GNG 2101 – Intro. to Product Development and Management for Engineers

Deliverable F- Prototype 2

Team 11

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1.0 Client Feedback

Our second prototype was modified based on the client's feedback on our first prototype. For instance, during our second client meeting, Darcy, the client, expressed the interest in having a removable backrest; however, it being preferable and not mandatory. Moreover, Darcy also stressed the importance of respecting the weight and dimension constraints. Darcy's feedback on our first prototype played a vital role in the creation of the second prototype, which was presented during our third client meeting.

During our third client meeting, Darcy expressed interest in our team's new removable backrest design. However, he also mentioned that the pivot point of the backrest is slightly high; which will affect the compact ability of the chair. Furthermore, Darcy also commented on the excess amount of water drainage holes; he, nevertheless, found the newly chosen diameter to be appropriate. When our team offered to add bottle holders to ease reachability while sitting on the chair, Darcy expressed interest in adding this feature. Additionally, Darcy asked about the depth in which the legs will be screwed into the seat, to which the team replied that the legs would be screwed into the seat to a depth that is at least equal to the diameter of the legs. Based on previous feedback, our team decided to use slanted legs to increase the sturdiness of the chair while functioning, to which Darcy approved the idea; however, expressed concerns regarding how slanted legs may increase the chances of plastic deformation. Our team also confirmed the height constraint of the chair being 21 inches, and whether it can be decreased since reduced height means better compact ability. Finally, after receiving feedback on the technical aspects of our prototype, our team asked questions regarding the aesthetics of the chair. For instance, Darcy still likes the flame effect that was proposed, and showed affirmation when our team proposed to put it on the sides of the chair. Darcy also showed interest in our team's proposal of adding a

charm slot; since the client's interest in 3D Printing was addressed during our first client meeting.

All in all, our third client meeting was a successful one in terms of gaining insights and receiving constructive feedback from our client, which will play an essential role in the design of our next prototype.

2.0 Critical Product Assumption

In order to use aluminum in the construction of our design as per our second prototype specifications, we were advised that at least one team member requires a minimum of 2 months training in order to acquire the welding skills needed for a successful assembly. Therefore, to deliver the product up to the standards and in a timely manner, aluminum must be substituted for another material.

Moreover, since the chair is required to support a minimum weight of 250 lbs, and since the weight distribution will not be uniform, an assumption was made regarding the maximum force distribution. This was that the maximum force ratio between any two adjacent legs is 4:1. Said ratio, consequently, implies that the maximum force applied to a single leg is equal to 64% or $(4/5)^2$ of the total force applied. Therefore, since the chair is required to support a total of 250 lbs., each leg must have a weight capacity of at least 160 lbs.

3.0 Second Prototype

3.1 Leg Prototype

Our team's most recent prototype, namely the Leg Prototype, is a focused/physical prototype representing the legs of the chair and is illustrated in figure 1 & 2 below. It is a prototype of one of the legs for our portable shower chair design. It was sketched before construction; this sketch is displayed in Figure 1 below.

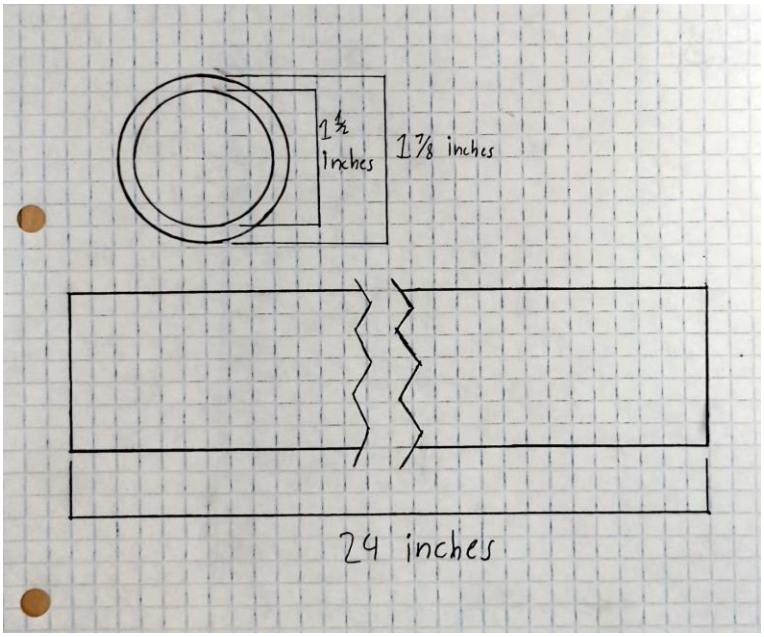

Figure 3.1.1: Sketch of Leg Prototype.

Figure 3.1.2: The Physical Leg Prototype

The goal of this prototype is to test if the legs can support 250 pounds of weight.

3.2 Seat Prototype

Our most recent prototype is a focused/physical prototype. For this prototype, the seat of a different shower chair was collected, and modified to respect the target specifications. Additionally, four ABS T-shaped fittings, which will be used for leg attachment and storage were taped to the underside of the chair. The seat prototype is depicted in Figure 3.2.1 and Figure 3.2.2.

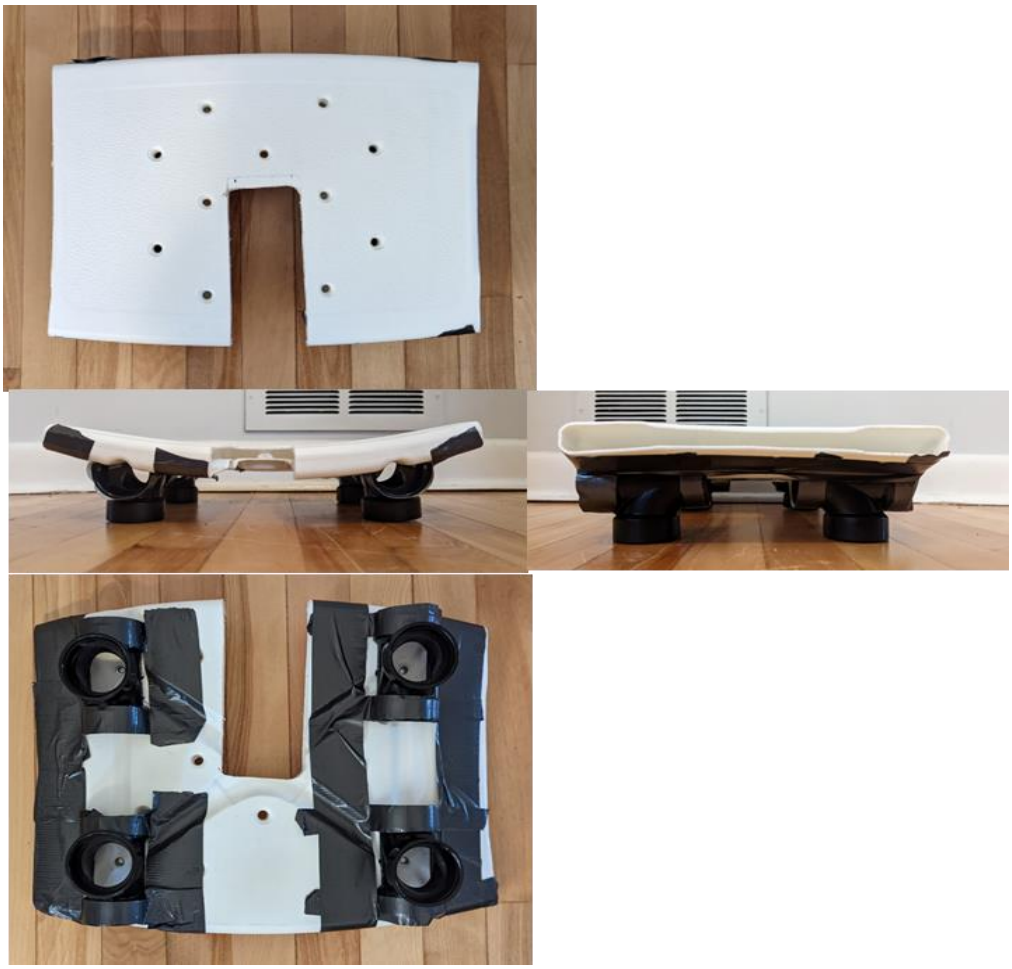

Figure 3.2.1: Projection of seat prototype using photos showing top, front, right side and bottom views.

Figure 3.2.2: Photo of seat prototype.

4. Prototype Testing

4.1 Leg Prototype testing

The goal of the leg prototype was to determine if the legs of the chair would be strong enough to support our client. It was designed to be longer than the product design legs so they could be tested more rigorously. The prototype is 24 inches long and the final length will be less than 24 inches. The aim of this prototype was to determine if the legs would be strong enough to support a 250-pound load. Two tests were performed to test components' strength. Test one was the snap test; it was performed by holding the prototype at both ends and trying to snap the prototype through a bending force applied in the center. If the prototype snaps or is plastically deformed, this is considered a failure. An image of this test taking place is depicted in *Figure 4.1.1*. The leg prototype was successful and passed the snap test.

Figure 4.1.1: Snap test taking place. A member of the team holds the leg prototype and tries to snap it using his knee.

Then, our team conducted the weight test. This meant leg prototype would support 160 pounds without any plastic deformation. If one leg can achieve this feat, then four legs will be able to support 250 pounds and meet the target specification. The leg prototype passed this test as well. Due to the success of the leg prototype, our team has decided that the ABS T-shaped leg design will be used in the final prototype.

4.2 Seat Prototype Testing

After having tested the shower seat legs, we now tested the seat through a weight analysis. 250 pounds of weight were to be placed on the seat prototype. To pass this test the prototype must not snap, fracture or display any form of plastic deformation. Upon prototype construction, it became evident that the new design would fail the weight test. This is because it took a very small force to deform the seat at the cleaning channel base. This is the design weak spot, as shown in *Figure 4.2.1*. To spare the shower seat material and design, our team decided to not test the seat until it's underside has been safely reinforced.

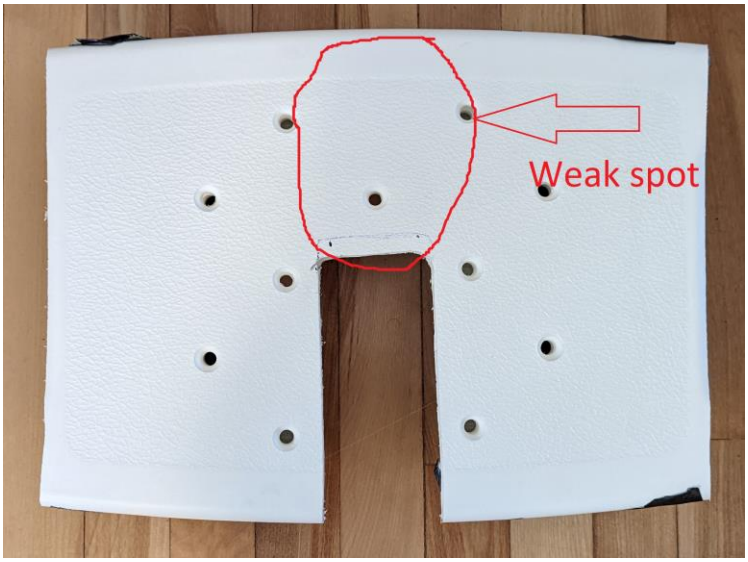

Figure 4.2.1: The weak spot in the seat prototype is in the area encircled in red.

Conclusion

The *Prototype 2 Deliverable* summarized our most recent client meeting, prototype product assumptions, and prototype testing results. The shower seat leg and seat sub-systems have been thoroughly analyzed and tested based on our client's needs. Unfortunately, the current seat design is not strong enough to withstand a 250-pound load. Therefore, our team will dedicate the next week to brainstorm potential reinforcement designs and test their feasibility using the weight test. In addition, we plan to seal the side edges of the shower seat, print the required 3D plastic pieces and improve the aesthetic appearance of our prototype. Our comprehensive prototype is following the milestone schedule accordingly and is expected to be ready as per client requirements for Design Day.