GNG2101 Deliverable G

Portable Ramp - Group 11

Submitted by

[Team 11]

[ROHIT NATH, 300073329]

[STUART GERUS, 300057344]

[BRIANNA LECAVALIER, 300062339]

[MOSTAFA KHAFAGY, 0300053603]

[JASMEET MANDER, 300065525]

[ANDREAS TAUBER JAKOBSEN, 300150779]

Date: October 24, 2019

University of Ottawa

Table of Contents

Introduction

Following our third meeting with Austin and Jill, we found that the trapezoidal configuration wasn't the most feasible because it added unnecessary weight to the ramp and served the same purpose as our new design, which is in the shape of a triangle. In our modified design, the peak of the triangle will hover over the root when Austin is going up a tree root and is straight when going up a curve. Instead of making the hinges load bearing, the weight of the wheelchair will be applied to a rebar supported by two eye bolts on each side that will be attached to the wooden support and carry the load. With our modified design, we created prototypes to begin testing the key concepts and ensure our design is feasible.

1. Summary of Client Feedback from Client Meet 3

Our team brought a solidworks model of the trapezoid configuration of the ramp to show Jill and Austin where we left off from client meet 2 when we came up with this new idea. After client meet 2 we reasoned that the weight and bulkiness of the three-piece ramp was unnecessary, so we also developed a solidworks model of the simplified triangular configuration of the ramp to communicate to our clients that this is a simpler and more reasonable option. Jill understood our concerns and agreed this was a logical step forward. She also noted her concern about the ramp being mountable to the back of the wheelchair so we took more measurements concerning where we will mount the ramp.

Measurements:

- Height from headrest to base of chair: 37 inches
- Width of back of chair: 20 inches
- Space extended from the chair due to bulk on back of chair: 6 inches
- Distance from attachment location on the left to the right: 26 inches
- Distance from bottom attachment to the back wheel: 6 inches
- Distance from top attachment to "back wheel" (distance out): 8 inches

Mounting the ramp to the wheelchair also brought about the concern of noise; if we are mounting a metal ramp to the back of a wheelchair that will be on a hiking trail, it is to be expected that it will bump against the back and make quite a bit of noise. To disable this from happening, we will secure the ramp from the top and bottom of both sides of the wheelchair, thus limiting its range of motion whilst mounted on the back of the wheelchair.

The concern of stabilizing the hinges and ensuring they are able to support the force as Austin travels over the ramp is of critical importance which resurfaced during client meet 3. One of Jill's friends, Doug, was present at the meeting and suggested a new mechanism: If we use a piece of rebar that passes through a loop that is welded onto each end of the ramp, we make the ramp itself the hinge rather than using hinges on the ramp which would need to be load-bearing.

Although the rebar (steel) will add weight, the trade-off for support may be worth it.

Supports: Expecting the tree roots to be inconsistent and unbalanced, we cannot rely on the placement of the ramp to be stable enough as Austin passes over

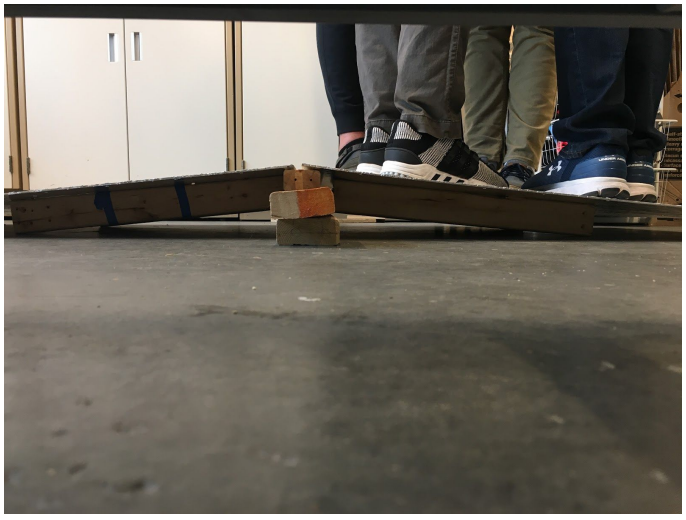
SUMMARY OF PLAN MOVING FORWARD:

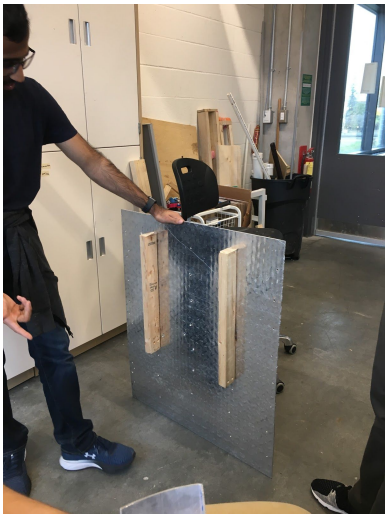
- Prototyping and Testing should investigate the following concerns:
    - How great is the impact of force on hinges?
    - How do the supports relieve the hinges of force?
    - What is the best way to stop the ramp from slipping?/How can we secure the ramp in place? (locking mechanism, pegs in the ground, etc.)

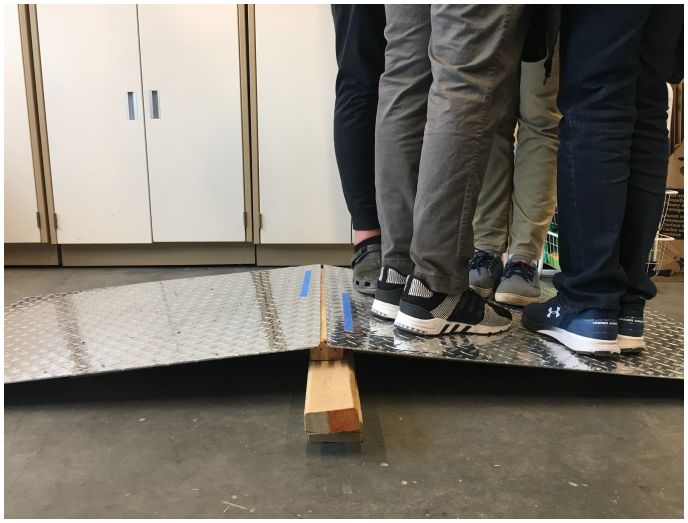
2. Prototype 2

The purpose of prototype 2 is to learn the best way to place the hinges and supports in order to bear the heavy load of approximately 500lbs. Throughout the past couple of weeks, we have discussed different possibilities of ensuring the hinges are not responsible for supporting the majority of the load. Prototype 2 will test our original idea of basic hinges and supports located under the ramp. In future prototypes we will test the method of welding loops and passing rebar through them to enable the entire ramp to act as a hinge. Once we have tested both methods and have determined the more feasible/successful option we will construct our final prototype accordingly.

Prototype 2.1

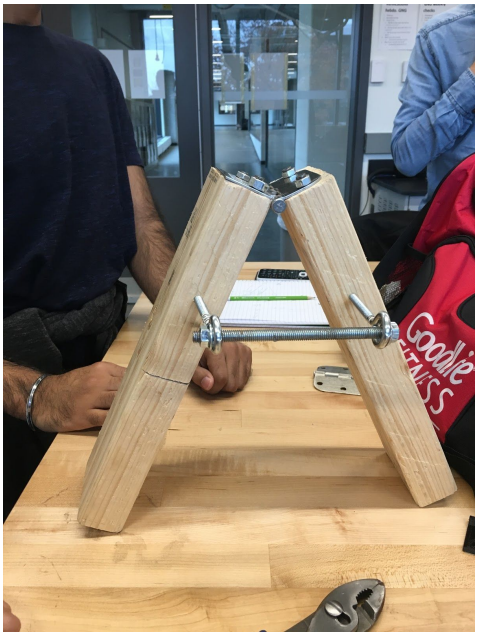






Prototype 2.1 was a medium fidelity, comprehensive prototype utilized to give us an idea of how much the wooden supports underneath actually help in reducing the bending (less load at the top of the peak). Using this prototype, we were able to get an idea of the triangle configuration used to go up a root, and evaluate any potential flaws in our design. We were not able to test the configuration used to go up a curb as we are in the process of looking for hinges that will connect the two sheets.

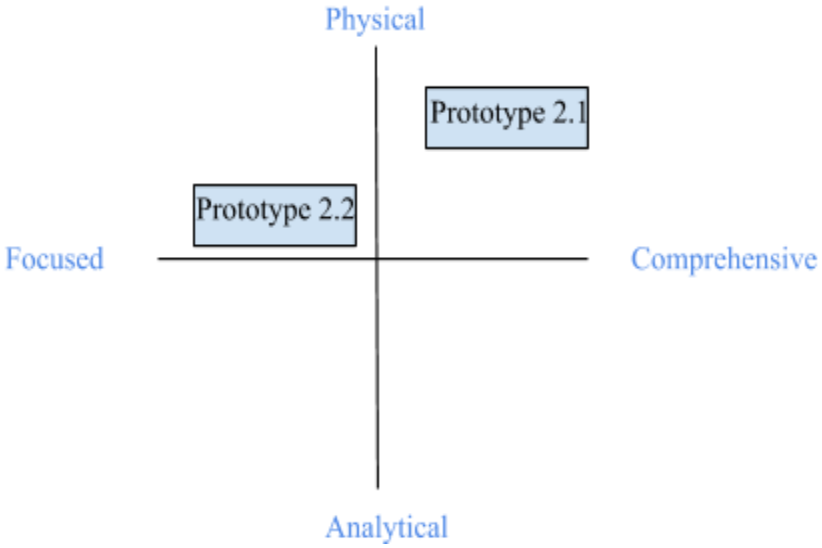
Prototype 2.2



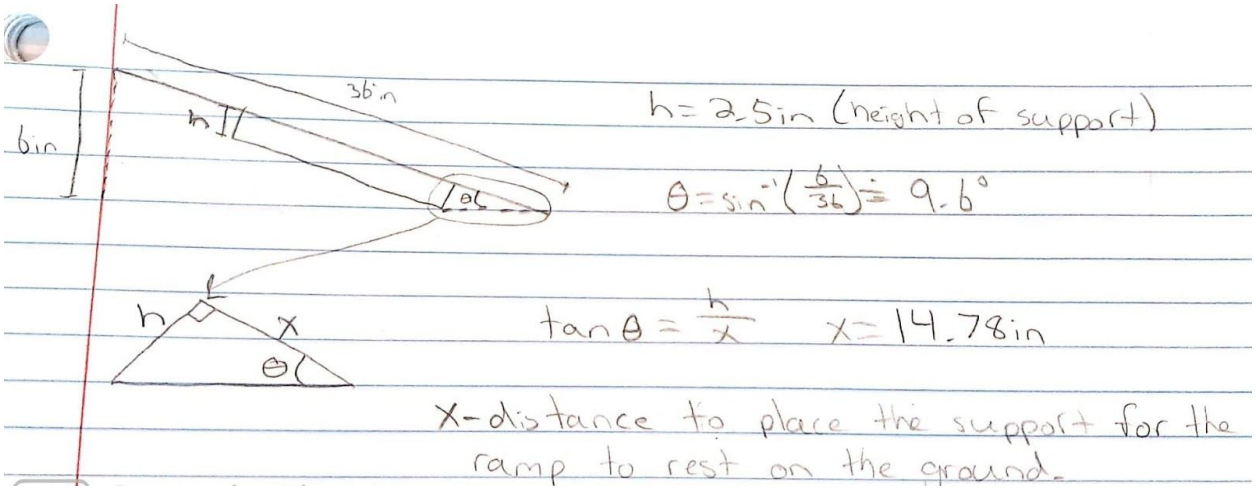
Our second prototype was a more focused prototype where we wanted to test the idea of having a rebar and an eye bolt to adjust the angle of the ramp and carry load of the wheelchair. We attached a butt hinge to two pieces of wood and drilled two holes to attach the eye bolts. The purpose of this prototype was to figure out how much weight is required to break the connection and test the distribution of the load and see if it is being applied to the hinge or rebar.

3. Prototype Testing

Purpose: To test if supports (wood blocks) can take the load off the hinges. If it can, then our original idea for hinges will be possible. If they don't, we may need to investigate a rebar and loop mechanism for extra support.



For the testing process, we calculated the desired length x (distance from ground to the wooden support underneath that will reach a height of 6 in.). We used analytical methods to figure out the angle needed and using this information we found out x. This value will be necessary as it allows the front end of the ramp to be level with the ground instead of leaving an elevation making it harder for the wheelchair to go up in the triangle configuration.



From this equation, we found out that the distance from the ground to the support was 14.78 in. We tested this by screwing in the wooden supports using the pre existing holes in the aluminum sheet. Testing showed that our calculation was correct as the ramp was flush with the ground. We also tested the strength of the support at the bottom of the sheets, by having all of us stand on top of the sheet (approximately 600 lbs) and we saw that there wasn't any significant bending from the load we applied. This test confirmed that the supports make a noteworthy improvement compared to prototype 1 when the flexion of the angle was increased as the load induced bending in the same aluminum metal sheets.



After testing prototype 2.2, as seen from the images above, the eye bolt bent after applying a load of approximately 150 lbs. We found out that the idea of adding the rebar to take the load off the hinges was proven to work as the hinge remained intact. To reduce bending of the eye bolt, the bolt will have to be screwed further into the wood to reduce the area that is subjected to bending.

Specifications	Marginal Value	Target Value	Actual Result	Units
Projected Cost	<=100	<100	<100	$CAD
Width	>= 24	26	30	in
Maximum Load	>= 448	>600	>600	lbs
Total Mass	<= 50	<7	35	kg
Setup Time	<= 60	<20	N/A	sec

Prototype 2.1 shows us the strength of the rebar and eye bolt idea reduced to a smaller scale, while Prototype 2.2 tested the ramp in the triangle configuration and tested the maximum load that can be applied before failure and yielded the final design dimensions and specifications.

4. Further Discussion

On design day, we intend to present our final prototype that is able to switch between the two configurations to allow our client to face both obstacles, the curb and the root. We want to incorporate all the features necessary for Austin to safely use the portable ramp, such as guard rails and locking mechanisms to secure the ramp's configuration.

To achieve this goal and verify that our "Solution Works Really Well", within the next 2 weeks our team will:

- ❏ learn how to assemble the ramp (where we will place the hinges to join the two sheets of metal)
- ❏ decide what the best way to stabilize the ramp will be (with the rebar?)
- ❏ try to complete a final product as soon as possible to conduct multiple rounds of testing
- ❏ focus more on the attachment of the ramp; how will we mount it to the wheelchair
- ❏ meet with Mohammed (a TA who is experienced in the portable ramp project) to discuss our plan and seek expertise regarding the strength of the hinges

Prototype Bill of Materials and Parts (BOM)

Part Name	**Description (Identify Prototype #)**	**Quantity**	**Unit Costs ($CAD)**	**Extended Cost (Qty x $)**
Final Prototype				
Metal Sheets	Diamond Aluminum sheets (3x2.5 in.)	2	0	0
Friction Tape [1]	394644 Friction Tape, 3/4-Inch by 30 Feet, Single Roll, Black	2	3.06	6.12
Hinges	3-inch Iron Black Door Hinge for 1 3/4-inch Thick Door	4	3.27	13.08
Rebar	Steelworks Steel Rebar (½" x 6')	1	13.49	13.49
Eye Bolt	1/2 Inch X6 Inch Zinc Eye Bolt	4	3.22	12.88
			Total	45.57

Conclusion

The client feedback, prototype development and testing in deliverable G allowed us to visualise the product and gain a comprehensive and focused idea that shows which areas need to be

explored and tested. The third client meeting got our ideas straightened out before the development phase. For the next client meeting we would expect to have a finished product to show the client and have them test it to verify the structural integrity of our solution. From the results and feedback, if necessary, we will be able to make changes to our prototype if design flaws come up during testing.