# THE EQUIBIKE

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Client: Justine Boudreau

# INTRODUCTION

- A wheelchair user wants to go on a bike ride with his friends, but gets ***excluded*** because they cannot afford an inclusive bike that exists on the market (which often retails for more than 5000$ CAD)
- The questions to answer are:
  - How do we create a solution that is **environmentally friendly**?
  - How do we make the product **affordably**?
  - How do can we make everyone feel **included**?

# EXISTING SOLUTIONS

| **Company** | Nihola | Vanraam | Mobility & Access Inc |
|---|---|---|---|
| **Product Name** | Nihola Flex 2.0 | VeloPlus wheelchair bike | The Duet Wheelchair Bicycle Tandem |
| **Product** |  |  |  |
| **Price (CAD)** | 14,292.90 $ | 13,800.00 $ | 7163.90$ |

# THE ORIGINAL PROBLEM

- We initially had a product that was **not functional** and **lacked** the ability to carry a wheelchair.
- The mounting system of the prototype was to the **front**.

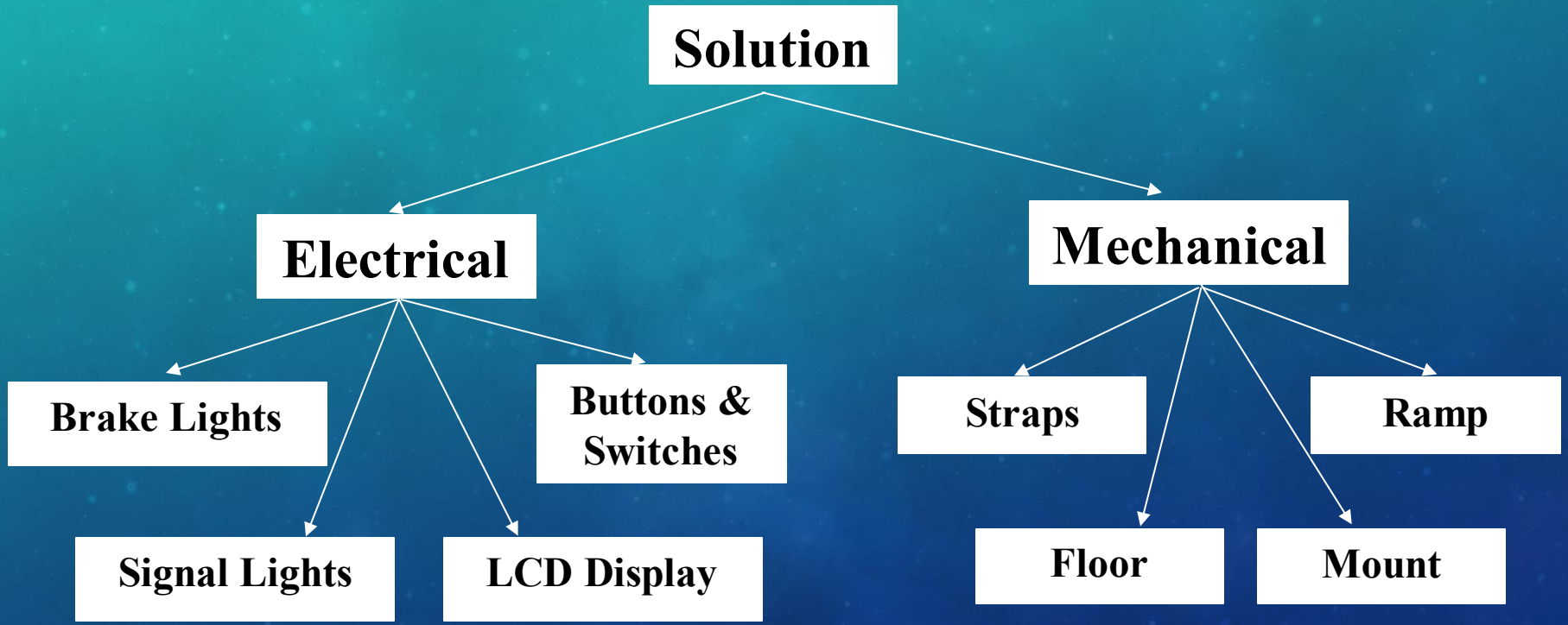
# PROBLEM STATEMENT

*"Developing an inclusive bike solution to enable individuals with physical disabilities to enjoy recreational rides with friends and family, ensuring accessibility, comfort, and safety for all riders. The system should accommodate a reasonable weight capacity while ensuring a seamless and enjoyable experience for the end user."*

# NEEDS AND REQUIREMENTS

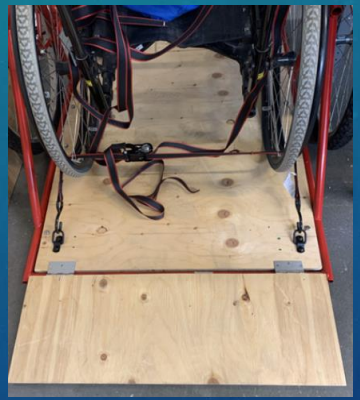
- **Safe to use** at city riding speeds on normal roads.
- Easy for the wheelchair to be **loaded and unloaded** from the attachment.
- **Light** and **durable**.
- Must accommodate **most types** of wheelchairs.
- Rear **brake lights** and **turning lights** to increase visibility on the road.
- Must **secure the wheelchair** so that it does not roll unintentionally while in motion.
- The **ramp must lock** so that it does not fall over while in use.
- There should be a means for the wheelchair user to **communicate** with the biker.

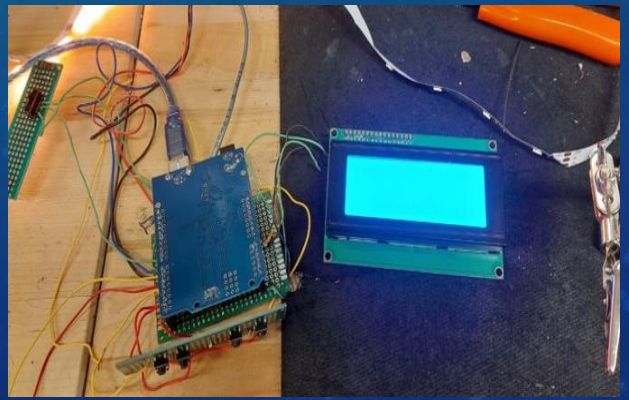
# GLOBAL CONCEPT



# BRIEF SUMMARY

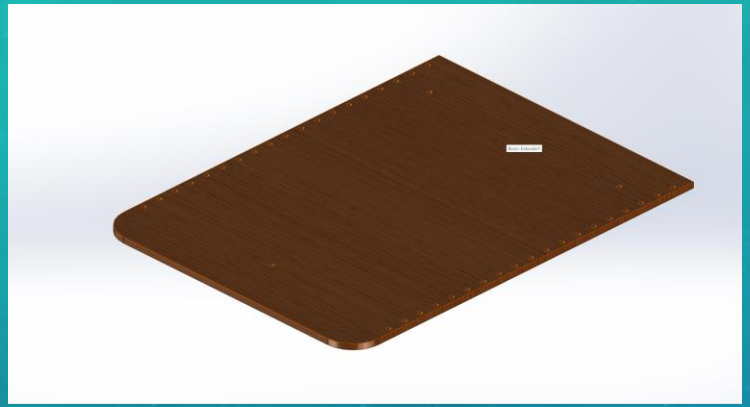
- We added **2 straps** so that we can secure various kinds of wheelchairs to the device.
- We settled on repurposed wood for the floor and ramp of the trailer. We added a **locking system** for the ramp so that it will stand at 90 degrees.
- We used brand new steel rods to weld the **attachment** that links the trailer to the bike.
- Our **electronics** are comprised of repurposed ethernet and phone cables, an Arduino, 4 buttons, an LCD display 2 slide switches, and a limit switch.
- Our solution is significantly **cheaper** to produce than competing products, while being made of **repurposed materials,** and our solution is a **trailer that can be attached to a bike the user already owns.**



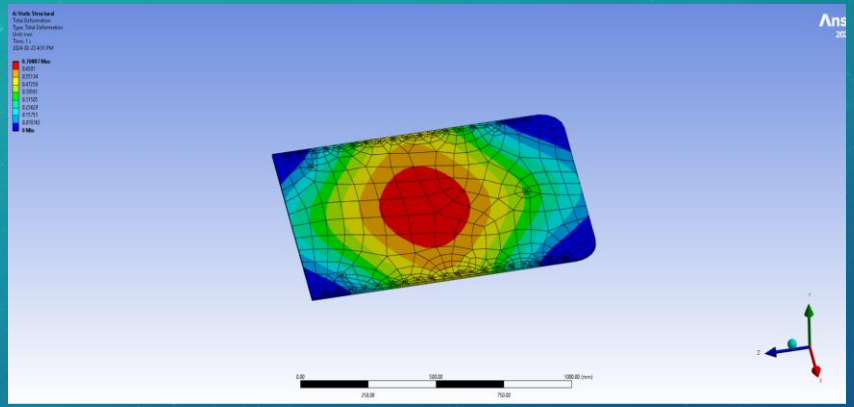


# FLOOR

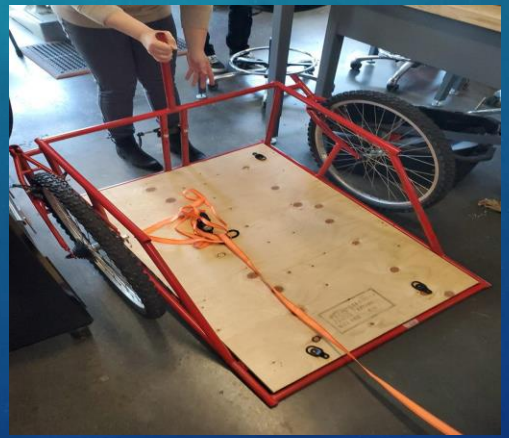
- The carriage made by the previous group had a just placed two wooden sheets on the floor of the carriage
- We decided to design a proper sturdy floor for carrying the wheelchair in safe and secured way
- We researched a lot of materials considering number of factors like strength availability and cost of material.
- We did number of computational analysis to finalize the floor
- We have finalized Birch plywood for our floor
- We have added two steel reinforcements to make it for sturdy and strong.



Floor Design



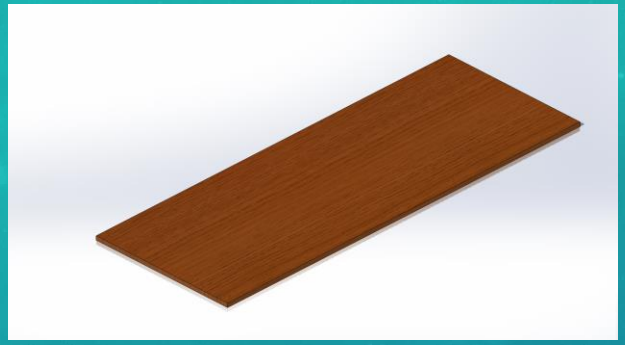
Strength Analysis

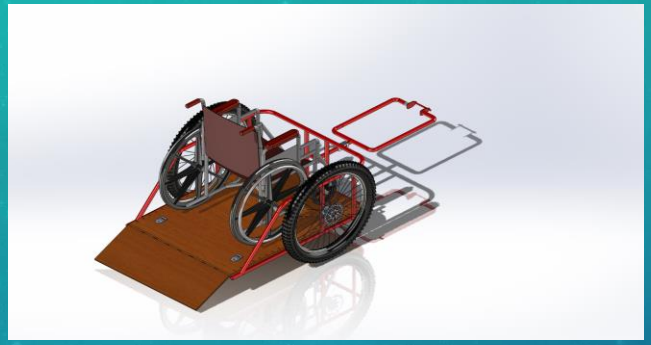


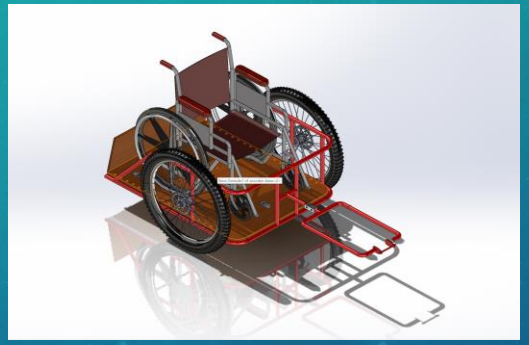
Final Floor

# RAMP

- We produced an idea of making a specialized ramp for our carriage for easy access of wheelchair
- We decided to design a ramp which will act as a ramp as well as prevent the wheelchair for going back just in case the straps fail
- We have used the same plywood which we have used for the floor .







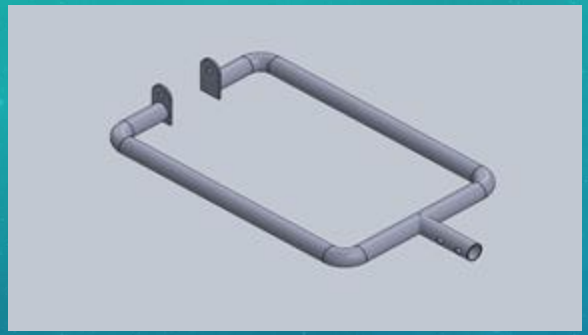
Design

Manufactured

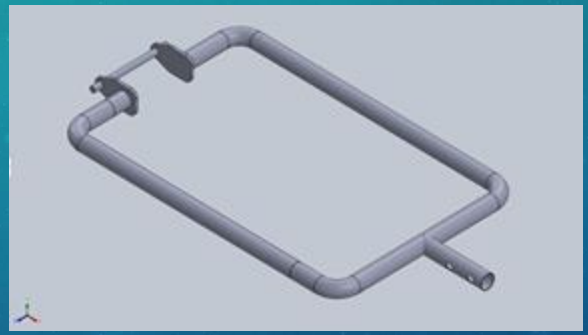
# MOUNT

- The carriage made by the previous group had a different type of mounting system to the bike.
- We decided to mount the carriage behind the bike and make a mount for it.
- The final design was selected after 4 design iterations.
- The mount consists of 1in x 1in hot rolled steel square rods which form the structure of the mount and 1/4in steel plates that connect the rods to the bike axle.

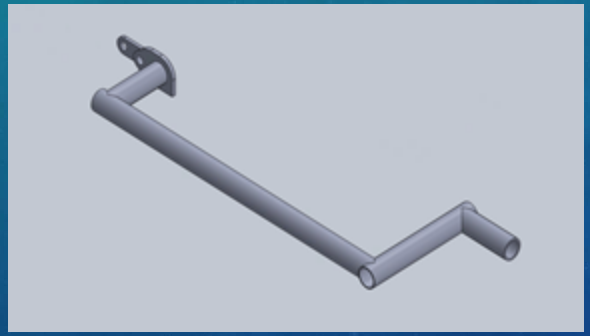
# DESIGN ITERATIONS



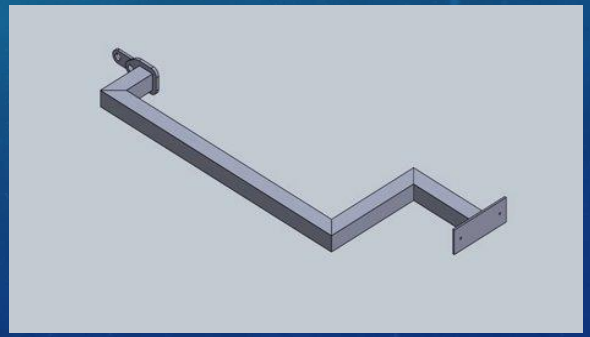
Design Iteration 1



Design Iteration 2

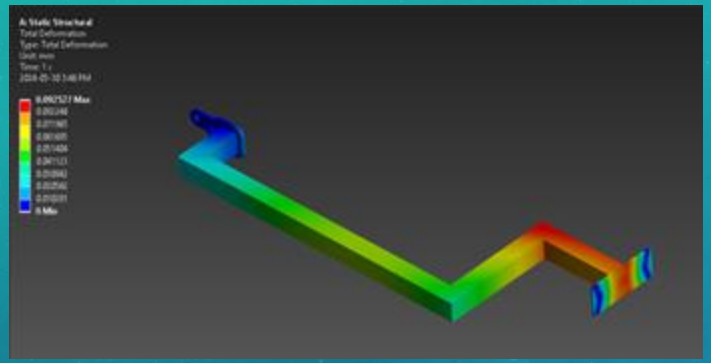


Design Iteration 3

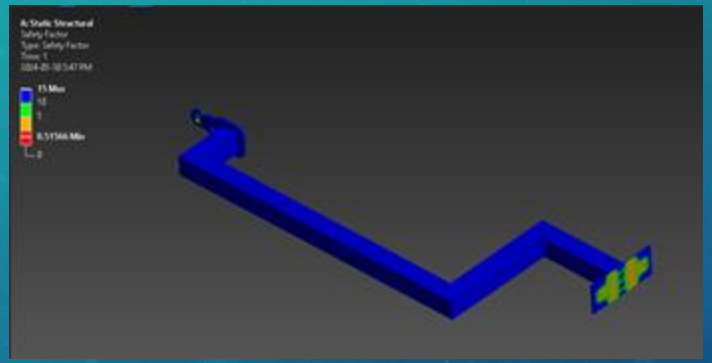


Design Iteration 4

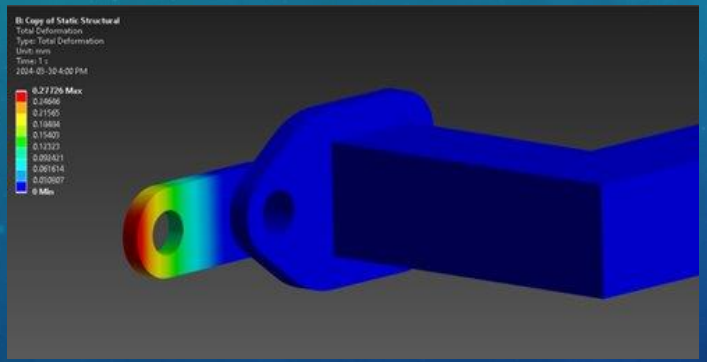
# TESTING OF DESIGN ITERATION 4



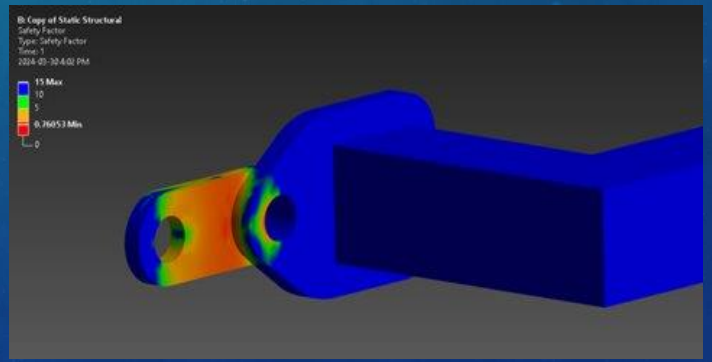
Deformation in longitudinal direction



FOS in longitudinal direction



Deformation in bending

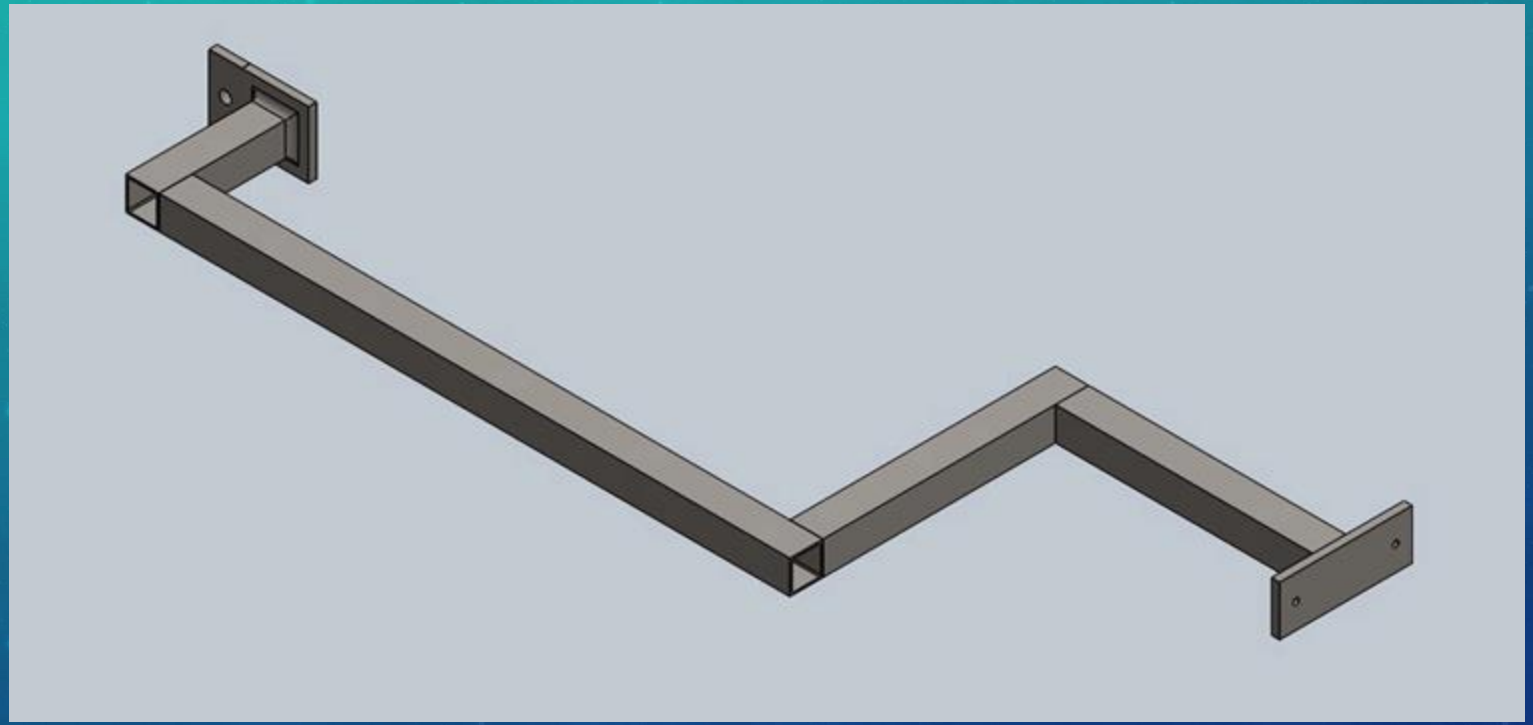


FOS in Bending

# MANUFACTURING AND FAILURE OF DESIGN 4

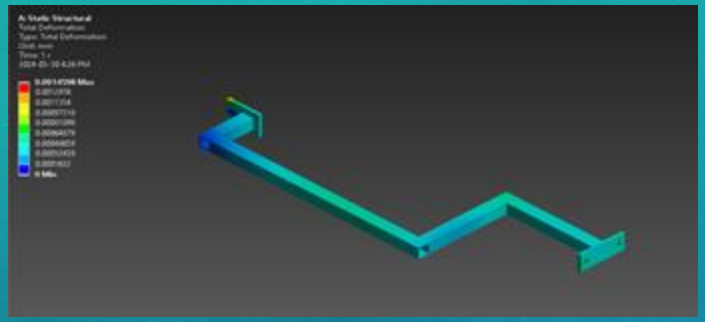
- Design iteration 4 was chosen to be manufactured as it covered all of the requirements of the mount.
- 1in x 1in hot rolled steel rods were chosen along with 4in x 1in and 2in x 2.5in which were 3mm thick.
- The rods and plates were welded together to form the design of the mount.
- When testing the mount on the bike, failure occurred in the plates fixed on the axle of the bike.
- This led to the creation of design iteration 5 with revised plate thickness.

# FINAL DESIGN OF MOUNT

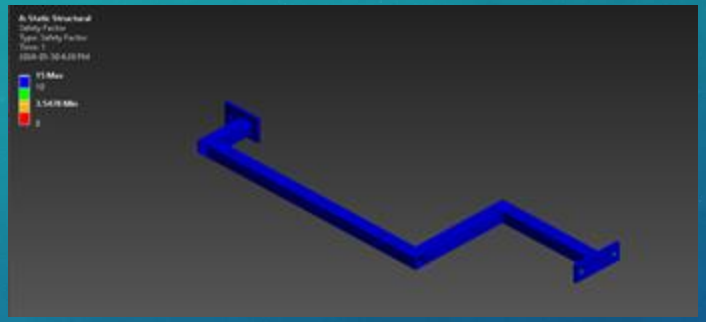


Design Iteration 5

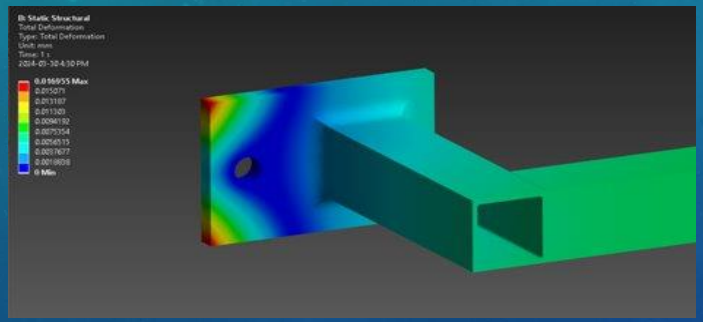
# FINAL DESIGN TESTING



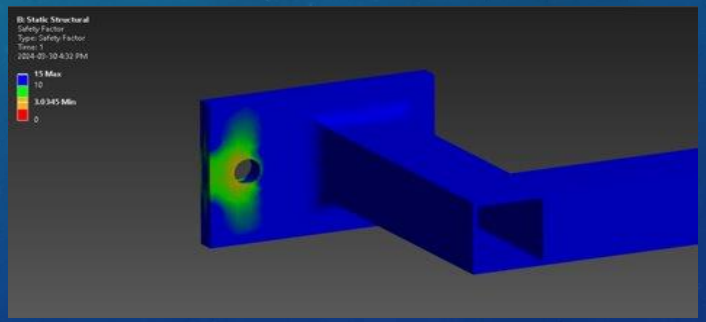
Deformation in Longitudinal Direction



FOS in Longitudinal Direction



Deformation in bending



FOS in bending

# FINAL DESIGN MANUFACTURING

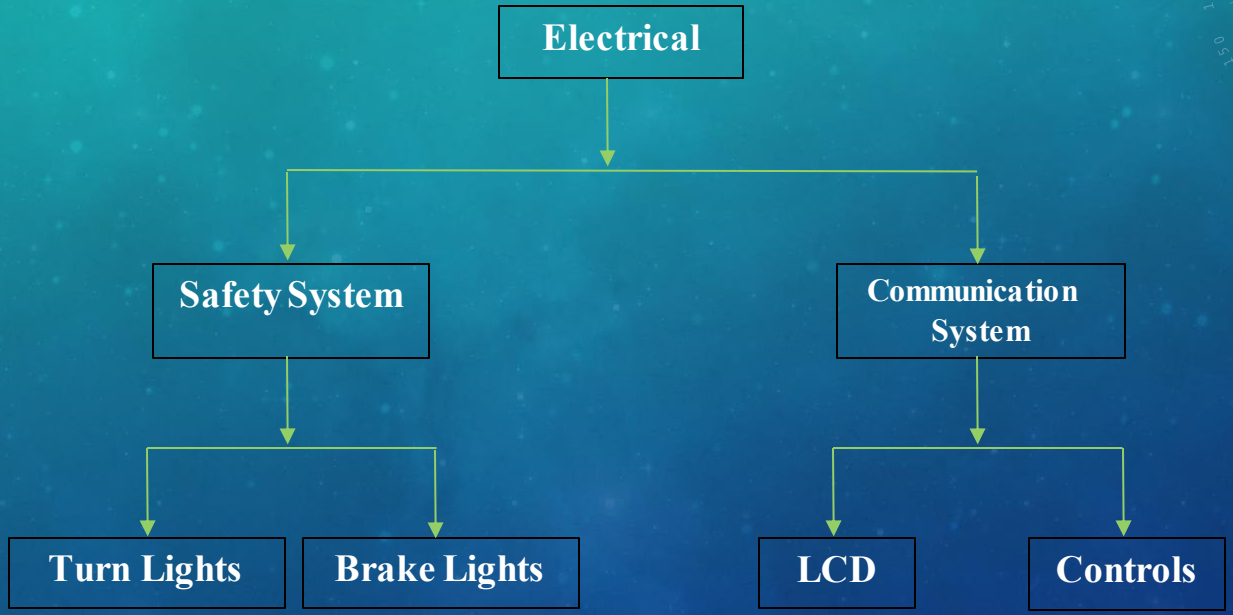
- The original steel plates which were used in design iteration 4 were cut from the original weld. A 1/4in thick hot rolled steel plate 6in x 3in was acquired and cut into two pieces, 1.5in x 3in and 2in x 3in.
- The two pieces were welded onto their respective ends.
- The mount was reattached to the bike and the carriage and tested again.
- The mount was painted black to avoid future rusting.

# ASSEMBLY

- We completely assembled the carriage and bike.
- We connected the mount to the carriage and fixed it with nut and bolts.
- We firmly connected the mount to bike axle
- We also mounted all the electronic prototype on the entire bike assembly

# THE FINAL TESTING

# ELECTRICAL SYSTEMS ON THE BIKE



# ELECTRICAL SYSTEMS

- Concept- Design of indicators while turning and brake lights when the brakes are applied and a system for basic message signal communication between the driver and rider.
- Preparation of a list of all components required for the project and obtaining them from the different available sources ensuring minimal costs. Initial design and testing of the system on a breadboard using LEDs, 12V led strips, contact switch and push buttons for the safety system and LCD for the communication system.
- Design of a more efficient and simpler safety system using a 5V led strip, LED, contact switch and slider switch. Improved design of the communication system using push buttons and LCD.
- Final design of the safety and communication system, integration and testing of both the systems ensuring functionality as per client requirements.
- Soldering of both the systems on PCB and final testing before the assembly on the bike.

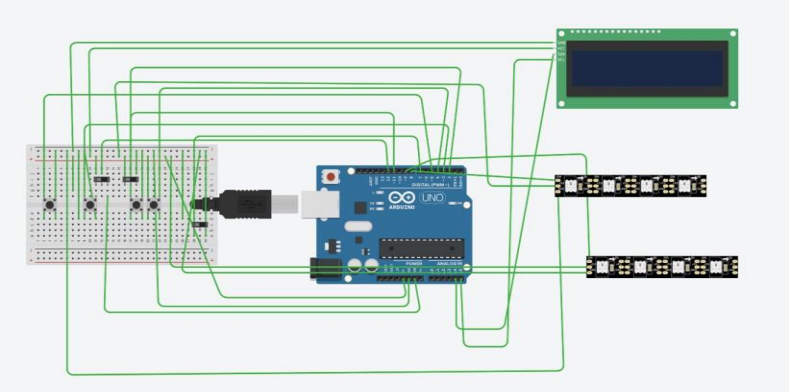
# POSSIBLE SOLUTIONS

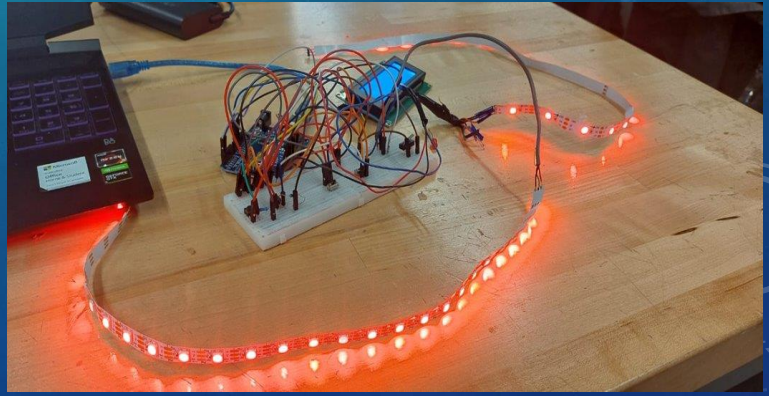
i. Usage of individual LEDs
ii. Usage of LED strips
iii. Power distribution using a 12V LED strip
iv. Power distribution using a 5V LED strip
v. Usage of push buttons for indication system control
vi. Usage of slider switches for indication system control
vii. Usage of push buttons for the communication system.

# IMPLEMENTED SOLUTION

i. Power distribution using a 5V LED strip

ii. Usage of slider switches for indication system control





# WHY NOT THE OTHER SOLUTIONS?

- Usage of individual LEDs cannot produce the desired intensity of brightness for visibility while a row of LEDs demands a greater number of wires and connections complicating the circuit.
- The second solution was the usage of 12V LED strips having a high intensity of brightness but the major problem was the distribution of power, working issues and there were high chances of frying up the Arduino along with other components.
- For controlling the LEDs, push buttons were used but the major problem was the blinkers were not working as per the desired needs and difficulty handling.
- Usage of two push buttons for rider communication with the driver but not meeting the required communication limits.

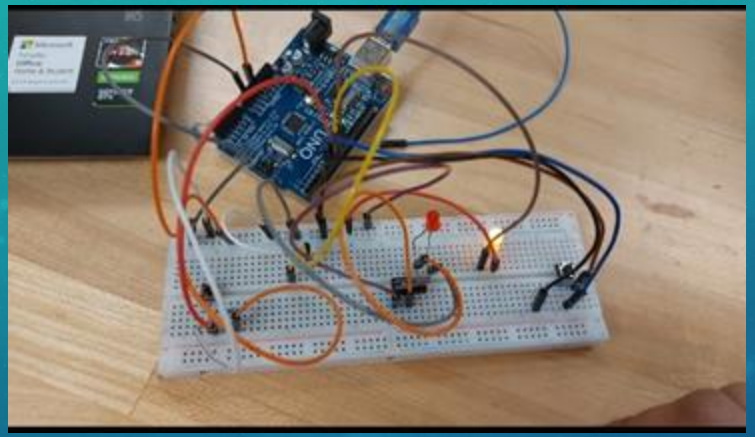
# DECISIONS TAKEN!

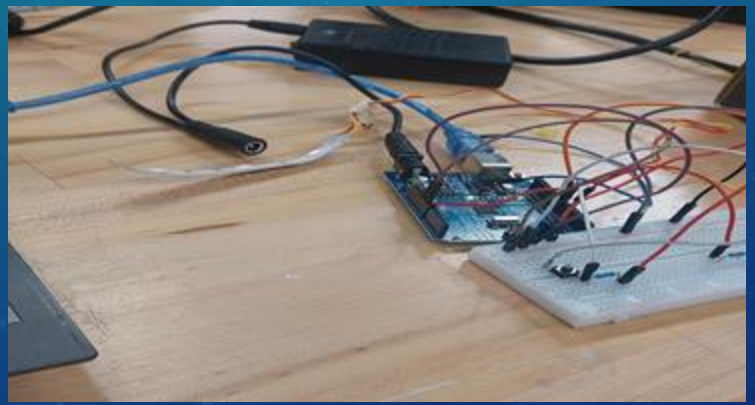
- The decision taken was the usage of 5V LED strips producing a good intensity of brightness and avoiding the risks of shorting the circuits.
- The final decision for implementation was the usage of slider switches which were working as per our requirements and these switches resemble the indicator switches in mopeds making it easy to handle.
- For the comm. system the final decision taken was the usage of 4 push buttons conveying all the basic communication needs.
- Usage of PCBs for soldering the components and systems using long single strand copper wires for easy placement on the bike.

# PROTOTYPING

Testing Stage I

- First testing using LEDs, push buttons, and jumper wires on the breadboard.
- Replacing LEDs with 12V LED strips and usage of LCD for communication.



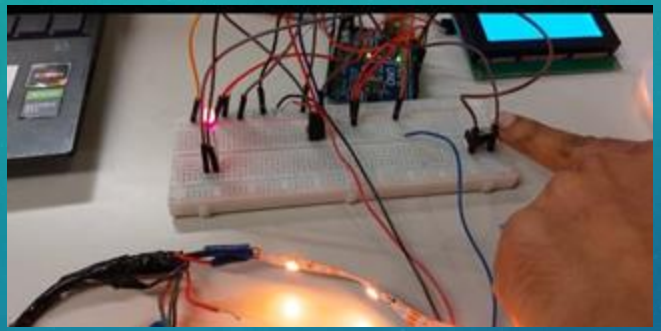


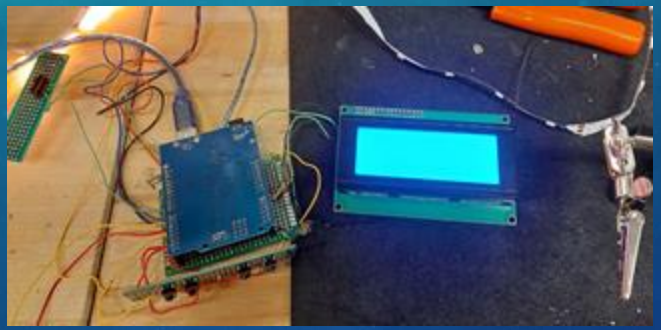
RESULTS

- LEDs are blinking as per the set counter value when the push button is pressed and then turns off.
- LED strips blinking with a very low brightness when the push button is pressed and then turning off after few seconds. Display a basic message on the LCD using a push button.

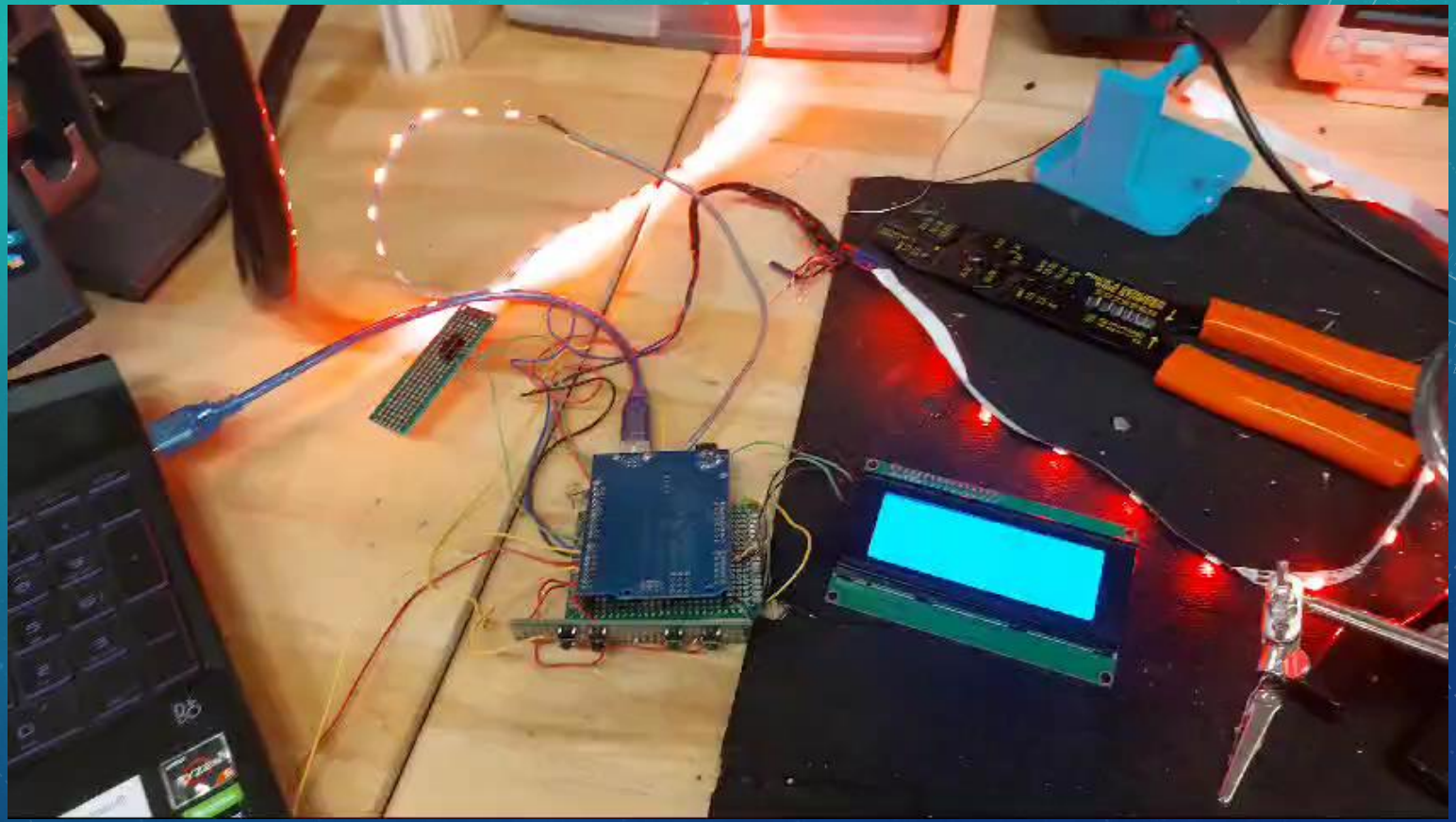
# FINAL PRODUCT

- Initial testing using 5V LED strips, slider switches, a contact switch, red LED, push buttons, LCD, and jumper wires on the breadboard.
- Final testing where both the safety and comm systems were placed on PCBs by soldering instead of a breadboard and usage of single-strand wires instead of jumpers.

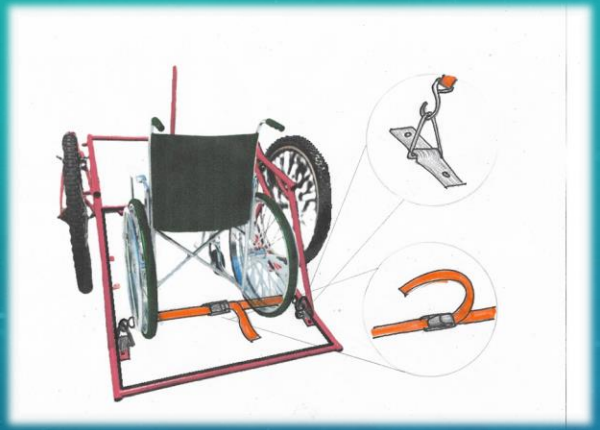


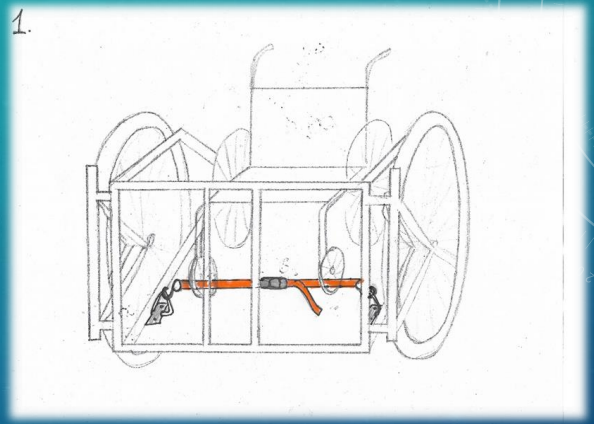


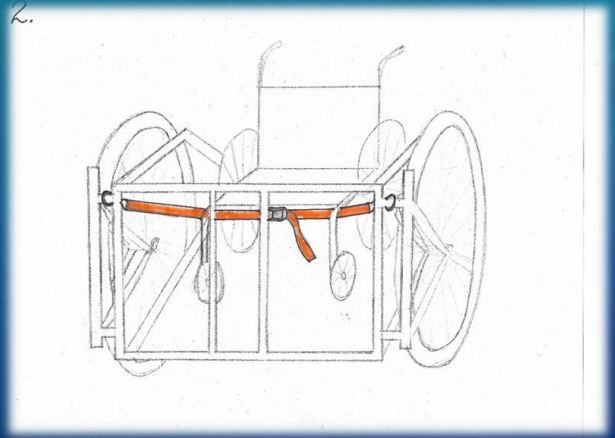
- Both the safety and comm systems were working well in coordination with each other as per the requirements
- Same result as the above where all the soldered components worked well meeting the client's requirements.

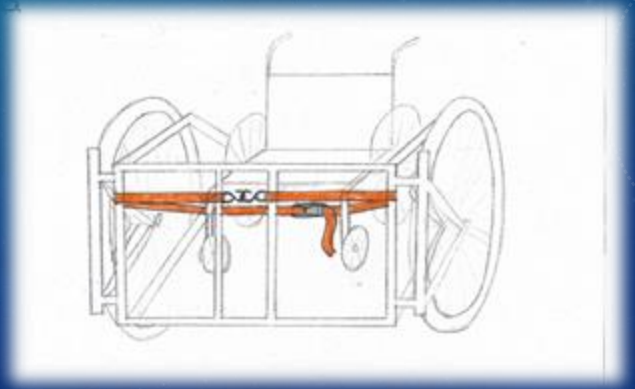


# Strapping options

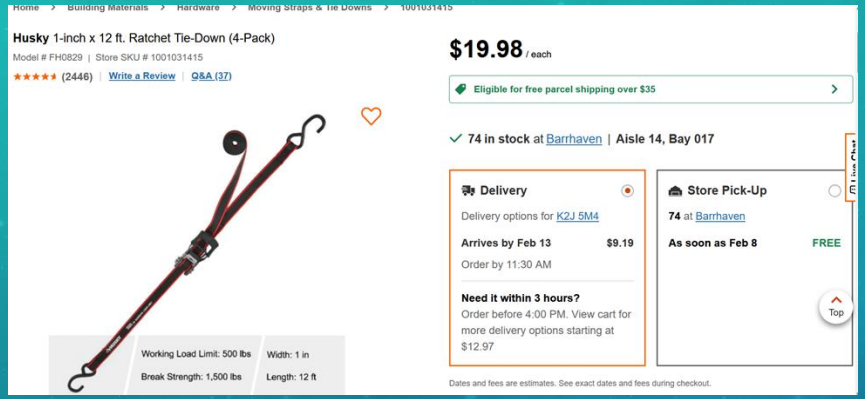


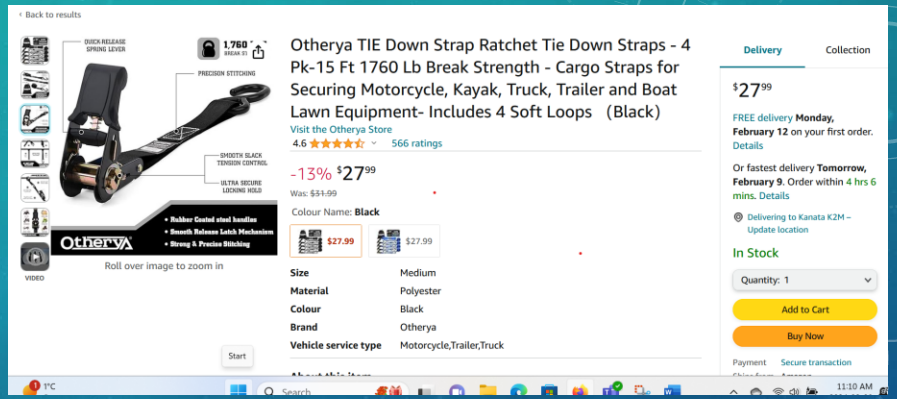


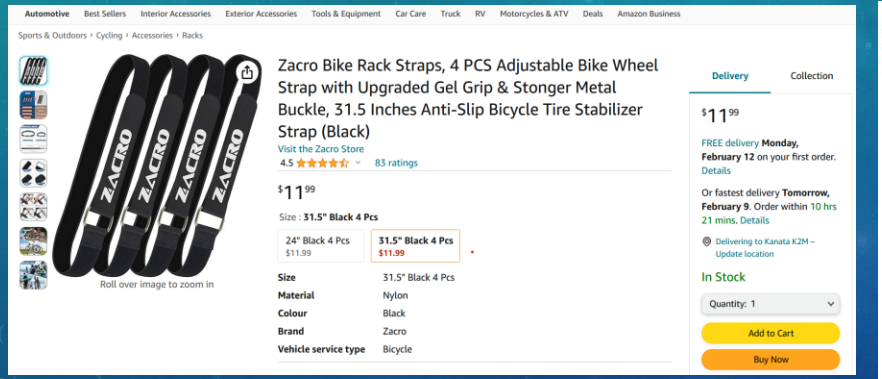



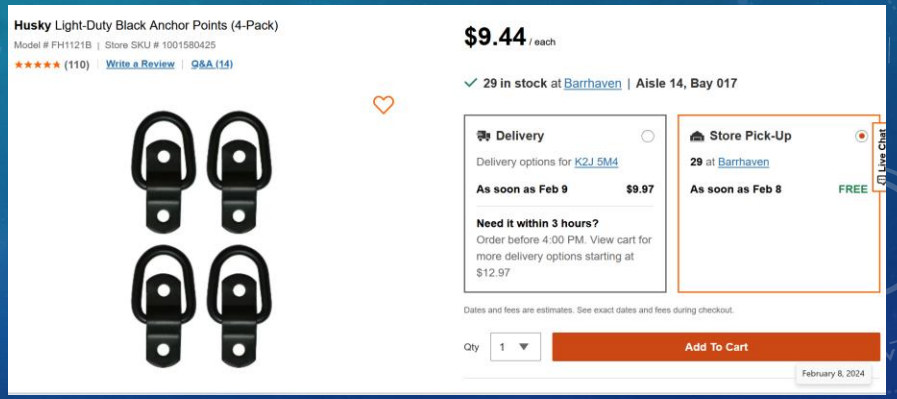



# Strapping system

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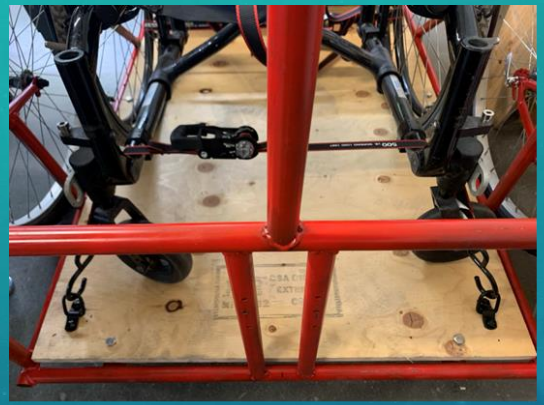
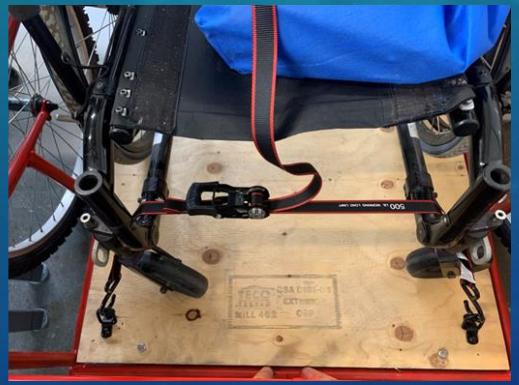
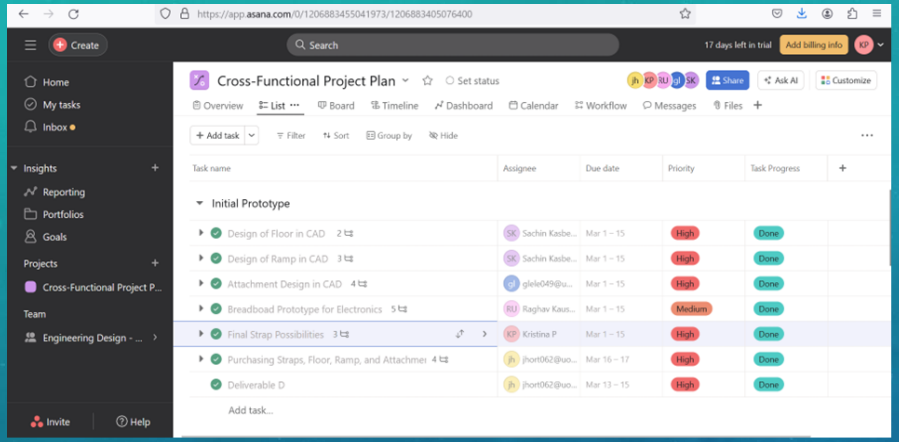
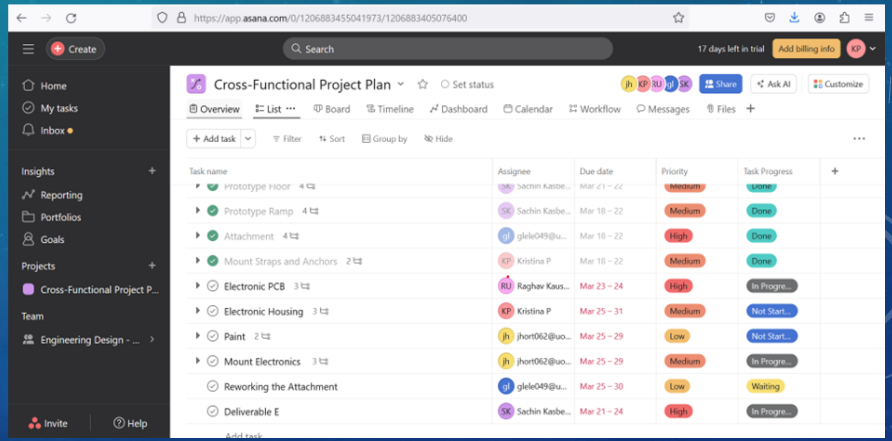
# Final strapping solution



# PROJECT MANAGEMENT

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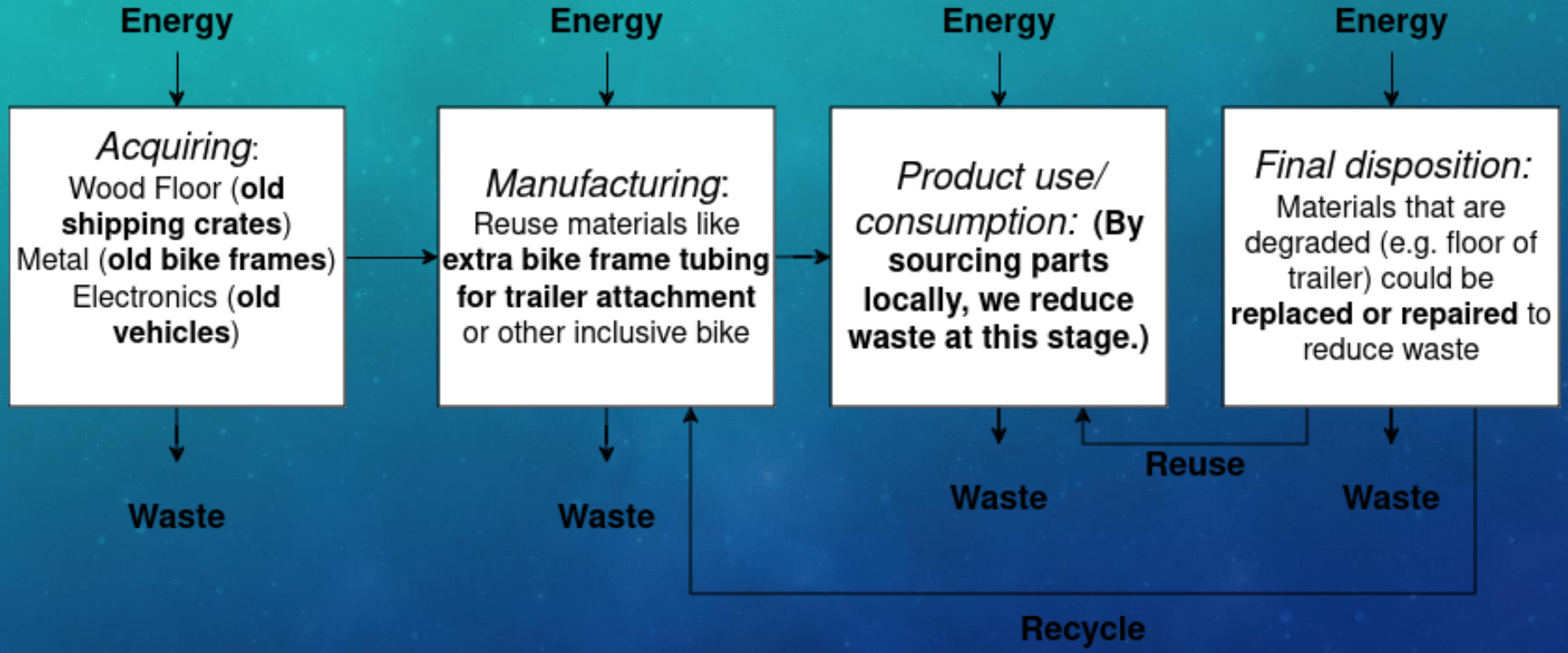
# LESSONS LEARNT

- Communication
  - Clear and timely communication can speed up the process a lot and allow more effective teamwork
- Time management
  - When tasks, communication and cooperation are done in a timely manner, there are more opportunities for improving the work and achieving the goals set
- Teamwork
  - Good cooperation is the key to a teamwork project!

# FUTURE WORK

- Improve strength and durability of bike attachment mount
- Improve stability of the trailer Improve the maneuverability of the trailer
- Change floor and ramp material to more durable and moist-resistant
- Improvements in the communication system where a rider can convey more information rather than the basic message signals.
- Use of a single switch for both indicators instead of two switches.
- Having an infotainment display rather than just an LCD.
- Lesser wire connections and easy removal of the electronics system.

# APPENDIX:
# OVERVIEW OF LIFE CYCLE ANALYSIS



# THANK YOU FOR YOUR ATTENTION!

## ANY QUESTIONS?