Group P - Ishan Taparia, Wenbo Nan, Kyle Fathauer, Jason Hahn Progress Report 2

Instructor - Dr. Parris, GTA - Sheena Marston
1/27/17

Week 2

Situation

During this week's lab, the team completed two main tasks, one was to build the sample AEV and test the reflectance sensors, the other was to use wind tunnel testing to get familiar with propulsion system efficiency. The reflectance sensor was able to capture the change of infrared signal and shows each change of signal as a "mark", which can further indicate the distance the AEV travelled. To set up the sensor on the AEV, the team taped the sensor as close to the wheel as possible. After setting up the sensor, the team used Arduino to test whether the sensor worked or not by observing the change of numbers shown in the serial monitor in Arduino when spinning the wheel in both clockwise and counterclockwise direction.

The wind tunnel testing was important because it is an easier and more efficient way to test the efficiency of a propulsion system. Instead of testing different motor designs, it tested various way of propellers designs. And the team completed the task by sending a team member to the wind tunnel equipment to take data and do further calculations.

The data gain from this week will allow for a framework of Arduino code to be laid down so that any tasks required can be simply added, without a complete redesign on the code structure.

Results & Analysis

The track run of the AEV was a failure. From the program start the AEV motor spun up then could not move the AEV on the power setting provided. This caused the AEV to stay in place until the power was removed. Although the reflective sensor worked perfectly, there will need to by troubleshooting done in order to understand why the AEV did not work properly.

The data below is the post analysis data that was collected from the lab. The first column is thrust, which is how much force was produced by the motor. The second column is RPM, which is how fast the motor is spinning. The third column has power input, which is the amount of energy that the motor is using per second. In the fourth and fifth column is the power output. Power output is the amount of energy it is producing per second. In the sixth column is propulsion efficiency which is the ratio of power output over the power input. Finally in the last column is advance ratio. The advance ratio is the comparative ratio between the speed of the air it is moving through and the speed of the blade tip. It is used to reflect the propeller's output power.

The data below should demonstrate that as power supplied to the motor increases the thrust produced by the motors increases. The inverse of the relationship holds true for the efficiency. As the power supplied increase the efficiency decrease. This data will allow the team to pick the proper motorspeed for any of the two propellers and both of the configuration that they can be in.

Table 1: EP-3030 Pusher

Thrust Calibration	RPM	Power Input	Power Output	Power Output	Propulsion Efficiency	Advance Ratio
grams	RPM	Watts	Horsepower	Watts	%	--
0.00	0	0.00	0.000000	0.000000	0.00	0.00
1.32	3113	0.10	0.000048	0.036089	36.13	0.66
2.22	4011	0.28	0.000082	0.060900	21.66	0.51
3.21	4730	0.52	0.000118	0.087967	16.98	0.43
4.19	5508	0.84	0.000154	0.115034	13.64	0.37
5.55	6227	1.24	0.000204	0.152251	12.25	0.33
7.11	6946	1.72	0.000262	0.195107	11.36	0.29
8.51	7544	2.23	0.000313	0.233451	10.46	0.27
10.03	8763	2.85	0.000369	0.275179	9.66	0.23
11.88	8862	3.50	0.000437	0.325930	9.31	0.23
13.69	4760	4.35	0.000504	0.375552	8.63	0.43

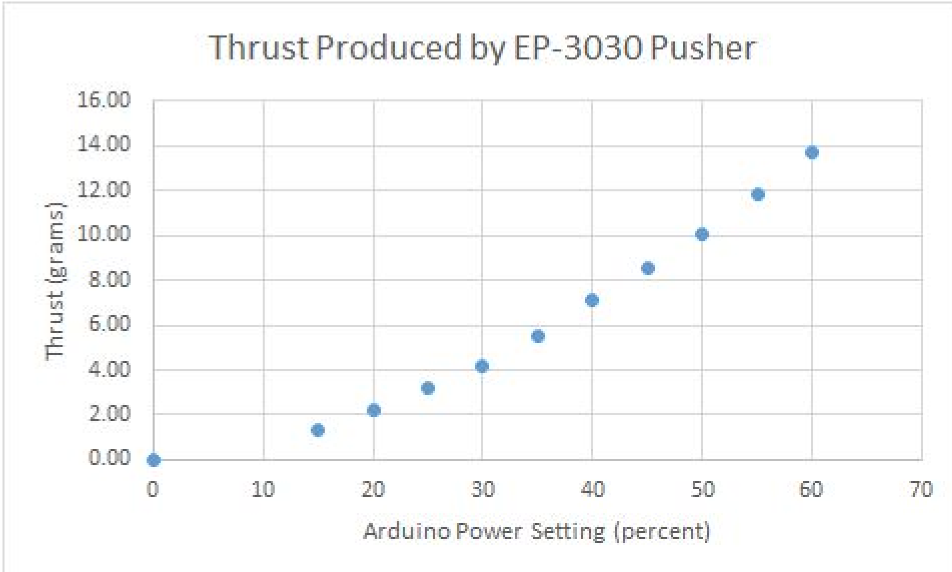

Figure 1: Thrust Produced by EP-3030 Pusher

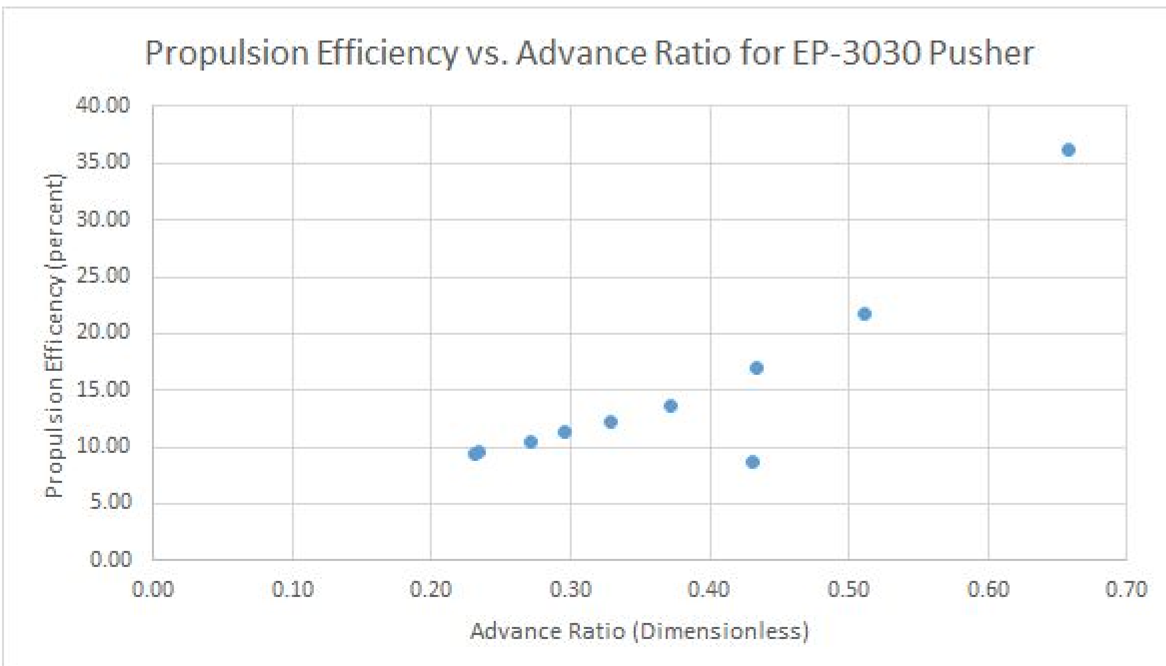

Figure 2: Propulsion Efficiency vs. Advance Ratio for EP-3030 Pusher

The EP-3030 pusher was the only propeller to have data collected without error. The maximum thrust produced is higher than the puller configuration of the same propeller. The advance ratio and efficiency are also both higher than the puller configuration.

Table 2: EP-3030 Puller

Thrust Calibration	RPM	Power Input	Power Output	Power Output	Propulsion Efficiency	Advance Ratio

grams	RPM	Watts	Horsepower	Watts	%	--
0.00	0	0.00	0.000000	0.000000	0.00	0
-0.78	3443	0.26	-0.000031	-0.022958	-8.99	0.64
-0.66	4640	0.46	-0.000026	-0.019333	-4.21	0.47
-0.66	5800	0.72	-0.000026	-0.019333	-2.68	0.38
0.16	7050	1.04	0.000006	0.004833	0.46	0.31
1.19	8263	1.40	0.000047	0.035042	2.51	0.27
1.40	9730	1.63	0.000055	0.041084	2.52	0.23
2.63	10650	2.16	0.000104	0.077334	3.57	0.21
3.45	11800	2.52	0.000136	0.101501	4.03	0.19
4.27	13000	2.85	0.000169	0.125667	4.41	0.17
5.92	14200	3.20	0.000233	0.174001	5.44	0.15

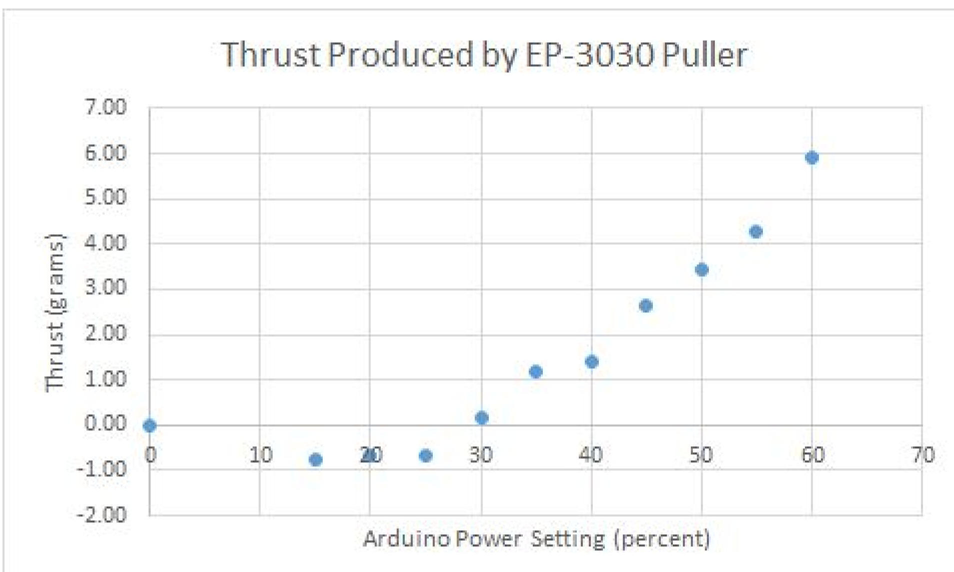

Figure 3: Thrust Produced by EP-3030 Puller

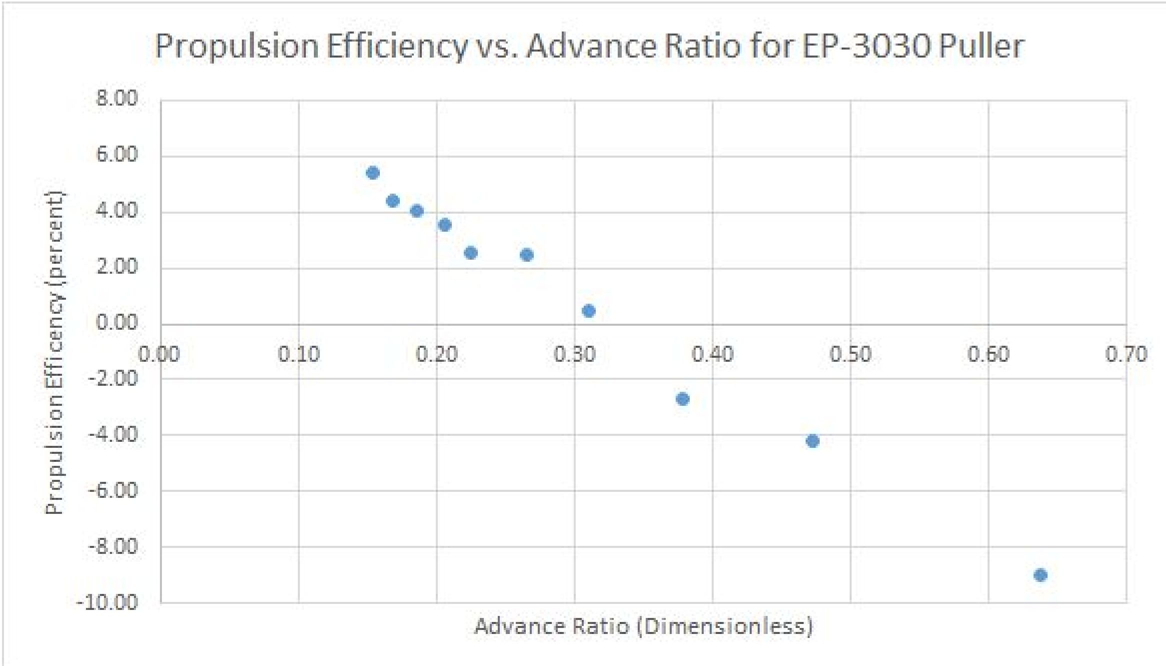

Figure 4: Propulsion Efficiency vs. Advance Ratio for EP-3030 Puller

The EP-3030 puller results were skewed by the scale used for measuring thrust being improperly calibrated before testing began. This resulted in the lower end of the power settings producing negative thrust which should not have occurred. The thrust still follows a linear path and increases as more power is applied. Because of the negative thrust, power output calculations were negative along with efficiency calculations in the lower end of the power settings.

Table 3: EP-2510 Puller

Thrust Calibration	RPM	Power Input	Power Output	Power Output	Propulsion Efficiency	Advance Ratio
grams	RPM	Watts	Horsepower	Watts	%	--
0.000	0	0.000	0.000000	0.000000	0	0
0	0	0.000	0.000000	-1.864227	0	0
6.740	3473	0.233	0.000313	0.184957	79.346	0.756
6.946	4730	0.444	0.000595	0.190595	42.927	0.555
7.110	5868	0.703	0.000943	0.195107	27.753	0.447
7.727	7065	1.043	0.001399	0.212023	20.320	0.372

8.672	8263	1.425	0.001910	0.237962	16.705	0.318
9.823	9760	1.658	0.002223	0.269540	16.261	0.269
10.357	10598	2.231	0.002992	0.284202	12.738	0.248
11.344	11796	2.664	0.003572	0.311268	11.684	0.223
12.166	12994	3.053	0.004093	0.333824	10.936	0.202
14.138	14191	3.463	0.004644	0.387958	11.202	0.185

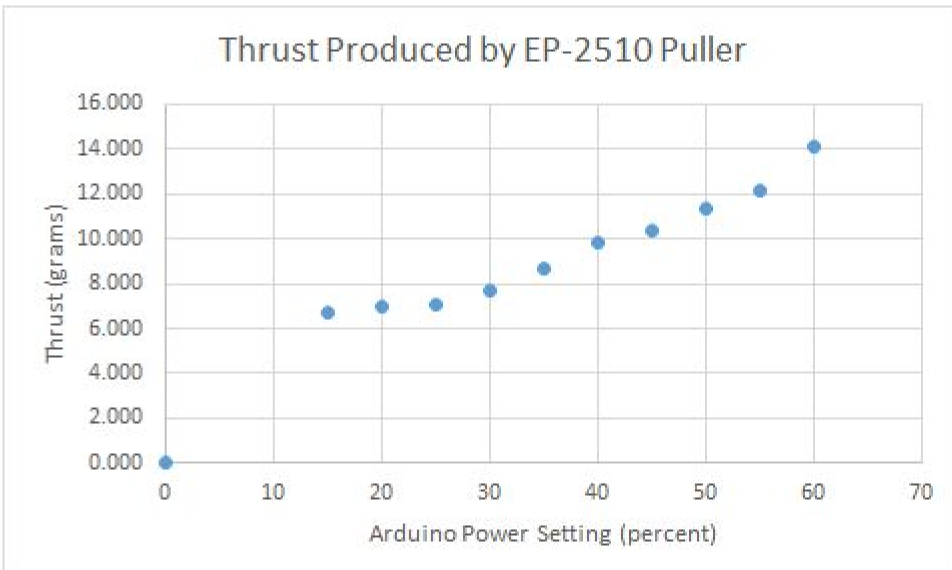

Figure 5: Thrust Produced by EP-2510 Puller

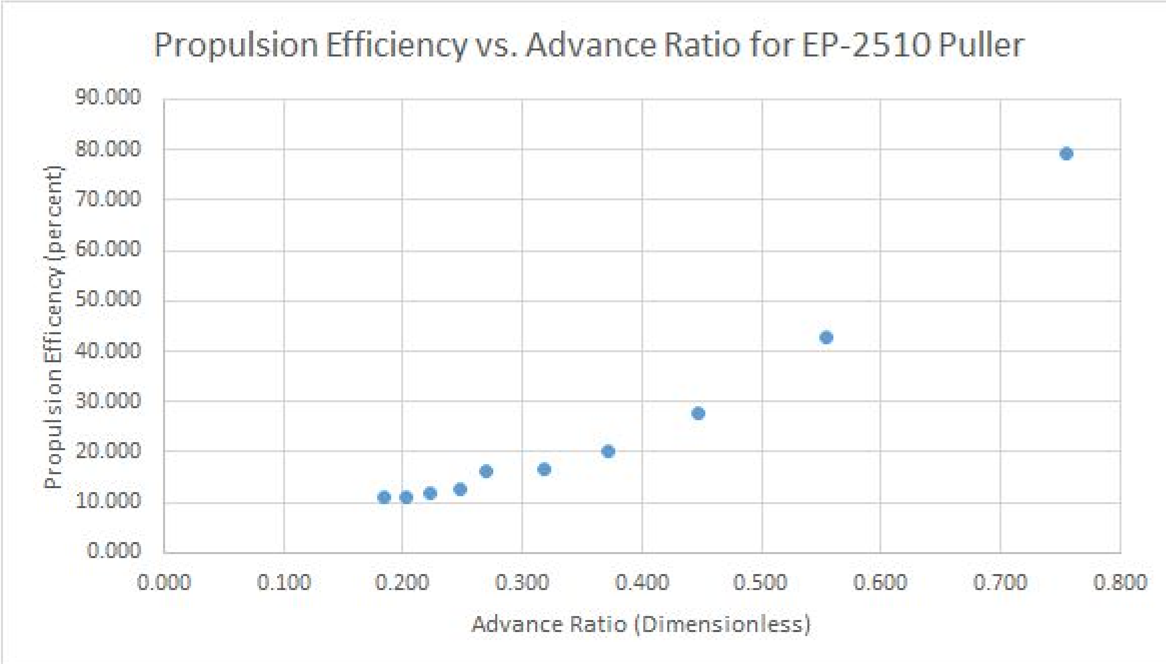

Figure 6: Propulsion Efficiency vs. Advance Ratio for EP-2510 Puller

The EP-2510 puller data was incomplete as operating data at 10% power was never collected. The rest of the data followed the trend of increased power resulting in increased thrust. Additionally, the thrust produced at maximum power was than all others tested. The EP-2510 puller also had the highest efficiency, but due the errors in data collection, the results may not accurately reflect true performance.

Table 4: EP-2510 Pusher

Thrust Calibration	RPM	Power Input	Power Output	Power Output	Propulsion Efficiency	Advance Ratio
grams	RPM	Watts	Horsepower	Watts	%	--
0.000	0.00	0.000	0.000000	0.000000	0.000	0.000
0.534	1916.00	0.096	0.000020	0.014661	15.240	1.370
0.781	3053.00	0.244	0.000029	0.021428	8.775	0.860
0.699	4191.00	0.474	0.000026	0.019172	4.048	0.626
1.151	5269.00	0.740	0.000042	0.031578	4.267	0.498
1.808	6407.00	1.110	0.000067	0.049622	4.470	0.410
2.137	7604.00	1.502	0.000079	0.058645	3.904	0.345

3.452	9760.00	1.539	0.000127	0.094734	6.155	0.269
3.576	9760.00	2.264	0.000132	0.098117	4.333	0.269
4.069	11077.00	2.775	0.000150	0.111651	4.023	0.237
5.549	12155.00	3.175	0.000204	0.152251	4.796	0.216
6.823	13350.00	3.641	0.000251	0.187212	5.142	0.197

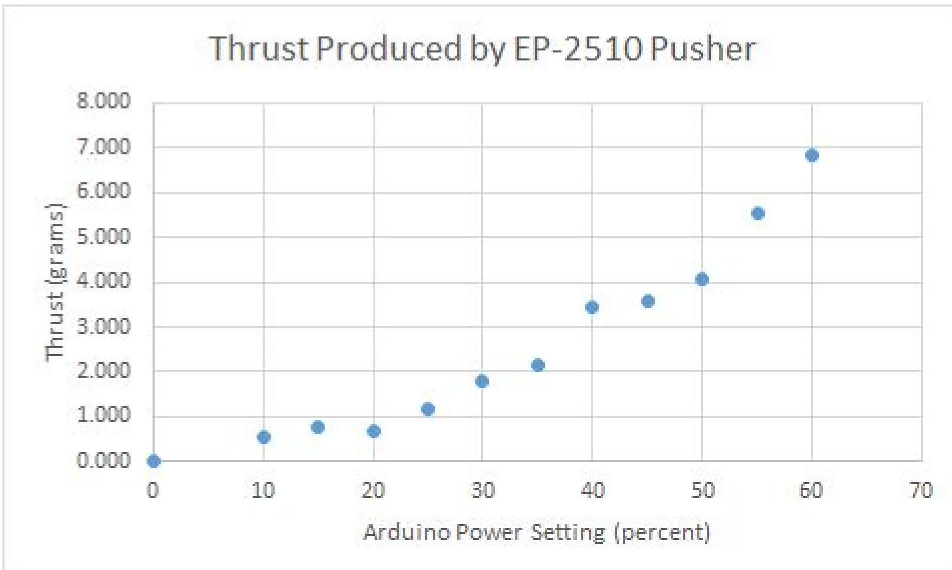

Figure 7: Thrust Produced by EP-2510 Pusher

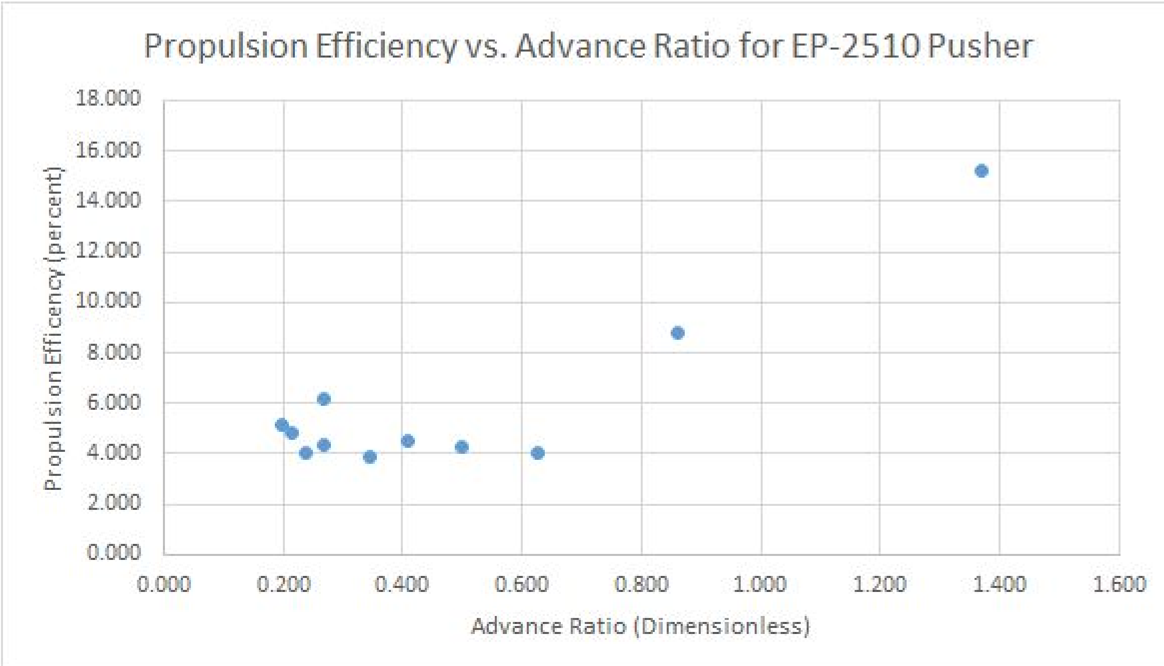

Figure 8: Propulsion Efficiency vs. Advance Ratio for EP-2510 Pusher

The EP-2510 in pusher configuration had a much lower efficiency than both the puller configuration and the EP-3030 propellers. Additionally, it produced less thrust at maximum power than the puller configuration and the EP-3030 pusher.

Takeaways

1) AEV -- During lab, many bugs in code and issues with construction of the AEV will arise, so working with the instructional staff is key to success
2) AEV -- Keeping up with construction of the AEV outside of class in addition to organizing meetings for progress reports is important
3) AEV -- The reflect sensor will allow for easy understanding of where the AEV is
4) General -- It is important to constantly check that the reflectance sensors are in sound condition as they control the movement of the AEV

Week 3

<u>Situation</u>

This week the team will design the AEV frame and chassis. This will be done by brainstorming about the AEV design. After the brainstorming the team will complete a mission concept review that will allow to see if the AEV will complete the requirement of the program. This required to come up with new idea that will improve the AEV.

<u>Weekly Goals</u>

1. Brainstorm new AEV ideas
2. Complete a mission concept review of each idea
3. Update team website

<u>Weekly Schedule</u>

Table 1

Task	Teammate(s)	Start Date	Due Date	Time Need
Week 2 Progress	All	1/27/17	2/3/17	2hrs
Pre-lab Preparation	All	1/27/17	2/3/17	2hrs
AEV Design	All	1/27/17	2/3/17	1/2hr

Appendix

Raw Data from Wind Tunnel Testing

Table A1: EP-3030 Pusher

Current	Thrust Scale Reading	RPM	Arduino Power Setting
amps	grams	RPM	%
-0.1	144.1	0	0
0.09	147.3	3113	15
0.19	149.5	4011	20
0.28	151.9	4730	25
0.38	154.3	5508	30
0.48	157.6	6227	35
0.58	161.4	6946	40
0.67	164.8	7544	45
0.77	168.5	8763	50
0.86	173	8862	55
0.98	177.4	4760	60

Table A2: EP-3030 Puller

Current	Thrust Scale Reading	RPM	Arduino Power Setting
amps	grams	RPM	%
0.06	151.6	0	0
0.23	149.7	3443	15
0.31	150	4640	20
0.39	150	5800	25
0.47	152	7050	30

0.54	154.5	8263	35
0.55	155	9730	40
0.65	158	10650	45
0.68	160	11800	50
0.7	162	13000	55
0.72	166	14200	60

Table A3: EP-2510 Puller

Current	Thrust Scale Reading	RPM	Arduino Power Setting
amps	grams	RPM	%
0	165.3	0	0
No data was provided	No data was provided	No data was provided	10
0.21	181.7	3473	15
0.3	182.2	4730	20
0.38	182.6	5868	25
0.47	184.1	7065	30
0.55	186.4	8263	35
0.56	189.2	9760	40
0.67	190.5	10598	45
0.72	192.9	11796	50
0.75	194.9	12994	55
0.78	199.7	14191	60

Table A4: EP-2510 Pusher

Current	Thrust Scale Reading	RPM	Arduino Power Setting
amps	grams	RPM	%

0	185	0	0
0.13	186.3	1916	10
0.22	186.9	3053	15
0.32	186.7	4191	20
0.4	187.8	5269	25
0.5	189.4	6407	30
0.58	190.2	7604	35
0.52	193.4	9760	40
0.68	193.7	9760	45
0.75	194.9	11077	50
0.78	198.5	12155	55
0.82	201.6	13350	60

Arduino Code for Lab 2 Outside Track Scenario :

```
//All motors set to 25% power
motorSpeed(4,25);

//Previous command for 2 seconds
goFor(2);

//All motors set to 20% power
motorSpeed(4,20);

//The vehicle goes to 393 marks relative to the starting position
goToAbsolutePosition(393);

//Reverse all motors
reverse(4);

//All motors set to 30% power
motorSpeed(4,30);

//Previous command for 1.5 seconds
goFor(1.5);

//Brake all motors
```

```
brake(4);
```

Team Meeting Notes:

Date: 29 - Jan - 2017
Time: 3:00 (Face-to-Face)
Members Present: Ishan Taparia, Wenbo Nan, Kyle Fathauer, Jason Hahn

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Objective: Today's objective was to complete the progress report covering this week's lab session, and to discuss design elements of the AEV with their Mission Concept Reviews(MCR).

To do:
- Write progress report.
- Examine and discuss preliminary AEV designs with their MCR.
- Update project website.

Decisions:
- The progress report will be completed as much as possible while waiting for Sheena to send the wind turbine data to complete full analysis.
- Ishan will be in charge of updating the online portfolio with information as needed.

Reflections:
- Even though we scheduled a meeting, in order to complete even more work, google hangout sessions will have to be scheduled.

Date: 1 - Feb- 2017
Time: 5:30 (Online)
Members Present: Wenbo Nan, Kyle Fathauer, Jason Hahn

Objective:Today's object was to answer the question about what propeller the team should use and the general configuration of the propellers.

To do:
- Continue progress report

Decisions:
- The data provided by Sheena is full of errors and will need to be looked into.

Reflections:
- Collecting good data is important
- AEV execution can be unpredictable at times

Date: 4 - Feb- 2017
Time: 1:00 (Online)
Members Present: Wenbo Nan, Kyle Fathauer, Jason Hahn

Objective:Today's object was to continue working on Progress Report 2 and begin Progress Report 3

To do:
- Continue Progress Report 2
- Incorporate updated data into Report
- Start Progress Report 3

Decisions:
- The team will use Kyle’s design for the initial AEV.

Reflections:
- Lack of communication makes working together harder.