

Situation (Weeks 1-4)

One problem facing many people in urban areas is a lack of transportation. Despite living in population-dense areas, citizens do not have access to regular food nor transportation to work which may be too far to reasonably walk to. In order to solve this problem, Koffolt Laboratories has been tasked with designing advanced energy vehicles as part of a monorail project to transport people to and from these isolated urban areas to areas where they can work and purchase goods to fulfill their needs. The team was tasked with helping create an efficient, reliable, safe, and sustainable monorail system. This began with the team first setting ground rules for the project. The team exchanged contact information as well as set up a GroupMe for communication. Following this, the team got familiar with the AEV and began setting up the motors and sensors. These features were tested using a program that can be found in the appendix. An Arduino IDE program was used to program the AEV, and this was set up in week 2.

The team ran into issues when programming the Arduino board, when the program would not run. Following this, the wires tended to become unattached from the board. These problems caused delays, but the team continued with the project. Each member of the team designed a concept sketch of an AEV that included conventional orthographic views of the design. The individual designs were made to fit each member's vision and ideas for how the AEV should be optimized to complete the mission, and the team voted on which one would be pursued.

Week 1

Results & Analysis

It was found that GroupMe would be the best way to stay in contact with everyone. Since two team members live on south campus, and two live on north, it was decided that meeting somewhere near central campus would work best. No specific roles were assigned yet, so no one member was assigned to a task at this point.

Week 2

Results & Analysis

The AEV motors were set up using the provided apparatus provided by the instructional team. The AEV sketchbook for Arduino IDE was downloaded and setup in the Arduino IDE application. A provided scenario was programmed in the Arduino program to test the motors using the aforementioned apparatus. This program can be found in Appendix A.

It was decided that the Arduino IDE programming would be done on Brian's lab computer. When trying to program the Arduino to run the motors in the provided scenario, there were many issues. The Arduino IDE program was displaying a message saying, "problem uploading to board." Somehow, the code was not being sent to the board properly. After consulting the instruction staff, a new USB cord was provided. The problem was still not resolved. Following this, a new Arduino board was provided. The program was then uploaded properly and ran. The setup of the AEV and Arduino was successful and is shown below in Figure 1.

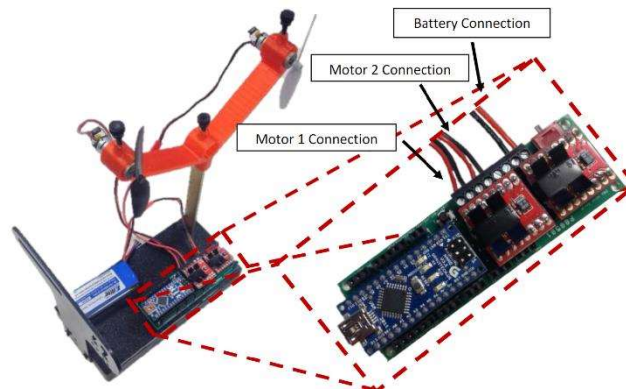


Figure 1: Arduino and AEV setup apparatus

Despite this, the propellers would not move because there was too much resistance. More problems were encountered when the program was run a second time on the new board. The rest of the lab was spent troubleshooting the program and motors. The team planned to meet up before the next week to fix the Arduino and motor system. When looking at the scenario, it called for a brake(m) command, which kills the power of the motors. It was noted that this would not actually “brake” the device, moreover would just have it coast to a stop. This could limit the AEV’s ability to stop quickly without a physical break.

There were a few sources of potential errors. When setting up the AEV system, it is possible that the team may have incorrectly put the apparatus together. This, as well as faulty equipment could have been the cause of the motors resisting to move. The equipment issues also contributed to the Arduino not running the program properly as well as the program not being sent to the Arduino board a number of times. To help prevent this, the team suggests that more guidance is needed throughout the preliminary portions of the lab to ensure that each team is on the right track. At often times with the website and the AEV setup, the team felt overwhelmed and though the process may have been too open-ended.

Week 3

Results & Analysis

After the group's lab process was delayed from the Arduino upload malfunctioning in the previous week, the team was determined to solve the error in order to complete the first activity and get back on track and complete the activity for the current week. As a result of not being able to solve the issue from the previous week, the group still needs to figure out why the Arduino code will not upload using the USB cable. In addition to addressing issues from the previous week, the group will need to focus in order to complete the previous week's exercises and current week's exercises. Exercise 3 will be done outside of class because the group is behind and it is the most simple exercise that the group can do without an of the resources in lab.

The cause of the Arduino malfunctioning turned out to be a result of an error on the Arduino desktop app, and once the app was reset, the code upload went smoothly. Shortly after the code was uploaded to the Arduino Nano, the sample AEV concept was constructed to the setup specified in the diagram.

Unfortunately, one of the wires connecting the motors to the Arduino snapped, causing another delay in the progress of our team's lab. After consulting a TA, the wire was fixed and we were able to test out the sample AEV. After all of the materials were fixed and assembled, the designated time for lab had ended,

so we had to clean up the workspace with about as much progress as we had going into Week 3 of lab. After very little testing, the group was able to get an idea of how the code was going to be working throughout lab this semester. Clearly, there will be a slight delay of transferring the code's commands to the board, and it will have a slight impact on the effectiveness and precision of the AEV once it is up and running on the tracks.

Week 4

Results & Analysis

Each member of the team designed a concept sketch of an AEV that included conventional orthographic views of the design. The individual designs were made to fit each member's vision and ideas for how the AEV should be optimized to complete the mission. From there, the team discussed and decided on a design that all members could agree upon to strike a middle ground.

Though three out of the four designs had the main body of the AEV oriented horizontally, the design that was decided on was Max Doucette's AEV Concept. This design and all individual designs can be found in Appendix C. This decision was made to minimize the amount of surface area perpendicular to the direction of travel, which the group believed would minimize air resistance without having to add additional aerodynamic features. Team R also believed this design would assist with stability, as the team thought there would be less torque applied on a vertically oriented AEV as there is less weight distributed across the horizontal axis of the vehicle. Unfortunately, due to equipment problems and time constraints, a power over distance chart could not be made fully. However, a power over time graph was able to be plotted and it showed that the Arduino board was properly programmed and could execute commands issued to it properly. The charts can be found in Appendix B.

Takeaways (Weeks 1-4)

1. GroupMe – The team will use GroupMe as its primary source of communication.
2. Meetings – The team will plan to meet on weekends near central campus if necessary.
3. AEV kit – Alex will hold on to the AEV kit outside of lab and bring it to lab each week.
4. AEV kit – The current Arduino board has technical difficulties and may need replaced along with the hardware that comes with it.
5. Exercise 1 – Exercise 1 will need to be finalized outside of class.
6. Website – The website will need to be updated with the current code, design, and minutes.
7. General – it is important to take care of the equipment and properly write the code to ensure the Arduino runs properly.
8. Concept Designs - Each member needs to develop their own AEV concept sketch by the next time we meet and then select the best sketch to continue lab with and test.
9. AEV materials - It seems that many of the materials are breaking or are not working properly, so either the group needs to be more careful with the materials or the materials should be tested so that the lab process runs more smoothly for the following weeks.
10. Playing Catch-Up - After 2 straight weeks of not having fully functioning materials, the group will need to meet up some time outside of lab in order to get back on track and on pace with the other teams in the class.
11. The main design has been decided.

12. The team now has a fundamental design to suggest improvements to as ideas for improvement come to mind.
13. Ideas of what each member wants from the AEV have been shared and discussed.

Situation (Week 5-7)

In the next weeks, the team will work to further understand what aspects of the AEV work best, including propeller configuration and design concepts. The second set of research and development labs begin here, with different tasks being split between the teams in Koffolt Properties. Team R has elected to conduct research utilizing different propeller configurations and wind tunnel trials. This week will begin with Team R completing the propeller configurations testing. Team R will spend this week focusing on the results of the previously completed aR&D test 1 which focused on propeller configurations. Team R had committee meetings with the instructional staff to check on progress, as well as gave a grant proposal to the class in order to request money to make a custom shell for the AEV to improve aerodynamic features and safety. The team finished week 7 with completing wind tunnel testing to check which designs would work best aerodynamically.

Schedule (Weeks 5-7)

Week	Item No.	Task	Start	Finish	Due Date	Est. Time	Alex Short	Brian Glowacki	Max Doucette	Justin Beachy	% Complete
1/11/2018		Organizational Lab	1/11/2018	1/11/2018	1/11/2018	1.5 hrs	1.5	1.5	1.5	1.5	100
1/18/2018		Preliminary Lab 1	1/18/2018	1/25/2018	2/1/2018	1.5 hrs	1.5	1.5	1.5	1.5	100
1/21/2018		Preliminary Lab 3	1/21/2018	1/21/2018	2/1/2018	1.5 hrs	1.5	1.5	1.5	1.5	100
1/25/2018		Preliminary Lab 2 & 4	1/25/2018	2/1/2018	2/1/2018	1.5 hrs	3	1.5	1.5	3	100
2/1/2018		Preliminary Lab Wrap-Up	2/1/2018	2/1/2018	2/1/2018	1.5 hrs	1.5	1.5	1.5	1.5	100
2/8/2018		AR&D 1 (Propeller Configuration)	2/8/2018	2/22/2018	2/22/2018	1.5 hrs	1.5	1.5	1.5	1.5	40
2/14/2018		Finalize Grant Proposal	2/14/2018	2/14/2018	2/15/2018	4 hrs	3	1	1	1	0
2/15/2018		Committee Meeting 1	2/15/2018		2/15/2018	1.5 hrs					0
2/15/2018		Grant Vote	2/15/2018		2/15/2018	1.5 hrs					0
2/18/2018		Team meeting to prepare for aR&D test 2	2/18/2018		2/22/2018	2 hrs					0
2/22/2018		Complete aR&D Test 2 (Wind Tunnel Tests)	2/22/2018		2/22/2018	1.5 hrs					0
2/24/2018		Meeting to work on presentation	2/24/2018		3/1/2018	3 hrs					0
2/25/2018		Meeting to work on Web Update 3 and Prog. Report 2	2/25/2018	2/25/2018	N/A	4 hrs					0
3/1/2018		Tentative date for oral presentation	3/1/2018		3/1/2018						0
3/8/2018		Progress Report 2 & Lab 09a	2/25/2018		3/8/2018	8 hrs					0
3/19/2018		Lab 09b	3/19/2018		3/19/2018	1.5 hrs					0
3/21/2018		Lab 09c/ Performance Test 1	3/21/2018		3/21/2018	1.5 hrs					0
3/22/2018		Lab 10a/CDR Draft	3/22/2018		3/22/2018	1.5 hrs					0
3/26/2018		Lab 10b	3/26/2018		3/26/2018	1.5 hrs					0
3/28/2018		Lab 10c/ Performance Test 2	3/28/2018		3/28/2018	1.5 hrs					0
3/29/2018		Lab 11a/Committee Meeting 2	3/29/2018		3/29/2018	1.5 hrs					0
4/2/2018		Lab 11b	4/2/2018		4/2/2018	1.5 hrs					0
4/4/2018		Lab 11c/Start Final Oral Presentation Draft/Prog. Report 3	4/4/2018		4/4/2018	1.5 hrs					0
4/9/2018		Lab 12a	4/9/2018		4/9/2018	1.5 hrs					0
4/11/2018		Lab 12b	4/11/2018		4/11/2018	1.5 hrs					0
4/12/2018		Lab 12c/Final Testing	4/12/2018		4/12/2018	1.5 hrs					0
4/16/2018		Lab 13a/ Final O.Presentation, CDR, Final Website	4/16/2018		4/16/2018	6 hrs					0
4/18/2018		Lab 13b/Final O.Presentation	4/18/2018		4/18/2018	1.5 hrs					0
4/19/2018		Lab 13c/Final Team Eval/Website/CDR	4/19/2018		4/19/2018	1.5 hrs					0

Week 5

Weekly Goals

- Begin advanced research and development labs
- Complete Grant Proposal
- Prepare for Committee Meeting 1

Week 6

Weekly Goals

- Continue aR&D labs, specifically the Wind Tunnel Tests.
- Complete Committee Meeting 1 + Grant Vote in lab
- Complete Website Update 2

Week 7

Weekly Goals

- Have completed aR&D tests 1 and 2 in their entirety
- Write script and prepare oral presentation
- Complete team oral presentation
- Complete Website Update 3
- Complete Progress Report 2

Appendix A – Arduino Codes

1st Code – Programming Basics Lab

```
celerate(1,0,15,2.5);// Accelerate motor 1, from 0% to 15% power, over 2.5 sec
motorSpeed (1,15);// Set motor 1 speed to 15%
goFor (1); // Run last two commands for 1 sec
brake(1); // Cut motor 1 power
celerate(2,0,27,4);// Accelerate motor 2, from 0% to 27% power, over 4 sec
motorSpeed (2,27);// Set motor 2 speed to 27%
goFor (2.7); // Run last two commands for 2.7 sec
celerate(2,27,15,1);// Decelerate motor 2, from 27% to 15% over 1 sec
brake(2); // Cut the power to motor 2
reverse(2); // Run motor 2 in the opposite direction
celerate(4,0,31,2);// Accelerate both motors from 0% to 31% power over 2 sec
motorSpeed (4,35);// Set both motors speeds to 35%
goFor (1); // Run last two commands for 1 sec
brake(2); // Cut off motor 2 power
motorSpeed (1,35);// Set motor 1 speed to 35%
goFor (3); // Run last command for 3 sec
brake(4); // Cut off both motor power
reverse(1); // Run motor 1 in opposite direction
celerate(1,0,19,2);// Accelerate motor 1, from 0% to 19%, over 2 sec
motorSpeed (1,19);// Set motor 1 speed to 19%
motorSpeed (2,35);// Set motor 2 speed to 35%
goFor (2); // Run last two commands for 2 sec
motorSpeed (4,19);// Set both motors speeds to 19%
goFor (2); // Run last command for 2 sec
celerate(4,19,0,3);// Decelerate both motors from 19% to 0% power over 3 sec
brake(4); // Cut off power to both motors
```

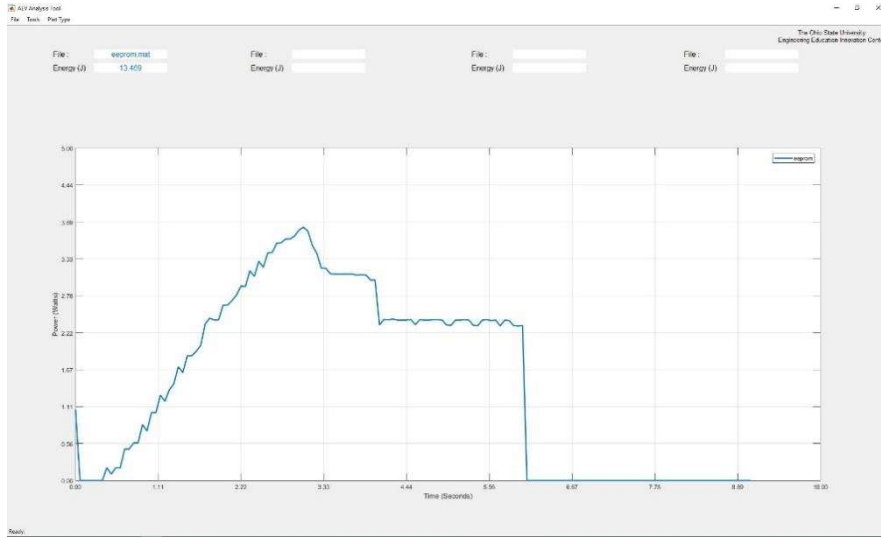
2nd Code – Reflective Sensor Test

```
motorSpeed (4, 25); // Set both motor's speeds to 25%
goFor (2); // Run last command for 2 sec
motorSpeed (2, 20); // Set motor 2 speed to 20%
goToAbsolutePosition(295.384615); // Run las command until AEV is at mark 295.384615
reverse(4); // Set both motors to reverse direction
motorSpeed (4, 30); // Set both motors speeds to 30%
goFor (1.5); // Run last command for 1.5 sec
brake(4); // Cut power to both motors
```

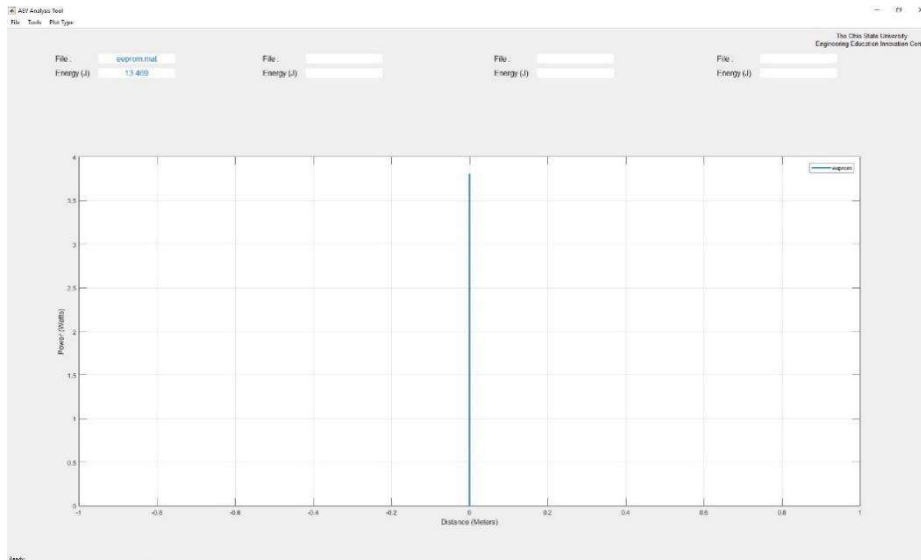
3rd Code – Data Analysis Tool Lab

```
celerate(4,0,25,3);// Accelerate both motors from 0% to 25% power over 3 sec
goFor (1); // Run last command for 1 sec
motorSpeed (4,20);// Set both motors speed to 20%
goFor (2); // Run last command for 1 sec
reverse(4); // Set both motors in reverse
motorSpeed (4,25);// Set both motor speeds to 25%
brake(4); // Cut off power to both motors
```

Appendix B - Data Analysis Graphs

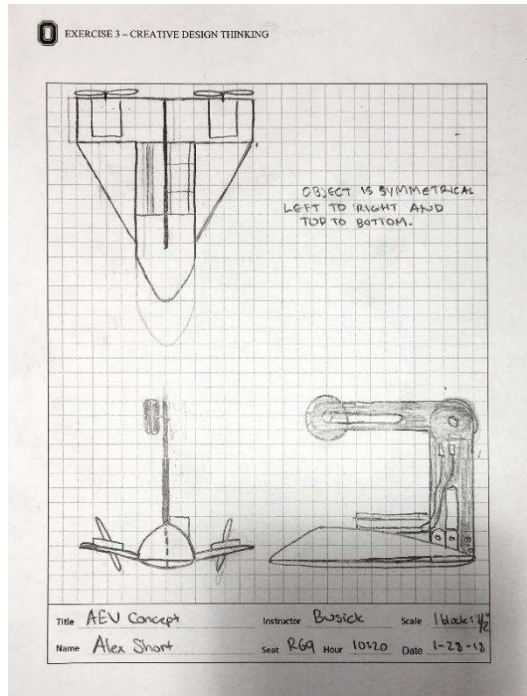


Power vs. Time Plot

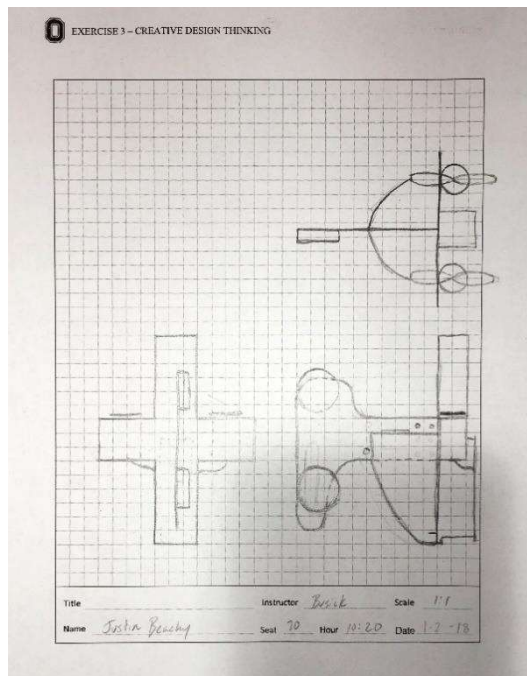


Power vs. Distance Plot

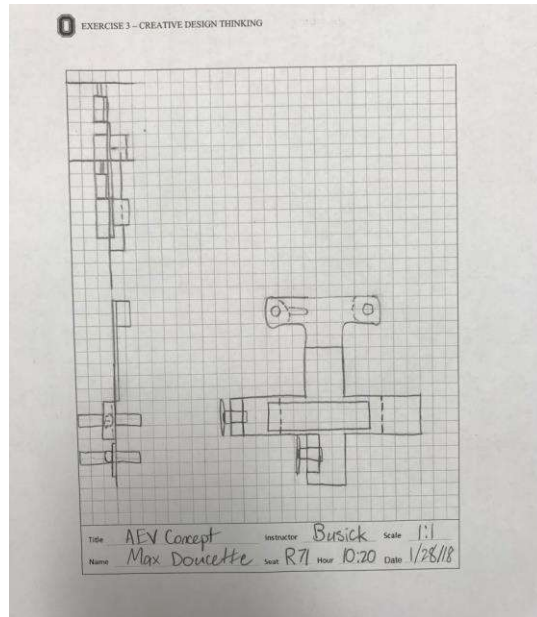
Appendix C - Team Concept Sketch



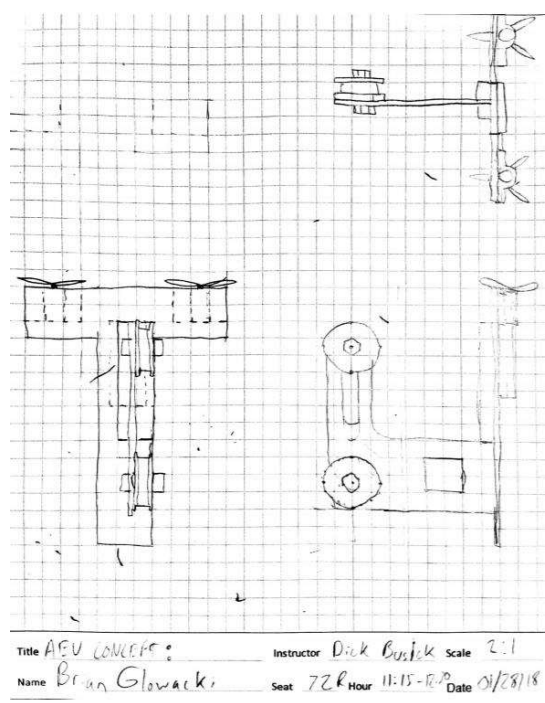
Concept Sketch 1 – Alex Short



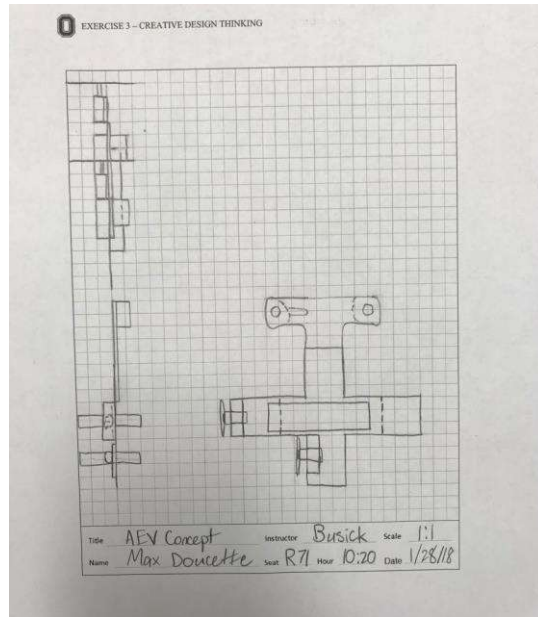
Concept Sketch 2 – Justin Beachy



Concept Sketch 3 – Max Doucette



Concept Sketch 4 – Brian Glowacki



Team Concept Sketch

Appendix D - Concept Screening/ Scoring Matrices

Screening Process Table:

Success Criteria	Reference	Short A	Short B	Glowacki A	Glowacki B	Doucette A	Doucette B	Beachy A	Beachy B
Stability	0	0	-	-	0	-	0	0	-
Aerodynamics	0	+	0	0	0	+	0	-	-
Weight	0	-	+	0	+	0	-	-	+
Durability	0	+	-	+	-	0	+	+	0
Safety	0	+	-	-	-	+	-	+	0
Sum +		3	1	1	1	2	1	2	1
Sum 0	5	1	1	2	2	2	2	1	2
Sum -		1	3	2	2	1	2	2	2
Net Score	0	2	-2	-1	-1	1	-1	0	-1
Continue?	Combine	Combine	No	No	No	Revise	No	No	No

Scoring Process Table:

		Reference		Design 1 - Short		Design 2 - Glowacki		Design 3 - Beachy		Design 4 - Doucette	
Success Criteria	Weight	Rating	Wighted Score	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score
Stability	20%	3	0.6	3	0.6	3	0.6	2	0.4	2	0.4
Aerodynamics	25%	3	0.75	4	1	3	0.75	2	0.5	4	1
Weight	25%	2	0.5	2	0.5	3	0.75	2	0.5	3	0.75
Durability	15%	3	0.45	2	0.3	2	0.3	3	0.45	3	0.45
Safety	15%	3	0.45	3	0.45	2	0.3	3	0.45	2	0.3
Total Score			2.75		2.85		2.7		2.3		2.9
Continue?			No		Develop		No		No		Develop

Appendix E - Team Meeting Minutes

Meeting 1:

- Time of Meeting: 01/11/2018, 11:10 AM
- Location of Meeting: Hitchcock Hall 224
- Members Present: Alex Short, Brian Glowacki, Justin Beachy, Max Doucette
- Topics Discussed: Underpinnings of the AEV project and next steps.
- Upcoming Tasks: Make GroupMe, discuss times for meetings and outline rules for teamworking agreements, begin making the webpage. No specific roles have been assigned yet, so no one member is assigned to each task at this point.

Meeting 2:

- Time of Meeting: 01/18/2018, 11:10 AM
- Location of Meeting: Hitchcock Hall 224
- Members Present: Alex Short, Brian Glowacki, Justin Beachy, Max Doucette
- Topics Discussed: Begin preliminary testing of motors and becoming familiar with the AEV kit. Begin programming for scenario 1 for Preliminary R&D Lab. There were issues when trying to run the program. When the code was attempted to be run, a message was received that said, “problem uploading to board”. The code was not being sent to the Arduino board properly. A new USB cable was received and the problem was not resolved. A new Arduino board was then provided and the program was properly uploaded and ran, however, the propellers would not move because there was too much resistance in the motors. More problems were encountered when the program was run a second time on the new board. The rest of the lab was spent troubleshooting the program and motors.
- Upcoming Tasks: All team members will review and properly prepare for Lab 03. Alex will update website and request help from team members as needed. The team members will meet to complete exercise 1.

Meeting 3:

- Time of Meeting: 01/25/2018, 11:10 AM
- Location of Meeting: Hitchcock Hall 224
- Members Present: Alex Short, Brian Glowacki, Justin Beachy, Max Doucette
- Topics Discussed: Team members worked to complete the first part of lab. The Arduino program was still having issues running correctly. A TA was called over to assist, and a few settings were updated in the Arduino application. The application was reset again and the program ran successfully this time. The motors were set up and the program was ran again and it worked fine. Next, the physical sample AEV was constructed. It was noticed that each screw and nut needed to be tightened down enough so that the jostling movement of the AEV would not affect the functionality of the AEV. After constructing the AEV, the black wire connected to the board was ripped so a part of the wire was stuck in the port. A new board was provided. The red wire now was having issues being connected to the AEV, so the Arduino was fixed again. The rest of lab was used to clean up the area and the

- Upcoming Tasks: The team will work to keep the website updated. The team will each create an individual concept design and then meet to collaborate and decide which design to pursue.

Meeting 4:

- Time of Meeting: 01/28/2018, 6:00 PM
- Location of Meeting: Hitchcock Hall Basement Commons
- Members Present: Alex Short, Brian Glowacki, Justin Beachy, Max Doucette
- Topics Discussed: Initial Concept Designs and Next Steps for the design process
- Upcoming Tasks: Each team member will upload a photo of their initial concept design and put reasons why that design was not used (if applicable). Team members will discuss which design to pursue next meeting.

Meeting 5:

- Time of Meeting: 02/01/2018, 10:20 AM
- Location of Meeting: Hitchcock Hall 224
- Members Present: Alex Short, Brian Glowacki, Justin Beachy, Max Doucette
- Topics Discussed: Complete pR&D lab exercises 2, 4, and 5. AEV was constructed and Arduino was programmed. Exercise 2: Program ran successfully. Exercise 4: Max's design was constructed by the team.
- Upcoming Tasks: Each team member will assist in making the Progress Report, team members will communicate when to meet to complete pR&D.

Meeting 6:

- Time of Meeting: 02/05/2018, 5:20 PM
- Location of Meeting: Hitchcock Hall 224
- Members Present: Alex Short, Justin Beachy
- Topics Discussed: Completion of AEV model as well as pR&D lab exercises 4 and 5. During exercise 4, the code only ran for the first half of the exercise. The propellers would not reverse. The code was rewritten and loaded onto the Arduino. The design was tested on the test track and the data was downloaded onto into the AEV Analysis application.
- Upcoming Tasks: Team members will communicate when to meet to complete progress report as well as prepare for Thursday's advanced R&D lab. Alex will bring the lab kit Thursday. Max will review the team meeting minutes to ensure everything is looking good. Brian will upload his codes as well as the comments. Justin will get the updated plot from MATLAB uploaded into the website.