To: Dr Janiszewska

From: Ian Claggett, Ed Doerring, Stuart Fanko (Group Jasper)

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Introduction:

Lab 3 consisted of screening and scoring out designs to see where the strength and weaknesses are. Each design was carefully reviewed and judged on stability, look, maintenance, durability, and cost and was given a score after being compared to the already provided design. If the design is better by comparison it receives a +, if it is worse it receives a -, and if it is equal it receives a 0. After evaluation the scores are added up and each design receives a final score. Secondly each design was once again evaluated on a points scale coming up with similar results and giving each design a final rating that can be compared to other designs to see which is the optimal one for use.

Individual Designs:

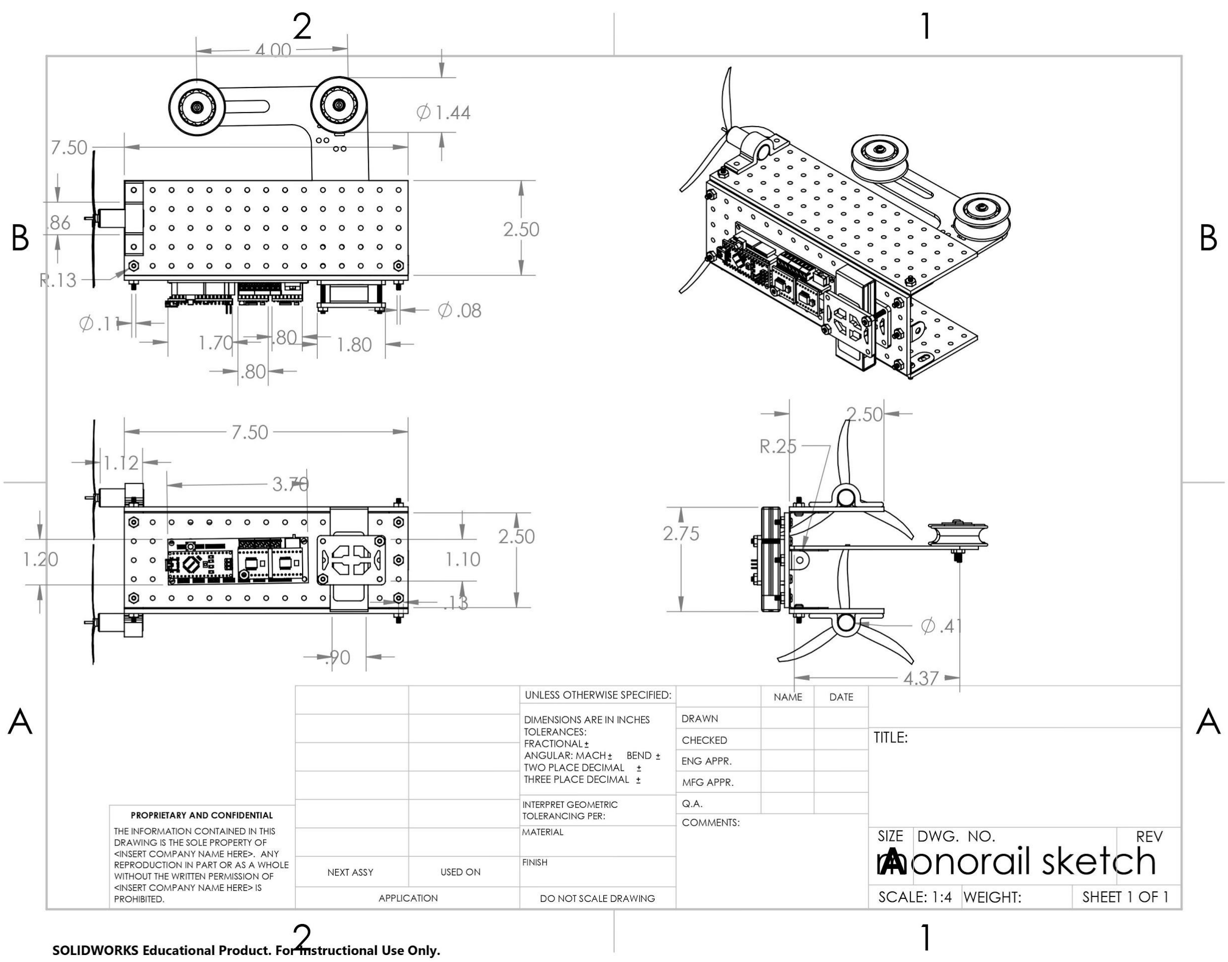

Figure 1: Ed Doerring’s design utilizing the tri-blade propeller

The first design consists of a large rectangular platform with an L bracket used to connect it to the track. I built large sides to the vehicle to mount the two electric propellers to. In the center of the rectangle mounted to the bottom is the Arduino and in front of it is the battery pack placed perpendicularly. It is held in place by two brackets. The design was not the most optimal as it was found to be unstable, cost inefficient, and harder to perform maintenance. The AEV also had a less than optimal design when it came to looks and also had a great part in why it was not chosen to be used as the team's design. The large box-like design required many parts and is the reason for high operating costs. It also made the design very heavy which led to its instability. Finally the box like design also made maintenance very hard as the sides hindered the user from accessing the innermost parts. One final problem that led to the selection of a different design was the selection of the propeller blades. The wrong ones were selected and were too big for the design.

To improve the design the whole project would most likely need to be scrapped. The sides would need to be removed and the propellers be placed on differently. One thing that could be kept is the positioning of the arduino. It was placed on the bottom of the AEV making it easy to access for turning it one and off. Using the two bladed propellers would have been a better choice and would suit this design better if it was being redesigned.

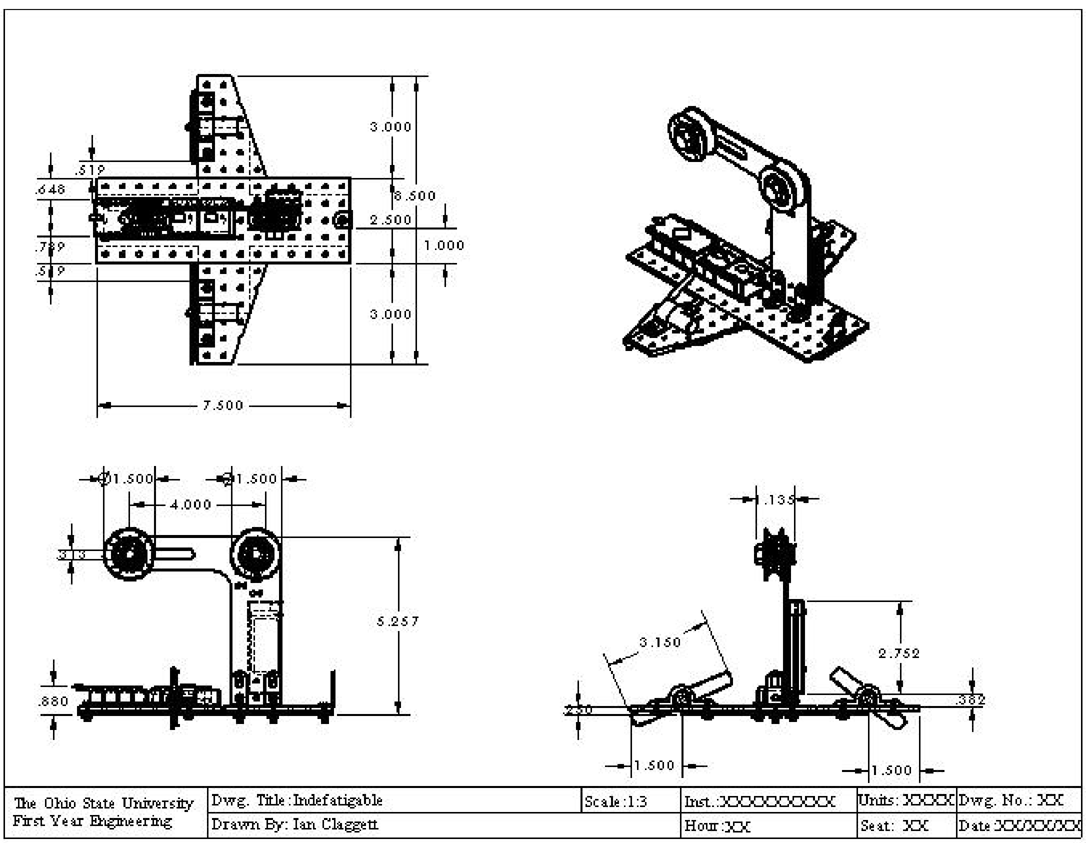

Figure 2: AEV final design used in the project, featuring a winged design with twin blade propellers

The final design for the AEV project to be utilized was “Indefatigable”. Featuring a winged design which allows both propellers on each side to propel the AEV forward using equal strength on either side. The design also has a centered gravity both on the top and the bottom of the base, with the Arduino chip on the top front and the battery pack screwed in on the bottom back of the AEV. The distribution of the weight on this design allows for a very efficient and centralized balance which ensures that the AEV will not dislodge itself from the track while performing its code. However, due to the placement of both the battery and the Arduino wire management has become an issue along the AEV. The distance required for the battery, motors, and sensors to plug into the Arduino is very short and strained. Although this issue was able to be resolved, in scenarios in which the ship were to be larger or distributed differently this issue may cause a much larger issue. Besides wire management, the AEV itself suffers no flaws and performs its tasks proficiently and safely.

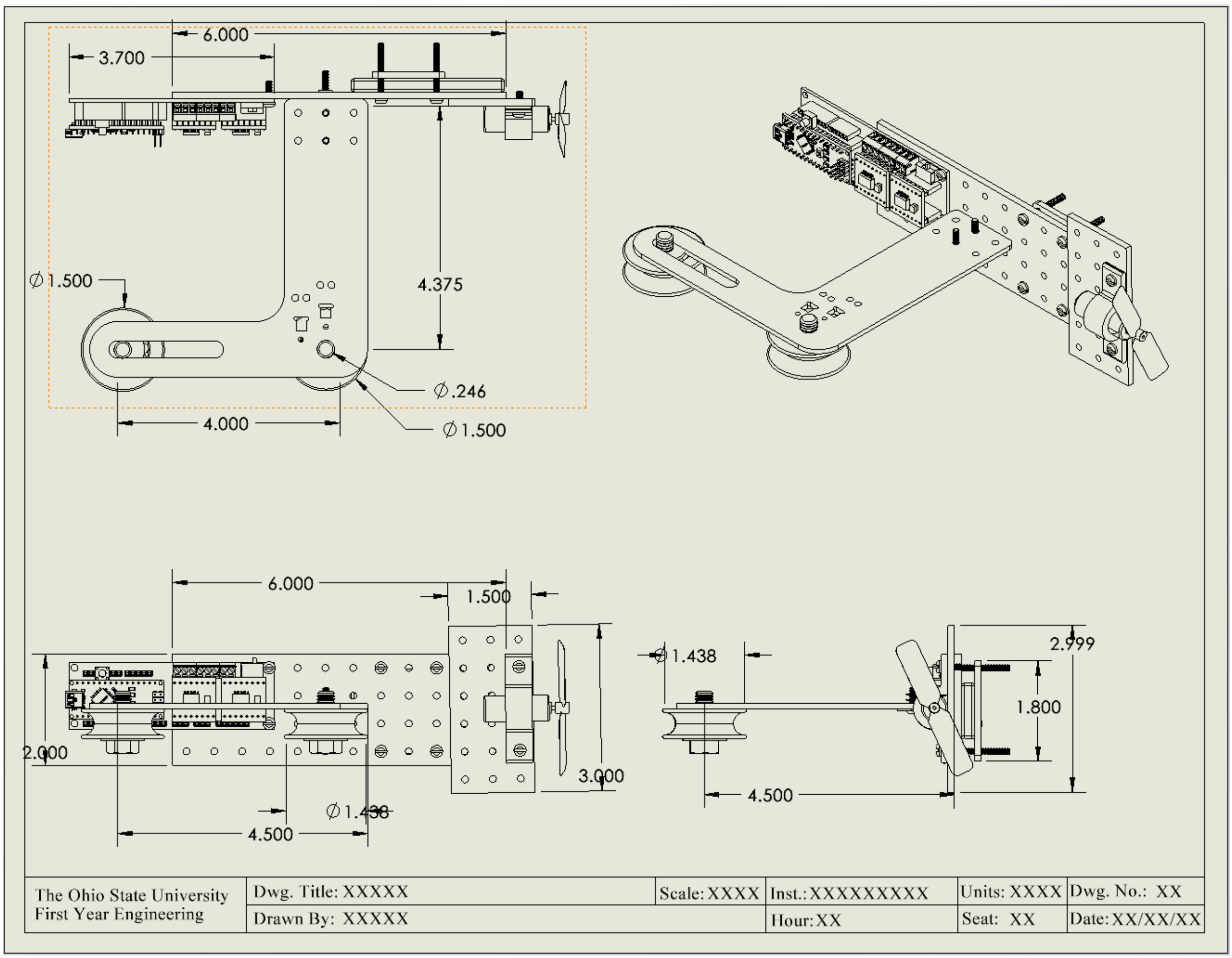

Figure 3: Stuart Fanko’s design, utilizing a single-propeller design

The design in figure 3 featured a thin design for low weight and high propulsion. The design holds the pulley in the middle of the AEV to maintain a level balance between either side of the vehicle. The arduino would be placed on top of the AEV to protect the vehicle from impact in the case that the vehicle were to dislodge itself from the track. The wire management and sensors would also be centered around the middle of the vehicle, allowing it to have a much more efficient management of the circuitry. However, the vehicle would only have one motor to propel itself forward or backward along the track. To resolve this lack of propulsion, the design allowed the body of the AEV to be much smaller and condensed to account for the use of a single motor. Having only one 3x6 addition to the body in the front to allow the motor to be placed in the front of the vehicle. The blade would also feature a twin-blade contour, which would allow for a strong propulsion along the track. However, depending on the load weight that would be required for the AEV the propeller could be exchanged for a tri-blade to account for this. This allows the AEV to be flexible in a variety of different scenarios to adapt to the requirements given within the experiment.

AEV Behavior:

The AEV followed the code perfectly upon the first test. Traveling 10 feet forwards, and 6 feet backwards as it had been programmed to follow initially. The ship remained consistent and traveled at a very stable rate. However, the speed at which the ship traveled left much to be desired as it ran along the track at a very fast pace. The AEV nearly ran out of track as it approached the initial 10 ft to travel, slowing down to change the direction. Lowering the rotation speed of the motors in the code would allow for a much safer and secure travel of the AEV, as well as a much more expected rate of transfer. However, the AEV design itself proved to be extremely reliable and balanced, as it suffered no issue with dislodging itself from the monorail, or wobbling on the course. This centered gravity helped greatly in the regulation of the efficiencies of the motors.

Complications did arrive initially in the composition of the wheel sensors, reading the opposite of the direction which the wheel was going. This issue was resolved very easily and swiftly however, with the exchange of the sensor ports to output into different pins. After this issue was resolved, the sensors worked perfectly as was expected by both the code and the group.

The group used its preliminary knowledge on the brake and motor speed system to create a code which would allow the transfer and reversion of the motors to properly allow the AEV to travel either direction according to the requirements of the lab. This was done by first setting the motorspeed and moving the first two second to gain the initial momentum, and then accelerating the speed up to the required speed of the lab in the span of one second, and from there initializing the goToAbsolutePosition function. This allowed the AEV to begin its measurements while having already begun a steady progression along the monorail track. From there after having reached the required distance, the motors would both brake and revert the direction of the motors, and begin traveling back the required amount of distance.

Issues remain within the design however, in it being the deceleration and reversion of the motors. The AEV had a limited amount of space left on the track to be used to brake the motors and reverse the direction. Since the wheels do not stop when the propellers stop, the vehicle proceeded to travel down the track even after the propellers had begun to push back. This could have become a much more intricate and serious problem if the AEV were to be in a circumstance where there is not enough room left on the track to successfully perform the reversion, causing the AEV to remove itself from the track and suffer possible harm. Outside of this scenario however, there were no other problems witnessed with the AEV and the code that was written.

Conclusion:

After each design was completed and drawn up in solid works, they were all evaluated using two different scoring systems, giving a good system to compare each design. This made it easy to find which design was most optimal for use in the project. After a comparison was made, the third design was decided to be most optimal for use as the groups design project. It had the highest all around score of 3 and seemed to outperform the reference design in almost all categories.

Concept Matrix:

Success Criteria			Reference		Ed Doerring		Stuart Fanko		Group design
	Weight	Rating	Weighted score	Rating	Weighted score	Rating	Weighted score	Rating	Weighted score
Stability	15%	3	0.45	2	0.3	4	0.6	4	0.6
Look	10%	2	0.2	2	0.2	2	0.2	4	0.4
Maintenance	15%	3	0.45	2	0.3	3	0.45	4	0.6
Durability	15%	2	0.3	2	0.3	2	0.3	4	0.6
Cost	5%	3	0.15	2	0.1	4	0.2	1	0.05
Balanced	20%	3	0.6	3	0.6	2	0.4	4	0.8
Minimal Blockage	10%	3	0.3	3	0.3	2	0.2	3	0.3
Environmental	10%	3	0.3	2	0.2	2	0.2	2	0.2
Total score			2.75		2.3		2.55		3.55
Continue?			Combine		combine		combine		Develop

Concept Screening:

Success Criteria	Reference	Ed Doerring	Stuart Fanko	Group design

Stability	0	-	1	1
Look	0	0	-	1
Maintenance	0	-	1	1
Durability	0	0	0	1
Cost	0	0	1	-
Sum +'s	0	0	3	4
Sum 0's	5	3	1	0
Sum –'s	0	2	1	1
Net Score	0	-2	2	3
Continue ?	Combine	combine	combine	Develop

Arduino Code:

```
motorSpeed(1,30);
motorSpeed(2,30);
goFor(2);
celerate(1,30,25,1);
celerate(2,30,25,1);
goToAbsolutePosition(246);
brake(1);
brake(2);
reverse(1);
reverse(2);
motorSpeed(1,30);
motorSpeed(2,30);
goToRelativePosition(-148);
brake(1);
brake(2);
```

Lab 3: Concept Screening and Scoring Grading Rubric		
Executive Summary Content		
Introduction		6
	Purpose	
	Background	
Results		23
	Objective presentation and analysis of results	
	Individual assembly image	
	AEV Behavior	
	Pros/Cons of each Design	
	Resolving Error	
	Recommendations	
Conclusions		5
Attachments		
	Concept Scoring Matrix	4
	Concept Screening Matrix	4
	Arduino Code	8
Writing Total		
	Spelling/Grammar Language Usage	35
Total		80

Instructor signature ______________________________

Work division for this summary

Student Name: Description of work

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