Adaptive Mountain Bike Chairlift

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Introduction

Lift-serviced mountain biking is gaining attraction around the country, especially among adaptive riders. This pastime includes riding a ski chairlift up and biking down the mountain.

The objective of the adaptive chairlift is to allow the riders to stay in their bikes the entire time and speed up the process to make it easier for everyone involved, from the rider to the assistants and lift operators. To accomplish this, we researched current chairlifts and aerial platforms and decided to create a trailer-like platform with folding ramps for entry & exit. Doing so allows for the rider to ride up onto the platform, while the lift operator moves the ramp down and pins it in place.

Figure 1: (Left) Picture of the team at Powder Mountain with an adaptive bike. (Right) Biker on an adaptive bike going down a trail.

Problem

Most of the adaptive riders have complex disabilities that make the current process very challenging. They need help being transferred in/out of their bike directly to/from the chairlift, and then their bike, which has three to four wheels, needs to be awkwardly placed on a bike rack meant for a bike with two wheels. This takes up to 15 minutes and requires a lot of assistance.

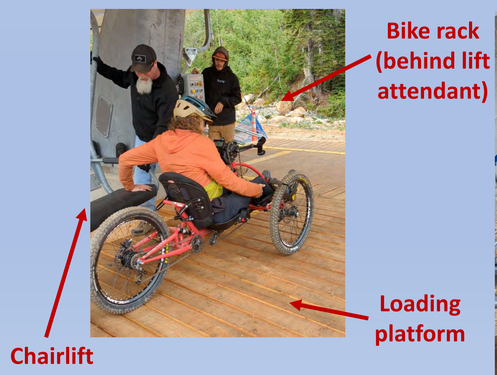


Figure 2: Both the chairlift and bike rack are stopped by the lift operators on the loading platform. Bike is positioned for the transfer.

Figure 3: Adaptive bike on a two-wheel bike rack in the current process.

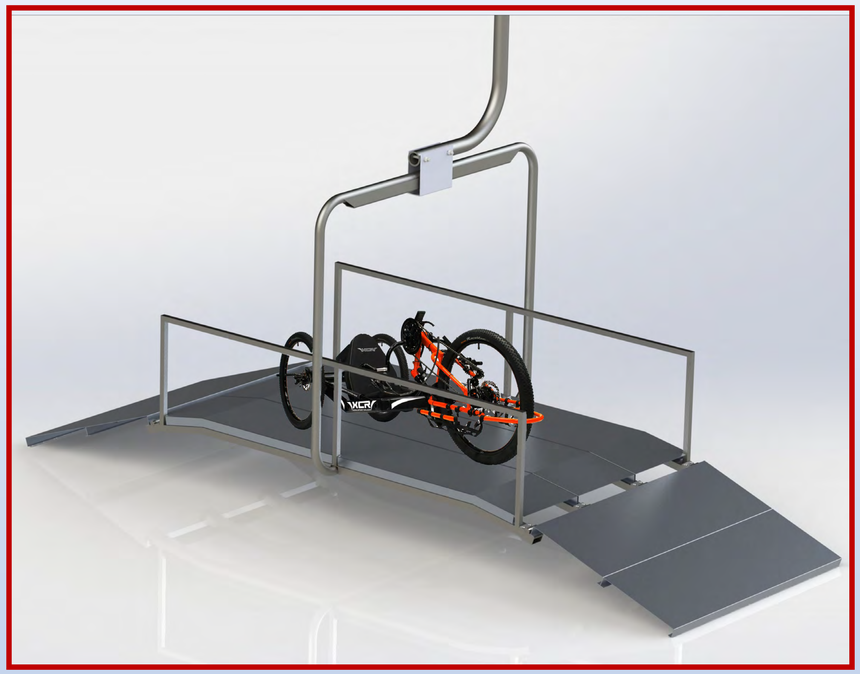


Figure 4: SolidWorks model of the Adaptive Mountain Bike Chairlift with a handcycle on the platform. Ramps are down. In operation, ramps will move up and down during the loading and unloading processes.

Design Metrics

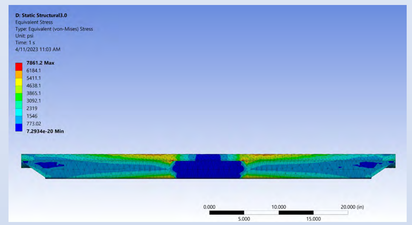
The solution to this problem is creating a new aerial lift that attaches at the Taco (see picture) and creates a more autonomous process without disrupting the flow of normal bike traffic. This lift needs to meet the metrics below:

- Takes significantly less time to execute (<3 minutes)
- The rider stays in their bike the entire time
- The lift meets safety standards (ANSI, swing < 15 degrees)
- The system can be supported by the Taco (total max load < 6.6kN)

Figure 5: This is where the system's top bar interfaces with the Taco. The rubber grommet is the black piece in between the Taco and the chairlift top bar. The Taco is a U channel that connects the adaptive chairlift to the stem by bolts. The stem then connects to the chairlift cable (not pictured).

Methods

The most critical design requirement to meet was the ANSI standard that states the system must have a safety factor of 4. This means that the stress at any point due to the max applied load X4 would not exceed the tensile strength of the material. All analysis was done through hand calculations and Finite Element Analysis (FEA) in ANSYS.



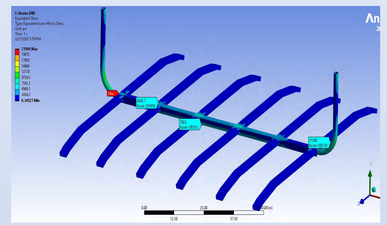


Figure 6: ANSYS models. The highest stress concentration under max load is 12 ksi at the end of the bike platform. Comparing this to the yield strength of 50 ksi steel, the lowest safety factor is 4.

Manufacturing process

The adaptive chairlift frame is made of steel welded together with aluminum grip-strut planks bolted to the platform. Different parts were sent out to different machine shops on and off campus to complete the bending and welding.

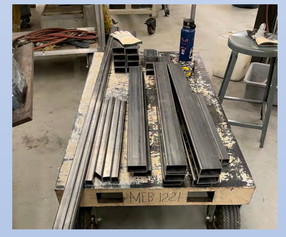


Figure 7: (Left) Steel tubing cut to correct lengths for the platform. (Right), Aluminum grip-strut planks being bolted together.

Results

The adaptive chairlift meets the most critical design requirements. The lowest safety factor is 4 at the end of the bike platform.

Table 1: Predicted values for our performance measures. See metrics to the left.

Performance Measure	Unit	Predicted
Unload/Load Time	min	3
The rider stays in their bike the entire time	Y/N	Y
The lift meets ANSI safety standards	safety factor	4 < SF < 70
Allowable swing under loading	degrees	5
System total weight is below Taco max load	lbs	800

Conclusion

We designed and manufactured an aerial lift that can be used during summer lift service mountain biking that takes x minutes to load/unload, allows for the rider to stay in their chair, and meet the safety standards. This will allow lift-serviced mountain biking to become a more accessible sport.