GNG2101- Intro. to Product Dev. and Mgmt. for Engineers

Faculty of Engineering – University of Ottawa

Project Deliverable D: Detailed Design

Submitted by

A1-Seat Belt Guide

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Introduction

This deliverable's objective is to go over the design details for our concept using a prototype. The prototype is used to determine a bill of materials and parts, along with testing the concepts functionality as compared with the target specifications determined in deliverable two.

Client Feedback Summary

In the second client meeting we showed the client the metrics we used to determine our concepts, along with two concepts that we developed from individual ideas in deliverable C. The client found the metrics to be acceptable and liked both of the concepts. They were intrigued by the novelty of our second design and expressed their desire to see if we could make it functional. Regarding the concept itself, the client's main concern was for us to make sure that the part attached to the webbing can easily slide across it. As a matter of convenience, they suggested using the cigarette lighter outlets to power the device.

Bill of Materials (BOM)

Table 1 Preliminary Bill of Materials for the final prototype

Item Needed	Cost	Source
Stepper motor	$8	https://makerstore.ca/shop/ols/products/small-reduction-stepper-motor-5vdc-32-step-116-gearing
Winch drum/gear box	$0	Can 3D print

		https://www.thingiverse.com/thing:1814188
Hooks	$0	Can 3D print, or use the hooks on the bungee
Rope/Cord	$4.79	https://www.canadiantire.ca/en/pdp/flat-strap-bungee-cord-18-in-2-pk-0403078p.html
Arduino	$17	https://makerstore.ca/shop/ols/products/arduino-uno-r3
Arduino wires	$1	https://makerstore.ca/shop/ols/products/jumper-cables-per-10
Breadboard	$0	Borrow From University (the final prototype will involve soldering and not use a breadboard)
Clips for attaching to the seat belt	$0	Can 3D print

Prototype

With this design, we are focusing on using a winch system to replicate the physical action of pulling a seat belt across a body. The prototype is used to demonstrate that the spool attached to the motor will pull the belt in. We believe that a simple stepper motor will be capable of providing the torque necessary. An Arduino and Bluetooth adaptor will be used to power the winch on and off using a remote. The winch drum and the belt webbing attachment will be designed and developed using 3D printing technology available at the University of Ottawa. The cable will be flat with a large hook – with the assumption that this will allow it to be easier to grab and hook.

The first prototype for this project is a rudimentary proof-of-concept with cardboard. This prototype is non-functional and exists as a 3D representation of the sketches.

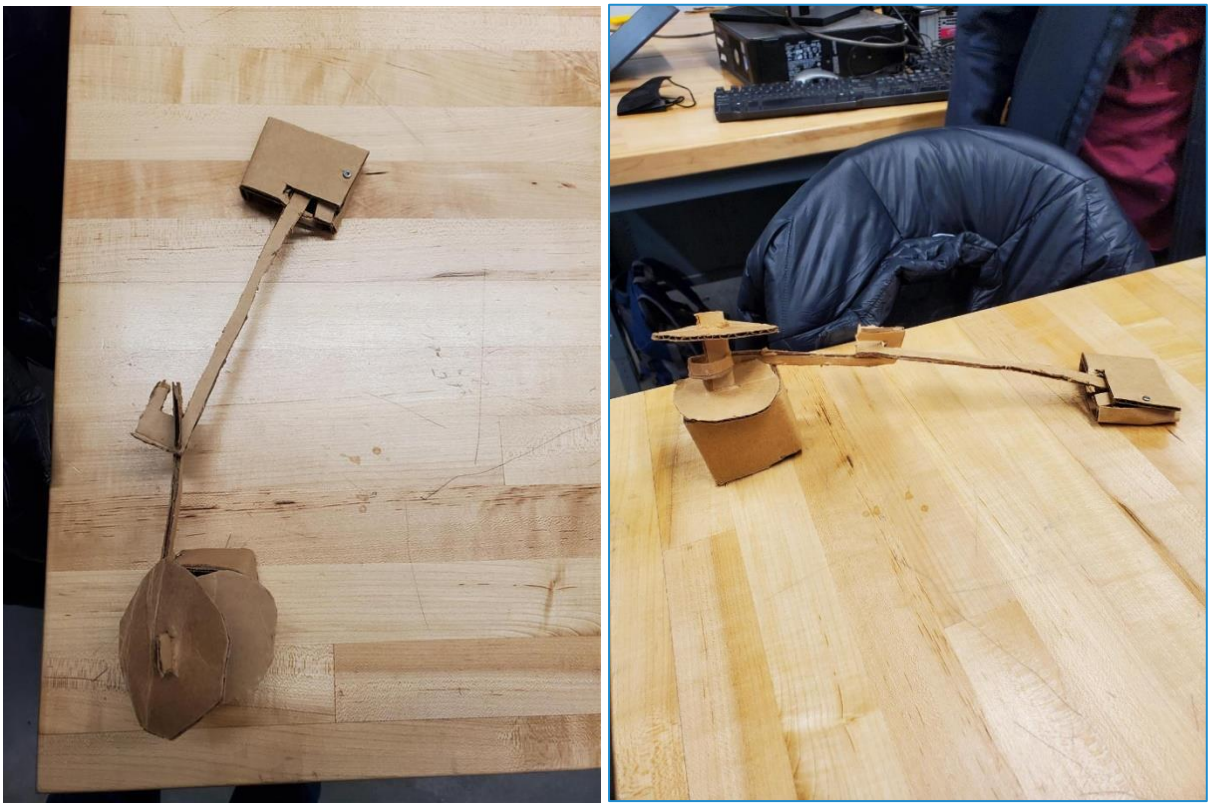

Figure 1 Prototype 1 of the seat belt assister

The box on the left underneath the spool represents the stepper motor. The spool above it will be connected to the stepper shaft and will rotate, drawing in the cable. The webbing attachment on the right has a hook that the cable will attach to.

Prototype Testing

This prototype tests the basic feasibility of the concept and ensures that all major parts are accounted for in our planning.

Cost:

The prototype was made using scrap cardboard and did not cost anything

Ease of Use:

The prototype is straightforward but fails to consider where the cable will rest when not in use, along with how easy it will be for the customer to hook the two clasps together. It is therefore only moderately easy to use.

Versatility:

The prototype can be applied to any car seat and seatbelt.

Size:

The motor and winch part of the device are somewhat cumbersome and will take up part of the middle seat if used in the backseat.

Durability:

The prototype is made out of cardboard and is not tested for durability.

Weight:

The prototype is made out of cardboard and is not tested for weight.

Force to buckle:

The prototype has not been tested regarding force to buckle.

Aids Mobility:

The prototype has not been tested on how well it aids mobility.

Reduces Arm Travel:

The hooks in the prototype show some reduction in the amount of movement needed, but the rigidity of the cardboard makes it difficult to compare a more flexible cord or rope.

Ease to Install:

The webbing attachment is easy to install, taking less that 30s, but the prototype fails to consider where the winch will rest.

Table 2 Testing results table for Prototype 1

Target Specs	Expected	Actual (for Prototype 1)
Cost	< $40	$0
Ease of Use	Easy	Moderate
Versatility	Very	Very
Size	Compact	Moderate
Durability	Withstands 20lbs force	N/A
Weight	< 5lbs	N/A
Force to Buckle	15% Reduction	N/A
Aids Mobility	Yes	N/A
Reduces Arm Travel	15% Reduction	50% Reduction
Ease to Install	Easy	Moderate

In conclusion, the prototype demonstrates that the idea is sound but that certain key parts have been neglected. One of the most important client needs was that the concept is safe in a crash and this prototype fails to account for that. Moving forward, we will make sure to address this issue along with the durability, weight, force to buckle, and mobility aid in a more comprehensive prototype.

Conclusion

Our next client meeting is not for two more weeks, and by then a more comprehensive prototype will be under development, taking in the client feedback and what was determined during the prototype tests. Ideally, we can test the winch mechanism on the seat belt and see if it works smoothly or if there is any interference with the sliding. If not, at least we will have a better idea of the mechanics involved in the piece so we can demonstrate them to the client to see if they fit their needs. For example, if the user is able to attach the hooks together by themself, or if more assistance is needed. With a greater understanding of the client's needs, our next prototype will address some of the device's key functions, including increasing mobility and introducing some durability.