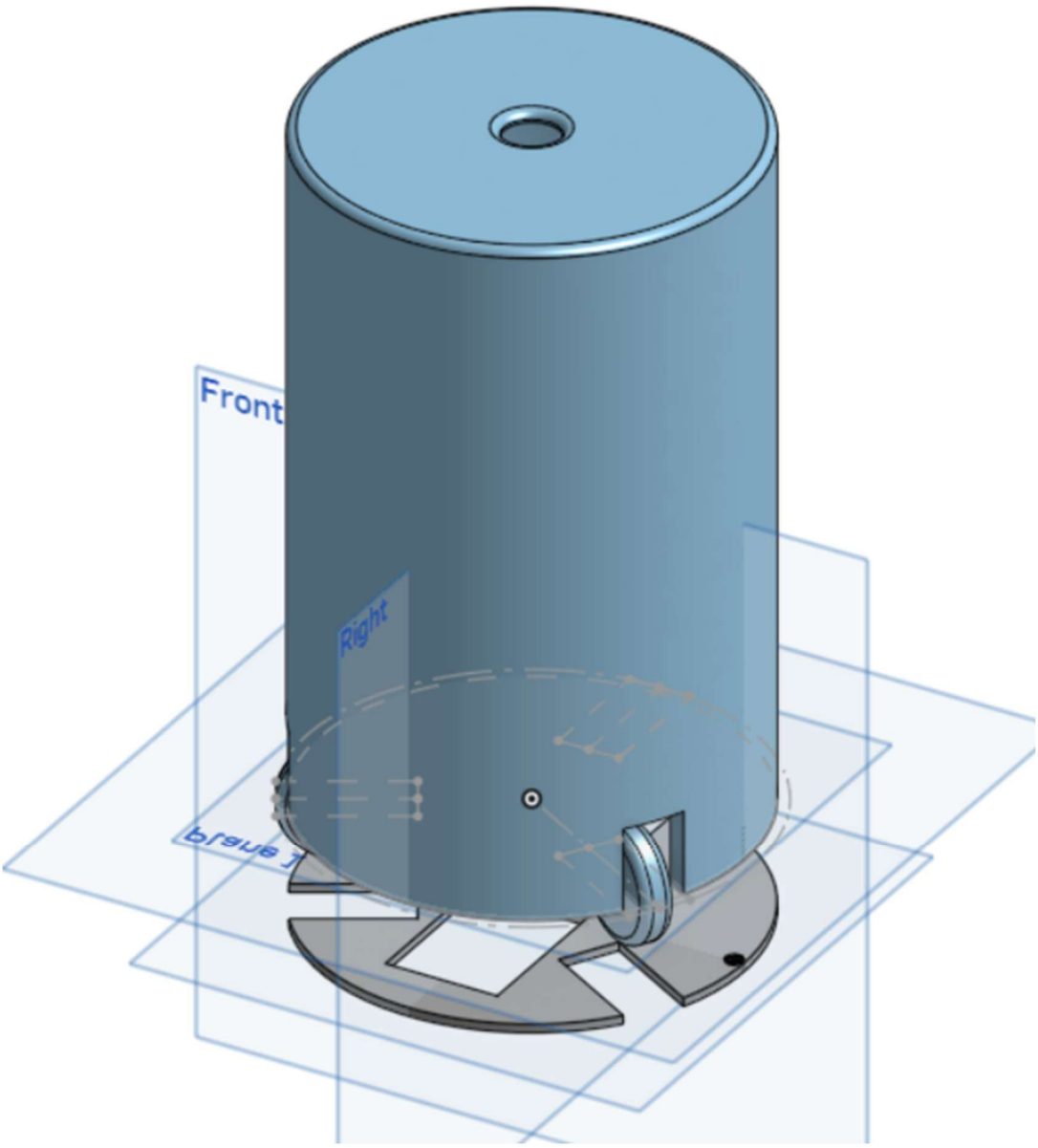
Client Meeting 2:

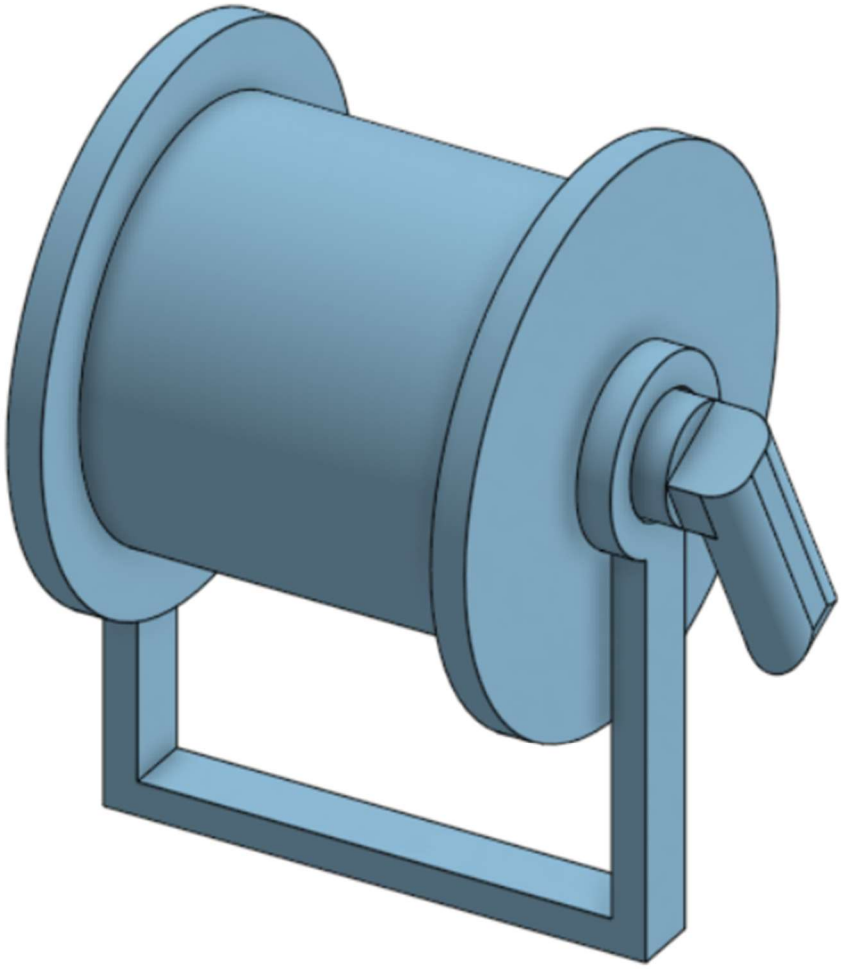
The design has been changed to include a mechanical solution for sampling. Although we are still designing this change, we have a rough idea how it will work. We also need to consider how this change will affect sampling in the vertical orientation.

Final Design.

The design has implemented the mechanical solution via a mouse trap with a laith bit attached. Not much else has changed other than some minor changes to minor parts in the system to allow for easier mounting of motors.


2
1
B
A
M4 0.7 Pitch
screw
sampling
shovel
front drive wheels
driven by motors(spec not defined
yet)
tether
UNLESS OTHERWISE SPECIFIED,
DIMENSIONS ARE IN INCHES
SURFACE FINISH
DO NOT SCALE DRAWING
BREAK ALL SHARP EDGES AND
REMOVE BURRS
THIRD ANGLE PROJECTION
NAME
DATE
DRAWN
CHECKED
APPROVED
MATERIAL
FINISH
TITLE
SIZE
A
SCALE
1:4
SHEET
1 of 1


Front
Right



# 7 Future Prototyping/Testing Plan

In the final days

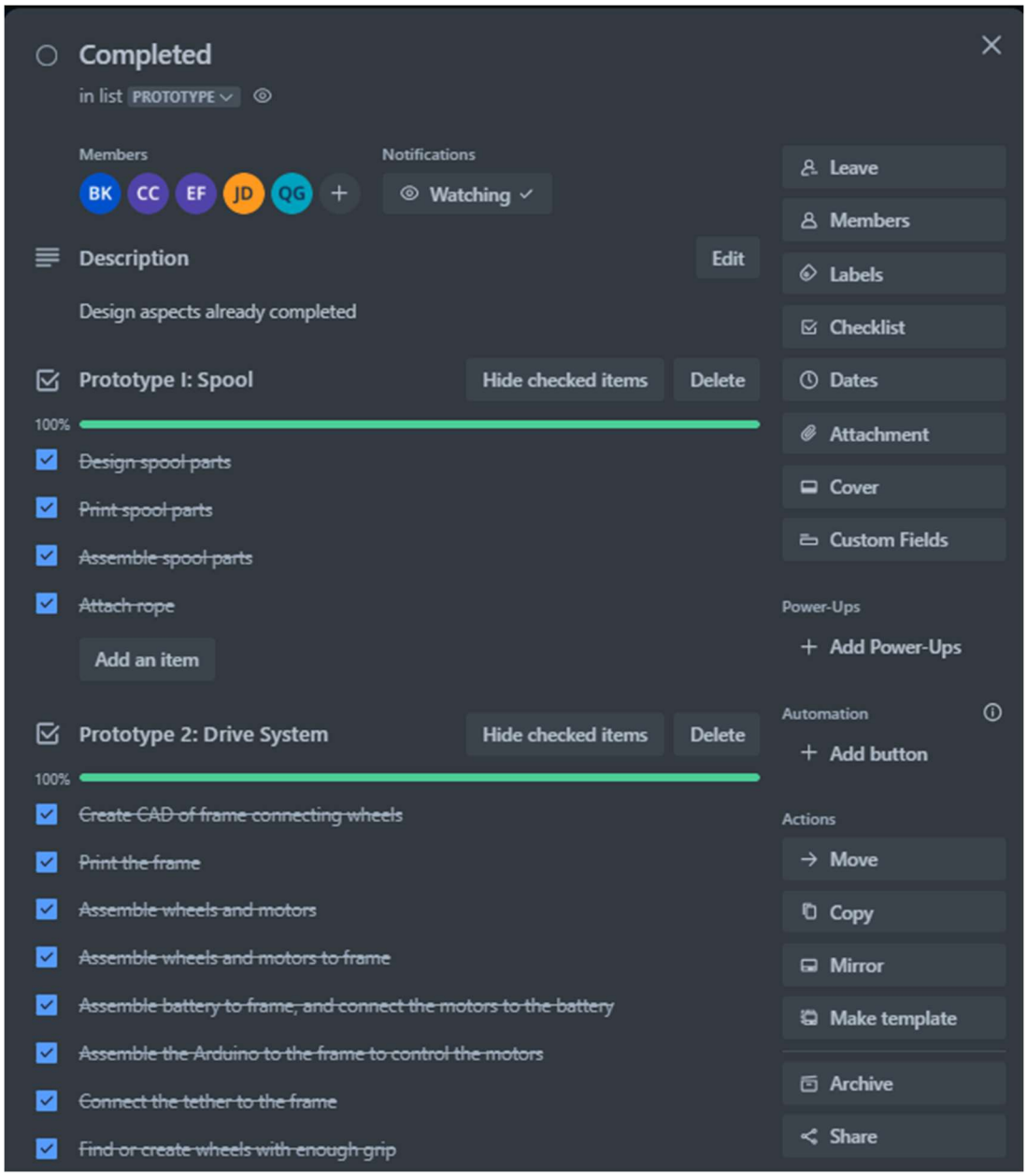
| Prototype | Planned Date | Description | Goals |
|---|---|---|---|
| Updated Sampling System | Mar 24 | See if we can fix the small size of sample by incorporating a new sampling head. | Increase sample size while still being able to use rest of subsystems. |
| Full Device | Mar 25 | Test the whole device to see if it can complete the task | See which components could be improved or if the whole device works perfectly and doesn't need to be changed |

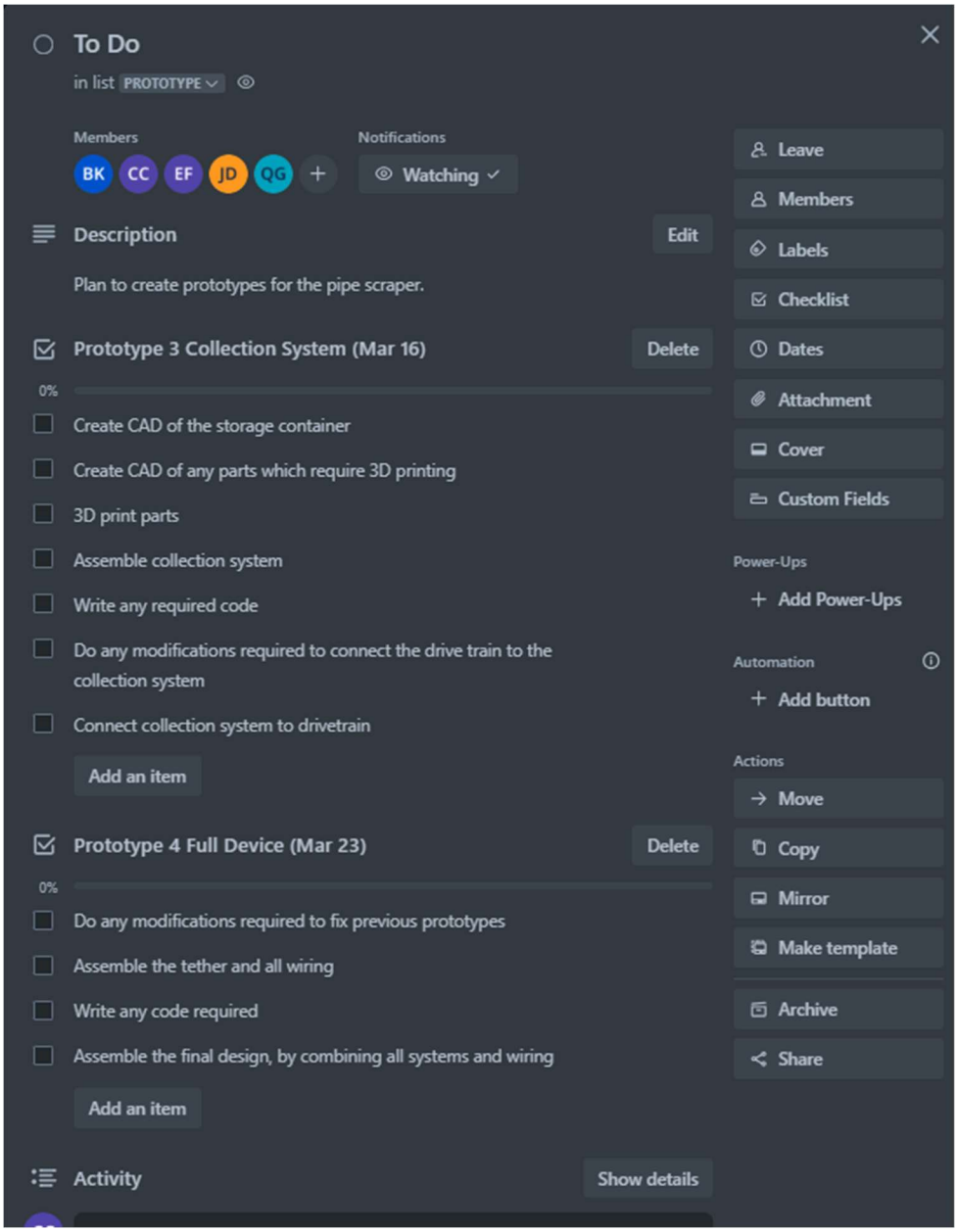
# 8 Conclusion

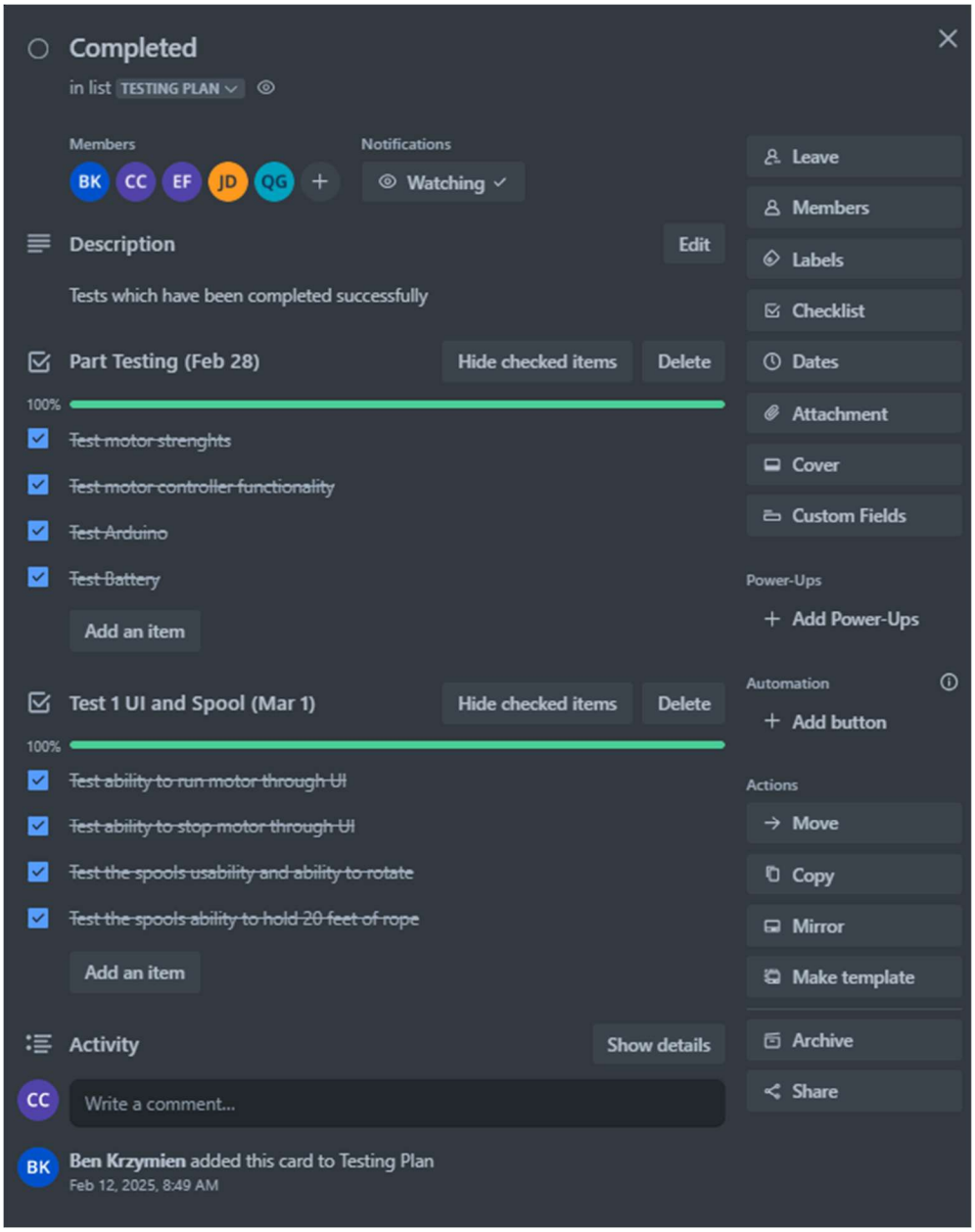
The updated prototyping/test plan helps with identifying key milestones, potential risks, and contingency measures, so that the team can proactively address challenges and maintain project momentum. The scheduled prototype tests will validate the design's functionality, allowing for iterative improvements before design day.

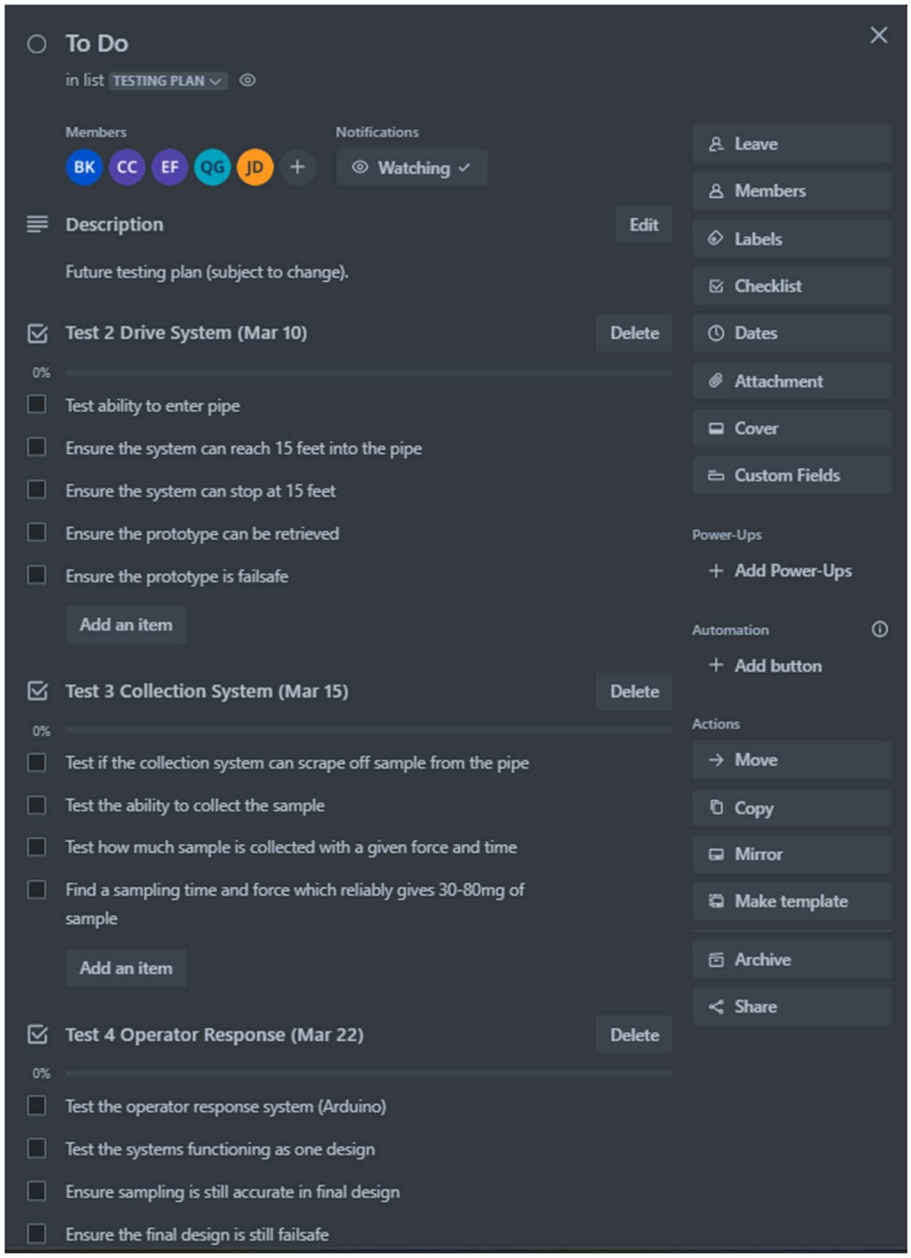
# 9 Trello

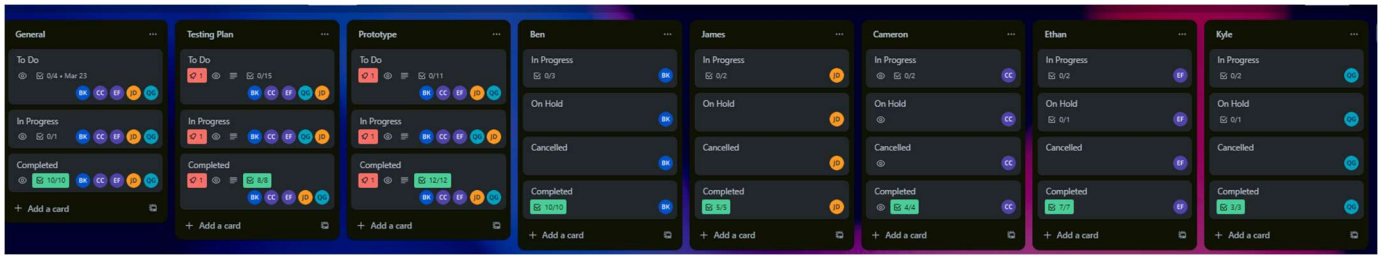
https://trello.com/invite/b/678bc328fcbb9b7db0fab8b0/ATTIb5d8e91d121234e28540e5f853a4602159A94F27/gng1103-design-project-group-4




To Do
in list PROTOTYPE
Members
BK CC EF JD QG
Notifications
Watching
Description
Edit
Plan to create prototypes for the pipe scraper.
Prototype 3 Collection System (Mar 16)
Delete
0%
Create CAD of the storage container
Create CAD of any parts which require 3D printing
3D print parts
Assemble collection system
Write any required code
Do any modifications required to connect the drive train to the collection system
Connect collection system to drivetrain
Add an item
Prototype 4 Full Device (Mar 23)
Delete
0%
Do any modifications required to fix previous prototypes
Assemble the tether and all wiring
Write any code required
Assemble the final design, by combining all systems and wiring
Add an item
Activity
Show details
Leave
Members
Labels
Checklist
Dates
Attachment
Cover
Custom Fields
Power-Ups
Add Power-Ups
Automation
Add button
Actions
Move
Copy
Mirror
Make template
Archive
Share


Completed
in list TESTING PLAN
Members
BK CC EF JD QG
Notifications
Watching
Description
Edit
Tests which have been completed successfully
Part Testing (Feb 28)
Hide checked items
Delete
100%
Test motor strenghts
Test motor controller functionality
Test Arduino
Test Battery
Add an item
Test 1 UI and Spool (Mar 1)
Hide checked items
Delete
100%
Test ability to run motor through UI
Test ability to stop motor through UI
Test the spools usability and ability to rotate
Test the spools ability to hold 20 feet of rope
Add an item
Activity
Show details
CC
Write a comment...
BK
Ben Krzymien added this card to Testing Plan
Feb 12, 2025, 8:49 AM
Leave
Members
Labels
Checklist
Dates
Attachment
Cover
Custom Fields
Power-Ups
Add Power-Ups
Automation
Add button
Actions
Move
Copy
Mirror
Make template
Archive
Share


To Do
in list TESTING PLAN
Members
BK CC EF QG JD
Notifications
Watching
Description
Edit
Future testing plan (subject to change).
Test 2 Drive System (Mar 10)
Delete
0%
Test ability to enter pipe
Ensure the system can reach 15 feet into the pipe
Ensure the system can stop at 15 feet
Ensure the prototype can be retrieved
Ensure the prototype is failsafe
Add an item
Test 3 Collection System (Mar 15)
Delete
0%
Test if the collection system can scrape off sample from the pipe
Test the ability to collect the sample
Test how much sample is collected with a given force and time
Find a sampling time and force which reliably gives 30-80mg of sample
Add an item
Test 4 Operator Response (Mar 22)
Delete
0%
Test the operator response system (Arduino)
Test the systems functioning as one design
Ensure sampling is still accurate in final design
Ensure the final design is still failsafe
Leave
Members
Labels
Checklist
Dates
Attachment
Cover
Custom Fields
Power-Ups
Add Power-Ups
Automation
Add button
Actions
Move
Copy
Mirror
Make template
Archive
Share


General
Testing Plan
Prototype
Ben
James
Cameron
Ethan
Kyle
To Do
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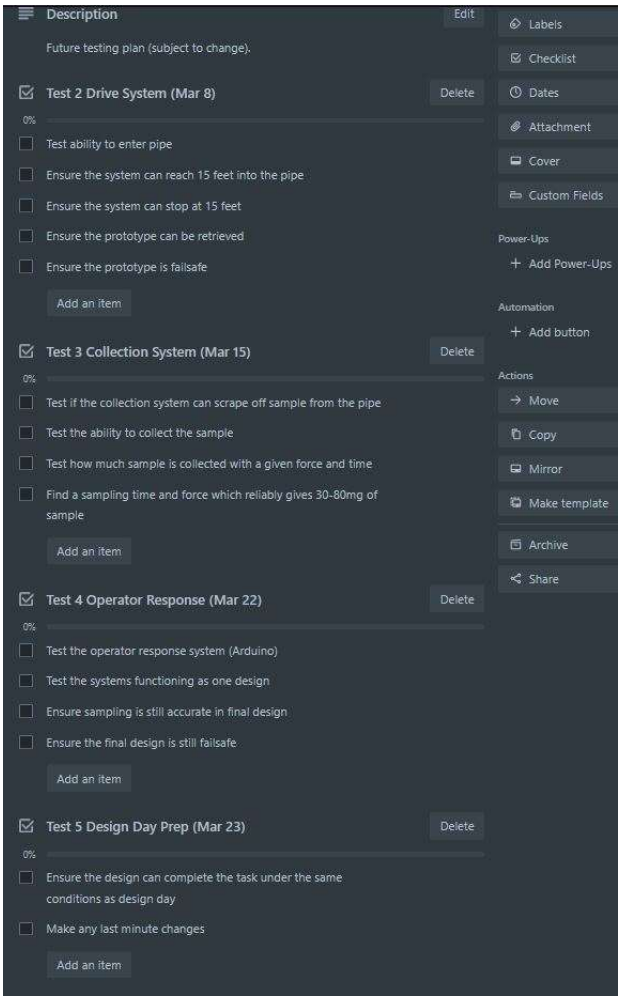
On Hold
Cancelled
Completed
Add a card


Description
Edit
Future testing plan (subject to change).
Test 2 Drive System (Mar 8)
Delete
0%
Test ability to enter pipe
Ensure the system can reach 15 feet into the pipe
Ensure the system can stop at 15 feet
Ensure the prototype can be retrieved
Ensure the prototype is failsafe
Add an item
Test 3 Collection System (Mar 15)
Delete
0%
Test if the collection system can scrape off sample from the pipe
Test the ability to collect the sample
Test how much sample is collected with a given force and time
Find a sampling time and force which reliably gives 30-80mg of sample
Add an item
Test 4 Operator Response (Mar 22)
Delete
0%
Test the operator response system (Arduino)
Test the systems functioning as one design
Ensure sampling is still accurate in final design
Ensure the final design is still failsafe
Add an item
Test 5 Design Day Prep (Mar 23)
Delete
0%
Ensure the design can complete the task under the same conditions as design day
Make any last minute changes
Add an item
Labels
Checklist
Dates
Attachment
Cover
Custom Fields
Power-Ups
Add Power-Ups
Automation
Add button
Actions
Move
Copy
Mirror
Make template
Archive
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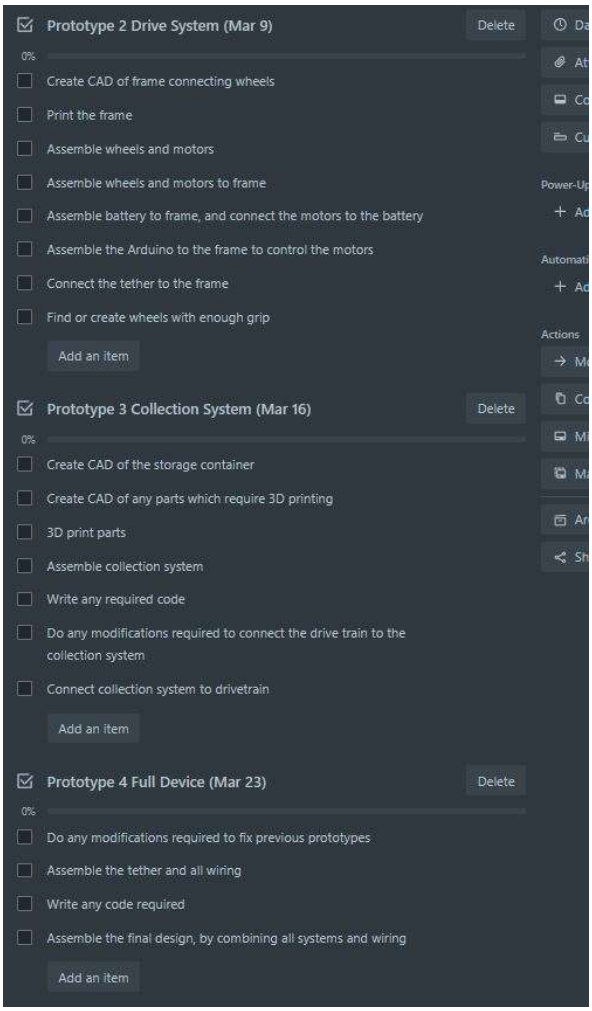
Prototype 2 Drive System (Mar 9)
Delete
0%
Create CAD of frame connecting wheels
Print the frame
Assemble wheels and motors
Assemble wheels and motors to frame
Assemble battery to frame, and connect the motors to the battery
Assemble the Arduino to the frame to control the motors
Connect the tether to the frame
Find or create wheels with enough grip
Add an item
Prototype 3 Collection System (Mar 16)
Delete
0%
Create CAD of the storage container
Create CAD of any parts which require 3D printing
3D print parts
Assemble collection system
Write any required code
Do any modifications required to connect the drive train to the collection system
Connect collection system to drivetrain
Add an item
Prototype 4 Full Device (Mar 23)
Delete
0%
Do any modifications required to fix previous prototypes
Assemble the tether and all wiring
Write any code required
Assemble the final design, by combining all systems and wiring
Add an item