To: Professor Jolanta
From: Heath Meyers, Nate Johnson, and Jason Kibler II
Date: 1-22-2020
Subject: Lab 1: Creative Design Thinking

Acknowledgments:

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Introduction:

The goal of this project is to design an alternative form of transportation through a national park to lower the amount of traffic on the roads; while still providing a scenic view for passengers, being energy efficient due to the remoteness of the park itself, and be an Advanced Energy Vehicle (AEV). One of the designs proposed must be also a monorail. Designs were intended to focus on energy management, efficiency, and consistency, and the AEV shouldn't be track-specific. The vehicle will also have to make frequent stops, carry cargo, and move forward and backward. To complete this task, three different modes of transportation were designed to attempt to alleviate the issue. The three designs were the X-rail (monorail), the tri-copter, and the quad-rail. Throughout this process, designees were encouraged to consider user comfort and satisfaction, energy consumption, and energy availability. The proposed designs were presented with an orthogonal sketch as well as a description of how each design should run. The vehicle designs were also required to take into account how it will run, design considerations, and pros and cons of the design.

Designs:

As can be seen in Figure 1 the tri-copter is simply a square cabin where the 8 passengers will sit. The cabin is then sounded by solar panels that will aid in the charging of the batteries for the electric engine. Then outside the solar panels are 3 turbines that will provide the lift and steering for the tri-copter. The right and left turbines will provide the main lift powers as well as the forward and backward movement capabilities. The back turbine is mainly designed for turning left and right but can provide some lift if the side turbines are oriented correctly. The turbines will change orientating by sliding the beams attached from the main square to the turbine up and down causing the turbine to tilt. Moreover, the tri-copter can land on water and land because of the flotation device that is attached to the bottom of the craft. This flotation device is also used to protect the batteries and electric engine that is under the cabin during landing. The solar panels, flotation device, seats of the passengers, pivot pints of the turbines, batteries, and electric engine can be seen labeled in figure 1. The design of the tri-copter was motivated by the quad-copter design that is used in recreational drones and by the fan boats that are used in the Everglades to conduct tours. These two motivating designs were then combined and modified to suit the need to traverse all different types terrain.

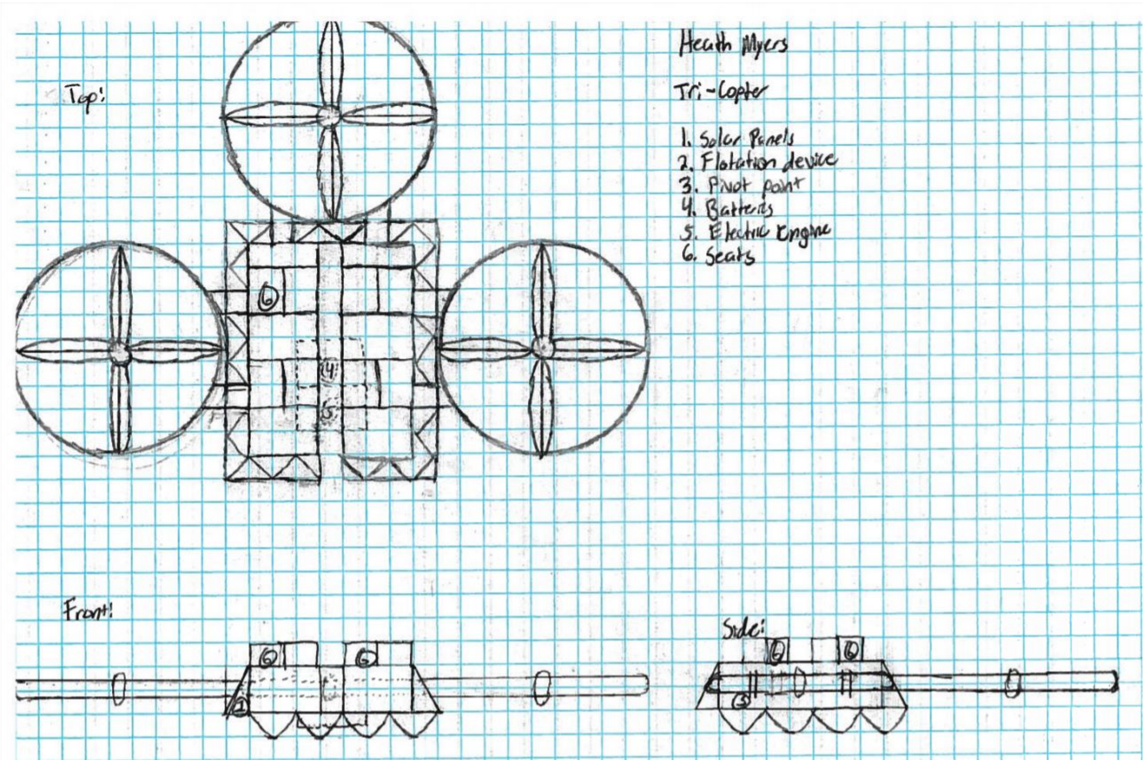

Figure 1: Tri-Copter orthogonal design.

Besides the being able to fly and land almost anywhere, fit 8 passengers, and be environmentally friendly, the tri-copter does come with the cons of having a max weight, having no cover for passengers, being off balance with the turbine in the back causing some of the turbine power having to go towards stability, being extremely loud, and the need for time for the batteries to charge. Moreover, these cons do bring several aspects of the design that need to be taken into account if the tri-copter where to ever be produced. One design consideration is that the material of the tri-copter will need to be light weight. The landing areas and battery charging times will also need to be taken into consideration, as well as protective gear for the passengers since the design is not enclosed.

The following description will include number references to figure 2, in the format of "part described (#)"

Figure 2 depicts the X-Rail design in three different views, top, front, and from the right side. The design itself is modeled loosely off of an airplane for aerodynamic reasons. The system is powered by a battery (5) that is attached to the bottom of the vehicle. This battery powers two motors (4) that rotate blades that resemble closely to that of a wind turbine, which can change directions based on which way the vehicle is going. The "brain" of the vehicle is an Arduino board (6) that is attached to the belly of the vehicle itself, this board is responsible for controlling the speed of the vehicle (stop/start, speed up/slow down). The individual feature that sets this design apart from the rest is the x-shaped wings (3) that jet out from the sides. The vehicle itself moves by being attached to a track by a long arm (2) and being pushed by the motors and blades. A hook is fastened onto the end to pull/push cargo if needed. The seating (7) for this vehicle is found both in the front and the back, leaving one row for entrance/ exit on each side.

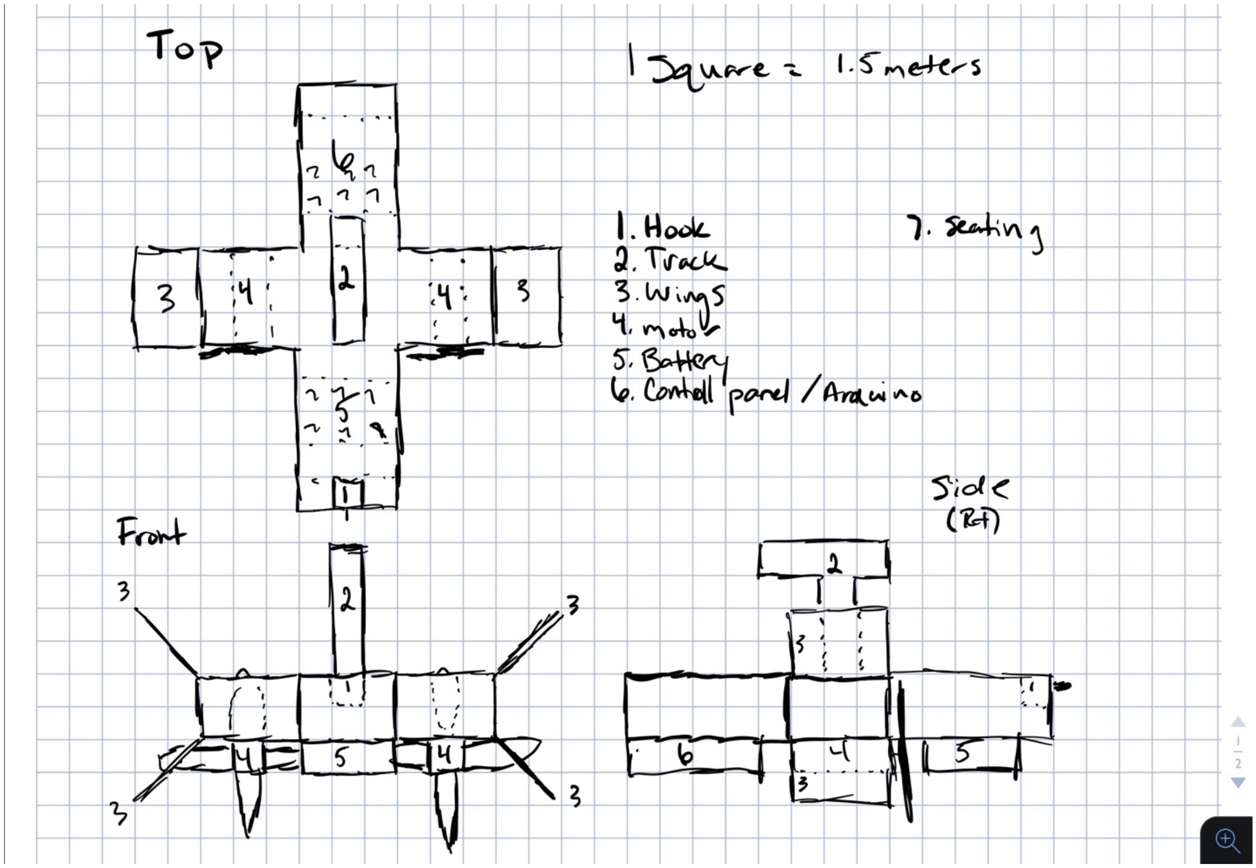

Figure 2: X-rail orthogonal design

There are both advantages and disadvantages to this design. Starting with the advantages, there is an ample amount of electricity readily available to charge the battery on the vehicle. Without having to worry about the future of oil and fossil fuels, this design gives a reliable and clean option for power. Another advantage of the vehicle are its wings, because they are rectangular, they provide a good amount of aerodynamics for both directions, forward and backward. A slight advantage to the design is the openness of the build concept. Due to the open seating design, passengers are able to take full advantage of the views they will have when riding the vehicle throughout the mountainous landscape. A shortcoming of this design lies in the weight of the design. With the vehicle being so large, there will be an equally large power consumption, which may mean frequent recharges in-between rides. Another slight disadvantage is that the arm that suspends the vehicle may become an obstacle of the rider's view causing lower satisfaction.

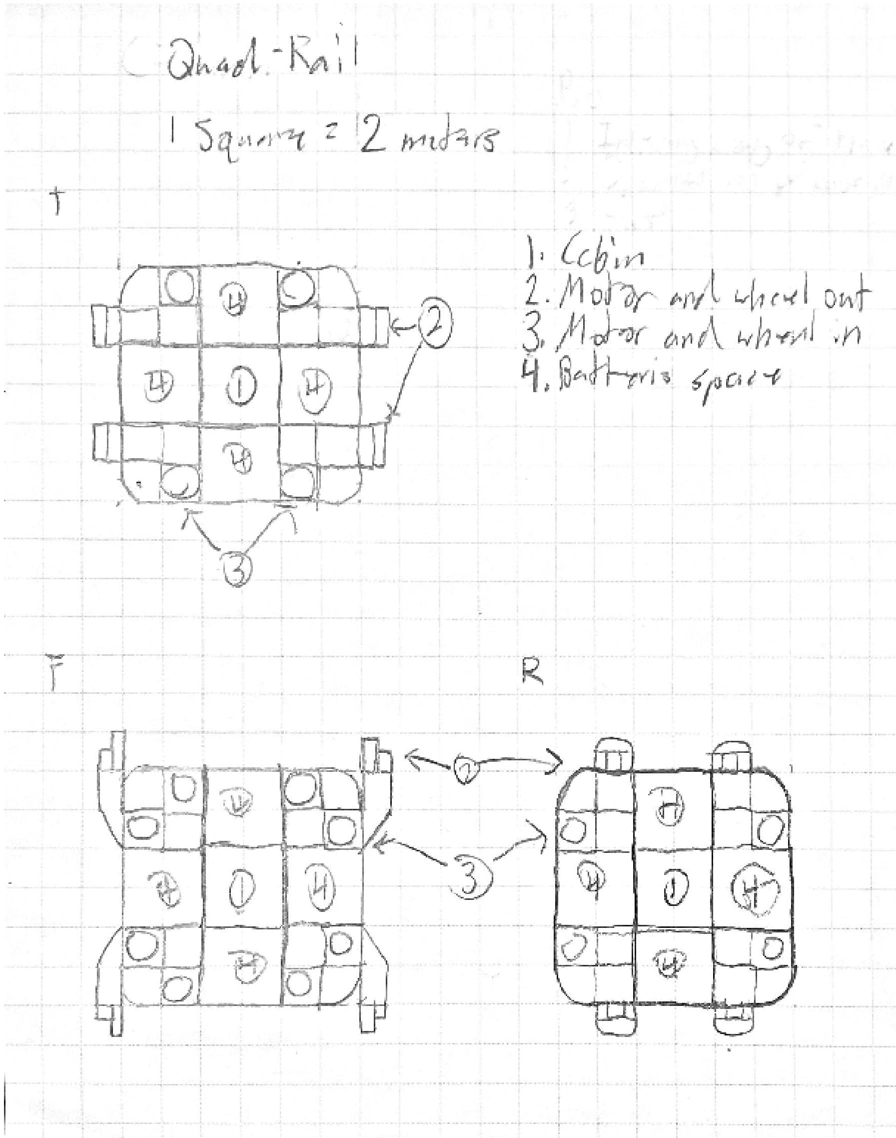

Figure 3: Quad rail orthogonal design

As seen in figure 3, the quad rail uses 4 different rails located at each corner to move along a path. On each of the quad-rails' faces is eight motors and retractable wheels for a total of 48 Motors and wheels. Having this setup allows the quad rail to move in any direction have an instant's notice. For example if the quad rail needed to go from the horizontal direction to the vertical direction it would reach the end of the horizontal track retract the wheels that allowed to go horizontal and then extend the wheels that will allow it to go vertical. The power source of the system will be lithium ion rechargeable batteries. The entrance into the cabin which can hold 8 passengers can be entered from any side of the quad-rail as the cabin will be self-leveling to the ground.

There are some advantages and disadvantages to the design. With the eight motors used at any given time, the speed and acceleration of the unit can be faster than other designs. The quad rail can move with 3 degrees of freedom along the rails so for example, if it needs to go down into a tunnel, it can go straight down instead of sloping down. With it able to enter and exit on any side setup, the quad-rail can do any sudden movement it may need to do in order make it to its destination. One problem with the quad-rail is there are a lot of moving parts, so precision is a very important piece when setting up the system. With all the electric parts involved, the quad-rail will use a lot of power cooling and charging may become a constant problem. If the ride becomes to dynamic for some passengers, they may experience motion sickness. Also depending on how many are used at a time, multiple setups for the rails would have to everywhere taking up space.

Results/Discussion:

After designing, presenting, and discussing each design; the group then rated each design on a scale of 0-5 based off user comfort and satisfaction, energy consumption, and energy availability. The results of the ratings can be seen in table 1 below. Each member rated the designs in every category and then the average of the scores was taken to obtain the ratings shown in table 1. The groups reasoning for the given scores produced during discussion are also listed below the table.

Design:	User Comfort and Satisfaction	Energy Consumption	Energy Availability	Average Score
X-Rail	3.75/5	3.67/5	3.83/5	3.75
Tri-Copter	3.2/5	2.17/5	4.5/5	3.29
Quad rail	2.33/5	2/5	4/5	2.77

Table 1: Ratings of each design in three categories on a 0-5 rating scale.

The X-Rail received a rating of 3.75 in user comfort and satisfaction because, although it would be comfortable and quiet, the bar that attaches to the rail would be obstructing many of the passenger's view's as the trip was made. Moreover, the X-Rail is restricted to a single path that will have to be taken every trip and not have the change for a new experience.

The tri-copter received the 3.2 ratting in user comfort and satisfaction because, with the turbines being so close to the passengers, the noise that is going to be produced by them is going to be intrusive on the experience. Moreover, the tri-copter also received this ratting because, since it can travel quickly, the wind will become quite disruptive to the experience. However, the tri-copter has the ability to travel anywhere and see any sight.

The quad rail received a 2.33 in user comfort and satisfaction because, based off of the design, it would only leave standing room for the passengers while also having an obstructed view of the scenery due the massive amounts of rails needed to construct it.

The X-Rail received, in the energy consumption category, a 3.67 because it has the wheels that will allow for it to use little to know energy when going downhill. However, since the design itself will quite large and only is propelled only by the turbines at the back, it will require a large amount of power to get it started and to move up hill.

The tri-copter received a 2.17 due to the fact that it would require a large amount of energy to not only get the copter off of the ground, but also to keep the copter in the air (unlike the X-Rail that can use less energy while going downhill). Also, as stated before, the turbines would also not be able to blow directly down because it is off balance and would require the side blades to be tilted, at all times, to be level.

The quad rail with its 48 motors and extreme weight, received a 2 in the energy consumption category.

In the last category the X-Rail received a 3.83 because it has a massive battery pack that will allow it to hold all the necessary power that would be needed to conduct the trip. Also, if needed, since the X-Rail follows a single path each trip, there can be designated charging stations along the rail for longer trips.

In power availability the tri-copter received a 4.5 because it has 6 feet of area designated for batteries that will power the electric engine. Moreover, all along the outer edge of the tri-copter are solar panels that will allow for not only charging while on the ground when it is not in use, but also charging during the trip itself.

Lastly, in the power availability category the quad-rail received a 4 due to the fact that the design allows for a massive amount of batteries between the cabin and the engines.

Overall the X-rail won with an average score of 3.75.

Conclusion:

The goal of this lab was intended to reduce the amount of traffic within national parks. In order to obtain this goal three different modes of transportation where designed considering user comfort and satisfaction, energy availability, and energy consumption. The modes designed where the X-rail, tri-copter, and the quad-rail. Although none of the three designs were perfect, each of the proposed designs do come with their distinct advantage that would provide for a unique experience for the tourists exploring the park. The X-wing will provide a slow, smooth ride on a specific destination in the park with some view obstructions because of the rail arm. The tri-copter will allow for a much more extreme experience in the air that will allow for the tourists to see any section of the park, with the con of having the tourists deal with extreme winds and noise. The quad-rail will also allow for a unique experience in the park; however, the passengers will have to stand and will have to deal with the plethora of rails across the park. However, based off of the designs presented with in this lab and the scoring system implemented in table 1, the X-rail, with an average score of 3.75, would be the best mode of transportation for the park to implement.

Within this lab, several difficulties where faced. Specifically, having to come up with an original design that would not only fulfil the requirements of the park but to also make the design practical. Another challenge that was faced was to put the idea on to paper with the orthogonal design.

Lab Participation

Jason Kibler II wrote the conclusion, Nate Johnson wrote the introduction, and Heath Myers wrote the results/discussion and lab participation sections. Each group member also wrote their own description; pros, cons, and design consideration list; and motivations for their individual designs, as well as, sketched and inserted their individual designs.