ENGR 1182 Progress Report 1 - Group C

Matthew Zirbel, Jacob Manion, Nick Folino, Joe Jerig

Lab 1:

Backwards looking summary:

For this lab, the group had to set up the motors, arduino, and battery, and run the motors. The goal was to learn the basics of arduino control, setting up the AEV software, and to ensure that all motors worked properly. On the first lab day, the group was not able to set up the arduino code in time to test the setup, but managed to set up the motor mount, arduino, and wiring. The group also got the majority of the way through the arduino setup. The next lab day, the team managed to test the motors, and managed to get everything working without any problems.

The lab equipment used was the AEV motor mount, the AEV Controller, two motors, the USB cable, and the Li-Po Battery. The importance of the motor lab was to understand how the motors worked, how the propellers worked, and how to control them with arduino code. The team learned a lot about the motors, such as the way that they spun. The motors did not spin on below 15% power, indicating that the power supplied to the motor was outweighed by the torque required to spin the blades. In terms of how the arduino functioned, the coding had to be very specific and the results of the coding were often times less precise than intended. This resulted in the coding increasing in length as it took more coding to specify how the arduino should function. The takeaways for the group were a fundamental knowledge of how the arduino and motors worked, and the successful setup of the arduino code.

Forwards Looking Plan:

The upcoming lab is based around understanding the reflectance sensor equipment. This next step will primarily include the reflectance sensors, which are the focus of lab 2. The objectives of the upcoming activity are to become familiar with the external sensor hardware, to learn the troubleshooting techniques for it, and to understand the function calls associated with the external sensors. To ensure that there is sufficient time for the activities during the lab time, some of the upcoming tasks will need to be assigned to members of the group. The tasks for each group member were: Matthew - write arduino code for upcoming lab, Joe, Nick and Jacob - Construct sample AEV. For the tasks, Joe, Nick and Jacob will need the AEV parts, and Matthew will only need his computer. The team's goal of setting up the reflectance sensors in proper, working order must be completed by the next lab day at the beginning of class.

The group will also need to complete the web deliverables listed at the end of the lab. The website deliverables will require equal participation from all members, and will need to be completed by the time of the next lab day.

Lab 2:

Backwards Looking Summary:

The lab was to set up the reference AEV based off of the online model, and properly set up reflectance sensors on it. The objectives of the lab are to become familiar with the reflectance sensor components, troubleshooting techniques, and how to program using the reflectance sensors. The lab equipment used was the AEV, external reflectance sensors, zip ties, USB cable, Li-Po battery, and the desktop stand. The procedure for the lab was to attach the reflectance sensors to the L-arm using the zip ties. After ensuring that the reflectance sensors were attached correctly, the team used the program which had been written by Matthew to test the reflectance sensors and the reference AEV. The reference AEV, code, and reflectance sensors all worked properly. The results of the reflectance sensor test were correct, with the motors stopping correctly with the use of the goToAbsolutePosition function. The reflectance sensors were shown to be accurate at reporting the distance travelled by the AEV. This means that they will be crucial in later stages to ensure that the AEV travels the correct distance.

Without careful planning, the commands used in this lab can restrict the programmer and therefore limit the functionality of the AEV. For example, the brake command will not cause the AEV to stop immediately, it simply stops the motors. To fix this, the programmer has to add additional lines to decelerate the AEV. Because of this, the team concluded that careful planning would be needed in future coding of the AEV to ensure the vehicle moves as intended. The important takeaways from the lab are the importance of reflectance sensors due to their accuracy in going specific distances it's programmed to, and that care must be taken when coding to ensure that the AEV uses the reflectance sensor data correctly to stop when it needs to.

Forwards Looking Plan:

The upcoming lab is based around creative thinking. The objectives of the lab are to begin designing the AEV, and to think through ideas for testing. To successfully do this on the next lab day, the team will need to brainstorm ideas about how to design the AEV. Each group member will need to construct their own idea for an AEV, draw it in an orthographic view, and dimension it. The drawings will need to be completed for the next lab day, and will need to ensure that all design considerations are met. The group will also need to complete the web deliverables listed at the end of the lab. The website deliverables will require equal participation from all members, and will need to be completed by the time of the next lab day.

On the day of the next lab, the schedule will include time to brainstorm as a group before collaborating on an orthographic drawing. The orthographic drawing will also need to ensure that all design considerations are met. The team will also need to employ creative design thinking techniques to ensure that design ideas are not overlooked.

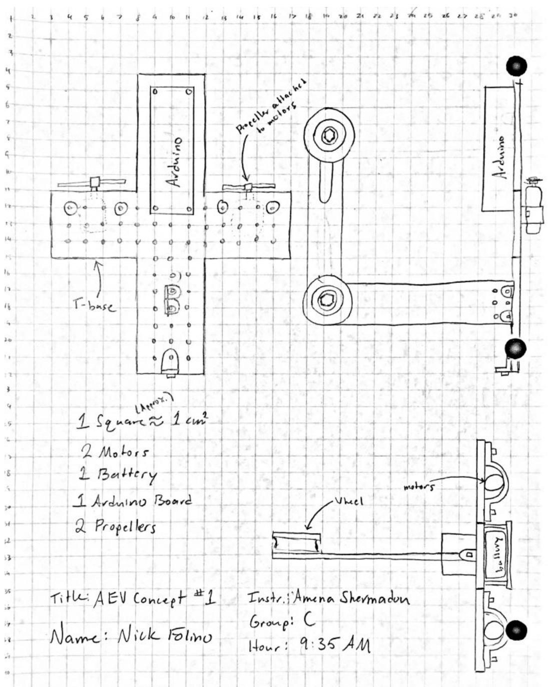
Lab 3:

Backwards Looking Summary:

The goal of the lab was to familiarize the group with creative design thinking techniques, obstacles to creativity, and to create concrete ideas for the AEV by making orthographic drawings of our ideas. There was no necessary lab equipment as the lab was focused on drawings and ideas. The lab focused on aspects of creative thinking design techniques, such as brainstorming, attribute listing, fail fast, and drawing. An example of fail fast design thinking is Matthew's servo powered design, which turned out not to be viable, as the servo is not able to rotate continuously. The takeaways from the lab are the creative design techniques the group learned, and the designs each group member created. The designs and reasons behind them, as well as the bill of materials, are listed below:

Nick:

The goal of this design was simplicity and functionality, ignoring appearance, for a small number of potential sources of error. The design aims to be successful in reaching the overall goal of the vehicle by minimizing weight and air resistance to make it as agile as possible.

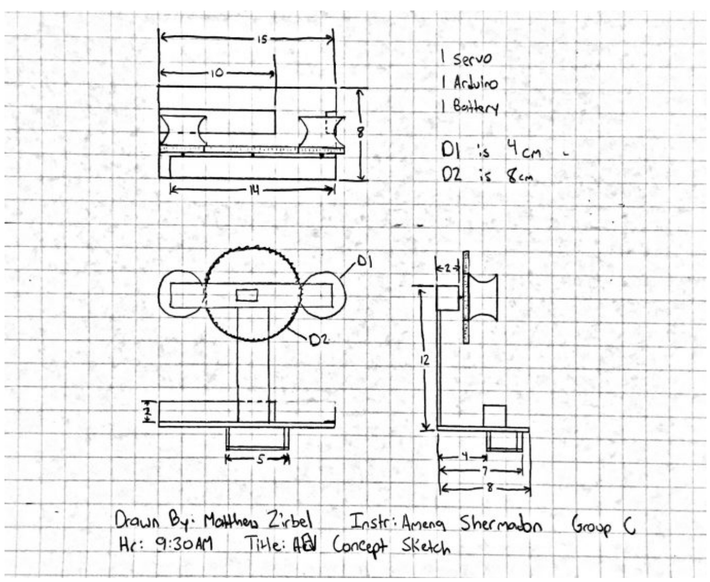


Bill of materials:
Arduino x1 - $100,000
Electric Motor x2 - $19,800
Count Sensor x2 - $4,000
Count Sensor Connector x2 - $4,000
Propeller x2 - $900
X-Shape x1 - $2,000
Motor Clamp x2 - $1,180
L-Shape Arm x1 - $3,000

Wheel x2 - $15,000
Battery Support x1 - $1,000
Angle Bracket x2 - $1,680

Estimated Total Cost: $152,560
Estimated Weight: 450 grams

Matthew:
The central idea of this design was to avoid using the motors as propellers. Instead, the design used the servo to drive the wheels. The purpose of this was reliability and power usage, as directly powering the wheels will be more consistent, and will also take less power since all the power will go to moving us forward, instead of moving air around. This design will require four 3D printed components: the large gear which will be attached to the servo, the two wheels, which will need to include gears so they can be pushed by the servo, and the piece which will hold everything together. This design is quite different from the traditional design, as it does not use the propellers at all.

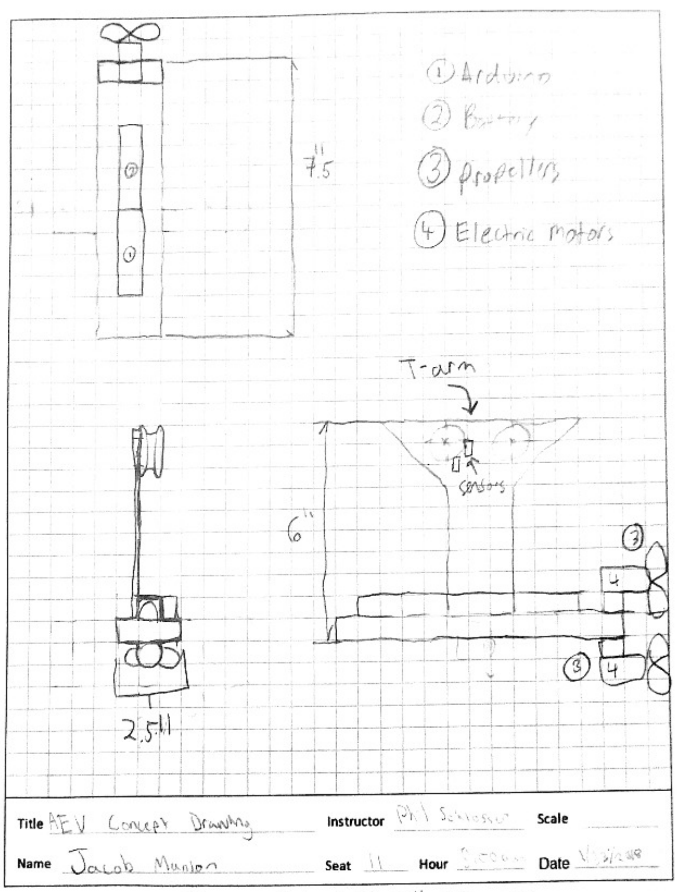


Bill of materials:
Arduino x1 - $100,000
Count Sensor x2 - $4,000
Count Sensor Connector x2 - $4,000
T-Shape x1 - $2,000
Battery Support x1 - $1,000
Angle Bracket x2 - $1,680
3D Printed Wheel x2 - $2,000
3D Printed Gear x1 - $1,000

3D Printed Wheel and Gear mount x1 - $2,000
1” x3” Rectangle x1 - $1,000
2.5” x7.5” Rectangle x1 - $2,000

Estimated Total Cost: $120,680
Estimated Weight: 350 grams

Jacob:
The idea of this sketch is to minimize the drag of the AEV. It uses vertically aligned propellers to focus on pushing the AEV. In addition the breadboard and the battery will be both on top of the AEV so there are no loose parts on the bottom. This design successfully reduces weight, cost and maximizes agility. The T-Arm is also an advantage over the L-arm because it makes the AEV less likely to tilt forwards and backwards while moving, increasing stability.

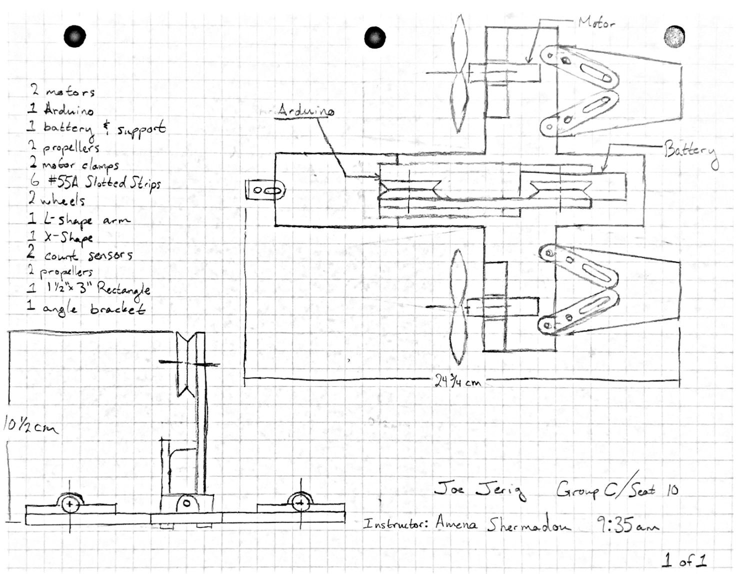


Bill of materials:
Arduino x1 - $100,000
Electric Motor x2 - $19,800
Count Sensor x2 - $4,000
Count Sensor Connector x2 - $4,000

Propeller x2 - $900
2.5” x7.5” Rectangle x1 - $2,000
Motor Clamp x2 - $1,180
T-Shape Arm x1 - $3,000
Wheel x2 - $15,000
Battery Support x1 - $1,000
Angle Bracket x2 - $1,680

Estimated Total Cost: $155,560
Estimated Weight - 400 grams

Joe:
The goal of this design was to balance functionality and aesthetic design. The X-Shape base provides a solid base for the propellers, although it does require being turned so that the longer sections point to the sides, to give the propellers enough room. To ensure enough room at the front for the magnet, an extra rectangle had to be added. This base is one of the simpler possible bases, but the trapezoids at the back of the "wings" add an aesthetic effect, as well as adding momentum to get up upward slopes in the track.

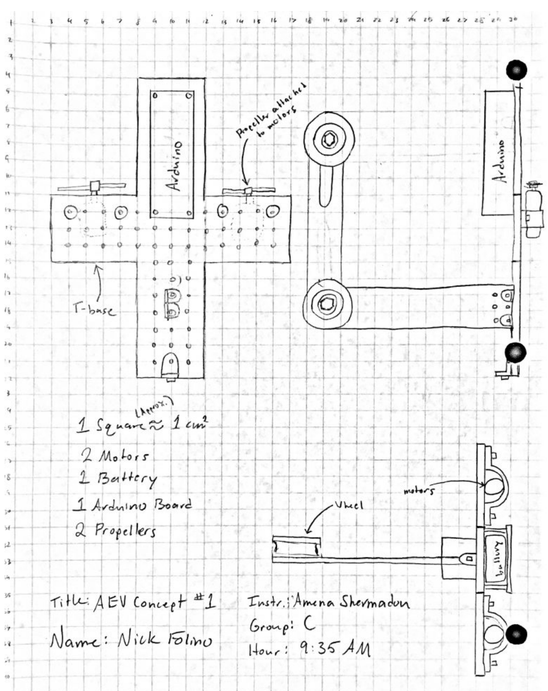


Bill of materials:
Arduino x1 - $100,000
Electric Motor x2 - $19,800
Count Sensor x2 - $4,000
Count Sensor Connector x2 - $4,000
Propeller x2 - $900
X-Shape x1 - $2,000

Motor Clamp x2 - $1,180
L-Shape Arm x1 - $3,000
Wheel x2 - $15,000
Battery Support x1 - $1,000
Angle Bracket x6 - $5040
#55A Slotted Strip, 2” x4 - $5,040
Trapezoid x2 - $2,000
1.5”x3” Rectangle x1 - $1,000

Estimated Total Cost: $152,560
Estimated Weight: 650 grams

Team Concept Sketch:



The scale of the drawing is 1 square = 1.5 cm

Bill of materials:
Arduino x1 - $100,000
Electric Motor x2 - $19,800
Count Sensor x2 - $4,000
Count Sensor Connector x2 - $4,000
Propeller x2 - $900
T-Shape x1 - $2,000
Motor Clamp x2 - $1,180

L-Shape Arm x1 - $3,000
Wheel x2 - $15,000
Battery Support x1 - $1,000
Angle Bracket x2 - $1,680

Estimated Total Cost: $152,560
Estimated Weight: 450 grams

Forwards Looking Plan:

The upcoming lab is based around the design analysis tool. The goal of the lab is to become familiar with the matlab design analysis tool, learn to upload arduino data to the design analysis tool, understand the information given by the design analysis tool, and export the graphs given by the design analysis tool. The lab equipment used for the upcoming lab will be the reference AEV, external sensors, Li-Po Battery, and the rail. To prepare for the lab, the design analysis tool will need to be installed on Matthew's computer, which is currently the main computer used for coding. For the next lab day, Matthew will install the design analysis tool, and the rest of the group will complete the web deliverables listed at the end of lab 3. The website deliverables will require equal participation from all members, and will need to be completed by the time of the next lab day. During the lab, the group will need to write the code for the AEV to use, run the code, and then use the design analysis tool to generate graphs of power vs. time and power vs. distance.

Lab 4:
Backwards Looking Summary:

The goal of the lab was to become familiar with the matlab design analysis tool, learn to upload arduino data to the design analysis tool, understand the information given by the design analysis tool, and export the graphs given by the design analysis tool. The lab equipment used for the upcoming lab was the reference AEV, external sensors, Li-Po Battery, and the rail.

The group wrote and used the code required by the lab, and exported it to the design analysis tool successfully. The results from the design analysis tool can be found in the appendix. The graph of power vs. time represents the power used over the course of the arduino code running. The first three seconds are the acceleration up to 25%, then leveling out for a second, before the motor is set to 20% for two seconds, between seconds four and six. The motor then runs in reverse at 25% power for two seconds, before dropping to zero as it brakes. The height along the y-axis refers to power used by the motors, which translates very nearly to how fast the propellers are spinning. The Power vs. Distance graph is simply a vertical line, with the highest point being at 6 Watts. This is because the AEV did not move at the low powers the propellers were set at, and so all points were at distance 0; some takeaways for this would be that the AEV needs a high initial power setting to start moving and that the weight of AEV plays a large in role in determining the minimum initial power needed to move the vehicle.

Forward Looking Plan:

The upcoming lab is based around screening and scoring the designs made in lab 3. The objectives of the lab are to become familiar with the decision making processes of screening and scoring techniques, and perform the techniques on our designs. The plan is to screen and score the designs created in lab 3. To ensure that the lab runs smoothly, all members are expected to completely finalize their design by the beginning of the next lab day, so that the scoring and screening can be completed on time. The group will also need to complete the web deliverables listed at the end of lab 4. The website deliverables will require equal participation from all members, and will need to be completed by the time of the next lab day.

Day → Member	Tuesday	Wed. - Friday	Saturday	Sunday	Monday
Jacob	Record Lab info	Design	Assess Design	Group Meeting	Prepare for lab
Nick		Design	Assess Design	Group Meeting	Prepare for lab
Matthew	Finalize programming	Design	Assess Design	Group Meeting	Prepare for lab
Joe	Post meeting minutes	Design	Assess Design	Group Meeting	Prepare for lab

Tuesday:
Each group member will complete their roles layed out over the course of the last two labs.

Wednesday- Friday:
Each group member will finalize their design for their AEV for the concept screening and scoring.

Saturday:
Group members will assess their design in preparation for Lab 5.

Sunday:
Group meeting.

Lab 5:
Backwards Looking Summary:

The lab objectives were to become familiar with the method of screening and scoring design concepts, and then apply the methods to our designs. The results of the group's screening and scoring tables are below:

Table 1:

Success Criteria	Reference AEV	Matthew's Design	Joe's Design	Nick's Design	Jacob's Design
Stability	0	+	+	0	+
Agility	0	+	+	+	+
Safety	0	-	0	0	0
Cost	0	+	-	0	0
Functionality	0	-	0	+	0
Total Positives	0	3	2	2	2
Total Negatives	0	2	1	1	0
Net Score	0	1	1	1	2
Continue?	No	Combine	Combine	Yes	Yes

Table 2:

		Reference		Matthew's Design		Joe's Design		Nick's Design		Jacob's Design	
Success Criteria	Weight	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score
Stability	20%	3	0.6	4	0.8	4	0.8	3	0.6	4	0.8
Agility	25%	3	0.75	4	1	3	0.75	5	1.25	5	1.25
Safety	20%	3	0.6	1	0.2	4	0.8	4	0.8	4	0.8
Cost	15%	3	0.45	5	0.75	2	0.3	3	0.45	3	0.45
Functionality	20%	3	0.6	1	0.2	3	0.6	4	0.8	3	0.6
Total Score			3		2.95		3.25		3.9		3.9
Continue?		No		No		No		Develop		Develop	

The group decided on the five main systems for scoring designs by looking at the goals of the AEV project. Stability is important because a stable design will not fall of the track and will reduce the amount that it sways while moving, improving the chances of success. An agile design will be light and able to accelerate and decelerate quickly. This makes agility important, as it will reduce the time and energy required to reach the end. Agility scores were based off of the weight and the amount of thrust the designs were likely to get. Safety is very important because a safe design will reduce the amount of loose parts and reduces the likelihood of damage. Cost is also a major factor, as lower costs are better. The cost scoring was based off of the total costs of the designs, with the lowest estimated cost having the highest score. Functionality measured the overall viability of the design, such as being practical and be able to complete the goals outlined by the company.

The reasoning for Matthew's design's low safety score was the gears which could pinch fingers of operators. The low functionality score was because the design was found to be unusable, as the servo cannot rotate continuously. Based off of the concept screening and scoring spreadsheets, the group decided to develop Nick and Jacob's design, as they scored highest by a significant margin. These designs did well because they provided simple solutions, which have a lower chance of unexpected problems, allowing them to score well in safety, stability, and functionality. The takeaway from the lab was the decision to continue the development of Nick and Jacob's designs, and the screening and scoring systems for narrowing down options.

Forwards Looking Plan:

For the advanced research and development, the group has chosen to research Servo Function and Coasting vs. Power Breaking. The first goal the group has set is to research Coasting vs. Power Breaking. The group will follow the procedure to test whether coasting or power breaking suits the AEV better. The group will test this by recording the power used and forward distance for each run, and use the mean and standard deviation of the distance to determine which system is more likely to move the AEV reliably, with the goal of the experiments being to determine whether coasting or power braking is a better option for the AEV.

Appendix:

Lab 1 Code:

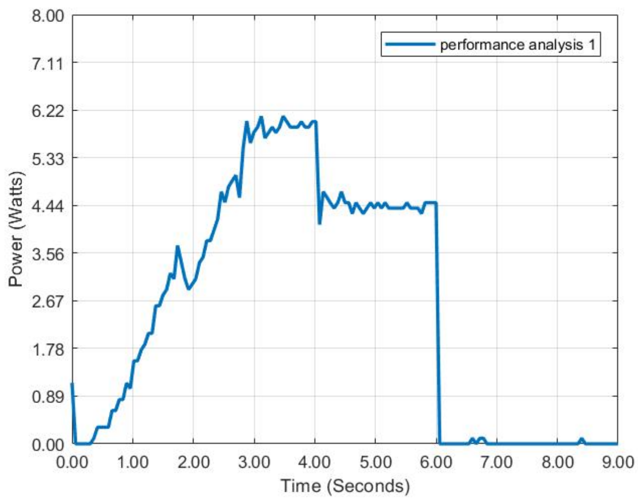
```
celerate(1,0,15,2.5);
goFor(1.5);
brake(1);
celerate(2,0,27,4);
goFor(2.7);
celerate(2,27,15,1);
brake(2);
reverse(2);
celerate(4,0,31,2);
motorSpeed(4,35);
goFor(1);
brake(2);
goFor(3);
brake(4);
goFor(1);
reverse(1);
celerate(1,0,19,2);
motorSpeed(2,35);
motorSpeed(1,19);
goFor(2);
motorSpeed(4,19);
goFor(2);
celerate(4,19,0,3);
brake(4);
```

Lab 2 Code:

```
motorSpeed(4,25);
goFor(2);
motorSpeed(4,20);
goToAbsolutePosition(12*12*(1/.4875));
reverse(4);
motorSpeed(4,30);
goFor(1.5);
brake(4);
```

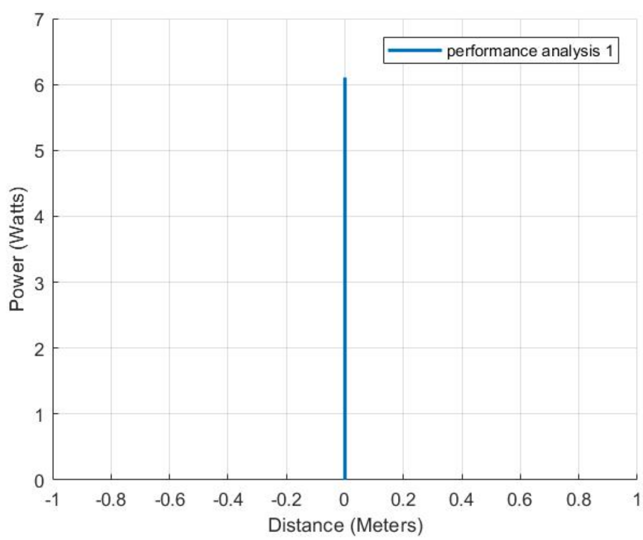
Power vs. Time Graph

Figure 1:



Power vs. Distance Graph

Figure 2:



Team Meeting notes:

Meeting 1

January 9, 2018
Time: 9:30 AM - 11:00 AM
Location: Hitchcock 224
Members Present:
Nick Folino, Joe Jerig, Jacob Manion, Matthew Zirbel

Activities:
Review parts list, ensure all parts are present
Discuss setup of website
Brainstorming for AEV
- Aerodynamic effects and Drag
- In-line vs side-by-side motor placement
- Weight and its effect on thrust

Establish means of communication - Using GroupMe

Goals for before next meeting:
Set up u.osu.edu website and complete Website Update 1

Meeting 2

January 16, 2018
Time: 9:30 AM - 11:00 AM
Location: Hitchcock 224
Members Present:
Nick Folino, Joe Jerig, Jacob Manion, Matthew Zirbel

Activities:
Testing motors
Set up Arduino code

Goals for before next meeting:
Finish setting up and writing arduino code
Sketch individual design ideas

Meeting 3

January 23, 2018
Time: 9:30 AM - 11:00 AM
Location: Hitchcock 224
Members Present:
Nick Folino, Joe Jerig, Jacob Manion, Matthew Zirbel

Activities:
Build example AEV
Test motors on example AEV
Test code on example AEV

Goals for before next meeting:
Set up AEV Analysis Tool

Meeting 4

January 28, 2018
Time: 6:00 PM - 10:00 PM
Location: Hitchcock 224
Members Present:
Nick Folino, Joe Jerig, Jacob Manion, Matthew Zirbel

Activities:
Website Update 2
Brainstorm and research for AEV design
AEV Design sketches

Goals for before next meeting:
Prepare for lab 5