

GNG2101 Deliverable D.1

Prototype 1

Introduction to Product Development and Management

GNG 2101

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Group Z13

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Abstract

In this deliverable, we will discuss the development of our first prototype. It will be used to test critical functionality and specifications that will be compared to our target specifications. This will help us validate some of our assumptions and help us get a better understanding of how we will reach our final goal of building our product. We state our plans for the next client meeting, focusing on the data that we will present to the client as well as the feedback that we would like to receive.

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Introduction

The purpose of this deliverable is to build, test, and examine our first prototype. To accomplish adequate prototype analysis and examination, we will test the constraints, physical properties, target specifications, and functionality of our prototype. We also intend to state our intentions surrounding the next client meeting and the data that we provide to the client, as well as the data and feedback that they will give us.

The prototype that we made was of the upper portion of our design, which required 3D printing. This is a focused physical prototype of the cup holder subsystem. The assumptions that we are attempting to validate include the print time, necessary infill percentage, how well the print turns out, strength, weight, and other constraints that will help us to ensure that our prototype meets all of our target specifications.

We will be including photographs of the physical prototype, as well as data collected from the testing of the prototype. Following the testing of the prototype and the client meeting, any changes or improvements that need to be made will be planned for and updated for the next round of prototype testing.

Prototype

Prototype 1 is a focused physical prototype of the cup holder subsystem. It has been 3D printed, and reflects the physical version of our CAD model to help us validate some assumptions and test the prototype to see how and if we hit our target specifications. The validation of prototype 1 will include the following:

1. Quality check of the 3D printed part

- a. Were all pieces printed smoothly?
 - i. All pieces printed smoothly and as expected.
 - b. Do we need to add supports for the final print?
 - i. No support needed.
2. Print time
- a. Did the print take longer or shorter than initially stated?
 - i. The print time was supposed to take 5 hours and 33 minutes, but took only 5 hours and 26 minutes.
3. Fit and function of the cupholder
- a. Does it look and do what we want it to?
 - i. It completes our goal of our prototype function.
4. Weight test
- a. Does the weight meet the target specifications?
 - i. The part weighed 107 grams, which meets our target specifications of less than 150 grams.
5. Strength test
- a. Does the prototype withstand enough force?
 - i. The prototype appears to withstand high enough force to meet our target expectations.
6. Dimension and tolerance check versus the CAD model.
- a. Measurements have tolerances that appear to be slightly less than desirable. The largest tolerance was -0.4mm. The print may have to be redone with slightly larger dimensions to allow a proper fit.

7. Infill test

- a. If the strength of the prototype needs to be improved, the infill may need to be increased
 - i. The strength appears to be fine and can withstand the required forces, so the infill can remain the same.
 - ii. Infill may be increased after the client meeting if so desired.

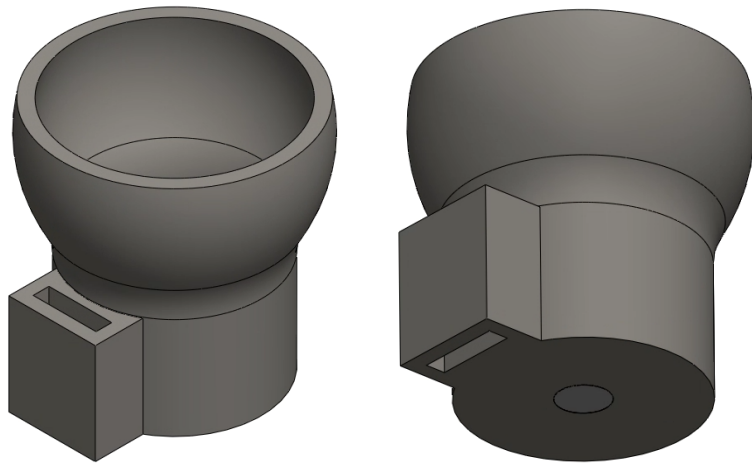


Figure 1. CAD model of cup holder

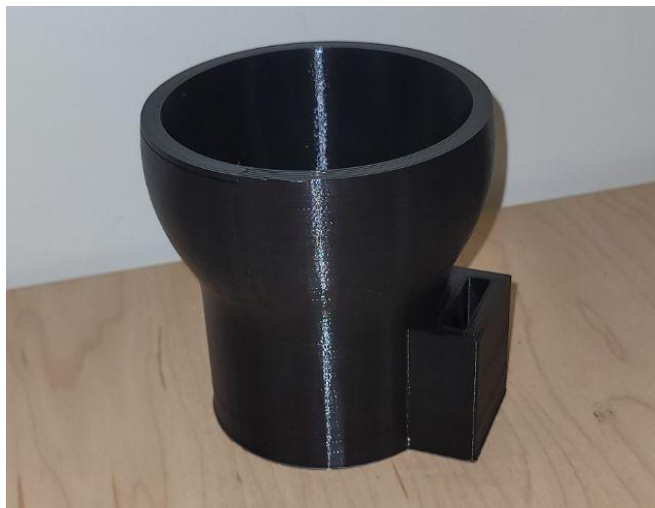


Figure 2. Prototype 1- 3D printed cup holder

Purpose and Function of prototype

The purpose of this prototype is to validate the 3D printed component of our secure cup holder design. It will also serve as a physical model that the client can see and feel which can result in useful feedback for future prototypes, and eventually the final product. Lastly, it will undergo extensive testing to ensure we are reaching our design goals and providing an initial prototype that meets or has the potential to meet our target specifications. If the prototype does not meet the clients desires, modifications will be done to ensure an improved prototype will be presented in the future.

The prototype will function in the same manner the final component will function. It will be able to fit the client's cup inside it, it will be tested to ensure the component will fit correctly with the other components such as the clamp and the magnet, and it will provide a good indication of how our final component will function.

Product assumptions the prototype is trying to verify:

- Correct printing the cup holder
- Our dimensions, to verify that the dimension is within the tolerance range of the design.
- Client Needs, to verify that the prototype meets the client's needs.
- Manufacturing, to verify that production and manufacturing times and materials are within the budgeted list and meet expectations.
- Cost and budget, to verify that the costs spent are within the budget and that the budget needs to be updated.

Testing

Four tests were performed to validate the first prototype. These tests were done to ensure the main functionality and constraints of our prototype were satisfied. The print time test was used to evaluate how long the print would take for the prototype and give us an indication of overall manufacturing time for subsequent prototypes and the final product. The weight test simply consisted of weighing the prototype to ensure it was below our weight target. A light weight product would be ideal for portability. The tolerance test was used to evaluate how close the 3D printer used would get to the CAD model of our prototype to see if it would be accurate enough for proper fit. The strength test in diametral compression and longitudinal compression was used to assess if the prototype could withstand the force that might be expected from dropping the cup holder or hitting it.

Table 1. Test Plans

Type of test	Description	Target Specification	Result
Print Time	Measuring the time needed to complete 3D printing	6 hrs >	5 hours 26 minutes
Weight Test	Measuring the weight of the 3D printed cup holder	150 g >	107 g
Dimension Tolerance Test	Measuring the dimensions of the cup to test how accurate the 3D printer is compared to the CAD model	+ 0.5 mm	- 0.4 mm for slot + - 0.2 mm for diameter
Strength Test	Measuring the force the cup holder can withstand in longitudinal and diametral compression	5 lbs < (22.25 N)	Withstands 5 lbs of force

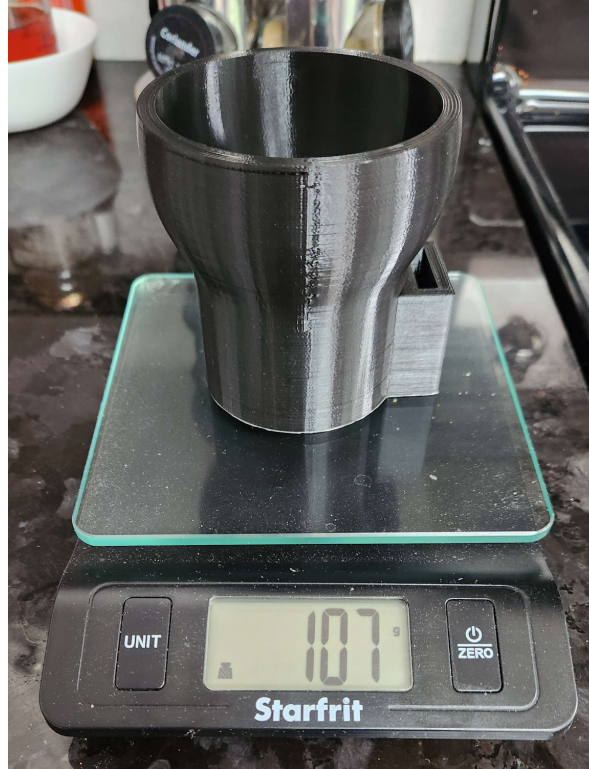


Figure 3. Weight Test



Figure 4. Strength Test Diametral Compression



Figure 5. Strength Test Longitudinal Compression

Interpretation of Test Results

The print time test for prototype 1 demonstrated that the final iteration of the cup holder subsystem has the potential of having a quicker manufacturing time than expected and desired. The print time was below our target of 6 hours and with some optimizing, could potentially be even lower for next prototypes.

The weight test for prototype 1 demonstrated that with our current infill, the weight is below our target spec, which is great for portability. This also allows us to increase the infill within target specifications to achieve a stronger cup holder while still being underweight.

The tolerance test proved to be the least desirable outcome from the four tests performed. Although not catastrophic, the slightly smaller dimensions for the slot would not allow our

desired clamp to slide into the cup holder as our current design intends. A remedy would be to machine the clamp for it to fit the slightly undersized slot, or reprint the slot with larger dimensions in order to allow the clamp to slide into the cup holder. The slightly oversized diameter for the cup holder is not an issue as it will simply give more room for the cup to fit.

Lastly, the strength test demonstrated that the cup is strong enough to withstand significant weight considering its own weight. This is ideal as the cup holder should be sturdy and strong enough to withstand accidental hits from the user. The strength can be further increased if infill is increased, as long as we are under our specified weight target.

Next Client Meeting

At our next client meeting, we would like to present our first prototype to our client in an organized and detailed manner so that our client knows what direction the project is heading. We will use both our physical prototype and our CAD model to give the client the best idea of what the final design may look like. We will start by explaining what type our physical prototype is and what portion of our final product the prototype represents. This will include what our prototype is made of, how we made it, what its function is, and how we managed our time. We will then present our prototype metrics and explain whether or not they have met our target specifications. The prototype testing plan and the result of the testing will also be explained.

Next, we will present the critical assumptions we came up with in project deliverable C and explain whether or not they were correct. After explaining all aspects of our prototype, it is likely that the client will like certain aspects and dislike other aspects. We would like to gather this information from the client so that we know what aspects to keep in our final product and how to fix or modify the other aspects. Furthermore, if this prototype fails to meet any of the

target specifications, we would like to discuss that with the client so that we know what to do for upcoming prototypes in order for our target specifications to be met.

Conclusion

The purpose of this deliverable was to create a prototype, which is a rough draft of our final product. Prototyping can have many importances such as learning more about your product by receiving client feedback or by learning about any constraints as you build the prototype. These are important because they serve as critical information for building our final product: how to make the product better, how to avoid risks, and how to satisfy the client further. In this deliverable, we managed to learn most of the information by documenting our prototype, the test plans for the prototype, and results from testing our prototype. We learned that our tests were mostly successful, and that the current progress of the product seems to be developing well. What remains now is to receive feedback from the client in our upcoming client meeting so that we can move on to build a more enhanced prototype.