Group P- Abby Hallock, Rensu Kumbhani, Julia Scott, Chuwen Sun Progress Report Week 4

Instructor- Dr. Kecskemety, GTA- Amena Shermadou 2/7/2018

Weeks 1-4

Situation

In the past few weeks, the preliminary R&D labs and testing have been completed. The goal of lab one was to become familiar with Arduino coding, write a simple code for the Arduino, and then the code was tested using the simple model containing the Arduino board, LiPo battery, motors and propellers. In lab two, the goal was to become familiar with the reflectance sensors. The reflectance sensor test was run to make sure the sensors were working properly, then a short code was written to put the sensors into action. Lab three was designed to test the team's creative thinking and teamwork. Individual AEV concept sketches were made, then the designs were compiled into one team sketch, taking the good aspects from each individual design, complete with an estimated weight, bill of materials, and cost. The goal of preliminary R&D lab 4 is to learn how to use a design analysis tool that provides an efficient and productive method to evaluate AEV performance. Plots were made using the DAT that analyzed power versus time and power versus distance of the AEV. Lastly, the goal of lab 5 was to compare and rank the individual and team sketches based on safety, efficiency, stability, and durability, in order to eliminate some designs and move on to the building and testing round with the strongest design ideas thus far.

Through these preliminary research and design labs, different aspects of the AEV were explored. Now that the team has a better understanding of Arduino coding, reflectance sensors, concept sketches, design and analysis tool, and comparing designs through scoring matrices, there is a strong foundation to carry forward in the AEV design process.

Results and Analysis

There were some setbacks, as well as positive things, regarding the performance of the AEV and electric motors in lab 1. In our first try of scenario 1, the propeller was placed too tight on the electric motors, so the propeller did not even begin to rotate. After we adjusted it, the propeller worked well. In scenario 2, propellers and motors worked well. In scenario 3, propellers and motors all worked well. However, because we made mistakes when we assembled the AEV, one of the propellers hit the plastic board once it started rotating and broke. Some adjustments to the AEV design were helpful when considering future designs.

In lab 2, some new Arduino codes were explored. The commands goToRelativePosition() and goToAbsolutePosition() could be a limit to the success of the AEV. The commands could be an issue when trying to find the exact number of marks the AEV should move. Also, the brake command does stop the blades right away, but it might take a while for the actual AEV to come to a full stop due to momentum. The reverse command would have the same issue as the brake command when reversing the entire unit. These issues will also be taken into consideration when coding in Arduino for future AEV testings.

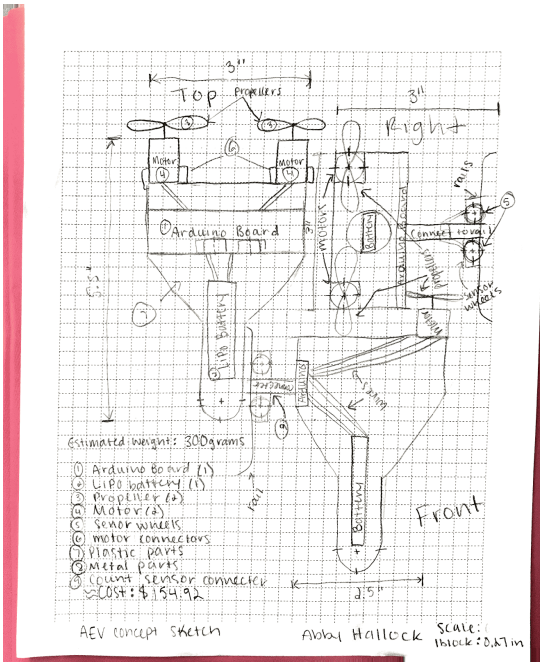


Figure 1: Design A

In lab three, many designs were considered with many different reasons for placement of features. Abby chose her design based on safety and stability. Abby choose to place her propellers connected to the motors at the back of the AEV. This allows for the propellers to move freely and not getting in the way of the motors and allows to propel the vehicle forward. Abby placed the Arduino in the middle for easy access to all of the wires and connections. The battery is at the front end so it can still connect to the Arduino board but it is out of the way of everything else. Sticking straight up would be the L bar connecting the sensors. The sensors measure the distance the AEV travels across the rails. The sketch made would keep everything that is necessary for the AEV separate and organized in order to successfully complete the task.

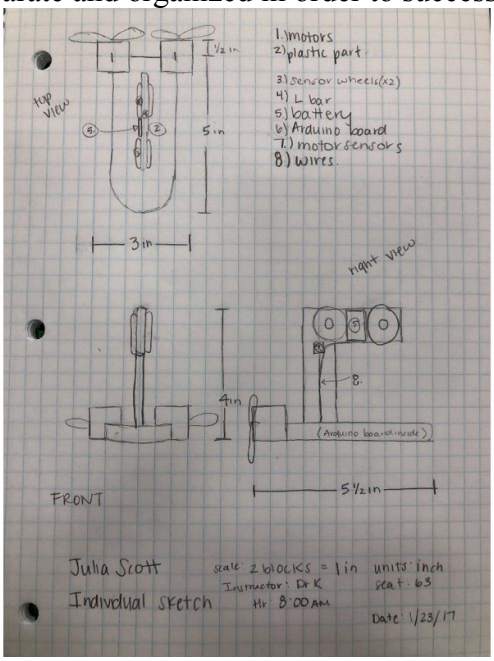


Figure 3: Design J

Julia choose her design based on efficiency and safety. The base is a shape of a submarine. The nose of the AEV comes to a subtle point. WHile, the propellers are on the direct back of the AEV to move the AEV forward. The batter and wires are all between the wheels on top of the track. This allows for more passengers to get on and of the AEV. It would also make it easier for maintenance to fix the AEV is something goes wrong as it is all in the same place. Julia estimates the weight to be about 300 grams and the cost to be about $160.00.

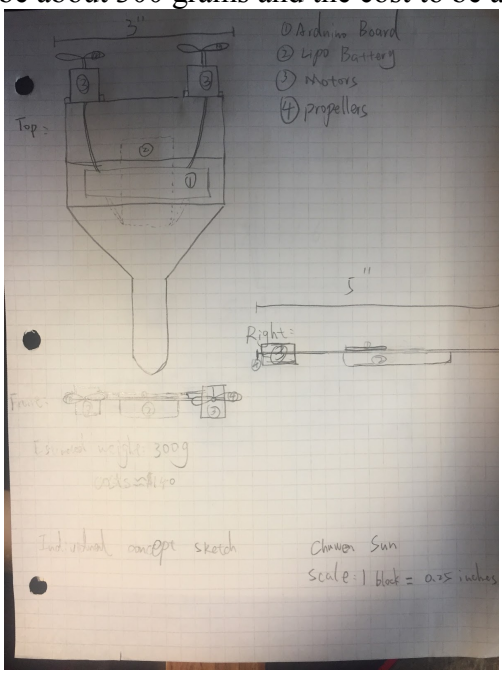


Figure 3: Design C

Chuwen's AEV design was based on durability, stability, and efficiency. Chuwen placed the Lipo Battery under the plastic board and placed the Arduino board on the plastic board. By doing some curve and holes about the plastic board, an engineer could connect the Arduino board and battery through the plastic board. This will allow for the company to save space and make the AEV more stable with the plastic board. Chuwen estimates the weight to be about 300 grams and cost about $155.00.

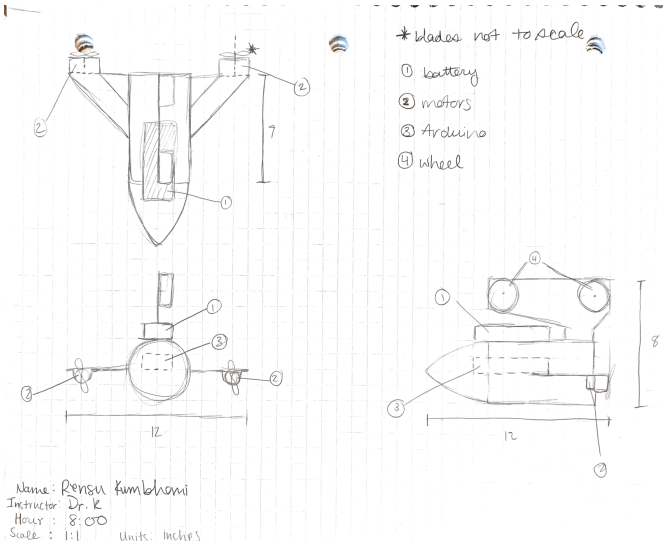


Figure 4: Design R

Rensu choose her design to resemble an airplane. By resembling an airplane it would minimize air resistance and drag. Rensu gave the body a pointed nose and wings in the back. Rensu placed the Arduino inside the AEV and the battery on top. The propellers and motors are attached to the wings and placed towards the rear of the AEV for safety reasons. Rensu did realize after designing it might have been a better idea to place the Arduino in a different compartment. Rensu estimates the weight to be 500g and cost about $160.00.

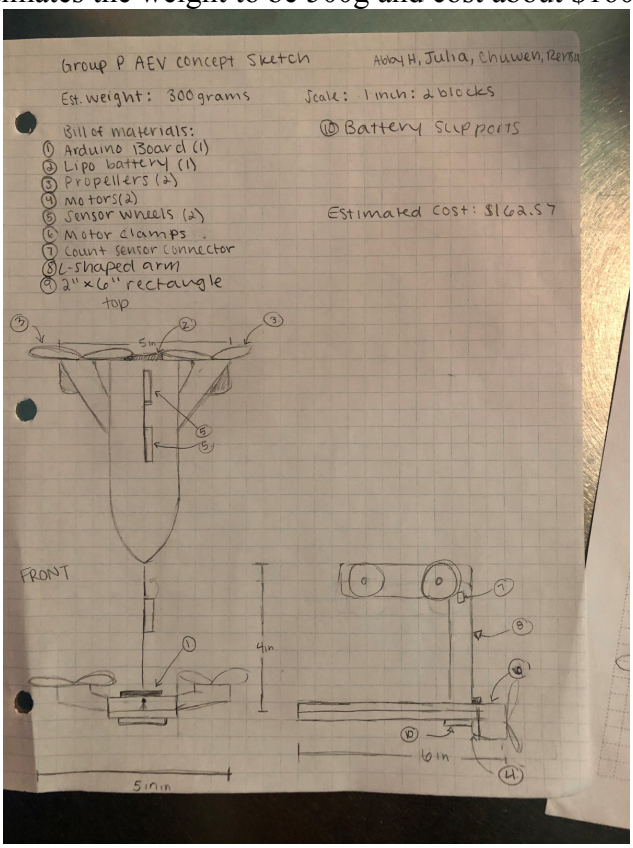
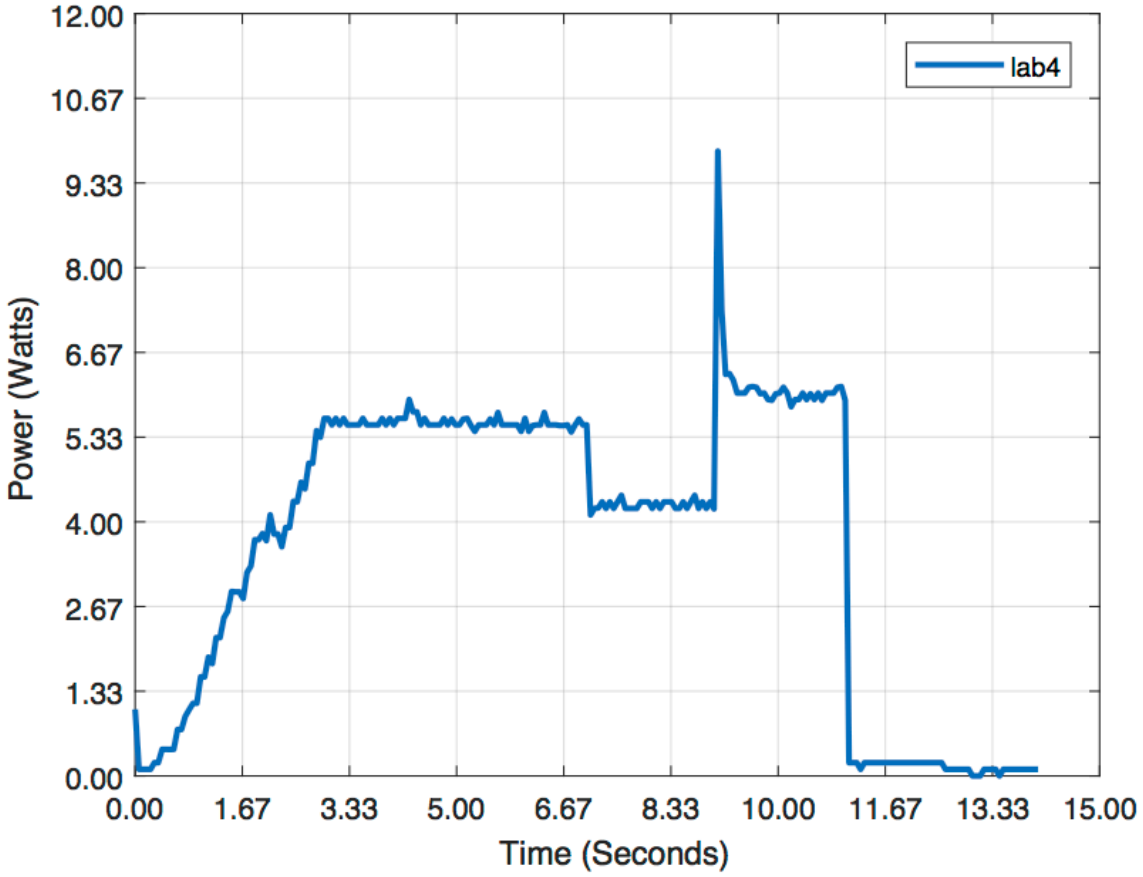


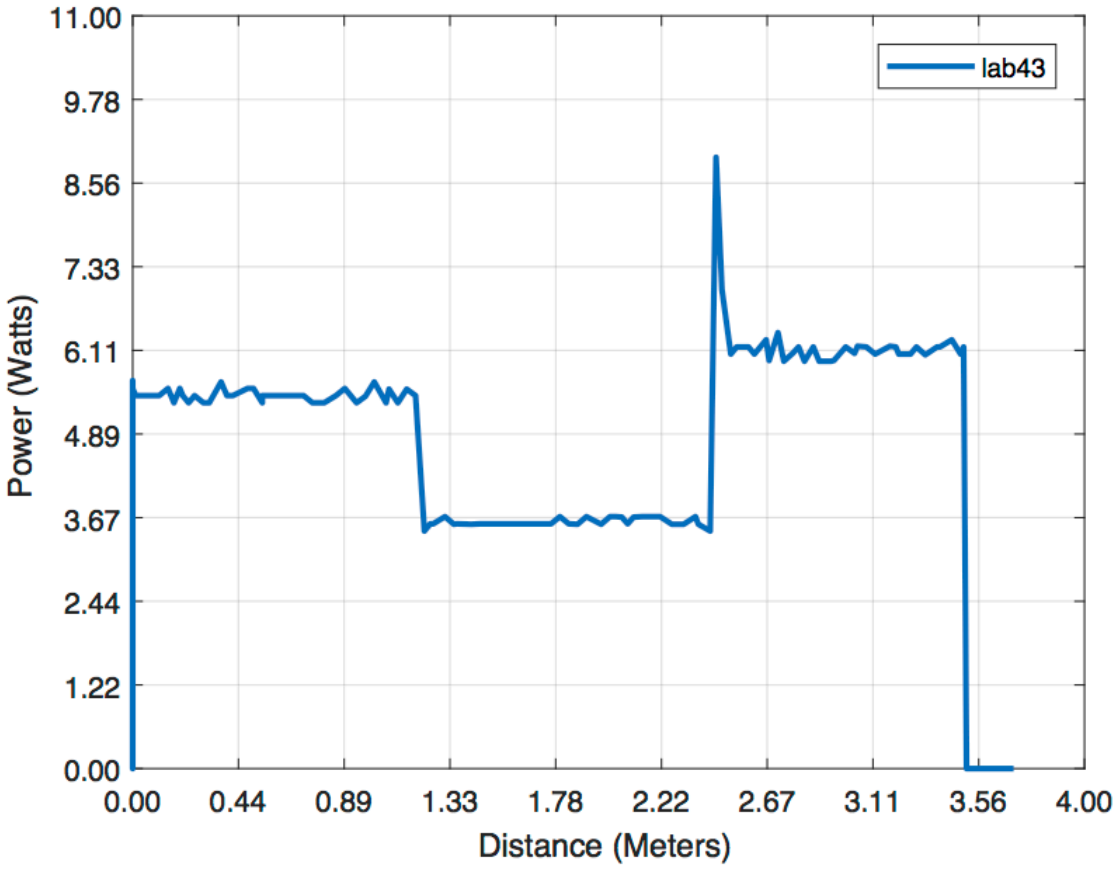
Figure 5: Team Design

The team decided to make an efficent design based on safety and stability. The team sketch weighs about 400 grams. The cost to build the AEV is about $160.00. The decided to combine everyone's sketch in some way. The propellers are in the back on the AEV closely aligned with Chuwen’s and Rensu’s design. The battery is located on the back side of the AEV resembling a wall so passengers do not fall off the AEV when it is moving. The wires and motor sensors will be in/ wrapped around the L bar like Julia’s and Abby’s design.The team tried to incorporate a goodaspect of everyone’s AEV.



Graph 1: Power vs. Time

Above is a graph of Power versus Time of the AEV. As the graph is increasing, from 0 to 3 seconds, the motors are accelerating from 0% to 25% power. The plateau that occurs for approximately 4 more seconds represents the motors at a constant 25% power. Then when the graph suddenly decreases, the motors' power is being decreased to 20%. They stay at this power for about 2 seconds. The spike represents when the motors reverse, and the line coming out of the spike is when the motors are at a constant speed of 25% again for another 2 seconds. The sudden drop is when the motors are braking to a stop.



Graph 2: Power versus Distance

The graph above was also made using the data analysis tool and represents power versus distance. When the motor is powering up from 0% to 25%, the AEV moves approximately 1 meter. As the power decreases to 20%, it moves another 1.5 meters. As the motors reverse the direction of the propellers, it moves just a fraction of a meter forwards before switching directions. As soon as the motors are back up to a power of 25%, the AEV moves another meter in the opposite direction before the motors brake and come to a stop. The AEV has moved about 3.5 meters over the whole test run.

Success Criteria	Design A	Design J	Design C	Design R	Team Design
Stability	0	0	+	+	+
Durability	-	-	-	0	+
Maintenance	0	+	+	-	0
Safety	0	+	+	-	0
Efficiency (cost/energy)	0	+	-	0	-
Sum +'s	1	2	2	1	2
Sum 0's	3	1	1	3	2
Sum -'s	1	2	2	1	1
Net Score	0	0	0	0	1
Continue?	Combine	Combine	Combine	Combine	Yes

Chart 1: Concept Screening Matrix

Success Criteria	Weight	Design A		Design J		Design C		Design R		Team Design	
Stability	25%	3	.75	3	.75	4	1	4	1	4	1
Durability	15%	2	.3	2	.3	3	.45	2	.3	4	.6
Safety	30%	3	.9	4	1.2	1	.3	3	.9	3	.9
Maintenance	10%	4	.4	1	.1	3	.3	3	.3	3	.3
Efficiency	20%	2	.4	4	.8	2	.4	2	.4	2	.4
Total	100	-	2.7	-	3.1	-	2.4	-	2.9	-	3.2
Continue?	-	No	-	Yes	-	No	-	No	-	Yes	-

Chart 2: Concept Scoring Matrix

The criteria for the concept screening and scoring matrices were chosen based on the safety of the AEV in the lab and in the real-life situation. The stability of the AEV is the balance or the vehicle's strength to stand when on the rails, whereas the durability is how well the AEV is able to withstand wear, pressure and/or damage. Durability also comes with another factor, which is maintenance. This is how often parts of the AEV will need to be fixed, put back on, or cleaned. Efficiency has two aspects- cost and energy. The goal is for the AEV to be energy efficient, which means it used the least amount of energy and does not waste any, and the AEV should also be cost efficient, which means the cost of all the parts should be minimized, while the design of the AEV is still maximized. Lastly, and most importantly, is the safety of the AEV and the people who are going to be travelling on it. This means that the AEV follows all considerations in the lab manuals, nothing is falling off (safe in lab environment), and the physical design of the AEV would be safe for customers to ride in.

There were pros and cons to each of the five concept sketches made by team P. Design A is not very durable and can break easily, but it is fairly safe and efficient. Design J is highly safe and efficient, but not very durable, so there would be a lot of maintenance involved. On the other hand, Design R has wings that create stability and safety, but it is not as energy and cost efficient. Design C is balanced and not too hard to keep in-tact, but falls low on the highly important safety rating. The Team Design is overall the best design with high stability and durability when on the rails, but could definitely improve on the cost efficiency and safety, which is something that can always be improved upon. Since Design J and the Team Design have the highest ratings on the concept screening and scoring tests, we will be using these two designs as the ones we will test going forward in the project. This lab made it easy to pick out which criteria are most important when designing the AEV and gave us a better idea of what aspects should be incorporated into our design going forward.

Takeaways

The material given for the AEV brought some troubles to group P in the process of testing the AEV. For instance, the propeller broke during testing and our count sensor connector did not work the same as the one on the tutorial. In addition, the coding takes a lot of time to complete before we are ready to test. We learned to be careful and innovative when dealing with the materials and to have the codes prepared before coming to class. On the other hand, new engineering techniques introduced this semester, such as Solidworks and Arduino coding, are difficult to use for the first time, but we gradually got familiar with these skills after a few classes and a lot of practice. Lectures from the professor and discussion between group members helped us a lot on the learning process of Solidworks and Arduino coding. We have gotten along well with each other as a group and this semester will go really well as long as we stay willing to help each other, ask questions and put in the effort required to do well.

Weeks 5-7

Situation

Team P will be investigating multiple items over the next few weeks. We'll be looking at the body of the AEV and how it performs in the tests in the upcoming lab. We'll be looking at its durability, safety and overall efficiency. The importance of performing these tests is that they will help to improve our AEV model overall. We'll be testing the different aspects of the model through several experiments through lab this week.

The topic that our team, Team P, chose for the advanced research and development labs is battery testing. Over the course of the nest few weeks we will be doing research on battery testing for AEVs and conducting a few experiments regarding the results of our research.

Weekly Goals

In week 5, the main goal for Team P is to submit the committee meeting notes and Grant vote by 8:00 AM on February 14th. Team P also will complete the Grant Proposal on February 14th and submit it to carmen by 8:00PM. During Lab, Team P's goal is to finish R&D 1 and start R&D 2. The group this week will meet outside of class once this week.

In week 6, Team P will finish R&D 2 and update the Website by Friday the 23rd. The team will get together once outside of class to discuss issues, ideas, or questions about the Website or Oral Presentation.

In week 7, Team P goal is for Rensu to submit the URL to Carmen on February 27 by 6:00 PM. Team P will start the R&D Oral presentation on February 26 at 5:30 PM and write the script for 30 minutes. Team P will record and submit the rough draft Oral Presentation on February 28th.

In week 8, Team P will meet during the weekend to start the progress report. During the week, the goal is to complete the progress report on March 6th at 8:00PM for Chuwen to revise, edit and submit on Carmen.

Weekly Schedule

In week 6, the committee meeting and Grant Vote is due on February 14th. Team P will reach out to the committee on February 12th. This meeting will take about one hour. Then, Abbie will submit the meeting notes on Carmen before 8:00 PM. Team P will evaluate each groups members input and discuss what is best for our team on February 14th and turn in our Grant Vote at 8:55AM on February 14th. Once the grant vote is complete, The team will get together on February 14th at 6:00pm and take one hour to write the grant proposal. On February 15th, Julia will edit the grant proposal before submitting it on 8:00PM.

In week 7, during lab, Team P will be finishing advanced R&D 1 and 2.Team P will begin to work on the website update on February 23rd at 5:00 PM. When Team P is together they will divided the work equally. Team P will start to fill in the missing website detail. Rensu will check the website for any grammatical errors on the website in week 8.

In week 8, Rensu will submit the URL to Carmen on February 27 at 6:00 PM. Team P will start the R&D Oral presentation on February 26 at 5:30 PM and write the script for 30 minutes. Team P will record the Oral Presentation on February 28th.

Overall, the preliminary research and design labs were very helpful in getting team P familiar with the AEV project, coding, and design process and has given us some good ideas and considerations when moving forward.

Appendix A

Meetings Notes

Meeting #1:

Attendances

- Abby Hallock
- Chuwen Sun
- Rensu Kumbhani
- Julia Scott

Location

Hitchcock Hall 224

Time

8:00 AM – 9:20 AM 1/10/2018

Topics

- Complete the AEV Kit Checklist
- What might be tested, designed or modified for the AEV?
- Minimizing of force of friction (Chuwen)

1. Modifying motor power when the elevation of the track changes (Abby and Julia)
2. 3D printing may be tested if additional parts may be needed (Abby)
3. Coding program and structure of AEV will be designed (Abby)
4. Structure test coding (Rensu)
5. Acceleration and deceleration (Julia)
6. Direction changing (Julia)
7. Amount of weight pulling down (Julia)

Assigning Future Tasks

- Take notes when group meeting (Abby)
- Carry the AEV kit box (Rensu)
- Reminders on due dates and staying on task (Julia)
- Debugging coding (Chuwen)
- Be familiar with AEV solidworks and start exploring and learning coding knowledge of AEV (Every group member)

Meeting #2:

1/17 at Hitchcock

All members present

Objective: Finish Procedures for Labs 1 and 2 from preliminary R&D

Tasks: Abby & Rensu- code for lab 1, Julia & Chuwen- setup for lab 1, All- test lab 1

Abby & Rensu- set up sensors and reflectance test, Julia & Chuwen- build model

Future work: test lab 2, sketches for lab 3, prepare & code for lab 4

Meeting #3:

1/24 at Hitchcock

All members present

Objective: Finish building the sample AEV and finish procedures for Labs 2 and 4 (including the reflectance sensor test)

Tasks: Abby & Rensu- worked on reflectance sensor test, Julia & Chuwen- set up AEV, All-test lab 2 and start to test 4

Major set back on lab 2!!
Future work: plot graphs for lab 4, sketches for lab 3, prepare for lab 5
Meeting #4:
1/30 at CBEC building
All members present
Objective: Complete procedure for preliminary R&D Lab 3
Tasks: Draw individual sketches- Rensu, Chuwen and Julia, update website deliverables and meeting notes- Abby, complete a team sketch with bill of materials and estimated weight- all
Future Work: Plot graphs for lab 4 during lab on 1/31 and complete lab 5
Meeting #5:
1/31 at Hitchcock
All members present
Objective: Testing for lab 4 and complete procedure for lab 5, then update website and progress report questions if time
Tasks: Create charts for lab 5 and update meeting minutes- Abby, set up for lab 4- Rensu, test lab 4- all, complete matrices for lab 5- all
Future Work: Update all website deliverables and progress report questions. Begin to make improvements to AEV and start testing designs

Appendix 2

Arduino Code

Lab 1:

```
celerate(1, 0, 15, 2.5);
motor(1, 15);
goFor(1);
brake(1);
celerate(2, 0, 27, 2.7);
motorSpeed(2, 27);
goFor(2.7);
celerate(2, 27, 15, 1);
brake(2);
reverse(2);
celerate(3, 0, 31, 2);
motorSpeed(4,35);
goFor(1);
brake(2);
motorSpeed(1,35);
goFor(3);
brake(4);
goFor(1);
reverse(1);
celerate(1, 0, 19, 2);
motorSpeed(2, 35);
motorSpeed(1, 19);
goFor(2);
motorSpeed(4, 19);
goFor(2);
celerate(4, 19, 0, 3);
brake(4);
```

Lab 2:

```
motorSpeed(4,25);
goFor(2);
motorSpeed(4,20);
goToAbsolutePosition(295);
reverse(4);
motorSpeed(4,30);
goFor(1.5);
brake(4);
```

Lab 4:

```
celerate(4,0,25,3);
goFor(3);
motorSpeed(4,25);
goFor(1);
```

```
motorSpeed(4,20);
goFor(2);
reverse(4);
motorSpeed(4,25);
goFor(2);
brake(4);
```