**DATE:** **01/23/2022**

**TO:** **Professor Jolanta Janiszewska**

**FROM:** **Matthew Geiger, Nick Stassen, and Ben Bazan**

**SUBJECT:** **Creative Design Thinking Lab Memo**

**Acknowledgments:**

The authors would like to thank The Ohio State University and professor Jolanta Janiszeswka for providing the materials that were used in the lab.

**Introduction:**

A national park wants to reduce the amount of traffic inside of the park, but still allow for good views for the tourists. To reduce the amount of traffic, the park will implement different types of transportation, however, with limited power, the types of transportation will need to be as energy efficient as possible.

**Background information:**

The decided forms of transportation that will be implemented in the park are a monorail, bus, and train systems. Although each form of transportation has its advantages and disadvantages, each form of transportation was selected for certain reasons. Buses were chosen to be included because they allow for mobility. Buses can go anywhere a car can but allow more people to ride, reducing the number of cars. Monorails were selected because they can transport a large sum of people fast over a certain distance without allowing for any additional traffic. And finally, a train system would allow the same as monorails, but also can be connected outside the national park.

**Individual systems:**

Matthew Geiger, Buses: The most notable pro for buses, particular buses that run on CNG or compressed natural gas is the fact that they produce almost zero Particulate Matter or PM for short. In a test in Boulder Colorado buses that ran on CNG produced 97 percent less PM than buses that ran on diesel fuel and the small amount of PM that was produced was due to crankcase oil consumption. Coming in as a close second is the affordability of buses, when compared to the diesel fuel that trains run on natural gas is significantly cheaper anywhere from $1.50-2.00 per equivalent gallon. Meaning not only are buses able to go anywhere that has a road, but they are also cheaper to operate. Additionally, natural gas produces an equivalent or less amount of greenhouse gases compared to diesel. One of the main cons of buses is that they can't hold nearly the amount of people a monorails or trains can. In figure 1 the design features a forward wheel drive system from two motors located on the bottom of the bus. Behind the motors there is the lithium polymer battery that supplies energy. In front of the motors the Arduino nano and motor controllers are located. The team discussed the mobility of buses as the main pro and the battery weight as its main con. Design considerations that need to be considered are

aerodynamics of the bus and space between the road and the Arduino nano and lithium polymer battery.

Ben Bazan, Monorail: Some of the pros of a monorail system are that they are quieter than other forms of transportation, can transport not only a large number of people very quickly but also materials, they are elevated above other vehicles and pedestrians so there are no accidents, and finally, they can run on electricity allowing for 0 direct exhaust. However, there are some cons that come with monorails. Some of them include the fact that if part of the monorail system breaks down then the majority of the system is unusable, not as mobile as other forms of transportation (buses), and costs slightly more than other forms of transportation. Figure 2 shows what a possible monorail could look like. This certain monorail runs on 2 electric motors which use propellers to move the car both forward and backwards.

Nick Stassen, Train: The train/rail system consists of a vehicle which rides on a dual rail with wheels. This design features 2 powered rear wheels with 2 unpowered front wheels. The powered wheels are moved with electric motors and receive information from the Arduino nano located behind the battery (refer to figure 3). This design stays low to the ground due to its shallow wheels which in unison with the angled front will make it aerodynamic. The pros of the train/rail system are that it's stable, aerodynamic, able to carry a lot of weight based on the placement of the wheels, and when it is going it does not require much energy to keep going. The cons are that it is heavy meaning it is not energy efficient for multiple frequent stops, it can only move in two directions due to its path dependency, and it is wide which makes it suffer on sharp turns.

**Team Evaluation**

Matthew's design for the buses was voted the highest with a value of 8. His was chosen the highest due to its mobility. While normally buses would be lowest when compared to trains and monorails because of their extremely low speed, in this situation a bus is the best option due to its ability to make stops at just about anywhere. Along with its low impact, unlike trains and monorails that need tracks that sometimes impend views, all the bus needs are a road. Energy availability is high since it can run on electricity renewable energy sources would be used to power the buses. However, user comfort would be impeded by irregularities in the road such as potholes. Ben's design for the monorail was voted the second highest with a value of 7. This was because while it may be the fastest mode of transportation in a straight path scenario in a park it is extremely limited. With increases in elevation switch backs would be necessary and the monorail car would have to accelerate and decelerate with each switch back making speed decrease and energy consumption increase. A second reason why the monorail was given this score was because of the track that would have to be built for the monorail car to move. The beautiful views of trees and landscape would be obstructed by the monorail track. Along with these issues the user comfort raised concerns because of the large amount of noise the propellers would make. While energy availability of the system is high the energy consumption due to

switchback caused concerns. Nick's design for the train was voted a score of 6. This score was chosen because not only would the train have the same problems as the monorail but additional concerns over maintenance and energy availability were raised. Additionally, energy consumption was a concern because of its relatively high friction compared to the monorail.

**Work Division:**

Ben Bazan completed individual systems - monorail, introduction, acknowledgments and background information. Matthew Geiger completed individual systems for Matthew Geiger and Team Evaluations. Nick Stassen completed individual systems for Nick Stassen.

**Appendix**

Figure 1

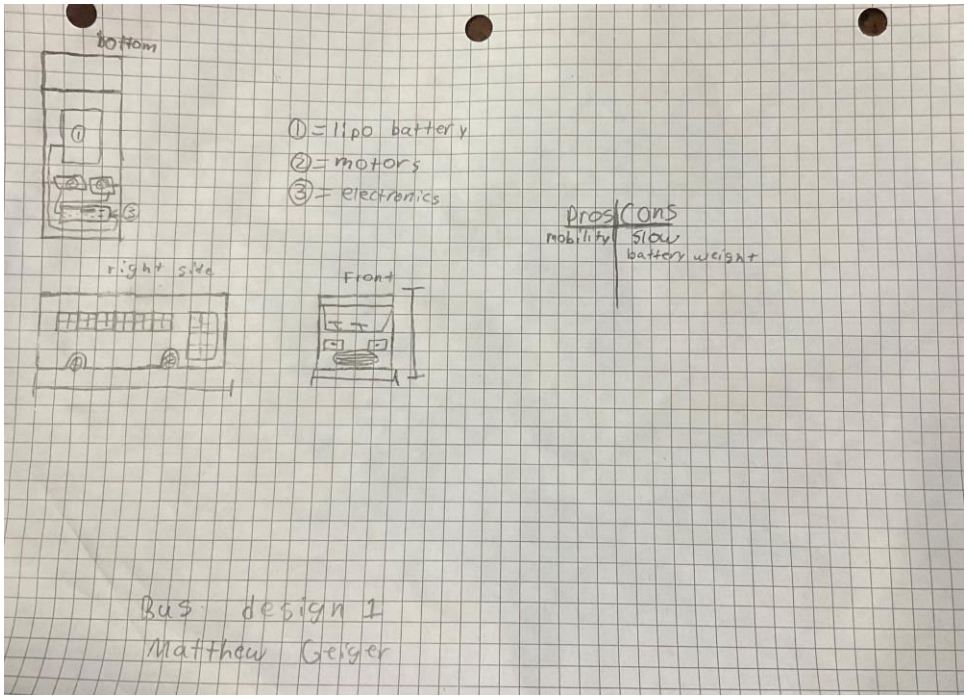


Figure 1 shows a design for a bus that uses electric motors to provide forward wheel drive. It shows where the lithium polymer battery would go along with the Arduino nano that has the code program on it.

Figure 2

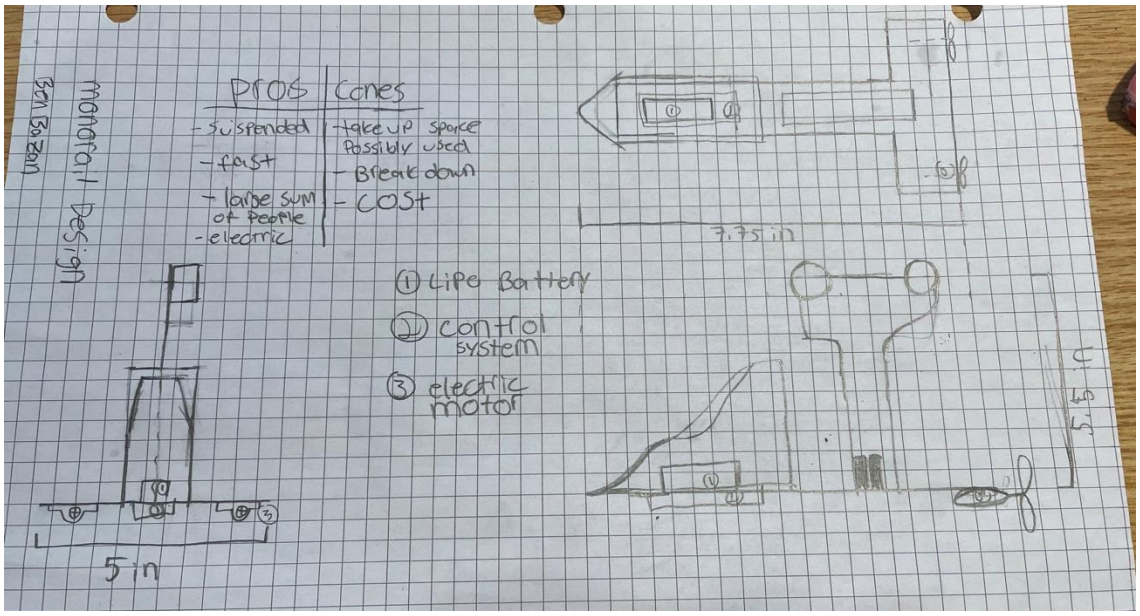


Figure 2 shows what a possible design for a monorail could look like. This certain design uses 2 electric motors located in the rear of the monorail which use propellers to push the car forward or pull the car backwards.

Figure 3

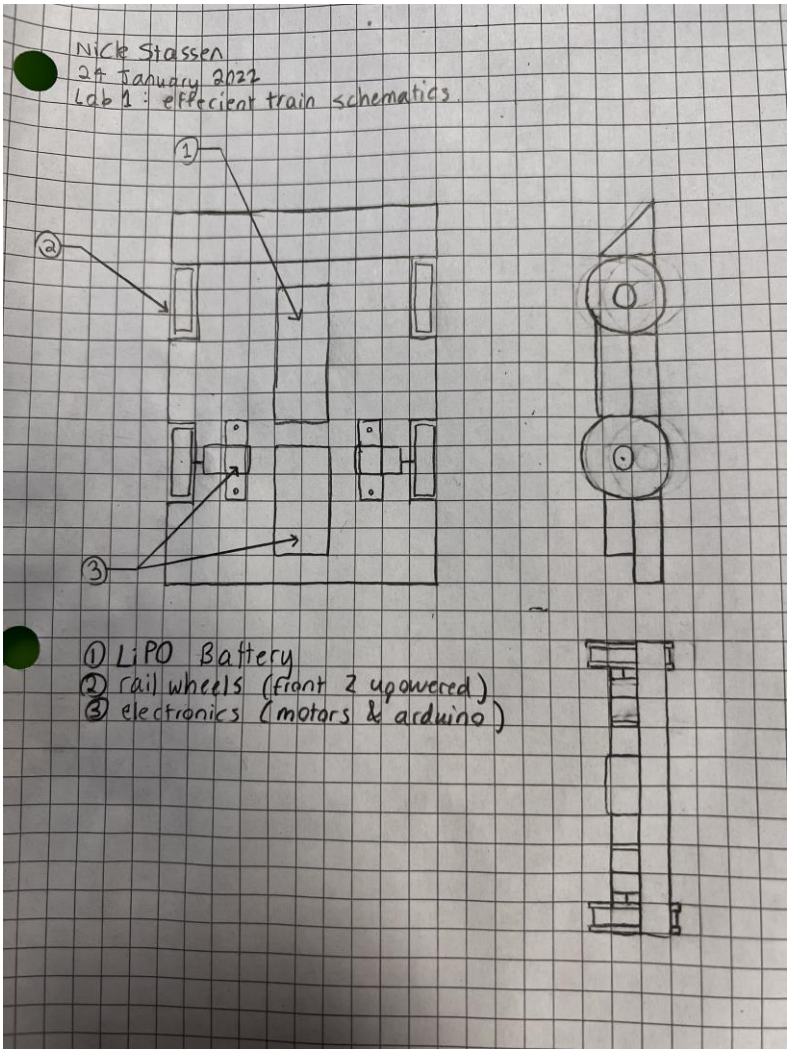


Figure 3 shows the train/rail system. This design uses two rear powered wheels and two unpowered wheels which are on their respective side's track. The track will be a dual rail system meaning the train will go wherever the path leads only forward or backward.