GNG 2101 Deliverable D

Deliverable D: Detailed Design, Prototype 1, and BOM

Submitted by

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Feb. 1, 2020

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Table of Contents

1 Introduction

Prototyping is a very important step to product design which brings a product to life. This step is crucial for testing out all the different ideas, materials, concepts, and mechanisms of a product. It's important to note that there are many different types of prototyping, the first concept prototype of design rarely becomes the final product of an idea. This prototype usually consists of very inexpensive conceptual physical creations of how the product would appear or function, which will show the main intention of the product, as well as different main components that can be apart of the product. Having such prototypes will allow us to explore the various ideas and concepts of the design to find a product that suits the desired needs. This prototype is simply determining what the user wants before we spend a lot of time and money into a supported design.

In terms of our prototype, it consisted of testing the dimensions of the product and if they suit the client, as well as many major mechanisms, such as different collapsing mechanisms, and the angles of the supporting bars which will lead down to the wheels. Producing the first concept prototype took lots of time since the main structure was still not completely decided. However, when the main concept prototype was created, it became much easier and faster to create other prototypes. By the end of creating the first concept prototypes, everyone had a really good idea of how the main structure would turn out, and the compromises that had to be made so that we achieve the clients' needs.

Once all the prototyping material has been presented to the client, we will know exactly where the product will progress and most of the major features it will have. In this document, a list of every concept prototyped will be listed, as well as the client's feedback and changes that may be needed for the next prototype. This prototype is simply a rough design and may or may not resemble the final product.

2 Prototype Plan and Purpose

When creating the prototype, it was very important to create a physical representation of the size of the walker so that we can compare it to our client and have a better understanding and visualization of how this product is going to turn out. Having this physical design allows us to determine the exact height needed, the width, and the length so that the user is comfortable when using the walker. Another important physical component that was being tested is the folding/collapsing mechanism which will be used on the walker. Two different folding design prototypes were created. One prototype is a simple lift-fold mechanism where some joints were on a swivel, while the other design consisted of a scissor folding design, where the back of the prototype has sliding joints and a scissor-like design. This prototype was mainly to have a better understanding and comprehension of how the main components would work together.

The goal, aside from actual comprehension and physical testing, is communication, how the product will work with the client. More so, will the product suit the client's basic and geometrical needs.

3 Prototype Results and Documentation

Prototype 1: Model created based off of our conceptual design from Deliverable D which when folded the length changes and the width stays the same

Prototype 2: Model created after realizing Prototype 1 might not fit into the car and that we might have to change the concept. Folds with a scissor mechanism at the back. The width is compressed and the height stays the same when it is folded.

Figure 1: Prototype 1, Front View

Figure 2: Prototype 1, Back View

Figure 3: Prototype 1, Side View

Figure 4: Prototype 1, Folded

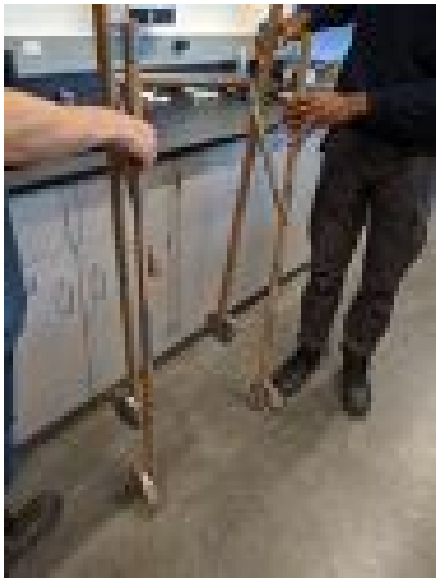

Figure 5: Prototype 1, Legs and Wheels

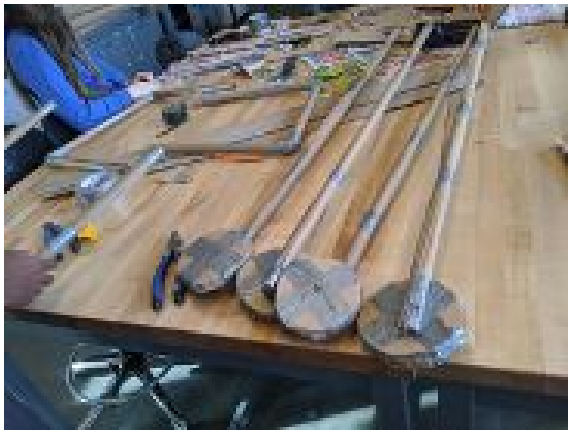

Figure 6: Prototype 1, 15'' width option

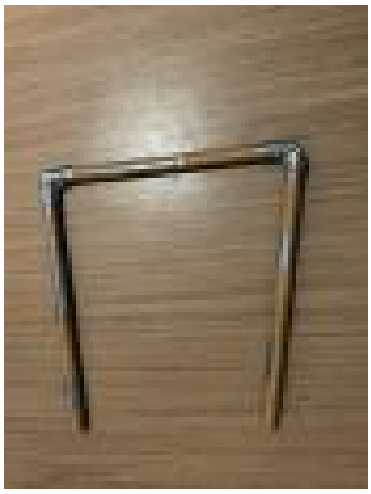

Figure 7: Prototype 2, Side View

Figure 8: Prototype 2, Front View

4 Prototype Testing and Results

The main purpose of the first prototype was to recreate the final conceptual design that we chose from Deliverable C to get a sense of the structure and test the folding dimensions. It is

also to see if the client likes our design and has any concerns. After creating this prototype and playing around with it, we realized because of its height when folded (45inches), it may not be able to fit into the backseat of Fahad and Erica's car while standing upright. We came up with the idea that we could lay it sideways in the backseat instead of putting upright. We tried to come up with ways in which we could shorten the length and came to the conclusion that we would have to create a whole different model in order to reduce the height when folded. With this complication and not knowing if it would be feasible for our client to lay the walker sideways, we decided to create a second model for the walker in order to give our client options just in case we would have to completely change the model. At the client meeting we tested to see if it would properly fit into the car if not upright then sideways. It does not fit upright, (might be able to fit once we reduce the height) but it does fit sideways, which Fahad was ok with as long as it stays closed as he picks it up.

We also tested our design by seeing if the width was fine and would be comfortable for her hand placement as well as not squishing her hips. The width of her current walker is 20" and she suggested to us for it to be around 15-18'' to reduce the amount of material used and therefore the weight of the walker. She did not have a preference for the width as long as it did not squish her hips. Another test we performed was to see if it would be comfortable height-wise for Erica because she would be putting all of her weight on it and would need it to be at the right height to not be so harsh on her arms when she uses it to balance herself. We found that it could be a little bit shorter height-wise so that her arms are comfortably placed on the handles.

Overall our client was impressed with our prototypes and is happy with the ideas presented. They for the most part did not have any concerns, other than the ones addressed and trust us to build a safe lightweight walker.

5 Outline Client Presentation Plan

During our second client meeting, we hope to present our original concept design to Erica and Fahad, as well as our two cardboard prototypes. We are looking for the following feedback:

- General impressions of the sketches so far of our final design.
- General impressions and feedback for the two types of walkers that we have made.
- Precise ideas of handle dimensions and placement.
- Preliminary ideas for device placement/dimensions/functionality.
- Clarification on some key points about brakes and height adjustability.

5.1 Key Questions for Meeting

- Is the height of the handles comfortable?
- Is the width of the handles comfortable?
- Are the current slow-down brakes something that can be adjusted on the fly?
- Is the current height something that can be adjusted on the fly?

6 Summarize Client Feedback

Our client meeting could be broken down into three approximate phases, where each phase gave us important information and feedback about a certain aspect of our prototype.

<u>Phase 1: Presenting Walker Designs</u>

We began by presenting our two cardboard walker prototypes.

1) We started with our original concept, which functioned in a similar way to a folding chair.
    - Their immediate response after we showed them our prototype was **very positive**.

- They liked this idea because of how simple it was to collapse and uncollapse. When we brought up concerns about fitting vertically in their car and asked if Fahad was comfortable rotating it to fit sideways, he replied that this would be fine as long as it was **light enough** and as long as he had **some kind of handle**. He also said that it would be nice to have some kind of **latching mechanism** to make sure it stayed in fold position.

2) The second walker we showed them was our scissor fold prototype.
   - Our clients seemed **skeptical** that this design would suit their needs.
   - They expressed **concerns that it would not be stable**. After they asked us what we were thinking for locking mechanisms, we brought up screws and lock pins, however they told us that they preferred our first design.

Phase 2: Trying dimensions

Next, we asked our client if she was comfortable trying out the preferred prototype so that we could assess if the width and height dimensions were appropriate.

- Our client was comfortable with the width of handle placement, however she also found that the hand grips were too high and mentioned that it would be better to have them about a fists'-height lower, which was about 2 inches.
- When we asked for clarification about height adjustment, our clients told us that it would be preferable to have some **height adjustment in the legs**, even if it they could not adjust it themselves and had to ask friends or family for help. They mentioned that this would not be something that they would have to do often, perhaps once every few months.
- When we asked for clarification about brakes, we learned that they are also **comfortable with slow-down brakes that cannot be adjusted on the fly**, saying that they would be happy with something that could be adjusted by a friend or family member every few months.

During this phase, we observed that it was difficult for Erica to get into the walker unassisted when required her to move backwards. We will have to check during the next client meeting if a sturdier walker is easier to get into.

We also observed that the client's back was right up against the back support bar of the walker, which means we will likely want to put some **comfortable cushioning** on this part of the frame.

Phase 3: Car fitting

We ended the client meeting by walking our clients to their car to see if the preferred walker design would fit in the back of their car.

- The chosen frame was **slightly too big to fit vertically**.
- We could fit in the back of the car horizontally, but then the walker took up all three back seat foot spaces. Our client stated that this was fine.

7 Team Debrief and TA Feedback

After our meeting with our client, we met as a team with our TA Justin to discuss our current status and our next steps.

- There are concerns with our idea to use carbon fiber as it is not affordable and not easy to work with. He also told us that in all likelihood, our design would require us to drill into the sides of the tubes, which would compromise material strength.
- We discussed the merits of other materials and came up with several ideas for our next prototype and our final product:
    - Aluminum extrusion, which is lightweight, strong, and easy to customize with a variety of standardized parts. There is a concern that it might be too heavy and it requires more investigation.
    - PVC, which is cheap to buy, easy to machine, and decently strong. There is concern that it might degrade near the joints and it requires more investigation. However we decided that it was an excellent material for our next prototype.

- Aluminum-steel alloys, which seem to be very common in similar applications. This might be a good end-goal material and it requires more investigation.

Justin was also concerned with weight bearing as right now, our eight proposed joints are bearing all of the weight. We came to the conclusion that with our current frame, there is no practical way around this.

- As we had already decided to use PVC as our next prototype material, Justin suggested a joint scheme that uses brass bushings and shear pins to reduce the amount of contact between a metal joint material and the PVC. We have decided to move forward with this idea for our second prototype.

Finally, Justin pointed out that we do not currently have a way of reducing the amount of outward flex on the walker.

- We determined that at this stage, all we can do is attach a rigid bar between the two back legs.

8 Presentation of Design 2.0

For our revised design we are choosing to keep the same frame, however we are dropping down the height according to client feedback. We are also reinforcing the bottom back legs with a bar, reinforcing the upper back support bar with cushioning, and adding in height-adjustment on the legs. We are now providing more details on things like joints and dimensions.

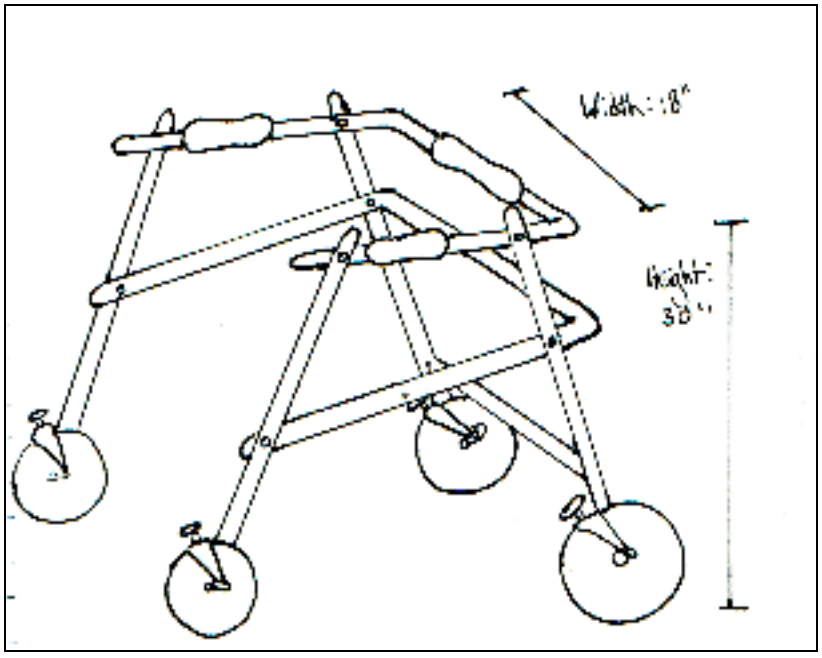

Figure 9: Improved final concept design.

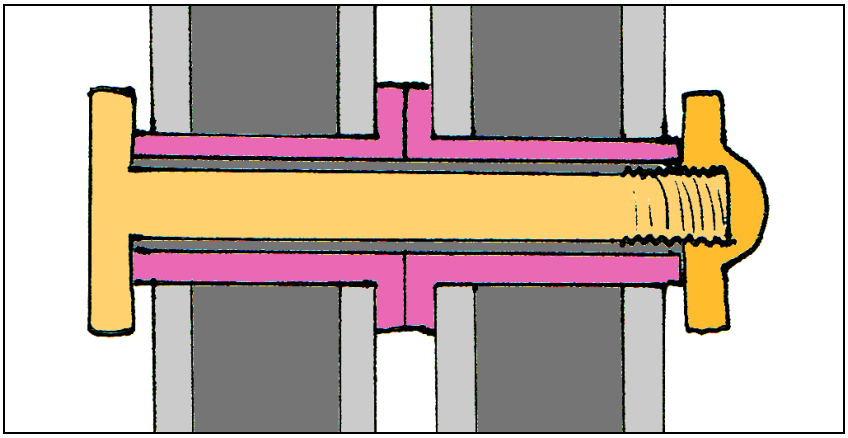

Figure 10: Cross-section of proposed joint, where brass bushings (in pink) are inserted into tubes (in grey) to facilitate a shear pin (in orange).

9 BOM

Part #	Part Name	Description	Qty	Units	Picture	Unit Cost($)	Total Cost($)
1	Foam Grips	Foam hand grips that are slipped unto the handles	1	3 pcs		3.49	3.49
2	Wheels	Rubber Wheels with a swivel plate over it and brakes.	1	4 pcs		30.48	30.48
3	Walker Body	Multipurpose Aluminum Round Tubes for the legs and handles	3	36 inch		15.06	45.18
4	PVC pipes	Long piece of PVC piping	1	10 ft		9.48	9.48
5	Bolts and Nuts	Bolts and nuts set for metals	1	10 pcs	NA	6.43	6.43
6	Plastic Tube Caps	Plastic caps used to seal any the handles	1	8 pcs		5.50	5.50
7	(Rod ends) Joints	Rod ends or joints used to connect 2+ pieces	2	1 pc	NA	5.35	10.70
Total			**10**				**$ 111.26**

10 Conclusion and Next Steps

After positive feedback from our client and a fresh approach to our problem, we can now move forward with our frame and incorporate what we have learned into our updated design. The next priority will be creating a higher-fidelity prototype. Ideally this prototype will be close enough to the final product that we can begin to swap out our prototype parts with more permanent parts as we approach Design Day.

Our next prototype will need to include:

1. A frame made out of a stronger, more rigid material. We have chosen to use PVC as our frame material and make our joints out of brushing and shear pins.
2. More accurate measurements obtained from our client meeting.
3. A CAD model that will allow us to perform better calculations of weight and strength so that we can narrow down our choices for material.
4. A latch that can fit on the back handles
5. A proof-of-concept on how we will join our material together.

We now need to investigate:

1. Wheels and braking mechanisms that are lightweight and simple to use.
2. Alternative joint mechanisms. This might include:
    a. External hinges that are glued, screwed, or epoxied onto our frame material.
    b. T-joints and aluminum casings for our frame material.
    c. Ball joints (however this may induce more shear in our product and would be unstable for our client.)
3. Carbon fiber machining techniques, to rule this material out as a viable possibility.

Overall, our team is feeling confident about our current progress and our client's reaction to our work so far. We are very happy that we were able to spend more time working and brainstorming with Justin as this gave us a lot of ideas to think about.