Team one's AEV

Group/Team 1/ Members – Zack Sentivany, Tim Jacino, Tyler Sullivan, Andrew Kolibaba

I. Introduction

The AEV project was contracted by a national park to design a transportation system for visitors. The system was to follow a monorail with several scenic stops along the way shown in figure 1. The design was supposed to focus on energy management, operational efficiency as well as operational consistency. Due to the complications that have arisen during this semester the AEV project could not continue as planned for the team. The original design with a completely 3D printed frame could not be completed nor could the team perform tests on the track leaving no option but to use sample data provided for a standard AEV design. This is not how the Team wanted the AEV project to go, however, they had to do what was needed and proceed accordingly.

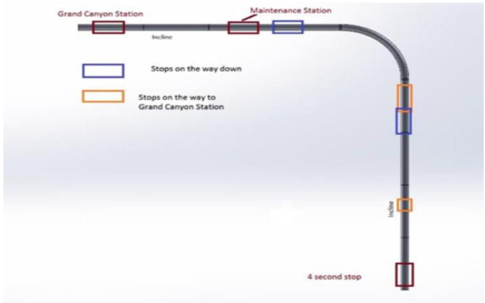


Figure 1 monorail system.

II. Initial/simple designs

Each of the four members created a design then decided on what should be used or changed. The first two designs were simple with the idea of trying to minimize weight as well as errors due to complications.

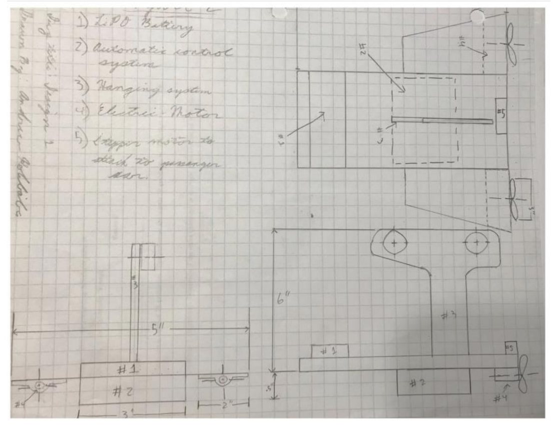


Figure 2 Andrew's design

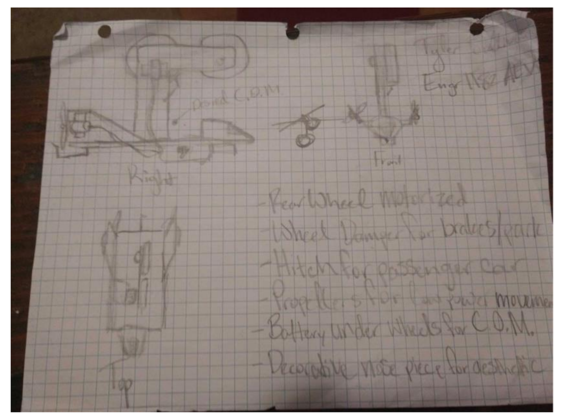


Figure 3 Tyler's design

The team decided that these two designs should be retained, however, there were better designs based on screening and scoring matrices shown in tables 1 and 2.

III. Addition designs & desired Solidworks assembly

The last two of the four designs were more complicated, however, had aspects desired by the team such as the use of a drive wheel rather than the standard propellers and clamping actions to physically attach the AEV to the rail.

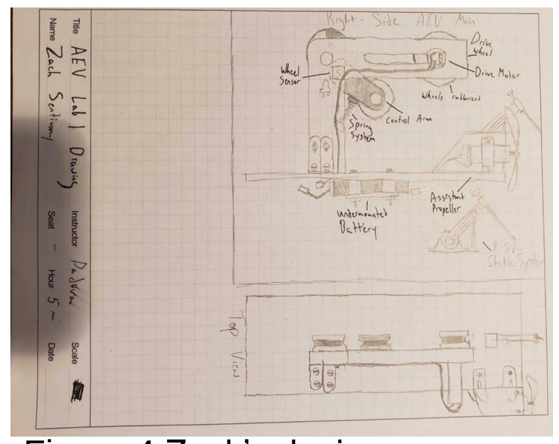


Figure 4 Zack's design

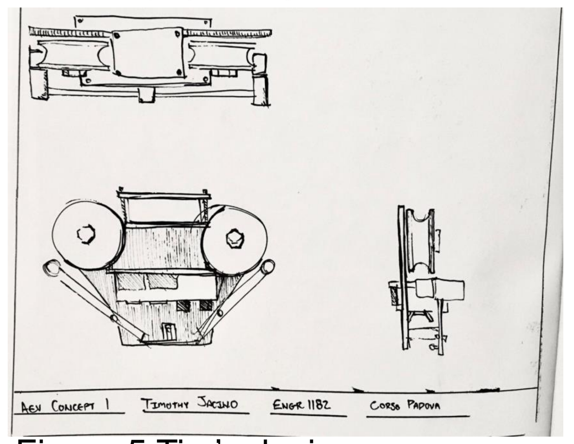


Figure 5 Tim's design

The design in figure 5 was the design selected to further develop and test primarily. This design scored the highest in both the screening matrix as well as the scoring as shown in Tables 1 and 2 below.

After selecting the design in figure 4 as the primary design the team went ahead with creating an assembly in Solidworks as show in figure 6.

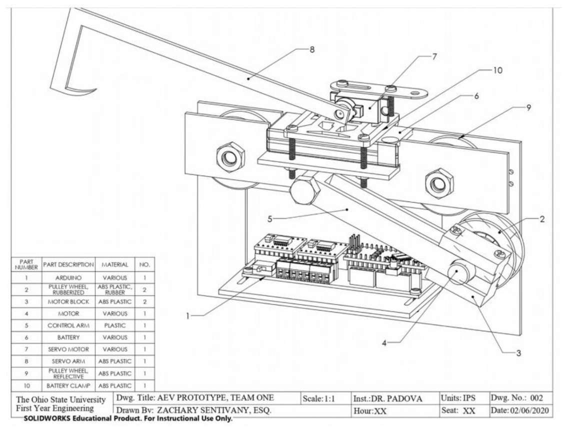
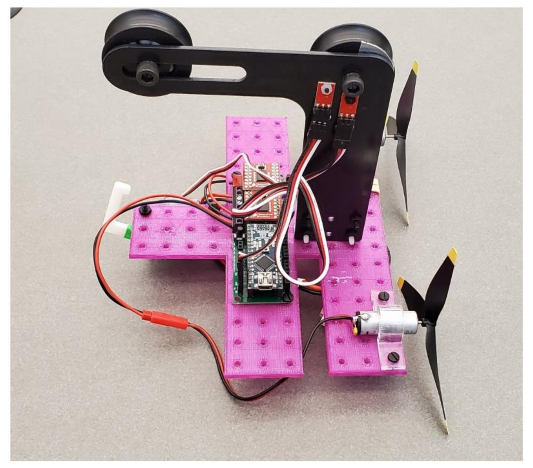


Figure 6 The Solidworks assembly of the desired AEV.

IV. Matrices and Design used due to Covid-19

Due to the in-person portion of the semester being cut short and the chosen design needing so much 3D printing the team was unable to finish the AEV nor collect any actual data on the monorail system. In order to continue the project a standard pink AEV design shown in figures 7 and 8 was given to the team as well as sample data gathered from running this AEV.



Even though the Pink AEV design did not score as well on the two matrices compared to the team's desired as shown in tables 1 and 2, using this AEV was the only option to continue forward with the project.

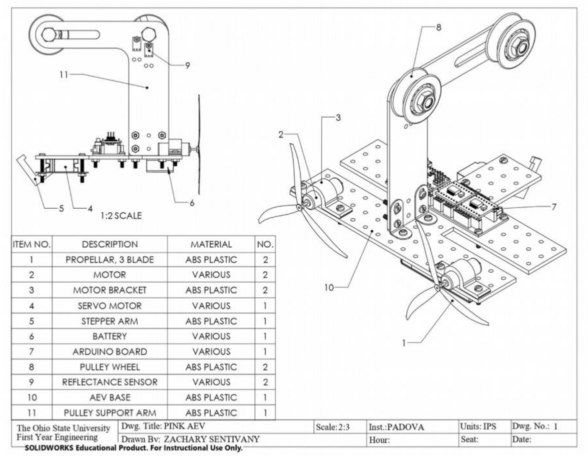


Figure 7 Subcontracted (Pink) AEV submission assembly

Figure 8 Pink AEV Solidworks

Success Criteria	Reference	Jacino Design	Kolibaba Design	Sullivan Design	Sentivany Design	Pink AEV
Track Stability	0	+	0	+	+	-
Energy Efficiency	0	+	+	-	0	0
Cost	0	-	+	-	-	-
Appearance	0	+	-	+	0	0
Profile Size	0	+	0	0	+	-
Weight	0	0	+	-	-	+
Sum +'s	0	4	3	2	2	1
Sum 0's	5	1	2	1	2	2
Sum -'s	0	1	1	3	2	3
Net Score	0	3	2	-1	0	-2
Continue?	No	Yes	No	No	Combine	Yes

Table 1 Concept Screening Matrix

Concept Scoring Matrix		Reference Design		Jacino Design		Pink AEV	
Success Criteria	Weight	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score
Track Stability	25%	3	0.75	5	1.25	2	0.50
Energy Efficiency	25%	2	0.50	3	0.75	2	0.50
Cost	20%	4	0.80	1	0.20	3	0.60
Appearance	5%	2	0.10	4	0.20	2	0.10
Profile Size	10%	2	0.20	4	0.40	1	0.10
Weight	15%	3	0.45	3	0.45	4	0.60
Total Score			2.80		3.25		2.4
Continue?			No		Yes		Yes

Table 2 Concept Scoring Matrix

Acknowledgement: Team one would like to thank Dr. Padova as well as Dr. Janiszewska without their help the project could not have been accomplished

V. AEV Run Data

Using Matlabs the team was able to write a code to generated several different graphs according to the AEV's run along the monorail.

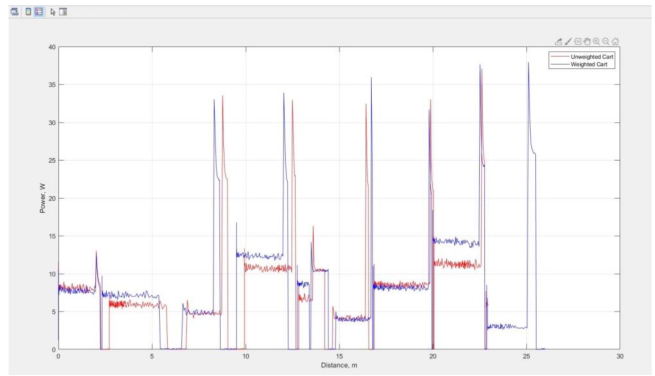


Figure 9 Power vs. Distance, Weight comparison

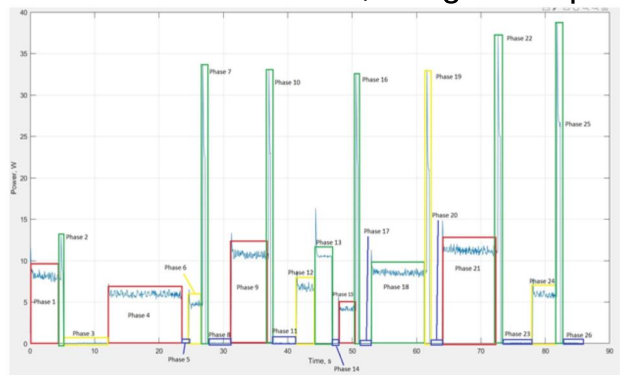


Figure 10 Power vs. Time weighted cart.

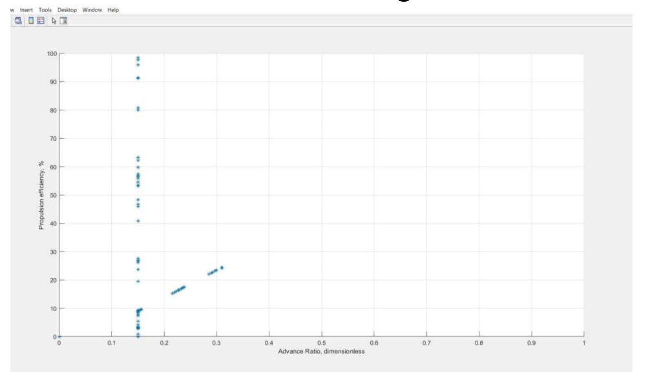


Figure 11 System efficiency vs. Advance Ratio

VI. Energy usage and Summary

The data gathered shown in figures 9, 10, and 11 help demon straight what is occurring as the AEV is moves along the rail and how efficient the design is.

Phase	Arduino Code	Time (s)	Total Energy (J)
1	motorSpeed(4,25), goFor(5);	5	40
2	reverse(4);	0.5	0
3	brake(4); goFor(7);	7	0
4	motorSpeed(4,20); goToMark(3m);	6	42
5	brake(4); goFor(1);	0.5	0
6	motorSpeed(4,18); goFor(3);	3	15
7	reverse(4);	0.5	0
8	brake(4); goFor(4);	4	0
9	motorSpeed(4,30); goToMark(2.5m);	4	52
10	reverse(4);	0.5	0
11	brake(4); goFor(4);	4	0
12	motorSpeed(4,23); goToMark(0.5m);	3	24
13	motorSpeed(4,30); goToMark(0.5m);	3	30
14	brake(4); goFor(1);	1	0
15	motorSpeed(4,18); goToMark(2m);	4	16
16	reverse(4);	0.5	0
17	brake(4); goFor(2);	2	0
18	motorSpeed(4,28); gotoMark(3m);	9	72
19	reverse(4);	0.5	0
20	brake(4); goFor(2);	2	0
21	motorSpeed(4,33); goToMark(2.5m);	4	56
22	reverse(4);	0.5	0
23	brake(4); goFor(4);	4	0
24	reverse(4);	0.5	0
25	motorSpeed(4,25); goFor(6);	6	18
26	reverse(4);	0.5	0
27	brake(4); goFor(2);	2	0
		Total Energy Used:	365

Table 3 unweighted Phase breakdown

Phase	Arduino Code	Time (s)	Total Energy (J)
1	motorSpeed(4,25), goFor(5);	5	45
2	reverse(4);	0.5	0
3	brake(4); goFor(7);	7	0
4	motorSpeed(4,20); goToMark(3m);	10	60
5	brake(4); goFor(1);	1	0
6	motorSpeed(4,18); goFor(3);	3	15
7	reverse(4);	0.5	0
8	brake(4); goFor(4);	4	0
9	motorSpeed(4,30); goToMark(2.5m);	6	66
10	reverse(4);	0.5	0
11	brake(4); goFor(4);	4	0
12	motorSpeed(4,23); goToMark(0.5m);	3	21
13	motorSpeed(4,30); goToMark(0.5m);	3	33
14	brake(4); goFor(1);	1	0
15	motorSpeed(4,18); goToMark(2m);	3	12
16	reverse(4);	0.5	0
17	brake(4); goFor(2);	2	0
18	motorSpeed(4,28); gotoMark(3m);	9	81
19	reverse(4);	0.5	0
20	brake(4); goFor(2);	2	0
21	motorSpeed(4,33); goToMark(2.5m);	7	84
22	reverse(4);	0.5	0
23	brake(4); goFor(4);	4	0
24	motorSpeed(4,25); goFor(6);	6	36
25	reverse(4);	0.5	0
26	brake(4); goFor(2);	2	0
		Total Energy Used:	453

Table 4 weighted Phase breakdown

As shown in the comparison of tables 3 and 4 there is only a slight difference of 73 J/kg in energy usage from a loaded cart and unloaded cart. This could be reduced by using natural inertia from inclines and lowing the motors' power usage during these slopes.

While there are still a degree of uncertainty due to current limitations and inability to physically witness the runs some things can be inferred based on logic. On final runs the AEV most likely behaved in a more sluggish manner due to the weighted cart. Also the addition weight could cause instabilities around high speed turns. Due to the square-cube law a full-size model would be proportionally heavier causing potential limitations. More testing would be required.